Assessment of Mass Transit in Medellin, Colombia – A Case Study

by

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ABSTRACT

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In Latin America, the rapid growth of large cities due to a rise of population along with increased urbanization has posed serious challenges in developing adequate infrastructure for mass transit. In these cities the demand for travel has risen sharply exceeding the supply. This case study intends to track the historical development of the City of Medellin, Colombia's transportation system, to assess the success level of the system and how the unique concept of "social urbanism" that centered on inclusive regional mobility and accessibility was instrumental in the development of its transportation system. Medellín, a city of over 2.5 million within a metropolitan area of 4 million, is exceptional in that its transportation policies were designed, promoted, and enacted in a context of extreme violence in the 1980s due to the drug cartel of Pablo Escobar.

The introduction of four aerial mass transportation systems known as "Metrocable" (aerial cable cars) are now serving to connect the informal areas of the more impoverished communes, along with a public transportation network consisting of "Metro" light rail, tram and bus-rapid-transit (BRT) system. These transportation strategies initiated a radical transformation and have helped develop a unique multimodal transportation system now serving the city. Beyond assessing the success of Medellin's transportation system, this paper will also explore the challenges that Medellin faces moving forward through targeted interviews with city planners, transportation officials and academics. It seeks to answer the questions of what have been the lessons learned during and after implementation of its transportation system as well as what can be learned from the success of other cities in Latin America.

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Chapter 1. INTRODUCTION & ORGANIZATION:

1.1 Introduction:

Transportation systems provide the framework around which regions, towns and neighborhoods are constructed. The nature of those systems influences the quality of the surrounding communities and plays a role in facilitating the functions of daily life. Transportation should serve a primary role in facilitating daily household activity needs by reducing transportation costs and should focus, not solely on mobility, but on accessibility to needed and desired activities (Ewing, 2018). However, in transportation, mobility should be a measure of system performance. Transit trips may include walking and transfers to other modes of transportation. Mobility thus becomes a part of system performance and requires the planner to undertake multimodal measures of mobility rather than just measuring individual components of a trip (Meyer, 2016 pg. 21).

The nature of a community can also play a significant role on the design and functioning of the transportation systems that serve that community. With an increase in the aging population, vehicular congestion, and environmental degradation, the focus is now shifting from automobiles to multimodal transportation systems. Transit in cities such as Medellin is providing benefits that road improvement often cannot, such as cleaner air, greater mobility, accessibility, and environmental sustainability (Ewing & Bartholomew, 2018).

Medellin more closely resembles what Robert Cervero has termed as a ‘Strong-core city’, which is a city whose job center is primarily at its core. The city has successfully integrated transit and urban development within a more confined, central city context (Cervero, 1998). It has successfully integrated transit services around mixed-traffic, light rail, tram, bus-rapid-transit (BRT), feeder bus, and bike-lane systems.

This case study intends to track the historical development of the City of Medellin, Colombia's transportation system, and to assess the level of success of the system. It will focus on Medellín in an interdisciplinary fashion in order to answer the fundamental question that defines what the elements are that make a transportation system successful and, in the case of Medellin, what were those elements that contributed to the level of the success that its system has achieved. From the social/political perspective, it will look at how its transportation system was developed and funded, allowing these projects to move forward, and how the concept of 'social urbanism' has played and continues to play such s a vital role in its development. What has been the lessons learned during and after implementation of its transportation system, and what can be learned from two other cities in Latin America?

Colombia's second largest city, Medellín, with a current population of 2,368,282 and a population density of 6,221 hab/km^2 (Plan de Movilidad, 2014) has experienced a major transformation in the last 20+ years. Once notorious for crime and violence, Medellín is now winning acclaim as a successful example for innovation in Latin America, drawing tourists, ex-pats, investors and entrepreneurs from around the world thanks to significant government investment in transportation and technology. The beginning of the end of the violence in Medellín came with the drug dealer Pablo Escobar's death in 1993.

Few cities have transformed the way that Medellín, Colombia's second largest city, has in the past 20+ years. Today, Medellín is among the safest cities in Latin America (Maclean, 2015). The city built public libraries, parks, and schools in poor hillside neighborhoods and constructed a series of transportation links from there to its commercial and industrial centers. The city is "constantly reinventing itself," as stated by Mayor Anibal Gaviria (2012-2015) despite its troubled history (Moncada, 2016).

In 2012, Medellín received the 'Innovative City of the Year' [1] award from the Urban Land Institute and the Wall Street Journal, adding to the long list of accolades which also include the 2019 award for the 'World's Smartest City'[2] from Newsweek, the 2016 'Lee Kuan Yew World City Prize'[3] awarded by the Singapore government, and the 2019 'Ashden Award'[4] for contributions to improve the thermal sensation in Medellín.

1.1.1 Research Basis of Study

There is a need for affordability and accessibility in most city transportation systems not only in the rapidly developing but also in the developed and urbanized world. This particularly holds true for the poor and underclass minorities. This study analyzes the social issues, such as lack of inclusiveness, which existed before and which led to the development of Medellin's transportation system as well as an examination of transportation issues facing Medellin and how they may be resolved by means of targeted interviews with city planners, transportation officials, and academics [see Section 6.3, pg..103], as well as data gathered from the city's transportation studies. Respondents' attitudes toward the city's transportation system will provide a basis for further research that may be applied to another city's emerging transportation system. It will also examine the role that political and private entities had in the development of these systems.

The study is exploratory in nature as it focuses on assessing the pros and cons of Medellin's system from operational data, user perception and opinions from the city's transportation

[1] https://www.bbc.com/news/world-latin-america-21638308

[2] https://www.newsweek.com/2019/11/22/medellin-colombia-worlds-smartest-city-1471521.html

[3] https://cities-today.com/medellin-wins-world-city-prize/

[4] https://www.acimedellin.org/medellin-is-awarded-by-the-ashden-2019/?lang=en

professionals. It will also endeavor to recommend solutions to transportation issues based on this research, new technology, and lessons learned from other cities in Latin America. It utilizes a mixed-methods research protocol which involves a blending of quantitative and qualitative approaches and will assess the success of the city's transportation system by means of a comparative analysis of where the city was before and after implementation, the current utilization of the system, and users' perceptions of the system.

It is hoped that the capabilities provided by this kind of mixed-method framework will prove increasingly important for other cities with transportation challenges to begin innovating and learning from Medellín's experience in order for them to shape a sustainable urban transportation system. Transportation policymakers worldwide would thus benefit from this practice of 'policy learning' where decision-makers in one city will look at Medellín to see what policies have been effective as well as foster or increase understanding for people that may not be familiar with the subject.

1.2 Research Organization: This paper is organized in the following manner:

- First, it will provide a brief discussion as regards the history of Medellin, the political environment that engendered infrastructural change, and the transportation system that was subsequently developed; then,
- It will map out the research problem and questions that are being addressed as well as the significance and contribution of the research.
- It will define the Case Study that guides this research methodology and explain the research strategy and expected outcome of the research.
- Finally, it will provide a background based on a literature review that maps out the development of Medellín's transportation system with a discussion and Case Studies of two successful Bus Rapid Transit (BRT) systems as follows:

- Politics – Social Urbanism and the politics that helped shape the success of Medellin's transportation system, how it strives for equity and a critique of the system.
- Transportation System – how the city developed an efficient multimodal transportation system and the status of Medellín's system now.
- Socio/Economics – The effect that Medellín's transportation system had on the residents of the city from a socioeconomic perspective as well as on community integration and crime, a discussion of funding sources for transportation, and how to assess security, crime and equity in a system.
- Successful Systems – How to assess a transportation system and Case Studies of BRTs in Bogota, Colombia & Curitiba, Brazil.

1.3 Medellin History, Politics & Transportation:

1.3.1 History: The valley of Aburrá was discovered by the Spanish explorer Jeronimo Luis Tejelo in 1541, but the settlement of Medellín was founded later, on March 2nd, 1616 by the Spanish conqueror don Francisco Herrera Campuzano under the name of San Lorenzo de Aburrá. Early development started in the southern part of the city which is now known as El Poblado. It was not until 1813 that the village received the denomination of City. Thirteen years later, it was proclaimed the capital of the Province of Antioquia, and sometime after that, the City was named Medellín.

During the 19th century, Medellín was a dynamic commercial center first exporting gold, then producing and exporting coffee. After the thousand-day war, it was the first Colombian city to take part in the Industrial Revolution with the opening of textile companies and transportation projects such as railways that allowed an export business to develop. In addition, several universities and vocational training institutions were established. In the 80s, the city showed its

dark side under the leadership of the drug trafficker Pablo Escobar and became the capital of the world's cocaine business. Gun battles were common, and the city's homicide rate was among the highest on the planet. In the early 1990s, Medellín recorded about 6,500 murders annually with certain areas of the city controlled by street gangs, guerilla groups and the drug cartel (Drummond & Dizgun, 2012). The beginning of the end of the violence came with Escobar's death in 1993. Today, Medellín is among the safest cities in Latin America and has incredibly become as safe as Washington, DC (Fukuyama & Colby, 2011).

1.3.2 Politics: A small group of experts at the department of 'social urban planning' ('urbanismo social') at the Medellín Academy started to think about how to re-conquer spaces torn by violence: "it was both a concept and a physical strategy, a mixture of ideas and bricks" (Vulliamy, 2013). With strong collaboration among scholars, professionals, business, and civic networks as well as local government, these ideas were put into practice. Public transport became the key part of this strategy as it was viewed not only as a means to enable ordinary people to move around the city and get to work faster but as well as a means to unite the rich and poor areas of the city thus allowing these different segments of the population to meet.

Mayors Luis Perez (1999-2003) and Sergio Fajardo (2003-2007) expanded on these ideas and took advantage of the positive political developments after the death of the drug lord, Pablo Escobar, in 1993. As mayor, Fajardo was also able to draw on important support from the local business community. Medellín's private sector also brought investment to social programs in the city's violent and marginalized neighborhoods.

An important element of the plan was the building of new schools and libraries in poor neighborhoods near the public transport network. Nine of the city's largest firms came together in 2006 to invest in *Parque Explora*, a science museum that provides free entry to Medellín's poor majority. The renovated Botanical Garden, which has brought life back into a formerly depressed

neighborhood, was partially funded by local environmental organizations. One of the city's universities runs a program in which business executives and scholars train community and NGO leaders on how to incorporate business basics regarding organizational efficiency into their social mobilization (Lowenthal & Mejia, 2010).

Another very successful public-private partnership is the unique contribution of the local utility company 'Empresas Públicas de Medellín' (EPM), which is responsible for water and wastewater management, electricity, and gas networks and landline telephones in the metropolitan area. The company is owned by the municipality, but it operates and pays taxes as a private enterprise and charges the city for the use of its services, just like any other customer. EPM is highly profitable and pays 30% of its profits to the municipality, enabling it to invest in the development of infrastructure projects, which includes transportation. The company's leadership believes that positive social and environmental impact is achieved through business itself, and through ethical management. Since 1998 EPM has extended its network to supply services to the informal (poor) neighborhoods and introduced a 'social' pricing strategy. In essence, prices are adjusted to people's income, and as a result, all households have drinking water and sewage, and 97% of households have electricity.

1.3.3 Transportation: The poor that live in the 'barrios' (hillside communities) suffered from a lack of efficient, timely and affordable access to the city center. The transportation systems that have been developed in Medellín were designed to reduce commuting times, spur private investment, and promote social equity as well as environmental sustainability. The Institute for Transportation and Development Policy recognized Medellín's efforts with the "Sustainable Transportation Award." In 2013 the Wall Street Journal named Medellín the "Innovative City of the Year" beating out New York City.

Preparations for the Medellín Metro started in the late 1970s, led by the Medellín municipality. Elevated (Metro) train lines opened in 1995 and then starting in 2004, a network of cable cars (Metrocable) connecting the Metro to the poorest barrio communities was built [see

Figures 1.1 a&b]. Metrocable greatly reduced the time and cost of commuting from the barrios to the industrial and commercial centers along the Medellín River, stimulating employment and social integration (Lowenthal & Mejia, 2010).

a **b**

***Figure 1.1 a&b*: Medellín Metro and Metrocable**
from: www.sarepa.com

Later additions to the public transport network include rapid buses (Metroplús) on mostly segregated bus lanes, a tram line (Tranvia) and a 28-storey high series of moving escalators in one of Medellín's poorest neighborhoods, so that residents can safely ride up and down the steep hillside. Other infrastructures such as bikeways, bike-sharing stations and bridges connecting the barrios to each other were also established [Figure 1.2].

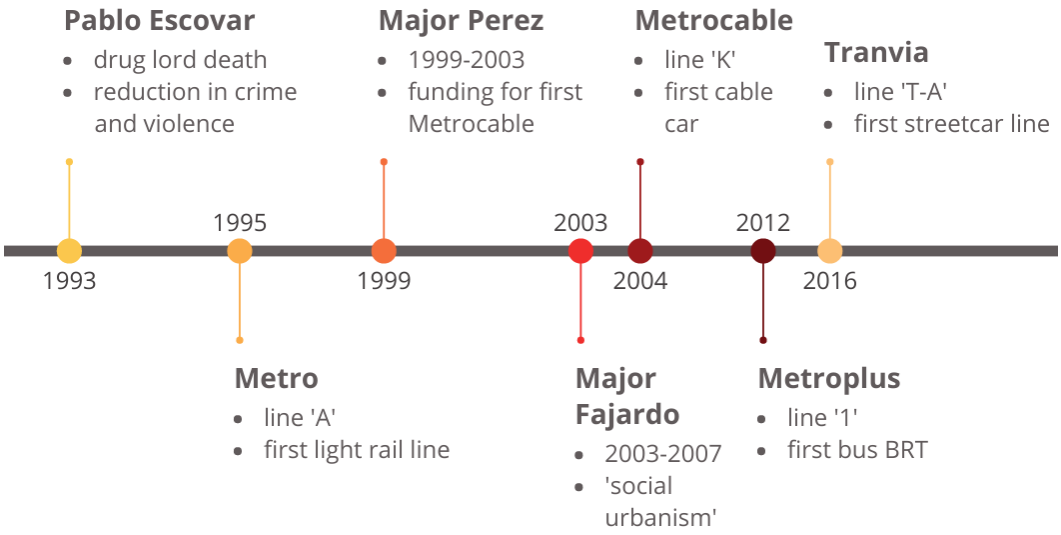


***Figure 1.2:* Timeline of Medellín Transportation Milestones**

Chapter 2. RESEARCH PROBLEM

The provision of adequate public transit services is one of the major problems in today's urban areas. Few metropolitan areas have developed adequate provisions for public transit. The research question for this study is: What were the elements that contributed to the success of Medellín's transportation system and what were the most important urban factors that contributed to this success?

Medellin is one city that took the initiative through 'social urbanism' to invest in its transportation system, thereby developing an equity-based multimodal system. It invested in public transportation, beginning with a light rail system that started operations in 1995, and culminating with a multimodal system that also includes cable cars, segregated (BRT) bus lanes [Figures 2.1 a & b], a tram line [Figure 2.2], feeder buses and bicycle lanes.

This study seeks to assess to what extent Medellin's transportation system has been successful and, how it achieved what it accomplished. It will analyze the elements that define success and their contribution towards the success of Medellin's system. It will accomplish this by gathering historical data from the inception of the system in the 1990s to 2019 and will include targeted interviews with Medellín planners, transportation officials and academics. The research addresses the following:

- What makes Medellin's transportation plan unique in helping to achieve the desired goals?
    - Analysis of elements that define success of a transportation system.
    - Analysis of the social issues, such as lack of inclusiveness, which existed before and which led to the development of Medellin's transportation system.
    - Examination of the role that political and private entities had in the development of its transportation system.

- Exploring the planning lessons learned (pros and cons) during and after implementation and from two other cities in Latin America.

a b

Figure 2.1 a&b: **Metroplús BRT ROW and Station**
from: F Kessler, 2019

Figure 2.2: **Medellín Tranvia (Tram)**
from: www.ohlconstruccion.com

Chapter 3. RESEARCH QUESTIONS

In order to determine whether Medellin's transportation system has been successful, it is necessary to examine what are the elements that would contribute to the success of a transportation system. A survey of the literature in the following fields was conducted to identify the elements of successful transportation systems. This analysis of the literature results in the following elements, as described in (Krumholz,1982), (Un-Habitat, 2013) and (Meyer, 2016) . These elements can be described as follows: [see Figure 3-1]

- The transportation system should be based on the principle of social equity by being socially inclusive and affordable for all income strata.
- The transportation system's infrastructure has to be well designed and the system needs to be efficient in regards to its operational schedule.
    - It should be multimodal and as seamless as possible between different modes of transportation.
    - It should provide affordable solutions for the last-mile-traveled from home or business to public transportation.
- It should serve important centers of the city such as the downtown, universities, employment centers, bus/rail/air terminals, and poor as well as rich communities.
    - It should reduce travel time.
    - It should be cost effective and provide revenue to the city and ideally be self-sustaining.

Figure 3.1 maps out 'Elements of Success' as derived from the literature review and that have been implemented in Medellin's transportation system and expresses the interrelationship of factors that would contribute to the success of the system.

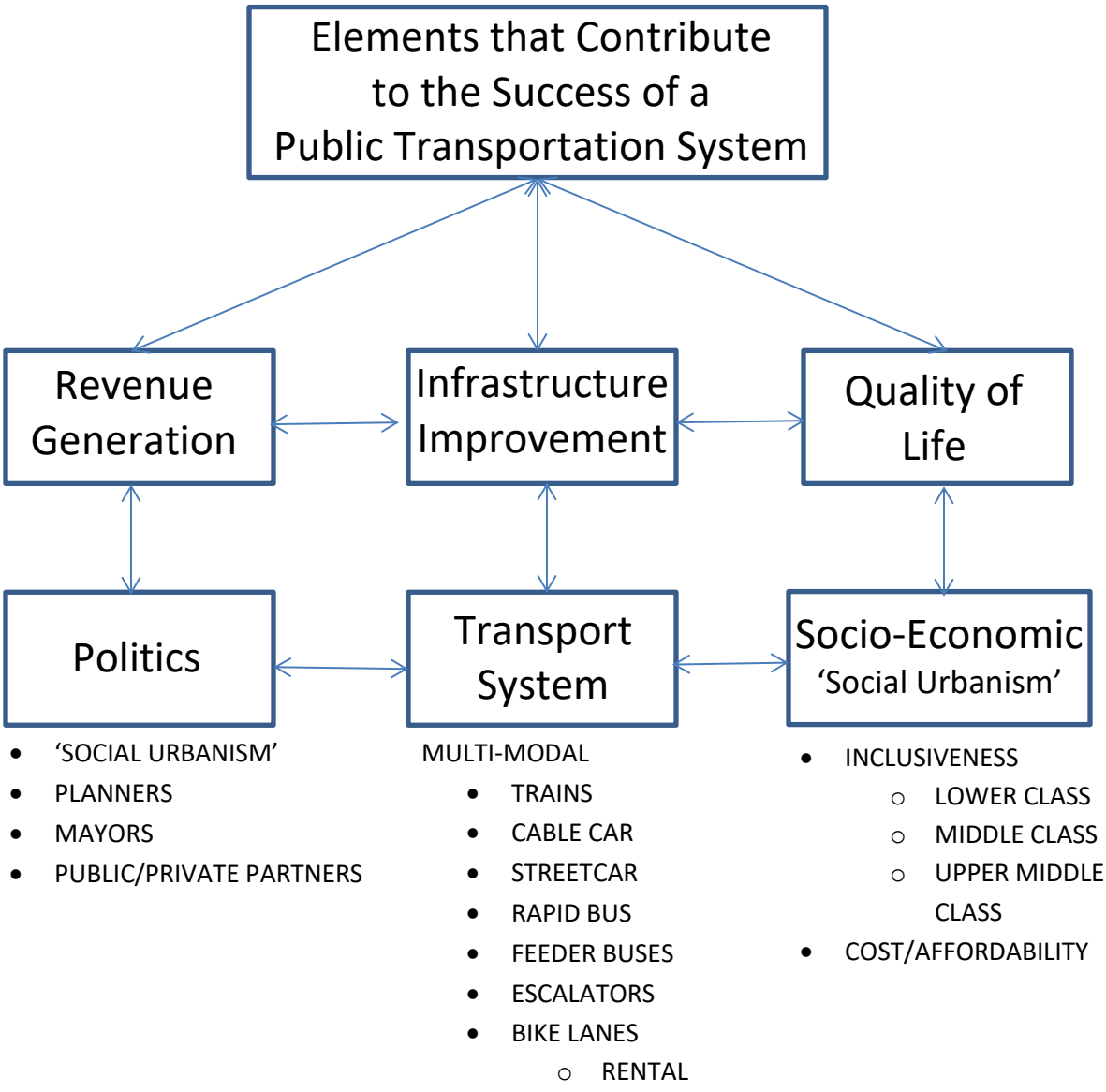


Figure 3.1: **Elements of SUCCESS**[5]

[5] Elements that contribute to the success of a transporation system as derived from the Literature Review.

Research Question: What were the elements that contributed to the success of Medellín's transportation system and what were the most important urban factors that contributed to this success? The following research questions that contribute to answering this fundamental question have been derived from the literature review:

- How did the system develop to help achieve some of the important goals in relatively short time?
    - What are the comparisons as regards to affordability and accessibility that existed before and after implementation of the system?
    - What were the social issues, such as crime and lack of inclusiveness, which existed before and which led to the development of Medellin's public transportation system?
- How was Medellin's transportation plan planned and implemented?
    - What was the approach to funding, which included public/private partnerships and city utility ownership for infrastructure development?
    - How did the transportation plan address inclusivity and affordability?
    - What is the most important urban factor that shaped the development of Medellín's transportation system?
- Has social, economic and political factors been instrumental in the success of Medellin's transportation system?
    - What was the role that planners, political and private entities have in the development of its equitable public mass transportation system?
- How are the growth in population and vehicular use in the city affecting transportation planning decisions now?
    - What has been proposed to tackle these issues based on the literature and targeted interviews?
- What are the lessons learned (pros & cons) during and after implementation, and what can we learn from other cities in Latin America?

Chapter 4. METHODOLOGY & RESEARCH STRATEGY

4.1 Methodology:

This study will include the history of Medellín and the development of its transportation system – past and present. It contains interviews [see Appendix 'A'] with Medellín planners, transportation officials, and academics regarding their knowledge of the development of the existing system and their vision for the future of sustainable transportation in Medellín and how they conceive of making it better. The study is exploratory in nature as it focuses on investigating the pros and cons of Medellin's system but will also endeavor to recommend solutions to transportation issues based on this research, new technology, and lessons learned from other cities in Latin America.

From the literature review, the research will assess the success of its transportation system studying where the city was before, the development process and how they went through it, and what has been accomplished after implementation. It will also draw from lessons learned from these infrastructure improvements. It will recommend solutions to transportation issues from interviews with Medellín planners, transportation officials, academics, and from the author's own readings and experience. This paper will also make recommendations, taken from the interviews and the research, on what technological advancements and innovative solutions in transportation can be applied to the city that may help solve some of its current and anticipated problems.

In conducting this study of the Medellín mass transportation system, I will be as an observer and interviewer in the program and will input the research process and results which will serve to support an assessment of Medellín's system. By presenting this case study, I intend to show that the observations made to arrive at this assessment are valid and that the message to the reader is one of importance and reliability. The case study will also serve the purpose of fostering or

increasing and understanding of the development of Medellín's transportation system to those who may not be familiar with the subject.

I will use the case study as the *research strategy* for this research. Yin, 2009, defines case study as an empirical inquiry that investigates a phenomenon within its real-life context and arises out of the desire to understand complex social phenomena. A case study can be based on any mix of quantitative and qualitative evidence (Yin, 2009). As Gerring would define it, in the case of assessing Medellín's transportation system, it will be an "intensive study of a single unit with an aim to generalize across a larger set of units" (Gerring, 2004). This case study in transportation will thus show what the roles of outside factors were in the understanding of the complex systems and organizations that shaped the current Medellín transportation system.

Limitations regarding case study research include a possible 'lack of rigor' where the researcher has been sloppy, not followed systematic procedures, or allowed biased views or equivocal evidence to cloud the findings and conclusions. All evidence must be reported fairly by the investigator and the conduct of any experiments must eliminate all bias. Another limitation is that case studies may provide little basis for scientific generalization; however, "case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes" (Yin, 2009). Another concern is that case studies take too long, are difficult to do, and result in lengthy, unreadable documents.

This study will entail a mixed-methods approach where the data collection includes both quantitative and qualitative data (Creswell, 2003), The case study I am formulating is more useful in forming descriptive inferences and enjoys a natural advantage in research that is of an ***exploratory*** nature. as it focuses on investigating the pros and cons of Medellín's transportation system as regards its efficiency, social and political issues.

The *explanatory* aspects of the study include the history of Medellín and the development of its transportation system between the 1990s and 2019. The *quantitative* aspects include transportation usage survey data from Medellin's municipal planning office and the Empresa de Transporte Massivo del Valle de Aburrá (EOD); while the *qualitative* aspects include the 'Medellín Como Vamos' (MCV) yearly surveys and seven interviews with Medellín planning professionals, transportation officials and academics regarding the issues they see with the current system and their vision for the future of sustainable transportation in Medellín as well as how they conceive to make it attainable.

These individuals were selected based on their knowledge and contribution to the city's transportation system and the interviews were conducted at their place of work. The respondents were asked a series of questions regarding Medellín's transportation system which can be found in Appendix 'B', and a comparative analysis of their responses has been included in Chapter 6. An analysis of the EOD and MCV mobility survey data has also been compiled and is shown in Chapter 6.

The quantitative research utilized regarding Medellin transportation will more closely meet the definition of *Inductive Reasoning*. This strategy, supported by Blaikie, starts with collecting data and proceeds to derive generalizations using some kind of inductive logic. It is essential for answering the 'what' questions in the study but limited in answering the 'why' questions (Blaikie, 2010). By its very nature, inductive reasoning is more open-ended and exploratory which becomes the best fit for this research. The research begins with observations about the development of Medellín's system that are specific and limited in scope and proceeds to a conclusion that is likely in light of the accumulated evidence. Moving from the specific to the general, this study gathers evidence, seeks patterns and forms a hypothesis or theory to explain what is observed. As this

research progresses, some *abductive reasoning* will play a part in formulating various hypotheses where an incomplete set of observations may be required to make the likeliest possible explanation for what is observed.

I will also utilize a *constructionist*, 'bottom-up' approach strategy to present a description and understanding of the interviewee's point of view regarding Medellín transportation issues (Creswell, 2003). This approach, also supported by Crotty, uses questions that are open-ended which allows the participants to express their views and the researcher to make an interpretation of what they find (Crotty, 1998). The research strategy utilized for this study is shown in Figure 4.1.

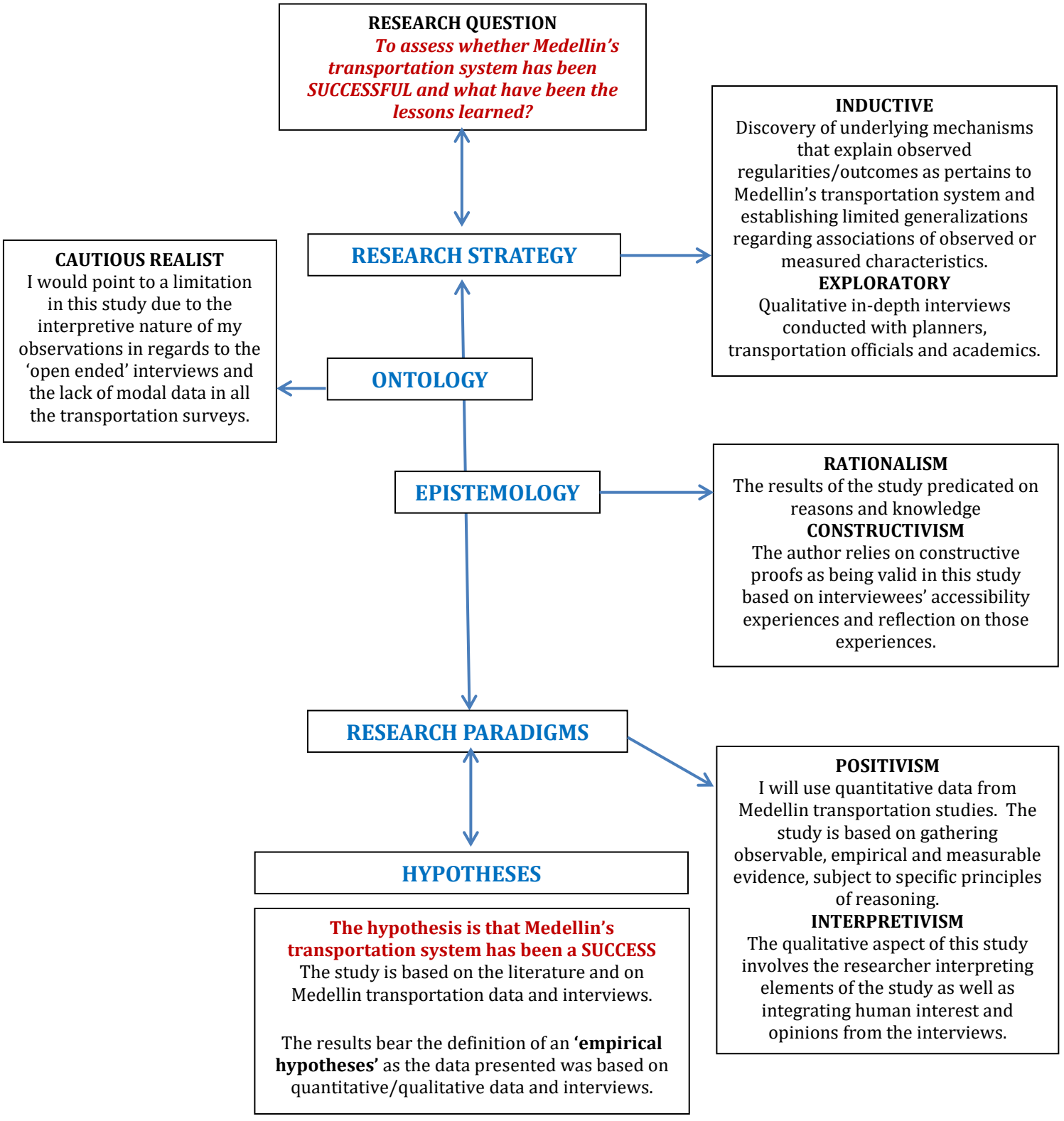


***Figure 4.1*: Research Strategy**

The key learning points from the development of Medellín's mass transportation system concerns the leading role of the local government and its strong partnership with the business and civil communities which is a contributing urban factor towards the system's success. 'Social urbanism' that has been so successful in Medellín, can be conceptualized as a form of local state activism spurring social equity (Plan de Movilidad Segura, 2014). As noted earlier, the local government in partnership with the private sector has played a key role in developing infrastructure, public services and promoting social inclusion. Interview respondents' attitudes toward the city's transportation system will provide a basis for further research and hypothesizing that can be applied to another city's emerging transportation system.

This research will endeavor to answer the questions of what makes Medellín's implemented transportation plan so unique and what were the lessons learned during and after implementation in order that other cities may learn from Medellín's example. The study will assess the Medellín success story as regards transportation, and will discuss, based on responses from targeted interviews with planners, transportation officials and academics, as well as from successful transportation solutions in other Latin American cities, what technological advancements in transportation or other solutions whether social or political could be applied to a City to make it more inclusive, efficient and sustainable. The contribution in this applied research is an effort to better understand and assess the problems that Medellín faced instituting its transportation system and how it overcame them.

4.2 The Hypothesis:

- The study will attempt to examine the Medellin's transportation system to see considering its recent background, history, and the constraint that has had if it has been a SUCCESS story. This will be achieved by defining what constitutes success and showing why and

how Medellin's system became so unique and successful, as well as what were the lessons learned from its implementation.

- The results would bear the relative definition of success as the data presented is based on 'real world' data and interviews.

4.3 Expected Outcome:

- It also will highlight the strong role that "social urbanism', political and private entities had in the development of Medellin's equitable public mass transportation system.
- However, as is the case in large dynamic growing metropolitan areas, the new planning solutions are required due to a growing population and increased vehicular use.
- The lessons (pros & cons) that have been learned during and after implementation of its transportation improvements have provided sufficient ground for overcoming the new changes and the increased demand . Some of the Positive outcomes include:
    - A reduction in crime and security
    - System efficiency / multi-modal linkage
    - Affordability
    - Social equity

4.4 Limitations:

The limitations of the study included not being able to obtain access to two individuals for interviews which included the current Director of Transportation and the current Mayor of the City of Medellín. However, I was able to interview the current Director of Mobility, an x-Director of Transportation for the city, and a Senior Engineer for the Metro system. The interpretive nature of my observations in regards to the 'open ended' interviews was also a limitation as well as the lack of modal data in the transportation surveys.

Another limitation is that the various modes of transportation aggregated in the MCV survey data under various transportation categories was not consistent in every year. The data in the MCV study is also limited to the city of Medellín and does not include the 10 municipalities that encompass the Medellín greater metropolitan area as included in the yearly EOD data. However, the MCV survey is completed every year whereas the last EOD survey was completed in 2017. Also, I was hoping to ride and evaluate the new electrical SITVA feeder buses that the city was starting to place into operation but they were undergoing trials and was not able to obtain access to the buses.

Chapter 5. LITERATURE REVIEW

Transportation planning is now expanding to include more emphasis on non-automobile modes of transportation and increased consideration of factors such as community involvement, mobility for non-drivers, accessibility, and environmental analysis. Nonmotorized planning which includes more comprehensive and multimodal evaluation has become increasingly important in recent decades (Litman 2015). "A systems approach to transportation planning and development, where flows in transport networks are analyzed in an integrated manner, is deemed necessary for a proper comprehensive and coordinated transportation plan" (Dickey, 1983 pg. 169).

This Literature Review focuses on the information presented in peer-reviewed journals, articles, and government sponsored reports and is intended to map out the development, issues, and accomplishments of Medellín's transportation system based on the following:

5.1 Politics

5.2 Transportation System & Air Quality

5.3 Socioeconomic / Community Integration / Crime

5.4 Successful Systems

5.1 Politics:

'Social Urbanism' and the politics and leadership that helped shape the success of Medellin's transportation system: Historically, prior to the 1990s, disengagement between local government and business coupled with low coordination in territorial control generated political and practical challenges for urban redevelopment. A decade later, collaborative relations between the local government and business, as well as high coordination in territorial control by authorities, sustained a coordinated response to the violence in the city due to the drug cartels (Moncada, 2016). In the early 1990s, members of the city's community organizations and religious, academic,

and business institutions began convening regularly to discuss ideas to fix what was then an embattled city (Fukuyama & Colby, 2011).

Through 'Social Urbanism' Medellín invested heavily in its poorer communities (Maclean, 2015) and has made remarkable economic and social progress since then in building a 'local developmental state' (LDS) by promoting enterprise and social inclusion with a renewed appetite for local state activism that is both popular and effective. This emerging 'social urbanism' model of local state activism is associated most closely with Medellín's Mayor Sergio Fajardo (2003-2007), although many aspects were initiated a little earlier under Mayor Luis Perez (1999-2003). Fajardo believed in the idea that modernist buildings and transportation systems would help bridge the gulf of distrust, separating the poor from mainstream society (Fukuyama & Colby, 2011).

Low tax rates in Medellín resulted in the local government being under-capacitated to implement its transportation plans. Key elements of LDS that evolved since the late 1990s include local state ownership of some key enterprises and assets that produce a revenue flow to the city. That allowed the city to embark on major longer-term programs of enterprise and community development. The city has retained ownership and management of the main energy company, Empresas Publicas de Medellín (EPM), which channels 30% of its net annual profit into the city administration's budget. These revenues give the city the fiscal space to engage in infrastructure development areas over and above what would otherwise have been possible (Bateman, Duran Ortiz, & Maclean, 2011). The city also has a high municipal tax rate that is tolerated by a uniquely civic-minded business elite (Fukuyama & Colby, 2011). Collaborative public-private sector relations have also aided infrastructural development by increasing municipal revenue that could be channeled into significant investments (Moncada, 2016).

5.1.1 Striving for Equity: Medellin's sprawling hillside neighborhoods to the north of the city called *communas* lie in sharp contrast to the more affluent areas in the south. The residents of these poorer neighborhoods initially fled their homes in other parts of the country due to conflict and violence. This resulted in a segregated city with a marked disparity between rich and poor. (McLaren and Agyeman, 2015).

A small group of experts at the department of 'social urban planning' (urbanismo social) at the Medellín Academy started to think about how to re-conquer spaces torn by violence: "it was both a concept and a physical strategy, a mixture of ideas and bricks" (Vulliamy, 2013). This concept, they subsequently termed 'Social Urbanism, ' which was inspired by the Barcelona model (Brand, 2013). With strong collaboration among scholars, professionals, business and civic networks as well as local government, these ideas were put into practice. "It is impossible to qualify or assess the apparent positive impacts of social urbanism without understanding the politics behind these policies and seeing the miracle as an ongoing, contextualized process" (Maclean, 2015). Medellín's mass transit is a solution not only in terms of urban design but also as regards indirect efficiency benefits and the ability to attract foreign direct investment (Fouracre, Dunkerley & Gardner, 2003).

Public transport became the key part of 'social urbanism' as it was viewed not only as a means to enable ordinary people to move around the city and get to work faster, but as well as a means to unite the rich and poor areas of the city thus allowing these different segments of the population to meet. There was an argument that a 'historical social debt' was owed to the marginalized areas of the city by the ruling elite and that 'social urbanism's' policies would be the means to tackle this geographical marginalization (Maclean, 2015). Metrocable lines became part of PUI (Proyecto Urbano Integral – *Integrated Urban Upgrading Programme)*, whose emphasis

was that of participation by the community at every stage of the planning process (Blanco and Kobayashi, 2009).

For example, in a city like Bogotá, the income of those who use cars is more than double that of those that don't [see Table 5.1]. 'Social urbanism' has created a poverty-oriented, largely affordable, urban transport strategy that concentrates on the movement of people rather than of vehicles (World Bank & Gwilliam, K., 2002).

Table 5.1: Average Income of Users by Transport Mode
from (World Bank & Gwilliam, K., 2002)

City	Average income car users	Average income noncar users	Average income car users/ noncar users	Percentage of all motorized trips done by car
Bogotá[a]	462.4	196.8	2.3	19.2%
Buenos Aires[b]	607.2	299.1	2.0	40.0%
Lima[c]	1,157.0	312.0	3.7	20.0%

a. Monthly income in dollars of 1995 for 1995 (Exchange rate is $1 = 1,000 pesos). Figure assumes 160 hours worked per month. Source: JICA-Chodai 1996.
b. Monthly income in dollars of 1994. Figure is for 1997. Source: Centro de Estudios del Transporte del Area Metropolitana 1999.
c. Monthly income in dollars of 1999 for 1999 (Peruvian currency seems overvalued). Source: APOYO 1999.
Source: Authors.

Medellín, Colombia's experiment in 'social urbanism' became the catalyst that channeled significant investments into the city's more impoverished communities and contains "very important lessons for Latin America and elsewhere, notably in terms of the potential and pitfalls of pro-active local economic development policy operating in extremely marginalized communities." (Bateman et al., 2011). The investment in 'social urbanism' that is associated most closely with Medellín's Mayor Sergio Fajardo, was not only in mass transit but also in parks, schools and libraries, which were designed and built-in concert with the transit improvements. Over the last 20+ years, this has helped transform the city from one of the most violent places in the world to an example of how to successfully include equity in the planning process.

The link between equity and efficiency in transport can be subtle. As an example, if you restructure feeder bus services to feed into a higher capacity rail or BRT systems, the restructuring could increase the number of multi-leg trips and involve separate payments. This could increase total trip costs and could hurt the poor, especially those most remote from the city or trunk line (World Bank & Gwilliam, 2002). Under the umbrella of 'social urbanism', Medellín has now effectively developed an efficient multimodal transportation system which has achieved integration within six modes of transport (light rail, cable car, BRT, tram, feeder buses, bicycle lanes), as well as fare integration, which allows users to travel on the Metro and Metrocable systems on a single ticket. From my personal observation, there has been considerable attention to detail for access to these systems by the disadvantaged, but further study is needed to assess what more should and can be done.

There is a coincidence between 'social urbanism's' agenda for social development and inclusion and the needs of the city to attract capital. The investment that Medellín has made in parks, libraries, and education/human capital, along with its transportation system, has contributed to economic development and also changed the image of the city on the global stage. There is no contradiction here because the levels of violence that had been observed in Medellín fostered a social exclusion that undermined the ability of the city to attract investment (Maclean, 2015). Medellín's planning under 'social urbanism' has been effective because it has been able to work for, rather than against, economic objectives and has been able to implement public transport, land-use, social equity, and development controls that consistently support its planning objectives.

A study by Cordoba, et al., 2014 sees the difficulty that complexity and limited data has in the assessment of the economic impact of the Metrocable cable cars as well as its other associated improvements. However, there was a positive economic impact of locating the *Cedezo (Zone*

Enterprise Development Centre) in the proximity of the Metrocable Line K that serves the *communa* of Santo Domingo. In the poor Popular and Santa Cruz districts, also served by Metrocable, there has been a significant increase in income as a percentage of the legal monthly wage (LMMW), particularly for male heads of households and only moderately in relationship with the city average. The following Table 5.2 shows income changes by gender in both districts as compared to the whole of Medellín (Cordoba, Stanley J. & Stanley J.R., 2014).

***Table 5.2*: Average salary of household head per district 2004-2009**

Household Head	2004 Legal Monthly Minimum Wage US$201			2009 Legal Monthly Minimum Wage US$279		
	Popular	Santa Cruz	Medellín Average	Popular	Santa Cruz	Medellín Average
Male	141	142	248	303	310	493
Compared against LMMW	70%	71%	123%	109%	111%	177%
Compared against Medellín	57%	47%	-	61%	63%	-
Female	108	110	191	266	269	455
Compared against LMMW	54%	55%	95%	95%	96%	163%
Compared against Medellín	57%	58%	-	58%	59%	-

Brand and Davila point out in their study that Line K, which was the first Metrocable line, has been highly successful and runs at full capacity. The second line, inaugurated in 2008, serve less dense communities, which may make this line less socially and economically significant. They further argue that lack of mobility can be an integral part of deprivation and disadvantage and that "it is far from clear that …marginally improved mobility options for the poor lead directly and inexorably to social improvement." They go on to state that the specific conditions of a given community influence any positive economic or social outcome from mobility (Brand & Davila, 2011).

In the case of 'social urbanism' and the Medellín Metrocable, the cable car system is serving the poor hillside communities. It involves no additional cost for transferring to Metro light rail, with the tariff being only marginally higher than conventional buses. Brand and Davila compare

Metrocable to studies of the implication of transport costs for people living on the urban fringes of the city of Santiago de Chile where living in fringe areas have limited the ability of people there to travel by foot. Thus, the high cost of public transport in relation to income has restricted their movement (Brand & Davila, 2011).

The Medellín Metrocable cable car systems have served as an adjunct to the already established light rail Metro system. The concept of 'social urbanism' that also strived to create new dynamic centers in poor areas was instrumental in developing the cable car system as a way of extending the benefits of the Metro to the least accessible and poorest areas of the city. Economically it also provided increased passenger numbers to a Metro system that was initially underutilized. Various studies were undertaken in the late 1990s, and by 2000 the economic feasibility of Metrocable became apparent. Line K began operation in less than 3 years after Mayor Perez' municipal government provided 55% of the funding costs. Cable car construction costs are relatively low, allowing Metrocable to be financed as a public sector project through typical capital investment budgets (Brand & Davila, 2011).

The impact of 'social urbanism', which includes mobility and urban improvement projects (PUIs), on family incomes and the local economy is hard to quantify due to lack of official data on short-term economic cycles, fluctuation in internal violence and those displaced by it, as well as rent and home prices. The obvious positive impact of Metrocable has been improved mobility with greater comfort and shorter journey times, but there can be long walks for those not close to stations with 45 minutes or more queuing during peak periods [see Figure 5.1]. Even though there is a single ticket fare, it may be cheaper for some to take a conventional non-transfer bus that would also allow for carrying larger loads (Brand & Davila, 2011).

Figure 5.1: **Metrocable entrance – Peak Period**
from: F. Kessler, 2016

So even though the system strives for equity, the Metrocable, and Metro system is used to a greater extent by formal sector workers (services, manufacturing, construction) that have longer north-south journey than those of the informal sector (housewives, children, elderly, disabled). Brand and Davila estimate that less than 10% of the poor area *communas* where the stations are located use the Metrocable/Metro combination. Walking and conventional buses continue to be the major transport mode and they did not see evidence of an increase in non-essential trips that would indicate greater participation in city life. There was, however, economic activity with new shops, bars, restaurants and small businesses in the vicinity of the Metrocable stations though this activity was not apparent outside these tightly defined areas (Brand & Davila, 2011).

The process of 'social urbanism' consists of the mayor and his administration which includes the planning department and a new government entity entitled EDU: Empresa de Desarrollo Urbano (Entity for Urban Development). This entity is tasked with the conception and execution of localized projects. The structure of 'social urbanism' also includes community-based planning

organizations that have the backing and funding from the municipality. These well organized and participatory organizations develop plans in accordance with the PUI-Proyecto Urbano Integral (Integral Urban Project) and include smaller interventions such as a sidewalk, handrails, and other similar scale improvements (Navarro, 2010).

'Social urbanism' strives for equity and an economically viable mobility solution as exemplified by Metrocable. Medellín enjoys healthy finances due to tax collection from local businesses and from the large profits received yearly by the city-owned public utility company Empresas Publicas de Medellín (EPM) which yearly transfers approximately 30% of its annual profits to the Medellín municipality for social investment projects which would include transportation (The Transformation of Medellín, 2014). EPM has 20 new projects that were planned for 2015 completion that were all designed through a participatory process with the community to make sure that the spaces generated met public needs (McLaren & Agyeman, 2015).

The synergy that makes the Medellín's transit system and 'social urbanism' so unique and as successful lies in the development of not only its transit system but also in the health centers, schools and parks that were developed around the stations. The success of Medellín's 'social urbanism' is also due to a coupling of the economic engine that funnels taxes from local businesses and profits from EPM directly into social investment. Add to this, the municipally funded community-based planning organizations that allowed not only planning participation but also in creating jobs for the local residents.

Striving for equity and developing a system that is economically feasible may entail the use of public transport subsidies. These need to be efficient and socially worthwhile and need to take into consideration that there are positive and hard to quantify, externalities that need to be taken into consideration. These could be improved air quality, climate change mitigation, road safety

and bicycle/pedestrian physical activity. These subsidies can then be used to lower existing fares. The resultant 'Mohring effect' is that these subsidies increase ridership and ridership results in an increase in the frequency of service (Un-Habitat, 2013, pg. 54). An example is the VIA shared vehicle system, which is a subsidized system now being used effectively in Arlington, Texas.

5.1.2 Critics of Social Urbanism & Response: Through the governmental experiment in 'social urbanism', Medellín has invested heavily in its poorer communities, hoping to transform itself from one of the most violent places in the world into an innovative city of the future. However, there has been criticism regarding the regenerative potential of policies such as 'social urbanism' that foster infrastructural investment, landmark architectural projects and cultural events that aim to attract international investment from the 'transnational capitalist class', multinationals and tourists at the expense of equality, inclusion and what is termed the 'right of the city' (Maclean, 2015). However, Medellín is unique as the city's regeneration was in the context of extreme violence and a concentrated effort was developed to improve the image of the city and attract foreign direct investment.

Critics also assert that many policies of 'social urbanism' reaffirm elite power and dominance and there is concern that the implementation of these policies, which was preceded by the pacification of crime-ridden areas by the military and paramilitary groups, resulted in a high number of civilian casualties (Maclean, 2015). The counter-argument here is that although this may be true, as a result of the pacification of these areas and with the policies of equity, inclusion and infrastructure improvements fostered by 'social urbanism', there has been a marked drop in crime and violence in the city between 1975 and 2015 [see Figure 5.2].

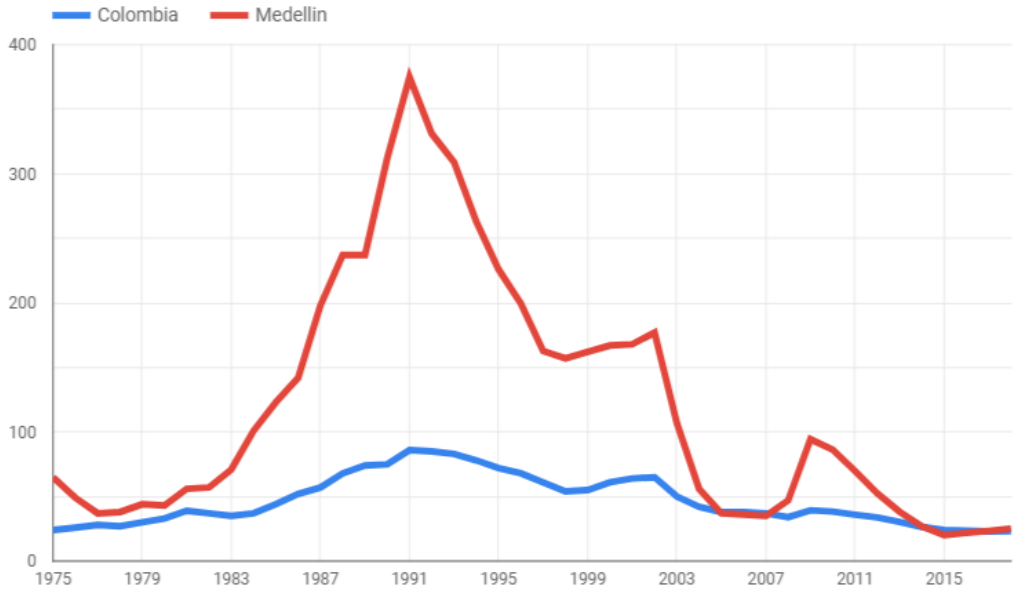


Figure 5.2: **Homicide rate per 100,000 population – 1975-2015**
from: Colombia Reports, (2019 December, 19)
https://colombiareports.com/medellin-crime-security-statistics/

There is also an argument that policies that have improved the city's economic indicators have also gentrified neighborhoods and, by doing so, displaced the poor and working-class residents, thereby increasing urban inequality. For example, some families were relocated by the government from Moravia, a poorer residential area close to downtown to make way for new public gardens into high-rise public housing in the community. Others were required to move into Nuevo Occidente, which is a massive housing complex of mostly displaced or forcibly evicted families. 'Nuevo Occidente' is located in a remote area of the city, about an hour from the residents' jobs and former neighborhood and at the end of a Metrocable cable car line [see Figure 5.3] (Milton, n.d). I was told by a professor at the University of Antiochia that some of these displaced residents cannot afford to pay for public transport to access jobs that they used to be able to walk to near the city center. A solution here may be to allow for transportation subsidies explicitly for these disadvantaged groups and on a personal basis.

***Figure 5-3*: Metrocable leading to Nuevo Occidente**
from: https://maptia.com/liannemilton/stories/social-urbanism

Medellín has developed a strong participatory element in its policies that resonates with the neoliberal agenda in terms of communitarian ideals and which allows for further opening of policies for progressive interventions (Maclean, 2015). As successful as interventions spurred by 'social urbanism' and the best of good intentions are, there are also some residents that are concerned that these "flashy new projects" distract attention from gang violence and drug trafficking that, to a lesser extent, still plague the *communas.* They question whether the welfare of the poorer residents of the city is the true driving force of the 'social urbanism' agenda (McLaren & Agyeman, 2015).

As is the case of many of the world's less developed countries, the poor keep migrating into the major cities. This is still happening in Medellín in an area called Nuevo Jerusalem, where previously barren hillsides are becoming populated with informal settlements that have no roads or city services. An ambitious project called the 'Cinturon Verde del Valle de Aburrá' (Aburrá Valley Green Belt), which is a 46-mile-long park located along the upper slopes of the valley that

surrounds the city is designed to contain and curb these settlements. Residents that have now settled above this 'green line' will have to be relocated and this has spurred criticism of the project (McLaren & Agyeman, 2015) [see Figure 5.4]. This study will need to include, via targeted interviews of Medellín planners, transportation officials and academics, how Medellín intends to address affordable access to its transportation system by the very poor.

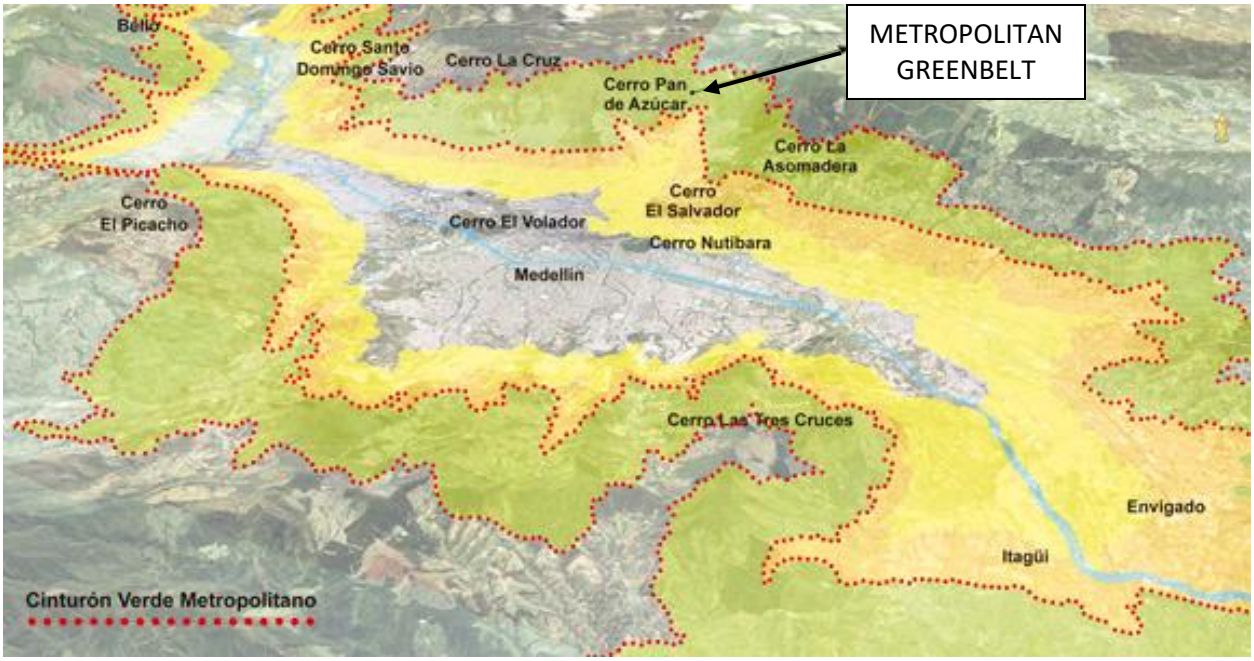


***Figure 5.4*: Medellín's Planned Metropolitan Greenbelt**
from: www.ecocitizenworldmap.org

Here I believe that targeted 'social marketing' can play an effective role. The municipal leadership in concert with Medellín's planning officials need to reach out to communities, determine what social issues are important to a community, how they intend to address these issues, as well as how any planned transportation improvements will serve as a benefit to the community. The striving for a system that is economically feasible many times can run at odds with economic reality and private ownership interests.

Public transport fares should be set at rates that will allow local residents to use it. In developing countries such as Colombia, fares often times are set above competitive equilibrium levels (UN-Habitat 2013 pg.112). This is now the case in Bogota's TransMilenio BRT system whose fleet of buses is privately managed and the fares have increased more than the rate of inflation. This can become a critical affordability issue for some users (Hidalgo, Pereira, Estupiñan, & Jiménez, 2013). User satisfaction that may also be trending downward due to overcapacity of some systems also needs to be addressed.

The tenacity of local government in Medellín to face the risks associated with a novel transport solution, particularly in areas with acute social tensions and poverty, is to be praised. At its core lies a political approach to local government involvement that seeks to deliver physical and infrastructure change through more active forms of community participation, and through *equity planning*. This is different than the top-down approach usually present in widespread patron-client practices (Davila, 2013). The equity represented in this approach to planning has generated great returns in terms of social inclusion through community consensus for the poor neighborhood *communa* area residents. It has also helped to address poverty through increased mobility for residents commuting to the city center.

5.2 Transportation System & Air Quality: How the city developed an efficient transportation system and the status of Medellin's system now.

5.2.1 Transportation: Preparations for the Medellín Metro started in the late 1970s, led by the Medellín municipality. There was no real effort to consider modernizing mobility in Medellín until the early 1980s with the construction of the city's rail transit (Metro) starting in 1985 with the first above-ground train line inaugurated in 1995 (Drummond 2012). The Metro helped bridge

the poor and rich areas of the city. There are now two rail lines in the city. Starting from 2004, with the opening of Line K, a network of chair-lifts (Metrocable), now numbering 5, that connected the Metro to the poorest hillside (barrio) communities was built. The first cable car system that was built in the northeastern part of the city alone cost $33 million (Moncada, 2016).

Metrocable greatly reduced the time and cost of commuting from the barrios to industrial and commercial centers along the Medellín River (Bocarejo, et al 2014 June) (Medellín Info, 2011). In addition, it also stimulated employment and social integration (Lowenthal and Mejia, 2010). Later additions to the public transport network include rapid-buses (Metroplús), a tram line, and a 28-story high escalator in one of Medellín's poorest neighborhoods so that residents can safely ride down the steep hillside, which has now become a tourist attraction [Figure 5.5]. Other infrastructure, such as bridges connecting the barrios to each other, was also established. The Medellín Metro system now transports well over 160 million passengers per year. The rail, tram and cable car systems are efficient, electrically driven systems that save over 178,000 tons of CO_2 emissions yearly (Jeff, 2017).

***Figure 5.5*: Medellín Escalators at Communa 13**
from: www.peoplebuildingbettercities.org

The Integrated Transportation System of the Aburrá Valley - SITVA is the set of public transport modes that allow metropolitan citizens to travel through the ten municipalities of the Aburrá Valley. SITVA is made up of the following subsystems, which as an integrated, multimodal service, provide mass transportation services. [see Figures 5.6 & 5.7].

This SITVA mass transportation subsystem consisting of the Metro trains, cable cars, tram, and BRT buses run on preferential and exclusive lanes, complemented by a bus feeder service. This system is also serviced by a subsystem of privately owned public buses 'colectivos' (TPC) with a municipal and metropolitan radius of operation. A growing public bicycle system, 'Encicla', also serves the Aburrá Valley. The city's SITVA system map is shown in Figure 5.6 (SITVA, n.d.)

- Metro: 31.3 kilometers of metro rail in the Aburrá Valley that moves 800,000 people a day at an average speed of 37 km / hr. The subway began its operation in 1995. Today it has two lines, 27 stops and a fleet of 80 train units.
    - Two rail lines – Line A (North to South) and Line B (Center to West) with a total of 27 stations *(blue and orange on map).*
- Metrocable: the cable car lines include 11.9 km with 12 stops spread across five lines and a fleet of 362 cable cars that mobilize 41,000 passengers daily. The first cable of the city was put into service in 2004.
    - Five Metrocable cable car lines – Line H, Line J, Line K, Line L and Line M with a total of 12 stations *(light green/brown, yellow, orange, red and dashed purple on map).*
- Tranvía: this tram started its operation in 2016, serves a single line of 4.3 km and nine stops traveled by a fleet consisting of twelve trams that mobilize 45,000 passengers daily.
    - One Tranvía streetcar line – line T-A with 9 stations *(thick vivid green on map).*

- Metroplús: this BRT bus system using segregated lanes mobilizes 125,000 passengers every day on two lines totaling 26 km. It has 48 stops served by a fleet of 30 articulated buses and 47 standard buses. It began operation in 2011.
    - Two Metroplús rapid bus lines – Line 1 and Line 2 with a total of 48 *stations (thin dark green and light green on map).*
- Rutas Integradas: Feeder buses integrate with the Metro to complete the city's SITVA multi-modal system. These buses mobilize 110,000 people daily, on 35 routes operated by a fleet of 302 buses of 40 passengers and 65 buses of 19 passengers and connect 1,033 bus stops in the Aburrá Valley [Figure 5.7].

***Figure 5.6*: Medellín Public Transportation System**
from: (Metro de Medellín, 2017)

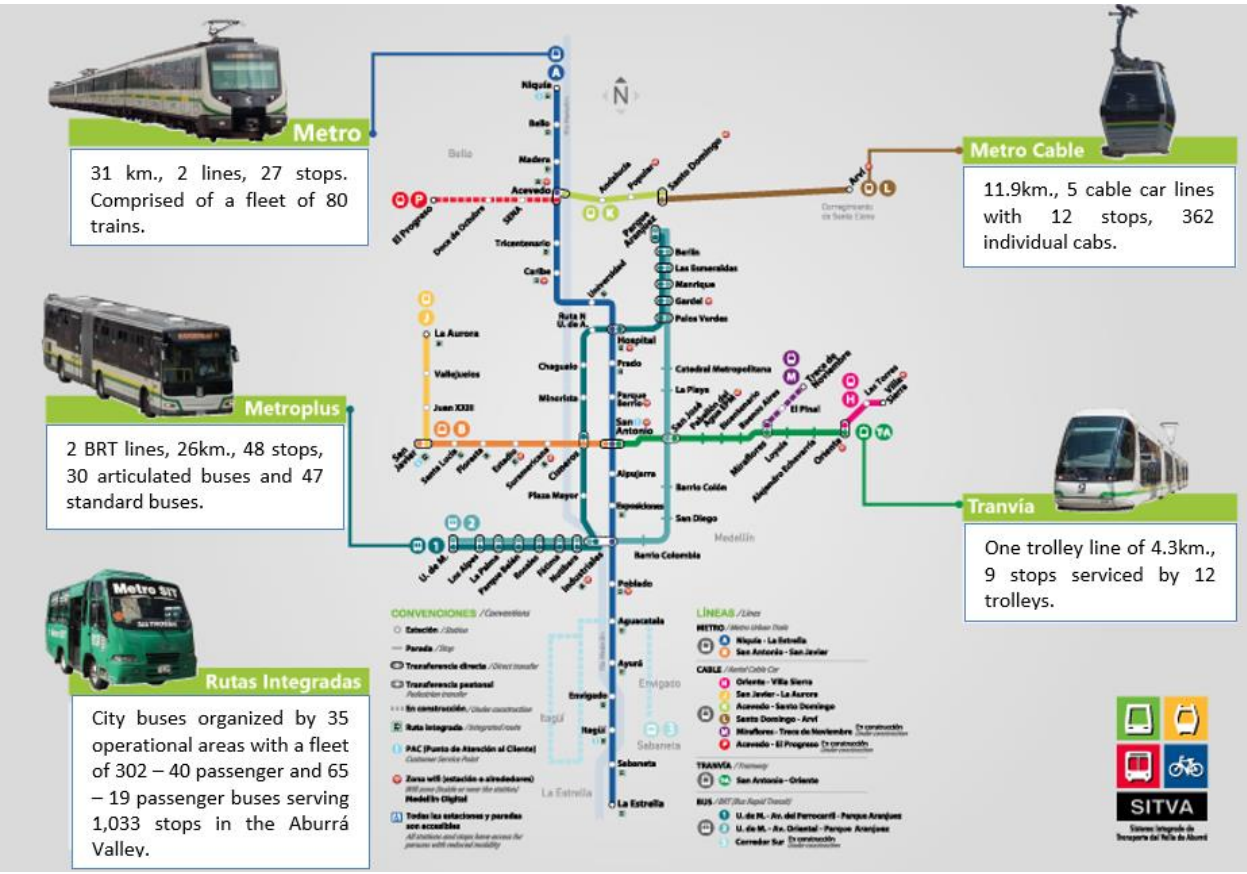


***Figure 5.7*: Medellín's Multi-modal Transportation System**
from: (SITVA, n.d.)

The SITVA multi-modal transportation system is completed with a public bus passenger transport (TPC) knows as 'colectivos' that have a municipal and metropolitan radius of operation, and made up of routes that pass through two or more municipalities within the Metropolitan Area of the Aburrá Valley. TPC is organized to serve the valley's outlying areas and are operated by different private transport companies [Figure 5.8] (SITVA, n.d).

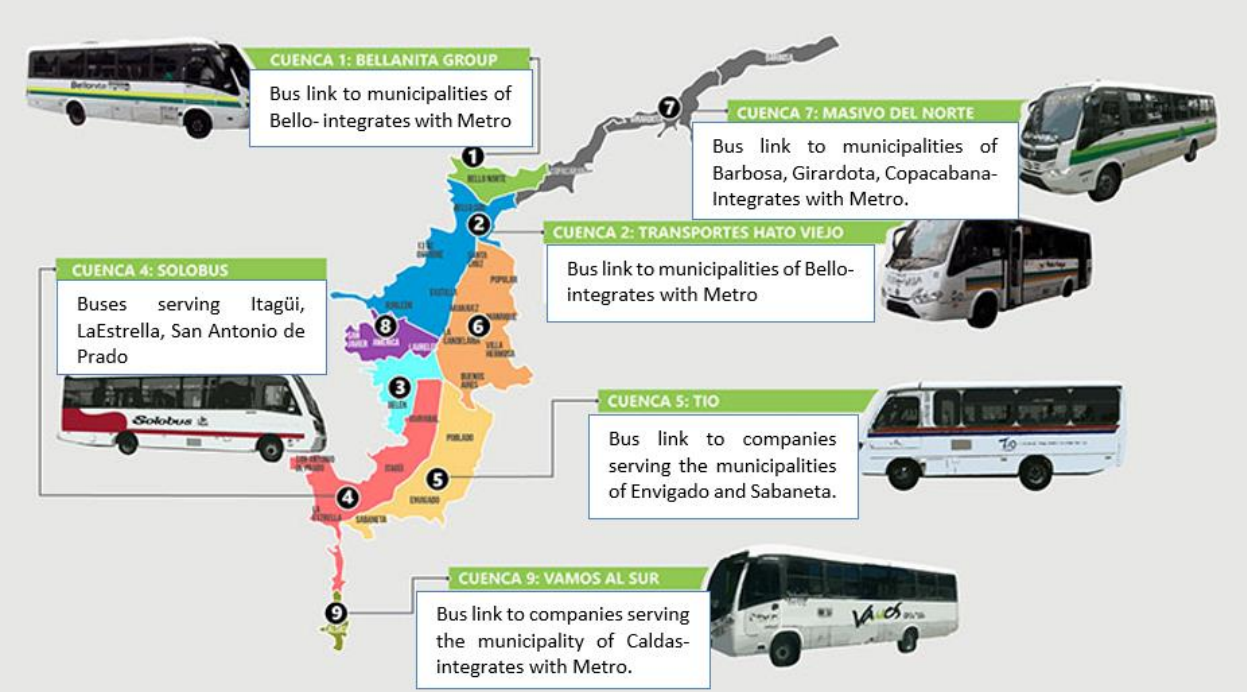


Figure 5.8: **Medellín Public Bus Transport (TPC) – known as 'colectivos'**
from: (SITVA, n.d.)

The Metro system utilizes a rechargeable 'CIVICA' card that can be used on all public modes of transport. It can be recharged at staffed ticketing booths or ticket machines. The current fares are currently affordable for the majority of the city's residents (Jeff, 2017). These fares include discounts for seniors and students.

'CIVICA' rechargeable card for Metro system ($1 US = $3573 CO)

- Metro fare with CIVICA card is 2,000 pesos (US $0.55)
- Student fare: 1,040 pesos (US $0.29)
- Senior fare: 1,910 pesos (US $0.53)

According to El País Colombia, The minimum salary in Colombia is 828.116 COP per month as of January 1, 2019; which roughly equals to USD $232 as of June, 2020. This minimum wage rate also applies to the capital Bogota.

The Metropolitan Area of the Aburrá Valley transportation authority delivered the results of the 2017 Source-Destination mobility survey, which is a fundamental instrument for the planning of Medellin's mobility in the medium term. It also is an important source for the

quantifiable aspects of this research, which addresses the question of the effect of the growth in population and vehicular use in the city as compared to earlier studies. The study highlights the growth from 2012 in the number of trips made daily and the higher percentage of people who travel on all modes of travel and helps answer questions regarding the efficiency and multi-modality of the transportation system. One of the highlights of the Survey has been the increase in average travel time, which went from 25 minutes in 2005 to 36 minutes in 2017. This result was expected due to the significant increase in the vehicle fleet, mainly due to motorcycles (EOD, 2017), which has had a measurable impact on congestion and vehicular emissions.

5.2.2 Air Quality: A research study disclosed by The Metropolitan Area Authority states that Medellín has become one of the most polluted cities in the world because of the quality of its fuel which, in 2008 had a sulfur composition of 4000 ppm; and only in 2010, did municipalities implement a diesel Euro IV fuel with a sulfur content of 50 ppm. Air pollution tends to stay inside the valley because of its topography, which causes breathing diseases (Restrepo, Garcia, Perez, Cortazar, & Biechl, 2008). This continues to be a problem to this day due to a growing population and increased vehicular use, especially motorcycles. Martinez-Jaramillo, et al. conducted a study quantifying the emissions that can be avoided by implementing Medellín's Master Plan, promoting telecommuting and developing a transport energy model for Medellín (between 2010 and 2040) and came up with a potential savings of 5.65 Metric Tons of CO_2 which is a 9.4% reduction (Martinez-Jaramillo, et al, 2017).

5.3 Socioeconomics / Community Integration / Crime:

The following subsection outlines the effect that Medellín's transportation system had on the residents of the city from a socioeconomic perspective as well as on community integration and crime.

5.3.1 Socioeconomics: Lack of adequate connectivity imposes a high financial burden on the poor by increasing transit transfer costs to reach the city center. This is especially true in areas where integrated transportation systems are not available (Oviedo, & Titheridge, 2016). This held true for Medellin before it improved its transportation system. Overall, the development of Medellín's transit system has had a profound effect on providing accessibility for the residents of the city. Metrocable, the city's cable car system which links to the city's two Metro (commuter rail) lines, in particular, has increased accessibility to the poorer areas of the city, like Communa 13, and has become a secure means of transportation for those residents (Heinrichs & Bernet, 2014). Prior to Metrocable, the Metro could not reach the poorer areas of the city surrounding Medellín leading to commutes to the central city from these areas being as long as 2 to 2.5 hours (Alshalalfah, Dale, & Shalaby, 2014).

It is also interesting to note that cable cars such as Metrocable have been cited as being cost-effective because they don't require massive infrastructure and can be easily integrated with the existing transit network which includes Medellín's Metro rail and the Metroplús BRT rapid-bus network into an effective and efficient multi-modal network (Garsous, Suarez-Aleman, & Serebrisky, 2017).

5.3.2 Community Integration: Metrocable has made an important contribution in integrating otherwise marginal areas to opportunities provided by the metropolitan area and has had a measurable impact on access to activities by the low-income population (Bocarejo et al, 2014

June) as well as becoming a rallying point for community pride and a belief that the city is improving (Bateman et al., 2011). It has led to improvements in urban integration, neighborhood upgrading, accessibility, safety, quality of life, and employment opportunities (Garsous et al., 2017).

Medellín has proven adept at using pro-poor transport policies to link communities together. The Medellín Metro system and Metrocable, which was started in 2000 under Mayor Luis Perez, connected the poorest locations with the metropolitan center, facilitating important family contact for the poor at a comparatively low price. Finally, better communications allowed the poor to work in more distant areas and to set up informal microenterprises to sell their products in the more prosperous markets in the city center (Bateman et al., 2011). Some of the more deprived areas of Medellín served by Metrocable are characterized by populations with a relatively high risk of social exclusion compared to other parts of the city. Metro and Metrocable have improved trip rates, which is one way to reduce the risk of social exclusion in the poorer districts and, in turn, improve the well-being of their inhabitants (Cordoba et al., 2014).

5.3.3 Crime: The social urbanism projects developed in Medellín in relation to Metrocable have proven effective as a crime-prevention tool and served as a key to the social integration of the population in deprived neighborhoods that were previously cut off from the city center. As such, it has helped create a climate of peaceful co-existence, which has resulted in a significant decline in crime rates (Bea, 2016). The intervention of these large-scale public works projects has also been associated with significant declines in neighborhood violence with a drop in homicide between 2003 and 2008 that was 66% times higher in intervention neighborhoods than in control neighborhoods (Cerda et al., 2012). The construction of cable cars was accompanied by

neighborhood upgrading, which included new schools, housing and other infrastructure improvements which also resulted in a decline in violence (Brand & Dávila, 2011).

5.4 Funding Sources and the World Bank:

Sustainable development which is a crucial concept of 'social urbanism' is increasingly being acknowledged as a key determinant of funding by international development agencies like the World Bank and its importance is expressed in their dealings with local decision-makers with measures being introduced that ensure that the mobility needs and the 'rights-to-accessibility' are addressed for the poor and disadvantaged (Un-Habitat, 2013 p.54).

The International Bank for Reconstruction and Development (IBRD), which is commonly referred to as the World Bank, is an international financial institution whose purpose is to assist in the development of its member nations, supplement and promote foreign investment, as well as promote long-range balanced growth in international trade. The World Bank transport policy paper of 1986 emphasized managing and planning infrastructure and traffic for economically efficient urban movement. In 1996 the Bank took a broader perspective with its general transport policy paper, which emphasized the integrity of economic, social and environmental dimensions of sustainable transport policy (World Bank & Gwilliam, 2002). This broader perspective which calls for a fuller involvement of project-affected persons in decisions and the avoidance of incidental damage to the interests of poor people, is stated succinctly by World Bank & Gwilliam:

> "It is thus important both to establish how effectively urban transport infrastructure, service planning, and investment targets the needs of poor people, and to establish the indirect effect of urban transport pricing and financing policies on the poor through those policies' impact on government expenditures and macroeconomic stabilization." (World Bank & Gwilliam, 2002).

Colombia's Programa Nacional de Transporte Urbano (PNTU – *National Program of Urban Transport*) has been supported by IBRD, as its primary external financier since 1996, and has financed studies for BRT systems in Bogotá and Medellín as well as the construction of the first segregated bus corridor that became a key milestone for the development of Bogotá's TransMilenio. Co-finance sources have been the Inter-American Development Bank and the Andean Development Bank. IBRD safeguard requirements mandated the creation of social and environmental teams in both of these cities' implementing agencies to develop and implement environmental and resettlement plans for these civil works. Since 2004, IBRD has launched an Integrated Mass Transit Project (IMTS) to finance portions of Medellín's BRT system. These bus systems are being replicated in many cities because they are cost-effective transport solutions and can be implemented in relatively short periods of time (World Bank, 2010).

The concept of sustainable development as embraced by 'social urbanism', and which encompasses mass transportation systems, is increasingly acknowledged as a key determinant as regards to funding by international forces such as the World Bank and multilateral development banks such as the Development Bank of Latin America, which in theory and in time should lead to the establishment of good planning practice. The framework for a transparent political/planning structure should be designed to remove any obstacles to the participation of all stakeholders in the decision-making process. The mobility needs and 'rights of accessibility' for the disadvantaged also need to be addressed (Un-Habitat, 2013 pg. 193).

Berg, et al. outline the broader objectives of financing institutions such as the World Bank that embrace social inclusion and sustainability and which tie closely with the concept of 'social urbanism'. They write:

"A useful categorization of the broader objectives of policies can be

- To facilitate growth (e.g., through lower transport costs, which facilitates agglomeration effects, trade and structural change, and leads to higher productivity.
- To improve social inclusion (e.g., through better access to transport services, which can improve economic opportunities for the poor), and
- To promote sustainability (e.g., through reduced health and environmental externalities)." (Berg, Deichmann, Liu, & Selod, 2015).

The above framework is represented in Figure 5.9:

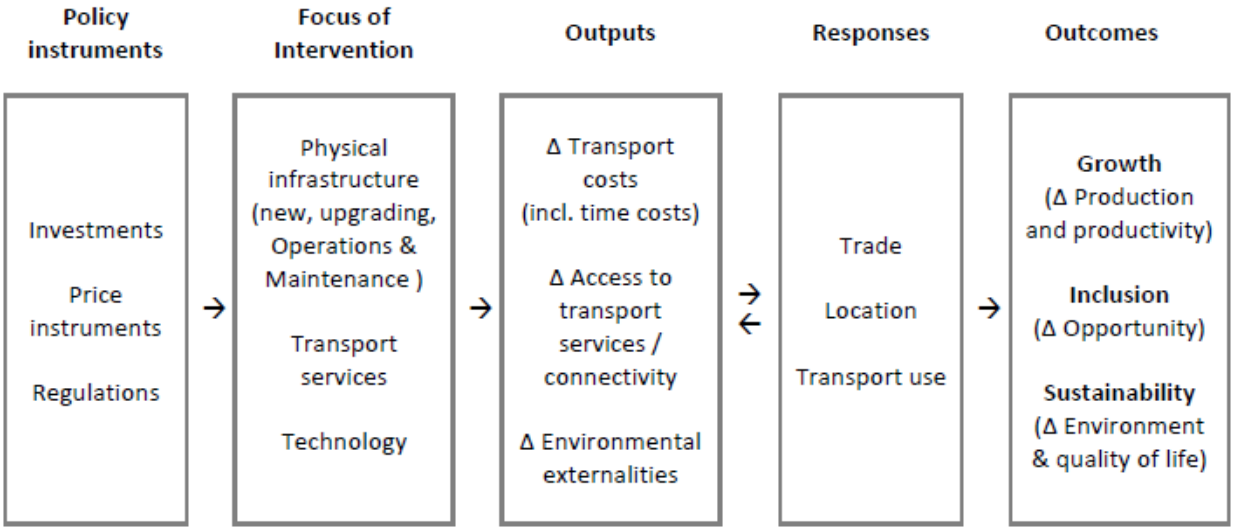


Figure 5.9: **Impacts of transport policies: the mechanisms**
from: (Berg et al., 2015)

During the Rio+20 Conference, the multilateral development banks pledged the US $175 billion to support sustainable transportation between 2012 and 2022. Funding considerations include expanded access, equity, and opportunities for low income and disadvantaged populations (Un-Habitat, 2013, pg. 54). These funding sources have an enormous largen impact on how these funds are managed and where and to what sustainable projects they will be distributed.

The World Bank also launched a city-based sustainable urban development initiative whose purpose is for developing countries to achieve greater economic and ecological sustainability and to draw from the synergy between the two processes. This World Bank's Eco^2 (Ecological Cities as Economic Cities www.worldbank.org/eco2) 'Integrated Approach' concept focuses on the careful coordination of transit and land development and holds great promise in advancing sustainable, economic, and socially inclusive development [see Figure 5.10]. It allows local governments to lead development processes taking into account their specific circumstances in order to realize the benefits of designing, managing and planning their whole urban system (Suzuki, Cervero & Iuchi, 2013).

Critics of 'social urbanism' should be made aware that the role of transit in urban development is being promoted as a way to increase the mobility of the poor and to mitigate the effects of climate change. It supports a decision-making approach that values cultural, natural and social capital. At the 2012 Rio+20 Conference, the international development banks, which included the World Bank, have committed substantial support for sustainable transport (Suzuki, et al, 2013).

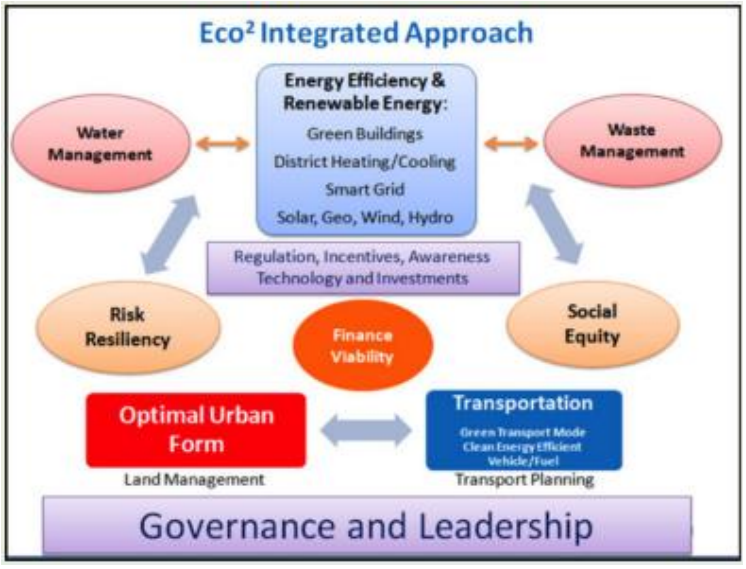


Figure 5.10: **The Eco^2 Integrated Approach to Development**
from (Suzuki, Cervero & Iuchi, 2013)

The planning approach envisioned by the World Bank's Ecological Cities as Economic Cities (Eco^2) concept, which is so closely tied with the 'social urbanism' concept, will promote sustainable development through cross-sector integration and will facilitate the creation of cities that are more inclusive, livable, cleaner as well as economically competitive (Suzuki, et al, 2013).

5.6 Assessing Security, Crime/Violence & Equity

5.6.1 Security: For assessing the existing level of security in the Medellín transit system, the study will need to include:

- An evaluation of the state of Medellín's transportation infrastructure, taking into account rider security and the threat of terrorism.
- Presence of security personnel and security cameras at transport stations.
- The opinions by riders regarding their perception of the security of Medellín's transportation systems.

5.6.2 Evaluation of Infrastructure for Security: For this part of the paper, I will rely on research from the literature as well as my personal observation of the security of the various transit modes in Medellín. I have visited the city on four occasions and I intend to also look at security from my perspective as a licensed Architect with over 35 years of experience having worked on a variety of security issues for Homeland Security as well as Aviation security projects that include DFW International Airport.

Security has now become an important issue in mass transit. It encompasses not only personal security from molestation and crime, but also from the threat of terrorism. People will not use public transportation if they don't feel secure while using it. The 2011 Country Reports on Terrorism (issued: July, 2012) shows that the threat of terrorism in Latin American countries remained low (Sullivan, 2013). Even though the Latin American countries have seen a few

terrorist attacks in their transportation systems, the recent horrific killings at two mosques in New Zealand show that no country is now immune to terrorism.

The TSA administrator in Obama's administration, John Pistole, said: "some terrorist groups see rail and subways as being more vulnerable because there's not the type of screening that you find in aviation" (Stoller, 2010). It would be relatively easy for a terrorist to board the Medellín Metro, Metrocable, or BRT with an explosive device concealed in a backpack. In a city like Medellín that has not recently experienced any threats from terrorism, security measures tend to be less harsh than in a city like London and are commensurate with any perceived threat. However, as Medellín becomes more of a magnet for international tourism, its transit system could increasingly become a target. Waugh writes:

> "Transit systems are dependent upon ridership for a significant portion of their funding. Ridership is heavily influenced by convenience and speed. Metal detectors and other measures that slow access and reduce convenience may discourage ridership, which can have a serious impact upon the financial viability of transit systems… The choice of commuter rail and subway systems over private automobiles may be swayed if security precautions slow travel time by more than a few minutes" (Waugh, 2004 p.310).

The difficulty in incorporating security in any transportation system is taking into consideration subjective factors such as what is the perceived threat for Medellín based on any historical markers for terrorism in that city. It was much greater 20+ years ago during the days of Pablo Escobar's drug cartel and the ensuing drug wars than it is today. If the threat in a city like

Medellín is now low, do hardening security measures such as those being implemented in cities such as London, Madrid or Moscow need to be implemented? If you harden one target, such as the Medellín Metro, the Metrocable or BRT may become more appealing to terrorists.

In the case of Medellín, a balanced approach needs to be reached. However, one must be cognizant of the fact that small charges in backpacks were used in the Madrid bombings of 2005 that caused 200 deaths and 15,000 casualties. Madrid joined Moscow, Paris and Tokyo whose subways and trains became scenes of terrorist carnage. In New York City, security has become even more important with stepped-up police patrols and closed-circuit cameras. However, even their authorities are not running riders through metal detectors or frisking them the way air travelers are screened (Clarke, 2004). Due to the large volume of riders being funneled through the Medellín Metro system in a relatively short time, the system would come to a virtual standstill if stringent screening measures were to be utilized. Possibly in the future, with enhanced technology, passengers will be screened without interrupting traffic flow.

The Medellín Metro, Metrocable and BRT systems are now open and easily accessible except for access controls at payment portals. There is no personal screening as you find in aviation. In almost all cases in Medellín, these portals have trained personnel to answer any rider questions, with some major stations having a police presence. Having visited Medellín recently on four occasions and riding extensively on its transit system, in no case have I seen an inspection of a rider's ID or bag, but that is not to say that it does not occur or should occur. The following Figure 5.11 by Bocchetti, et al. shows the rise in terrorism against public transport in the world between 1945 and 2005.

Figure 5.11: **Trend of terrorism against public transport**
from: (Bocchetti, Flammini, Pragliola, & Pappalardo, 2009)

This trend is continuing, and between January 2005 to June 2010, there were 213 attacks in over 20 countries on subways and trains (Stoller, 2010). In 2012 Montreal's subway was smoke bombed. Montreal's mayor Gerald Tremblay responded in the following way:

> "We've put in place whatever we had to do. Do you want me to take 4,600 policemen and women and put them in the subway? You want me to close the subway? What do you want me to do? Are we going to stop living because we have a crisis on our hands? No. What's the solution? That's the question'" (Gollom, 2012, May 14).

Currently, CCTV (closed-circuit television) is the most used security technology in the world's subway systems. Studies have shown that CCTV is "helpful in improving transit security and reducing fear of crime in transit passengers who are waiting at train stations or bus stops or riding transit vehicles" (Yavuz & Welch, 2010). After Tokyo experienced a sarin attack at its subway in 1995, it installed 2200 CCTV cameras at ticket gates, platform areas and even restrooms

(Loukaitou-Sideris, Taylor, & Fink, 2006, p735). Although this writer is aware of cameras at various Metro and Metroplús stations, this study will need to assess the degree to which these systems have been implemented throughout Medellín's multi-modal system and assess their effectiveness. Another deterrent may be random bag searches such as the one implemented in Washington, D.C., in December 2010 (Stoller, 2010). New York, Los Angeles, Washington and Boston not only search bags but also randomly search passengers as well (Gollom, 2012). None of these procedures are foolproof but can become an effective deterrent.

Smart Card systems are now being used extensively in the U.S., Europe and Asia. Medellín uses cards that can be recharged by machines or at the ticket counters, how 'smart' Medellín cards are needed to be assessed. With embedded microchips in these cards, a large quantity of data can be stored, which can include fingerprints, medical data, and a photo ID. They can even be used to pay parking fees and retail transactions. However, there are privacy concerns regarding how much information should be stored on these cards (Pelletier, Trépanier, & Morency, 2011).

A subjective assessment based on historical markers and on perceived threat needs to be made as to whether Medellín presently has a balanced security system. Funding for enhanced security measures also becomes an important consideration. Authorities must remain vigilant for any possible future threats and convince people that they are being protected and that security is a top priority and is being taken very seriously. The importance is to "create a feeling of security rather than reduce the risk to zero, which is practically impossible." (Loukaitou-Sideris, et al., 2006 p. 731).

The assessment of Medellín's infrastructure would also need to include station design and whether existing stations have spaces where people could conceal themselves or explosives. I have not seen vending machines other than ticketing machines at train stations. If they are to be

included in the future, they need to be designed and installed in such a way that you can't hide anything behind or on top of them (sloping tops). In London, some stations ban trash cans or have bins constructed from see-through plastic (Loukaitou-Sideris, et al, 2006 p. 738).

5.6.3 Security Personnel: The presence of over 600 uniformed police officers in London is a deterrent to crime and terrorism (Loukaitou-Sideris, et al, 2006 p. 737). After the sarin attacks in Tokyo and the bombing in Madrid, additional security patrols were added (Loukaitou-Sideris, et al, 2006 p 734). In Medellín, from my observation, there are armed police officers in some of the larger stations along with uniformed transit personnel that are there for ticketing, on platforms and to help riders and answer questions. In all of the Medellín transit stations that I visited, I saw at least one transit personnel there to aid riders and in most of the larger stations, there was also at least one armed police officer patrolling.

The training of transit personnel and the implementation of security protocols where you are specifically looking at gaps in security is necessary. In October 2003 Paris' authorities staged a fake nerve gas attack to its Metro to gauge response effectiveness (Loukaitou-Sideris, et al, 2006 p. 736). Response training has to be tailored for the type of attack, as training would be different for fire or first-aid versus a bomb, biological, or gas threat. Citizen involvement can also serve a role in mitigating terrorist activity. London, with its history of terrorist attacks, has encouraged citizen awareness to a level that the London Underground has to deal with around 10,000 reports that go unattended every month (Loukaitou-Sideris, et al, 2006 p. 738).

5.6.4 Rider's Opinions: A rider's perception of security has an important impact on what mode of transport is selected but, at the same time, can be very subjective and not easy to quantify. In most cases, the more unsafe a user feels in the mode of transport, the least likely that they will use it. Brand and Davila assert that in utilizing transit, most residents accept the necessity of rules

of behavior, police presence, and administrative procedures as something positive or at least necessary. However, they do see that it provokes a degree of discomfort, resistance and inconformity (Brand & Davila, 2011).

A study by Heinrichs focused on women's perception of security in Medellín's transportation system. Women were chosen because they are less likely to own their own vehicle, more apt to travel with children, and more sensitive to unsafe situations. The results were that security plays an important role, especially for women. They did not feel secure in the Metro (light rail) system due to overcrowding and the possibility of being groped in crowded cars but felt more secure on the Metrocable because they are sitting in a gondola facing each other with an easy exit at any stop in case they need to switch to another car. Users also pointed out that the rehabilitation of the public spaces in proximity to the Metrocable transit stations improved the general security in the vicinity of the system (Heinrichs & Bernet, 2014).

5.6.5 Crime and Violence:

This section of the paper will discuss:

- The measure of the reduction in crime following the installation of the Metrocable in Medellín.
- The opinions of the residents of the poorer *communas* that now is served by mass transit, which would include the Metro and Metrocable, regarding their perception of the level of crime and violence before and after installation of these transit systems.

Background: The social urbanism projects developed in Medellín in relation to Metrocable have proved effective as a crime-prevention tool and served as a key to the social integration of the population in deprived neighborhoods that were previously cut off from the city center. As such, it has helped create a climate of peaceful co-existence which has resulted in a significant

decline in crime rates (Bea, 2016). The intervention of these large-scale public works projects has also been associated with significant declines in neighborhood violence with a drop in homicide between 2003 and 2008 that was 66% times higher in intervention neighborhoods than in control neighborhoods (Cerda et al, 2012). The construction of cable cars was accompanied by neighborhood upgrading, which included parks, new schools, housing and other infrastructure improvements, which also resulted in a decline in violence (Brand & Dávila, 2011).

Measurement: Bea produced a study in 2016 where he compared homicide statistics before and after the construction of the Metrocables that serve the poor communities of Andalucia, Popular and Santo Domingo [see Table 5.3] (Bea, 2016).

***Table 5.3*: Reduction in homicides before and after Metrocable**

Neighbourhood	Before Metrocable (1999-2003)	After Metrocable (2004-2008)	Rate
Santo Domingo	344	34	-90%
Popular	358	48	-87%
Andalucía	96	16	-83%

Cerda showed that interventions in a neighborhood's physical infrastructure could reduce violence. Neighborhood conditions and violence were assessed in intervention neighborhoods and comparable control neighborhoods before (2003) and after (2008) completion of the Metrocable transit project. The following Figure 5.12 shows the diminishing violence in 25 Metrocable intervention (I) neighborhoods and 23 matched control (C) neighborhoods in Medellín (Cerda et al., 2012).

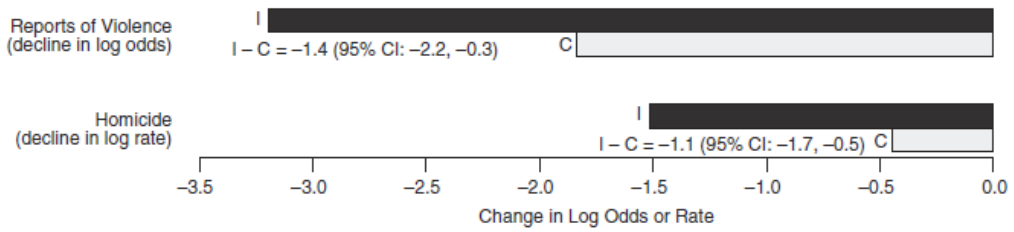


***Figure 5.12*: Reduction in violence – Metrocable (I) vs Control (C) neighborhoods**
from: (Cerda et al., 2012)

Resident Opinions: In his study, Sotomayor makes reference to interviews done in 2012, where residents reported that in their view, and as a result of the Metrocable improvements, the intensity and frequency of violent events have decreased and gangs have either dispersed or remained dormant. Also, residents feel proud of neighborhood improvements, such as the library park and sports fields that were done in conjunction with the transit project (Sotomayor, 2017). Brand mentions that "residents seem proud of what has happened in their communities and welcome visitors and tourists; once stigmatized, they now feel part of the city." (Brand & Davila, 2011).

5.7 Social Equity:

Metzger has defined equity planning as follows:

> *"Equity planning is a framework in which urban planners working within government use their research, analytical, and organizing skills to influence opinion, mobilize underrepresented constituencies, and advance, and perhaps implement policies and programs that redistribute public and private resources to the poor and working class"* (Metzger, 1996).

This model relies on planning issues to be resolved not through conflict but through a consensus-based approach and is used as a way of addressing poverty and racial segregation (Krumholz, 1982). 'Social Urbanism' embodies an equity approach to urban planning in Medellín. The questions that need to be addressed are:

- Has it been effective in Medellín? An evaluation from the literature on the effectiveness of the equity planning model that was initiated by the concept of 'social urbanism'.
- What is the role of local government and planners in the development of an equity-based, inclusive transportation system?
- What is the participation of the community in the design of the system?
    - Workshops held in the *communas*.
    - Inclusion of local residents in the construction of Metrocable.

5.7.1 Has it been effective? The tenacity of local government in Medellín to face the risks associated with a novel transport solution, particularly in areas with acute social tensions and poverty, is to be praised and has been effective for the most part. Social equity represented in the 'social urbanism' approach to planning has generated great returns in terms of inclusion through community consensus for the poor neighborhood *communa* area residents. It has also helped to address poverty through increased mobility for residents commuting to the city center. Some of the poorer areas of Medellín served by Metrocable are characterized by populations with a relatively high risk of social exclusion, compared to other parts of the city. The Metro and Metrocable have improved trip rates, which is one way to reduce the risk of social exclusion in the poorer districts and, in turn, improve the well-being of their inhabitants (Cordoba et al., 2014).

5.7.2 The role of government & planners

The Public Actors - The main public and private actors involved in the planning were:

- Mayor's Office of Medellín with its Planning Office.
- Metro Company of Medellín (created 1979) through its planning office gave "social participation" in the purchase of properties and the construction process, and highlighted the participation of citizens of the *communas* in urban management. This generated a sense of belonging among the communities and contributed to guaranteeing the sustainability of the project.
- PUI – Integrated Urban Upgrading Programme (Blanco & Kobayashi, 2009)
    - Part of the Medellín Development Plan of 2001-2003.
    - Integrated the aerial cable 'Metrocable' to the urban fabric.
    - Objective to promote new dynamics of social development, including the beautification of community spaces and pedestrianizing some areas (Castro and Echeverri, 2011).
    - Planners saw transportation as the backbone to urban transformation and believed that public transit in Medellín would bring benefits to the poor and improve "access and mobility options" that would generate "better living conditions" in the city (Brand & Dávila 2011).
    - First PUI included Line K and also included urban development around the metro stations.

The Private Actors - The consulting firms that carried out the technical studies and construction.

5.7.3 Community participation in the planning process:

Public Participation (Dávila (ed.), 2013)

- During the planning process, there were interviews with residents and users of the transport system that occurred in the Metro, in public spaces and on buses.
- Workshops were also held in the *communas* as part of the research [Figure 5.13].

Community Organizations (Valencia, Pulgarin & Florez-Acosta, 2009).

- The Metro gave "social participation" in the purchase of properties and in the construction process and highlighted the participation of citizens of the *communas* in urban management. This generated a special sense of belonging among the communities and contributed to guarantee the sustainability of the project
- One of the benefits to the communities that stand out is an expenditure of over US $500,000 for the hiring of unskilled personnel from the community for the construction of the K line (Sistema de transporte por cable aereo, 2012).

Figure 5.13: **Metrocable Line K – *Communa* workshop meeting**
from: www.eltiempo.com

5.8 Transportation System Assessment & Case Studies:

5.8.1 Assessment of a Transportation System: Since this study is an assessment of Medellín's transportation system, I will discuss here the attributes, factors and/or measures that I would use to determine whether Medellín's transportation system is successful, equitable and inclusive. The goal then becomes to assess how urban transportation systems in Medellín affect the quality of urban life and the factors that shape a traveler's experience, which include efficiency, affordability, availability, inclusiveness, convenience, and sustainability (Knupfer, Pokotilo & Woetzel, 2018). I will also briefly review a couple of successful transit systems in Latin America that have found world acclamation in the last decade or so.

Deteriorating transport conditions have a severe impact on the poorer population. If you look at poverty as "exclusion", accessibility by affordable transportation for the poor is essential for its role in facilitating access to stable income-earning employment and as a safety net for maintaining social relations (World Bank & Gwilliam, 2002). To be successful, designing an effective transportation service is not enough. It is also necessary to be able to refine and monitor the service on an ongoing basis. Ridership is also not enough, and it becomes necessary to answer additional questions such as:

- Whether transit mode share has increased?
- Have operating costs increased faster than ridership?
- Have passenger amenities and quality-of-service factors improved?
- Is transit meeting security, social equity, quality of life, ecological sustainability, and economic development goals? (Tumlin, 2012).

Performance metrics for a transportation system have to be developed and can be relatively simple but also need to be broad enough to encompass community objectives and the full range of

transportation services. In most urban transit, the factor that is one of the most important to measure is 'delay' and not the measure of 'speed' alone (Walker, 2012 pg. 98). For example, in a multi-modal system like Medellín's, delay in the frequency of Metro train arrivals added to delays in rail-to-BRT or rail-to-Metrocable connections can add significantly to travel time. Measurement factors that need to be considered are:

- Customer satisfaction:
    - This would include on-time performance and reliability as experienced by riders.
    - Rider Comfort
    - Rider perception/reality of personal security while using the system.
    - Wheelchair/disadvantaged accessibility.
- Cost-effectiveness:
    - Subsidies per trip for students, seniors, and disadvantaged.
    - Cost of monthly public transport ticket as a percentage of average income.
- Speed, safety and frequency of service:
    - Average effective speed of system studied during peak periods.
    - Safety: miles between accidents
    - Delay and Waiting time
- Capacity: passengers per hour.
- Transit mode share
- Economic benefits
- Environmental impacts
    - Air quality and noise pollution.

Measurements based on demographics as compared to the level of transit service in disadvantaged communities can be used to determine if transit service is equitable. Passengers should also be surveyed on a regular basis, which can include on-board, online, or mail-back surveys. On-time performance using vehicle sensors can provide data metrics, which would also aid in gauging customer satisfaction. Transportation services can also be compared with cities of similar size and form (Tumlin, 2012). Indicators of access range from proximity to transportation services to a variety of indicators of accessibility which can be the locations of relevant markets such as grocery stores and the physical connections which would include time and distance to those markets (Berg et al., 2015).

In summary, to adequately assess if Medellín's transportation system is successful, equitable and inclusive, it becomes necessary to study and determine:

- First: What travel options are available within and outside of the city and how affordable is transportation for the residents?
- Then: To assess the efficiency and convenience of the different transportation elements in regards to speed, delays and predictability of commuting time, and
- Finally: To analyze the sustainability of the transportation system as regards security, safety and environmental impact (Knupfer, et al, 2018).

5.8.2 Successful transportation systems in Latin America: A new paradigm recognizes that the ultimate goal of most transport activity is accessibility, which refers to people's overall ability to reach desired services and activities, and not merely mobility. This new paradigm requires a multi-modal evaluation, which expands the range of objectives and options considered in the planning process (Litman, 2015). The problem with public transportation is the time involved in getting to the bus or subway stop, waiting to be picked up, and then getting from the final stop to

one's ultimate destination. That time cost, which is independent of the distance of the journey, averages about twenty minutes for buses and subways. This is particularly important in a large growing city like Medellin, where a major portion of households cannot afford cars. The following systems in Latin America and Asia have been successful in improving affordability, accessibility for the user as well as resulting in a reduction in vehicular congestion.

Bus Rapid Transit (BRT): Curitiba, Brazil, is recognized as a model of urban planning. Since the 1970s Curitiba's administrators have constantly achieved innovations with the city's bus-based transit system through performance and capacity improvements and created the first full bus rapid transit system in the world with high capacity bi-articulated buses and electronic fare ticketing systems (Lindau, Hidalgo, & Facchini, 2010, October). Quito and Bogotá also decided to implement busway-based mass transit, copying several of the features of Curitiba and adapting them to their own circumstances. The success was immediate, and planners from around the world have been visiting those three cities to learn from their experience. Bus Rapid Transit is now being planned in many cities on all continents. (Menckhoff, Consultant, & Bank, 2005). In Bogotá, bus-based BRT corridors and feeder services have improved road safety and air quality. Crime, land values, employment, and tax revenue have also been positively impacted by these improvements (Hidalgo, et.al, 2013). Medellin has now implemented BRT routes in the city.

Unfortunately, transit in developing countries has in many cases been guided by the singular objective of enhancing mobility with a need by city leaders to see results while they are still in office resulting in a perspective that is short term and narrowly focused such as, for example, the goal of 'relieving congestion' (Suzuki, Cervero & Iuchi, 2013).

Cable Car Systems: Geographical and topographical barriers and infrastructure costs may not permit the implementation of conventional public transportation systems such as light rail and buses (Pojani & Stead, 2015). Using aerial ropeways in urban environments has gained more

attention worldwide, and cities such as Medellin, Bogota, and Caracas have incorporated gondolas and aerial tramways into their public transport networks creating effective urban transport solutions. They are cheaper than light rail, can access topographically challenging terrains and become part of a policy to reduce greenhouse gas emissions (Alshalalfah, et al, 2014). However, these systems move fewer passengers per hour than rail or BRT.

Vehicular congestion: Singapore has reduced congestion on its streets by adopting electronically charged (by transponder) congestion pricing in 1975. It also was able to maintain its green areas by building up (Glaeser, 2011).

Toxic Emissions: A well-to-wheels Life Cycle Assessment (LCA) was developed for the TransMilenio BRT system (diesel-powered) and compared it with the LCA from other modes of transportation used in Bogota: gasoline-powered vehicles (motorcycles, private cars and taxis) and diesel-powered vehicles (traditional buses). LCA results revealed that TransMilenio is the vehicle category with the lowest emissions of CO^2 eq, CO, and NO^x per kilometer and passenger (Cuellar, Buitrago, & Belalcazar, 2015, April). If this is the case for diesel fueled BRT, then the case can be made that electrically powered light rail, streetcars and cable cars, as is the case in Medellin, would fare well.

5.8.3 Bogotá & Curitiba BRT Systems:

The following are two examples of Bus Rapid Transit (BRT) from Latin America that have involved longer-term planning and have been mostly successful and that will help comparatively in the assessment of the success of Medellín's system. The first is the TransMilenio BRT in Bogota, Colombia, and the second is the BRT in Curitiba, Brazil. After researching these two transportation systems, I discovered case studies regarding these BRT systems (Bocarejo, et al. 2014 January) (Lindau, et al. 2010 January), but that did not thoroughly address the key ideas of

'success, equity, and inclusiveness'. I have included with these examples scholarly papers that address what is lacking in the case studies that address these key points.

Bogotá, Colombia – 'TransMilenio': Bogotá, the capital of Colombia, is a city of approximately 7.5 million in a metro area of 10.7 million inhabitants. Mayor Enrique Peñalosa was responsible for the physical transformation that created Bogota's 'TransMilenio' Bus Rapid Transit (BRT) system which expanded over several years with 2 Phases implemented between 1998 and 2006 (Hidalgo, Custodio & Graftieaux, 2007). A third phase began operation end of 2011 (Bocarejo & Oviedo, 2012). His administration planned and opened TransMilenio Phase 1 in 2000, which became the first mass transit system for Bogota. He started by overhauling the city's transport policy giving priority to pedestrians, and with the goal of developing a quality mass transit system. Over 300 kilometers of bikeways were built, also giving priority to cyclists and linking them to the new TransMilenio BRT system. This BRT became capable of moving 45,000 passengers at 29kph during peak hours. Successive mayors after Peñalosa continued support and expanded the BRT to an 84 kilometer, 1.4 million passengers/day network with the opening of Phase 2. This work also included the expansion of sidewalks and adding more bikeways (Despacio, 2008). The system has expanded further with the completion of Phase 3 [see Table 5.4].

Table 5.4: **Capacity and Infrastructure of TransMilenio BRT**
from: (Suzuki, Cervero & Iuchi, 2013)

Feature	Figure
Daily Carrying Capacity	More than 1.5 million
Covered Populaton	66% within 1 km. of the trunk and feeder buffer zone
Phase I	42 kilometers
Phase II	42 kilometers
Phase III	28 kilometers
Feeder System	200 kilometers
Source: World Bank study team	

Some of the pros of this BRT system are:

- Planning and implementation were successful and done in a short time.
- A good institutional arrangement with distribution of responsibilities, incentives and risks in project development and operation.
- Competitive bidding process for system operators with operators funded with fare revenues (no operations subsidies provided).
- High performance: 29 km/hr., 1200 px/per bus per day. Initially, the service received good ratings from riders (Hidalgo et al., 2007).

Hidalgo points out that an ex-post evaluation of TransMilenio Phases I and II shows a positive impact that the infrastructure investment has brought to the city of Bogotá, which shows the potential of providing BRT services to a city like Medellín which is currently developing its BRT system. Positive impacts also include reduced fatalities and injuries by taking some automobiles and smaller circulating diesel buses off the roads, resulting in better air quality. The study also outlines a decline in crime as well as an increase in tax revenues, employment and land values. However, apart from these positive indicators, Hidalgo mentions a decline in how the rider perceives the system along with a need for improving service (Hidalgo et al., 2013).

There has also been an increase in building density in areas served by TransMilenio, but surprisingly, areas away from the BRT saw a greater (9.8%) increase [see Figures 5.14 & 5.15]. Most of the structures along TransMilenio in Bogota are two and three story except for the CBD. Restrictive Floor area ratio (FAR) controls and a lengthy approval process restricts the pace for urban regeneration projects; thus, the development potential of these areas remains unrealized (Suzuki, et al, 2013). This lack of significant land-use changes near BRT stops in Bogotá has been due to lack of strategic station-area planning but also by the practice of sitting stations and lines in busy roadway medians and intersections and within stagnant urban districts (Cervero & Dai, 2014).

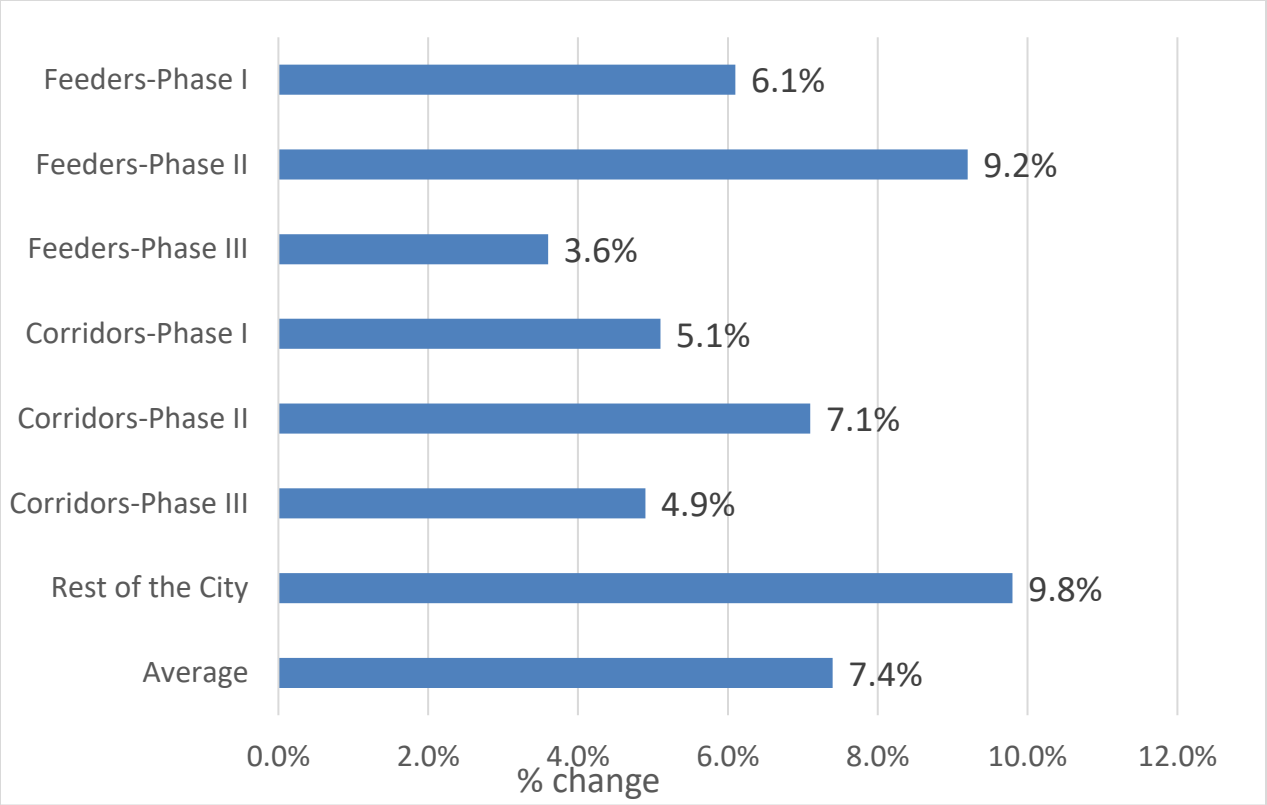


Figure 5.14: **Changes in building density in areas affected by TransMilenio**
from: (Suzuki, Cervero & Iuchi, 2013)

Comparing Curitiba to Bogota, Curitiba has been able to create articulated densities with higher FARs (Floor Area Ratios) along its BRT corridors while Bogota's TransMilenio has a low FAR except in the CBD (Suzuki, et al, 2013).

The question now is whether Bogota will continue to be on the cutting edge of BRT transportation. There is now occurring a shift from public transport to private vehicle use which exceeds the shift from private vehicles to mass transport. Modeling done by the Universidad de los Andes saw that with no system improvements, traffic would be paralyzed by 2012 (Despacio, 2008). Transit demand has now exceeded ridership projections due to the fact that the system has not expanded as initially planned (Bocarejo et al, 2014 January). Jaime Ortiz-Mariño, and advisor to Bogota's Mayor Moreno Rojas (2008-2011), saw that the shift from mass transport to private vehicles was also a vital issue for congestion (Despacio, 2008).

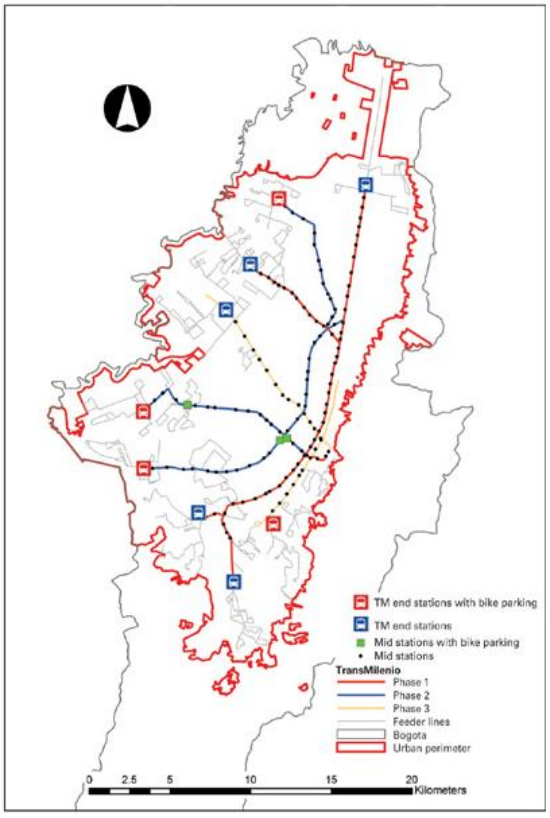


Figure 5.15: **TransMilenio -Phases I, II and III**
from: (Suzuki, Cervero & Iuchi, 2013)

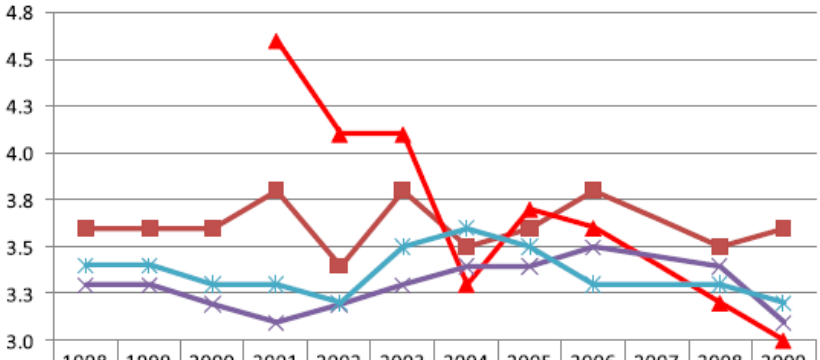
Equity and Inclusiveness: Bogota did not have in the 1990s, and not until around 2008, real citizen participation and advocacy for mass transport. Groups of citizens such as "Bicibogota" then began to form promoting policies representing the city's cyclists. The local Chamber of Commerce also took the lead in proposing improvements to transport projects advocating greater priority for people-centric transportation options as well as a re-evaluation of existing policies (Despacio, 2008).

The amount of time and the percentage of income that an individual spends on commuting determine the accessibility of a transportation system. TransMilenio has provided better conditions for mobility for most of the city's inhabitants. The third phase for Bogota's BRT seeks to develop a bus corridor to connect the north and south of the city on its east side, which are more

impoverished areas that have seen considerable growth. Bocarejo, et al. considers an increase in the accessibility for these study areas given the increase in travel speed for riders (Bocarejo & Oviedo, 2012).

In order to access the level of equity and inclusiveness of TransMilenio it is necessary to determine the affordability of the system for all income users as well as its accessibility to individuals based on gender, mobility and personal safety. TransMilenio has had a positive impact in terms of travel time savings, but the cost may have increased for some users, and this fare increase may be a critical issue for a large part of the population that the BRT serves (Bocarejo & Oviedo, 2012). The system has seen fare increases based on the cost of inputs such as fuel costs, maintenance, etc. However, the fare has increased more quickly than the rate of inflation especially due to fuel costs. The fares are also higher than for traditional bus routes up to as much as 30% (first quarter 2007). User satisfaction is also trending downward [see Table 5.5]. The red line signifies the large decrease in user satisfaction with the system between 2001 and 2009 (Hidalgo et al, 2013).

Table 5.5: **User rating for TransMilenio BRT (Hidalgo et al., 2013)**

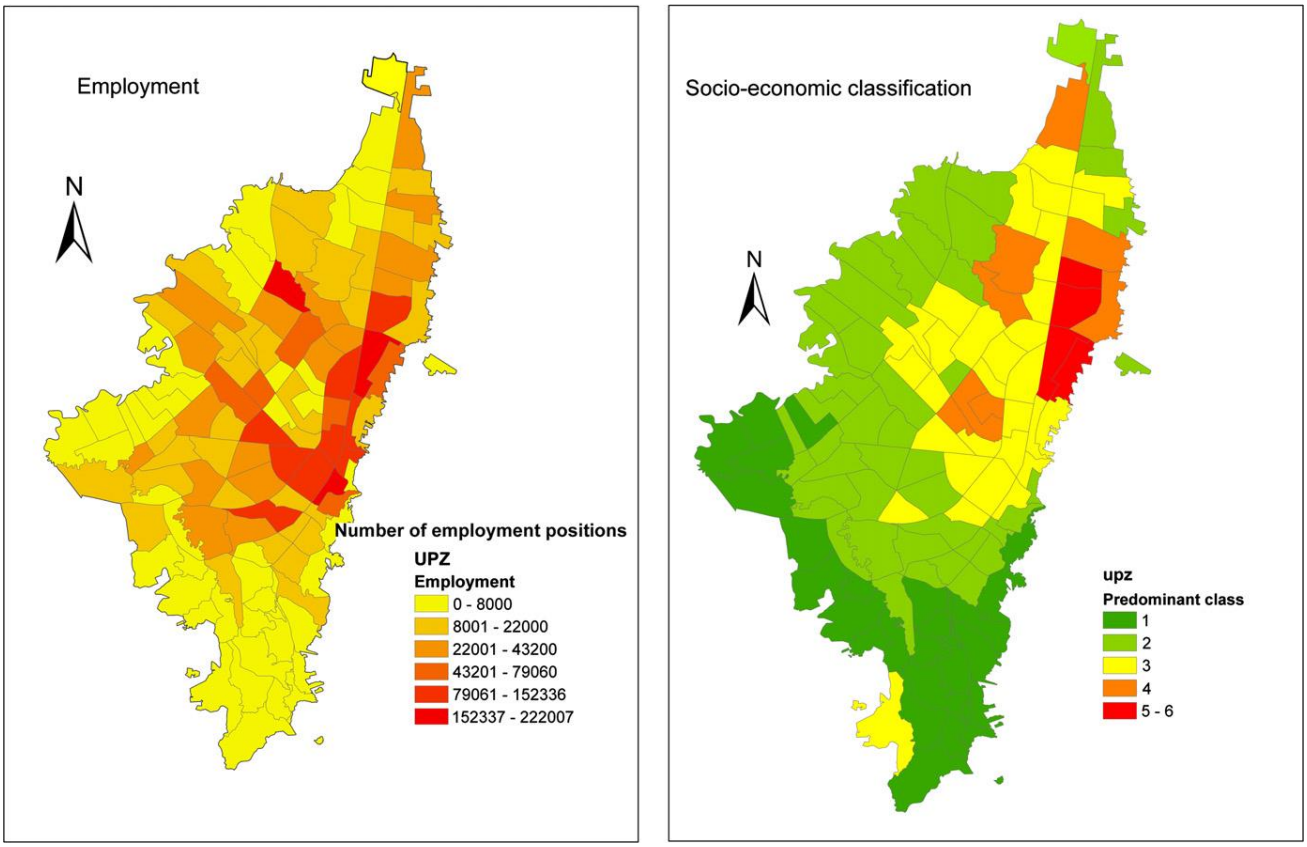


	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Colectivo	3.6	3.6	3.6	3.8	3.4	3.8	3.5	3.6	3.8	3.7	3.5	3.6
TransMilenio				4.6	4.1	4.1	3.3	3.7	3.6	3.4	3.2	3.0
Bus/Ejecutivo	3.3	3.3	3.2	3.1	3.2	3.3	3.4	3.4	3.5	3.5	3.4	3.1
Buseta	3.4	3.4	3.3	3.3	3.2	3.5	3.6	3.5	3.3	3.3	3.3	3.2

The main complaints from users of TransMilenio include crowded buses with low frequency both in trunk and feeder lines, insecurity mostly due to theft, as well as delayed routes. The decline in user satisfaction is also due to the slow expansion of the system after 2006, as well as a deteriorating infrastructure due to insufficient maintenance. Operational improvements are necessary for essential service aspects such as security, reliability, and system capacity with service improvements in bus feeder services [Figure 5.16] (Hidalgo et al., 2013).

Figure 5.16: **TransMilenio – Peak Period**
from: www.wrirosscities.org

There has also been a shift in the poorer areas of the city to the urban fringes. This has also been the case in Curitiba and will also be discussed. The following maps [see Figure 5.17] by the Planning Department of the District of Bogota (Secretariat Distrital de Planeacíon de Bogota, 2005) shows where the employment centers are located (Map A-dark red) and where the poorer inhabitants of the city live (Map B-green areas 1 & 2) based on a scale of 1 to 6. The socio-economic segregation is dramatic with the more impoverished people living the farthest from employment centers and hence having the longest commuting times (Bocarejo & Oviedo, 2012).



Map A Map B

Figure 5.17: **Employment and income distribution of Bogota**
from: (Bocarejo & Oviedo, 2012)

Bogota's planning system follows the same structured planning system found in some cities in developed countries like Barcelona, Spain. A Territorial Ordinance Plan (POT) adopted in 2000, guides its spatial development. The current POT sees Bogota in the mid to long term evolving into a compact, dense and integrated city with a mobility system that prioritizes pedestrian over vehicular and public over private transportation along with a higher density along its BRT corridors (Suzuki, Cervero & Iuchi, 2013).

Even though Bogota has enhanced urban mobility, promoted social equity, increased economic efficiency, and improved environmental conditions with TransMilenio; due to the

absence of proactive planning, market forces have steered urban growth away from the BRT corridors. In contrast to Curitiba's BRT, this case reveals that planning for mobility took priority over concerted efforts to reshape the city and for achieving a long-term vision of urban form through BRT investments (Suzuki, Cervero & Iuchi, 2013)

Curitiba, Brazil - BRT*:* Curitiba, Brazil is recognized as a model of urban planning. It is a city of 1.8 million with a metro area of 3.17 million. It was the first city in the world to implement a full BRT system with high capacity bi-articulated buses and electronic fare ticketing systems [Figure 5.18]. Since the 1970s Curitiba's administrators have consistently achieved innovations with the city's bus-based transit system through performance and capacity improvements. Curitiba's experiences in BRT show the payoff with linking good urban planning practices with investments in BRT over multiple decades (Cervero & Dai, 2014).

The success of its system is derived from a mix of innovation, political leadership, pragmatism, continuity and technocracy. The city has a long history of transport innovations as well as in land use and environmental management. However, the city did face turmoil when the status quo was challenged by political administrations, promoting change. Also, the city has one of the highest private car ownership rates in Brazil with 400 cars per 1,000 inhabitants. Unfortunately, as of 2010, the city had not conducted a home-based origin-destination survey (Lindau, Hidalgo & Facchini, 2010 October). Even though the city shows a high car ownership rate, it has a 45% share of motorized trips by transit, which is the highest in Latin America and this transit use has helped lessen the city's environmental footprint (Suzuki, Cervero & Iuchi, 2013).

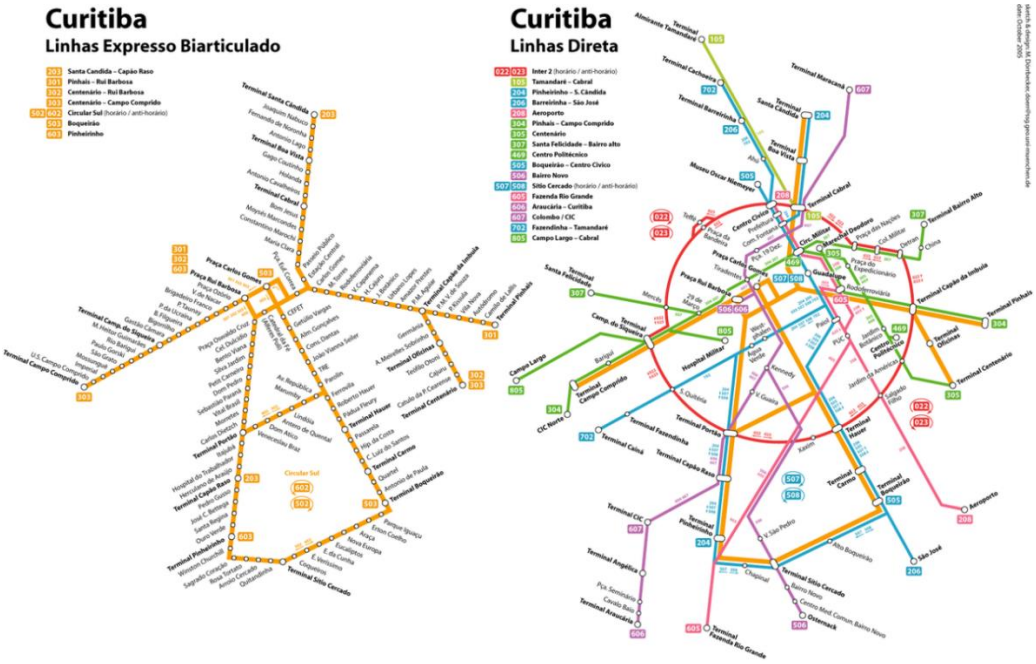


Figure 5.18: **Curitiba BRT System**
from: (https://en.wikipedia.org/wiki/Rede_Integrada_de_Transporte)

Curitiba has been unique in Brazil in that it has utilized a coherent system of regulation and political stability along with comprehensive long-term planning and land-use strategies. It has used the funding that was available since the 1970s to invest in busway corridors instead of just bus system performance improvements. The city, as the cradle of the BRT concept, introduced busways and feeder services in the 1970s and the 'Integrated Transit Network' (RIT) in the 1980s, which included level access for riders, prepayment systems and large buses with multiple doors. This bus system has been continually upgraded to become the first full BRT system in the world (Lindau, Hidalgo & Facchini, 2010 October).

In 1990, the State of Parana and City of Curitiba developed a legal arrangement guaranteeing continuity as regards urban planning, traffic and transit solutions. This arrangement, now the Integrated Transit Network (RIT), thus became a rare case where successful planning solutions transcends political administrations (Lindau, Hidalgo & Facchini, 2010 October). The RIT (as of 2010) covered 14 of the 26 cities of the metro area and was conceived around 'structural axes,

which constitute the backbone of a TOD initiative. This initiative which was accompanied by zoning ordinances allowing for higher density in proximity to the bus corridors proved successful in achieving a linear TOD (Lindau, Hidalgo & Facchini, 2010 October).

An interesting contrast is how Curitiba (population 3 million) and Sao Paolo (population 16 million) have managed urban growth. Curitiba's master plan channeled growth along BRT corridors with mixed land uses and intensified land development at key BRT stations while Sao Paolo did not. This has produced a dramatically different urban form between the two cities [see Figures 5.19; a & b] (Suzuki, Cervero & Iuchi, 2013).

a. Linear Density – Curitiba b. Unplanned Density – Sao Paolo

Figure 5.19 a&b: **Urban Form of Curitiba and Sao Paolo, Brazil**
from: (Suzuki, Cervero & Iuchi, 2013)

This initiative, which was accompanied by zoning ordinances allowing for higher density in proximity to the bus corridors proved successful in achieving a linear TOD. Bus services now include express, local and feeder services as well as 'circulator' buses in the downtown area. An electronic fare collection system was introduced in 2002. In 2007, 2,200 buses logged 483,000 km per day and approximately 1,027 boardings/bus/day. The RIT system includes 72km of busway corridors with 347 tube stations that allow for level access and prepayment. Additional express passing lanes for buses that don't stop at every station were introduced in March of 2010 that increased the capacity of the main Boquieirao Corridor to 20,000 passengers per hour per

direction (Lindau, Hidalgo & Facchini, 2010 October). The city also stands out for its comparatively small environmental footprint. It has developed a "trinary" road system, which is three parallel roadways. Along these roadways are compatible land uses and building heights that are higher in proximity to the center roadway and that taper down with distance from the BRT corridor. These urban design standards and zoning restrictions help promote ridership [see Figure 5.20] (Suzuki, Cervero & Iuchi, 2013).

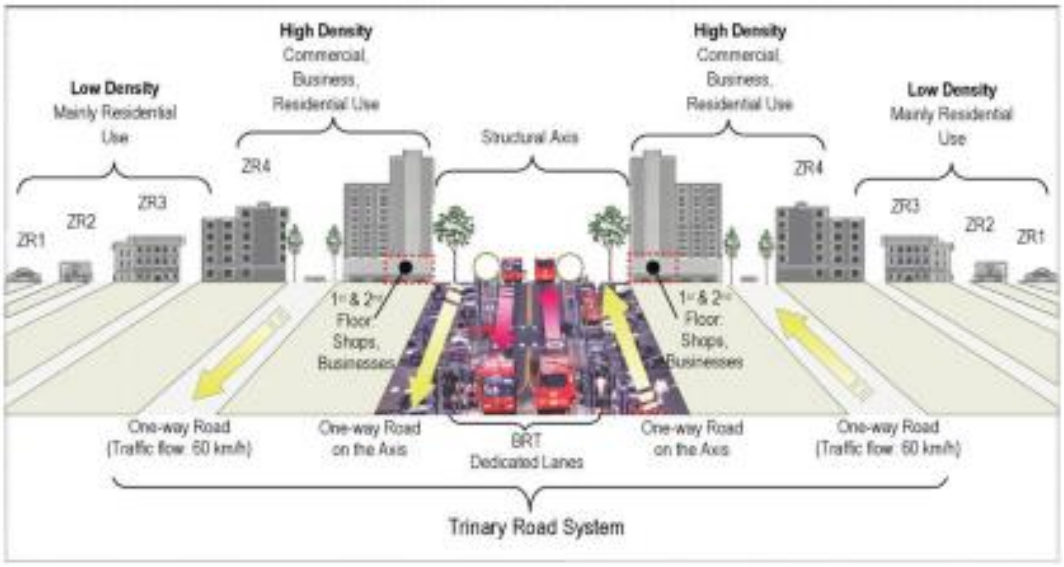


Figure 5.20: **Curitiba trinary road system**
from: (Suzuki, Cervero & Iuchi, 2013)

Equity and Inclusiveness: Since 1980, riders in Curtiba have been able to utilize a single flat fare on the bus system that allowed interchange between trunk (long-distance) and feeder (short distance) services. Also, gratuities in Curitiba's BRT system constitute 16% of the flat fare and include free services for those 65 and older, children less than five years, the disabled, policemen, transit workers, postmen and some government workers (Lindau, Hidalgo & Facchini, 2010 October).

Mercier notes that with the increase in the 'metropolisation' of Curitiba has come to an increase in citizen's need for participation which would result in participative/flexible transport

policies for the city, but he goes on to say "that there are no signs of a substantial move towards interactive-participative models at the present time in Curitiba transport policies" (Mercier, Duarte, Domingue, & Carrier, 2014 June).

There has also been a migration of the poor from the city to surrounding areas for economical reasons that has recently intensified. These areas have become 'dormitory cities' whose workers are economically dependent on the central city. Around 25% of 2.3 million daily trips on the RIT network go to these outlying areas, and this exodus from the city has created economic pressure on the State of Parana and the city to keep the transit fare at 2.7 reals ($ 0.48) while the cost is actually 3.13 reals ($ 0.56) (Mercier, et al, 2014 June). This 'flat fare' is deemed 'social' in Brazil because the poor residents that live in the outlying areas are paying the same fare as those with higher incomes that live close to downtown (Lindau, Hidalgo & Facchini, 2010 January).

Chapter 6. MEDELLíN – TRANSPORTATION SYSTEM ASSESSMENT

This chapter will focus on assessing Medellín's mass transportation system. Several studies have been very helpful for the research and constitute the basis for this chapter. A brief description of these sources is provided below:

6.1 Studies and Sources:

- Encuesta Origen-Destino (EOD) 'Origin-Destination Survey' is a quantitative survey taken by the 'Area Metropolitana Valle de Aburrá' (AMVA) at approximately 5-year intervals to gauge transportation use in the city.
- Medellín Cómo Vamos (MCV) 'Medellín How We Go', a yearly privately funded quantitative/qualitative study that uses some data from EOD as well as its own yearly survey data to gauge the quality of life in the city which includes mobility. It is a document that serves to determine the habits and transportation needs of residents and their perception of the transportation system. The study is targeted toward the head of household and/or the individual who is more apt to travel in the household.
- DANE: The Colombian office for national statistics called 'Departamento Administrativo Nacional de Estadística' (DANE). DANE categorizes housing areas and neighborhoods by strata or bands for the purposes of taxation on public services. The method for categorizing areas is based on a real estate classification system termed 'Estratos' to differentially identify the taxation due for public services, to allocate subsidies and collect contributions in the said area. The 'Estrato' bands used by DANE range from 1 to 6, with Estrato 6 being the highest ratable real-estate where the most affluent live [see Figure 6.8].

- Personal Interviews: Seven personal interviews were conducted by this author in October of 2019 with Medellín planners, transportation officials, and academics all of which were edited and approved by the authors for publication in this dissertation.

Also, the following symposium was held at the University of Antiochia and chaired by Medellín's transportation and planning experts outlining the future plans that the City has for the improvement and enhancement to its transportation system [see Chapter 7.2, pg. 126].

- Medellín Sustainable Mobility Symposium – University of Antiochia
    - 'Simposio Taller de la Movilidad Sostenible' – 16 October, 2019

6.1.1 Encuesta Origen-Destino (EOD) – Quantitative Survey: The Encuesta Origen-Destino (EOD) is carried out by the Metropolitan Area of the Aburrá Valley (AMVA) about every five years. It is a document that serves to determine the habits and mobilization needs of the inhabitants in order to determine who is using private vehicles (cars and motorcycles), the city's mass transportation system (metro, cable cars, buses and tram), privately-owned municipal buses, bicycles or on foot. It is a very large and complex study, and for that reason and for its cost, it is done about every five years. For this dissertation, I will mostly focus on the most recent studies done in 2005, 2012 and 2017.

On April 24, 2018 the results of the Origin-Destination Survey for 2017 were completed for the Metropolitan Area of the Aburrá Valley. The Survey is the update of the versions carried out in 2005 and 2012, and constitutes a very important tool for mobility and territorial planning in the Medellín's metropolitan region.

The 2017 study was carried out as follows: (EOD, 2017)

- An average of 2,000 polls was taken weekly for a total of approximately 114,000 surveys.

- Over 16,340 household surveys were completed that were proportionately weighted based on the number of inhabitants in each of 10 municipalities in the metropolitan area (Estudian cómo se está moviendo, 2017)

A comparative analysis with the 2005 study shows that the number of trips that take place daily in the Aburrá Valley has increased significantly since 2005 from 4.87 million in 2005 to 6.13 million in 2017, representing a growth of 26 %. [Figure 6.1].

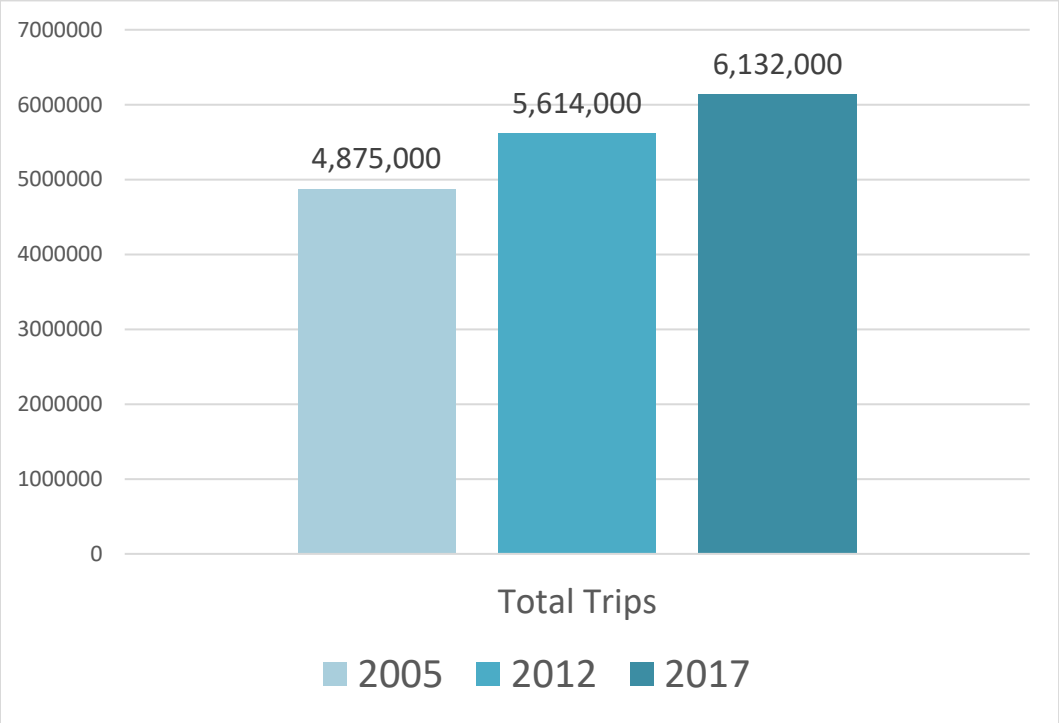


Figure 6.1: **Number of Trips 2005 - 2017**
from: (EOD, 2017)

The greater number of trips has also been accompanied by an increase in the proportion of people traveling daily. The percentage of people who travel regularly in the Aburrá Valley increased from 65% to 69% between 2005 and 2012, and in 2017 it reached 74%, a 9% increase from 2005, which means that more than 7 out of 10 people make trips every day [Figure 6.2].

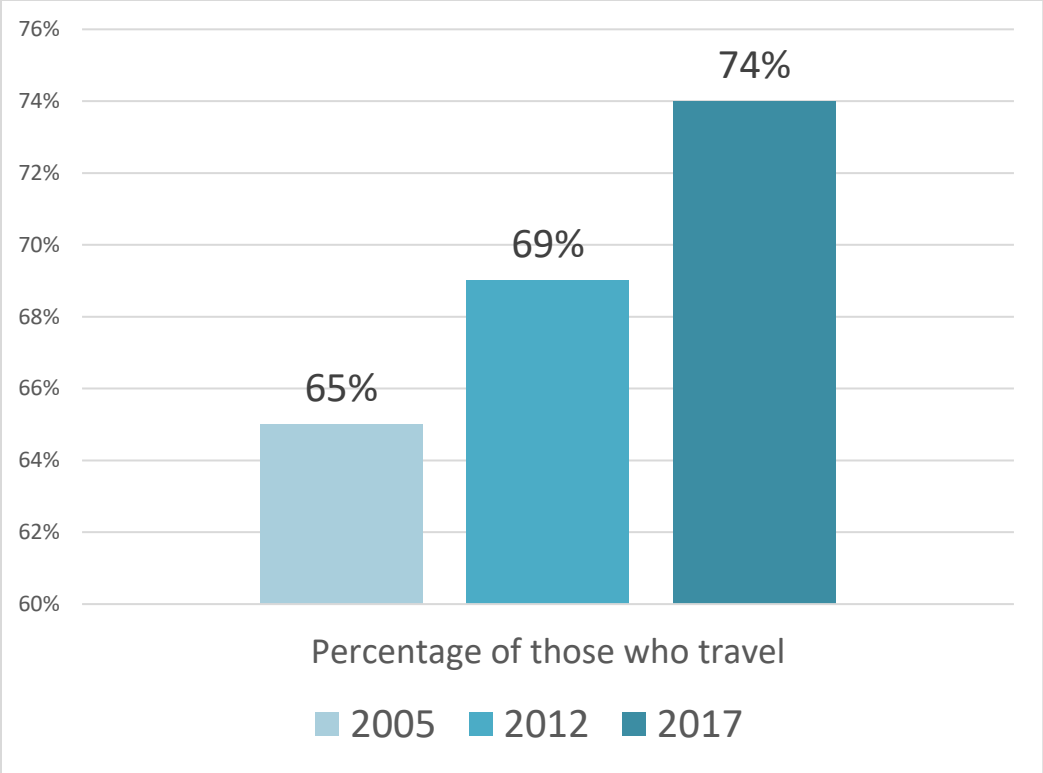


Figure 6.2: **Percentage of Those Who Traveled 2005 - 2017**
from: (EOD, 2017)

Each of the 6.13 million daily trips made in the Aburrá Valley in 2017 takes 36 minutes on average, 11 minutes longer than the same trip took in 2005. The average travel time increased; between 2005 and 2012, where it went from 25 minutes to 33 minutes, and in 2017 it reached 36 minutes [Figure 6.3] (EOD, 2017). Several reasons explain the increase in average travel time. These include population increase, greater congestion due to increased vehicle ownership, longer traveling distance, and the increase in total trips adding to congestion, which would account for the 26% increase (1.2 million more) as compared to 2005.

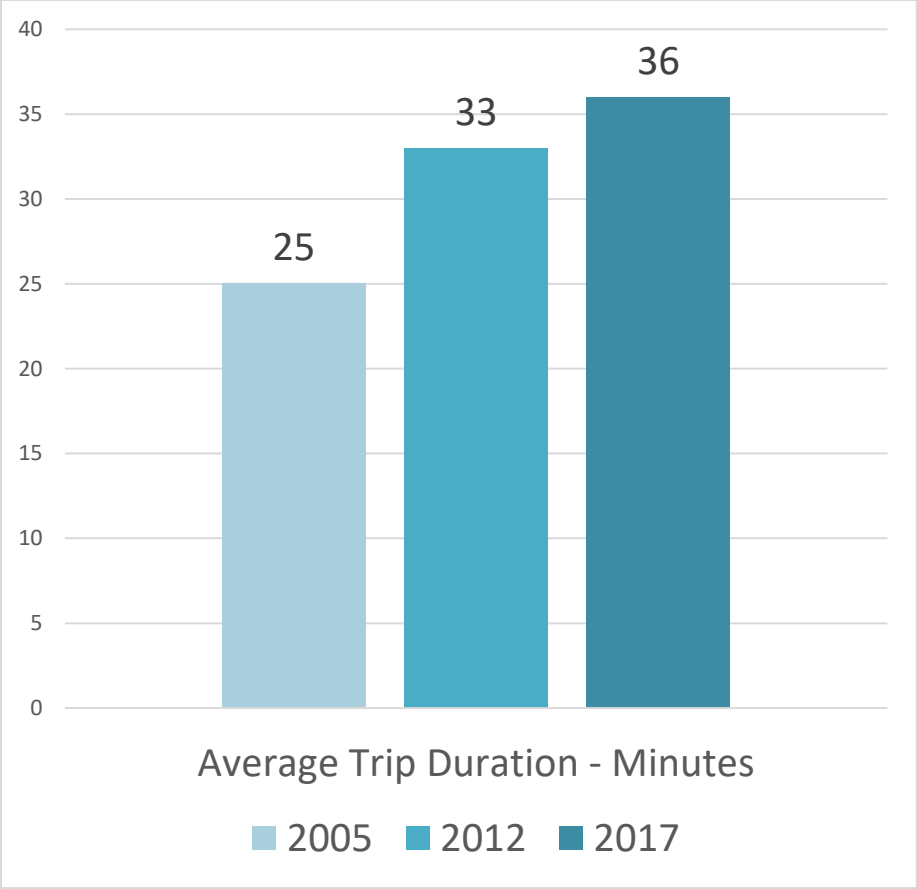


Figure 6.3: **Average Trip Duration 2005 – 2017**
from: (EOD, 2017)

Piedad Patricia Restrepo, director of Medellín Cómo Vamos (MCV), considered that the increase in the number of journeys is typical of growing economies and the greater purchasing power of an emerging middle class. However, the most determining factor for the increase in travel times is the increase in the number of private vehicles (Jiménez, 2018). Between 2005 and 2017 motorcycle ownership increased 207%; and car ownership increased 46% [Figure 6.4].

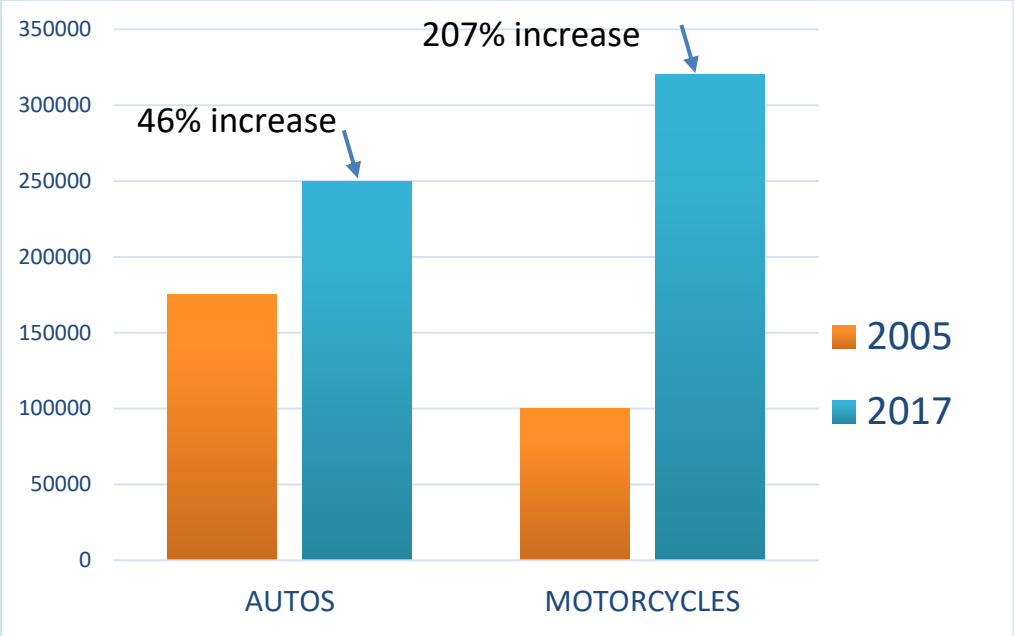


Figure 6.4: **Vehicle Ownership, 2005 & 2017**
from: (Jimenez, 2018)

If you examine the distribution of modes of travel for 2012 and 2017 from EOD data [Figure 8-5], trips by bus were reduced considerably by 10%, with Metro + Cable seeing an increase of 5%. Car use decreased by 2% from 15% to 13% even though vehicle ownership increased due to population surge, while motorcycle use went from 11% to 12% while taxi use went from 6% to 7%. Pedestrian means of travel increased from 26% in 2012 to 28% in 2017 (EOD, 2017).

The EOD Survey of 2017 shows that of the 6,132,000 trips made every day [Figure 8-1] in the Aburrá Valley, 1,778,000 (29%) are made by bicycle and walking (1%+28%%), 2,084,000 (34%) of trips by public transport which includes BRT, Metro and Bus (1%+15%+18%), and 1,533,000 (25%) through trips by auto and motorcycle (12%+13%) [Figure 6.5]. It is important to note here that the Metroplús BRT only became operational in 2012 [Figure 1.2, pg. 8]. During a 24-hour period, the highest travel use is for work and study (22%+11%=33%) with peak travel periods between 6 and 7 am and 4 and 6:30 pm (EOD, 2017).

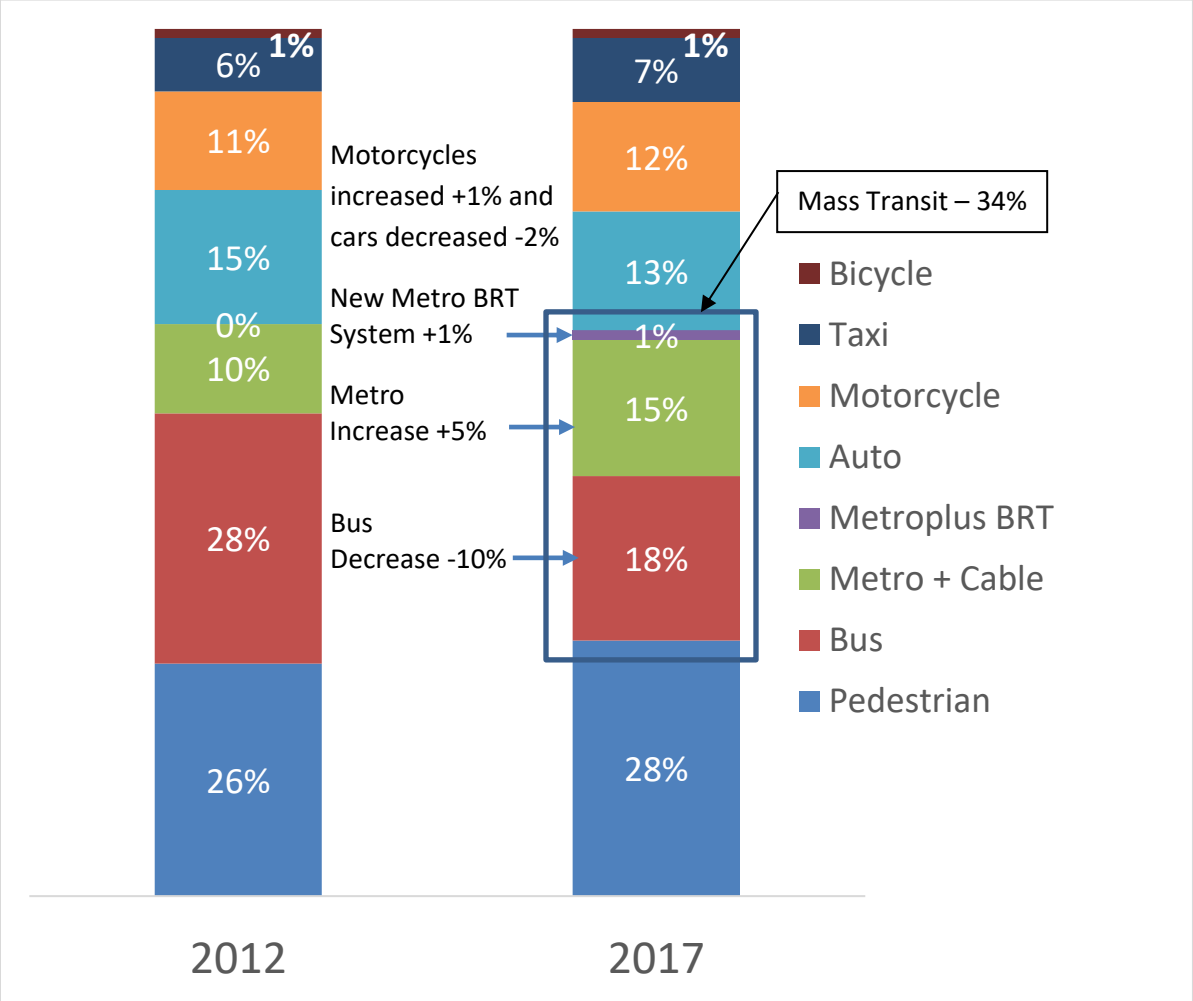
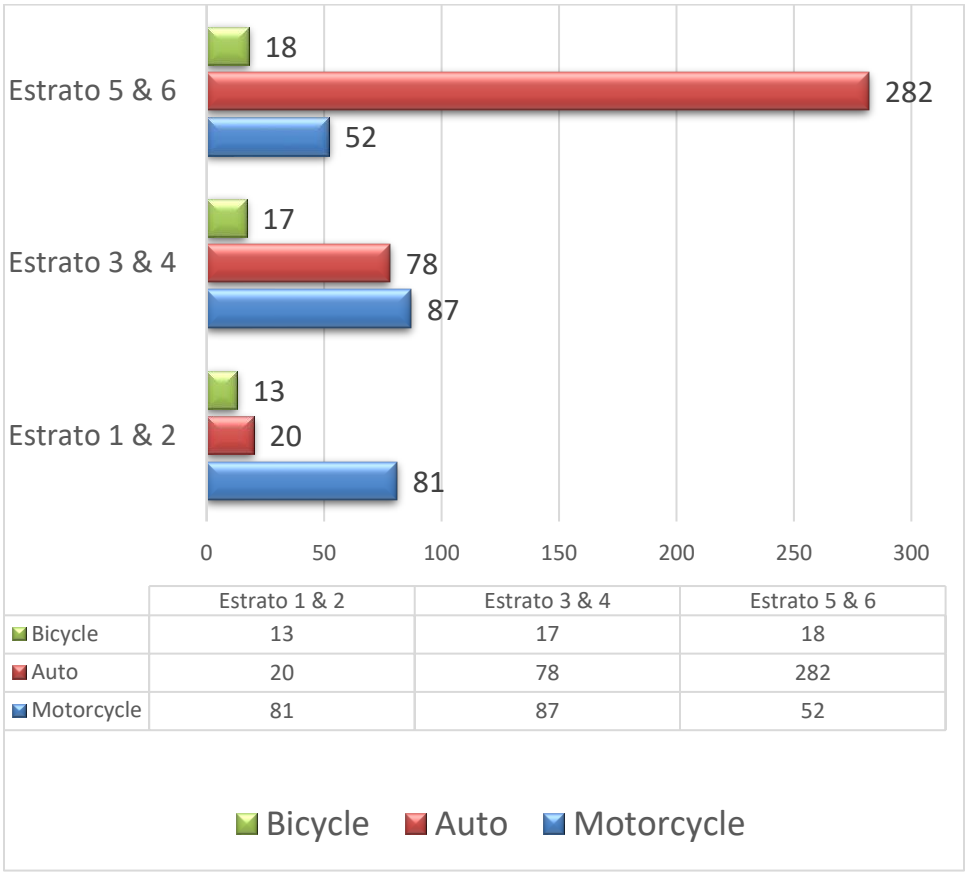


Figure 6.5: **Distribution by Modes of Travel, 2012 & 2017**
from: (EOD, 2012) (EOD, 2017)

Carlos Cadena Gaitán, the academic coordinator of URBAM, an urban planning arm of Medellín's EAFIT University, explained that there is a direct relationship between the decrease in bus participation [Figure 6.5] and the increase in motorcycle ownership [Figure 6.4], due to the lack of efficiency of public transport (Jiménez, 2018). Another of the findings of the 2017 Encuesta Origen-Destino (EOD) is that the morning rush hour is occurring earlier. According to Viviana Tobón, Deputy Director of Mobility of the Metropolitan Area, in 2005 peak travel time

was between 7:00 a.m. and 8:00 a.m., but in 2017 peak travel is between 6:00 a.m. and 7:00 a.m., when 11% of all daily trips are made (Jiménez, 2018).

Vehicle ownership is broken down in the following Figure 8-6 by types of vehicles owned and according to the level of income of the individuals based on tax 'Estrato'. It is interesting to note here that the most affluent areas in Estrato 5 & 6 exhibit the greatest auto ownership of 282 per 1000 population [Figure 6.6] (EOD, 2017).



	Estrato 1 & 2	Estrato 3 & 4	Estrato 5 & 6
Bicycle	13	17	18
Auto	20	78	282
Motorcycle	81	87	52

Figure 6.6: **Vehicle Ownership per 1000 Population, 2017**
from: (EOD, 2017)

Not only does the lack of efficiency in public transport spur private vehicle use, but also there are many more that can now afford to buy a motorcycle and even a car due to the reduction of poverty in the city between the years 2003 and 2018 [Figure 6.7] (DANE, n.d). The growth of

private vehicles also becomes a key that can be used to calculate the rise in toxic gases, which is a critical issue in the Aburrá Valley (Estudian cómo se está moviendo, 2017).

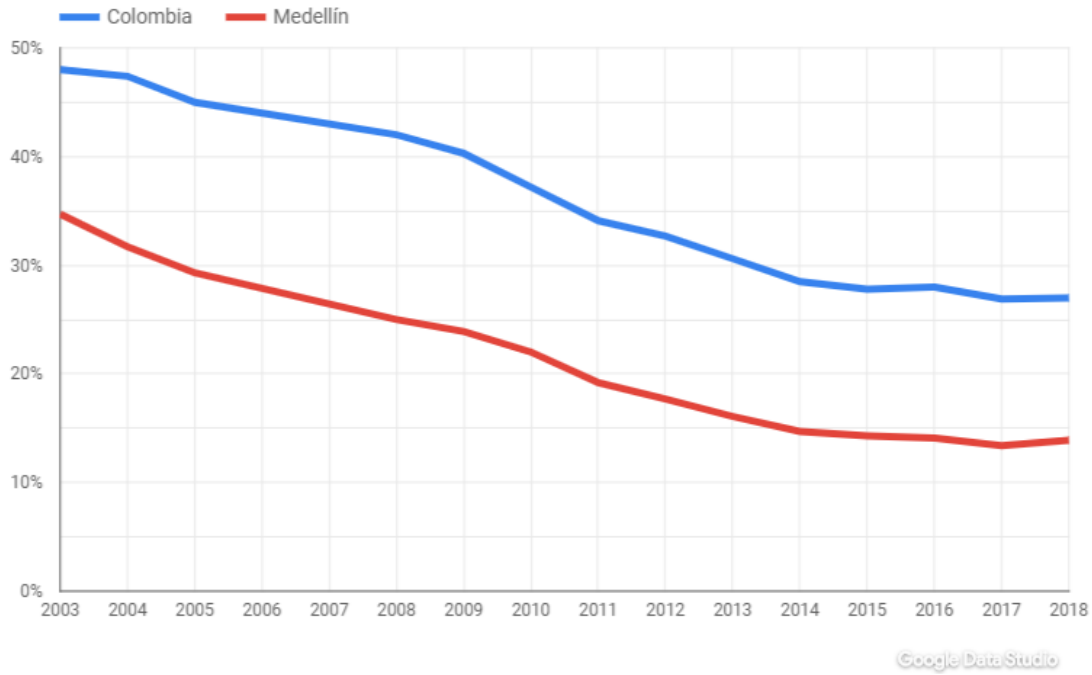


Figure 6.7: Reduction in Medellín poverty 2003 – 2018
from: (DANE, n.d)

As discussed earlier in this study, housing areas and neighborhoods are categorized by strata 'Estratos' or bands for the purposes of taxation on public services and are regulated by DANE, the 'Departamento Administrativo Nacional de Estadistica' (DANE, n.d.) which is the Colombian national statistics office. These taxation bands range from 1 to 6, with Estrato 6 being the highest ratable real-estate. Areas designating the various Estratos are shown in Figure 6.8, while the percentage that lives within each Estrato is shown in Figure 6.9. The highest-rated real-estate property is in the Southeast of Medellín, Estrato 6, where a higher level of college school attendance is also registered. Lower-rated real-estate coincides where there is also a higher rate of unemployment and lower college attendance. This dominates the Northeast and the North-West of the city [Figure 6.8] (Ferrari, Smith, Coupe & Rivera, 2018).

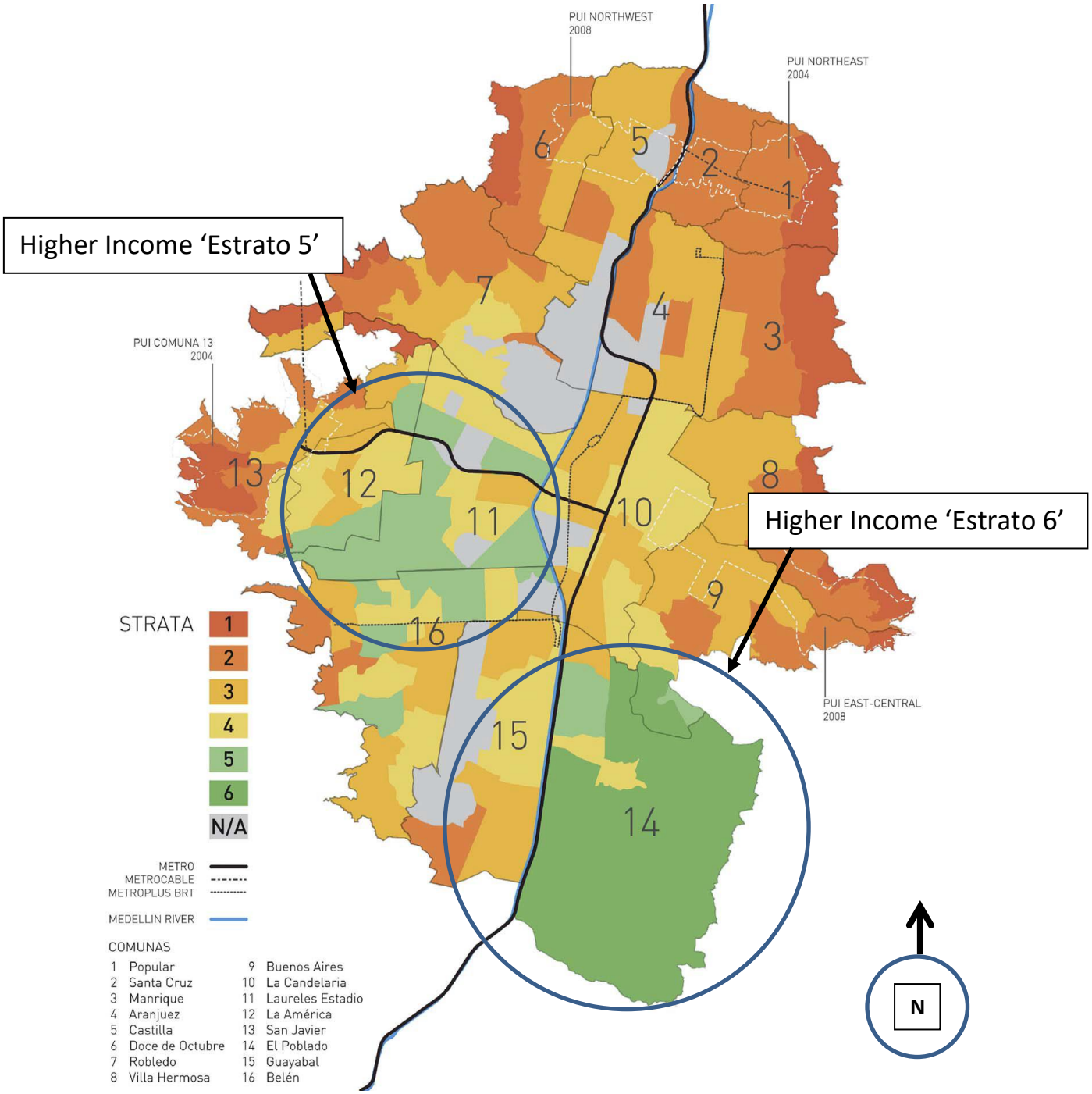


Figure 6.8: **Medellín 'Estratos' – Taxation Areas**
from: (Ferrari, 2018)

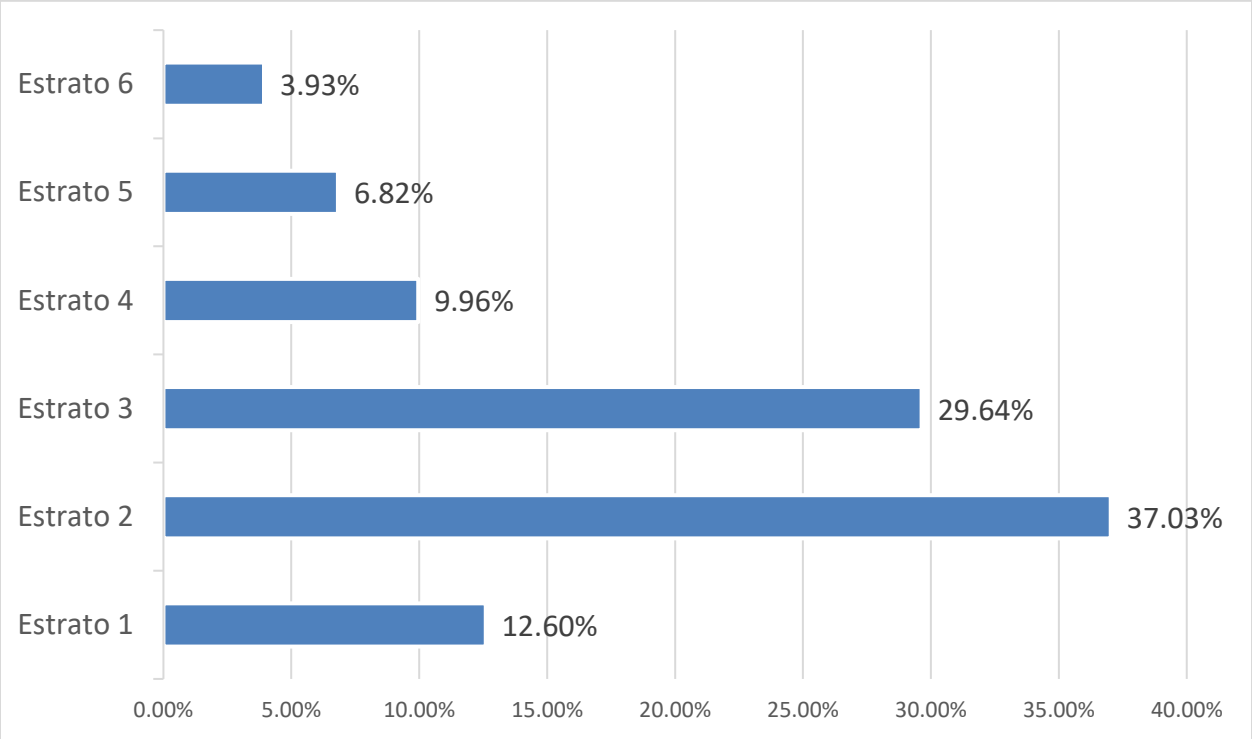


Figure 6.9: **Percentage of Population living in various Estratos**
from: (Ferrari, 2018)

The Encuesta Origen-Destino (EOD) study also determined that in 2017, 76% of low-income riders used public transport, 56% middle income; whereas only 38% higher income used public transport [Figure 6.10]. The inverse was true with private vehicle (car, motorcycle) use where only 15% of low income used private vehicles, 25% middle income, and 51% higher income [Figures 6.11] (EOD, 2017).

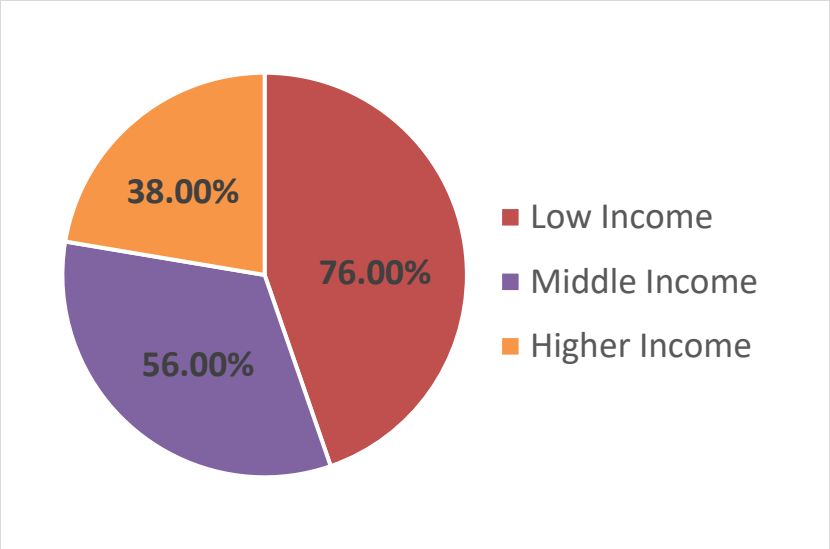


Figure 6.10: **Public Transport Use by Income**
from: (EOD, 2017)

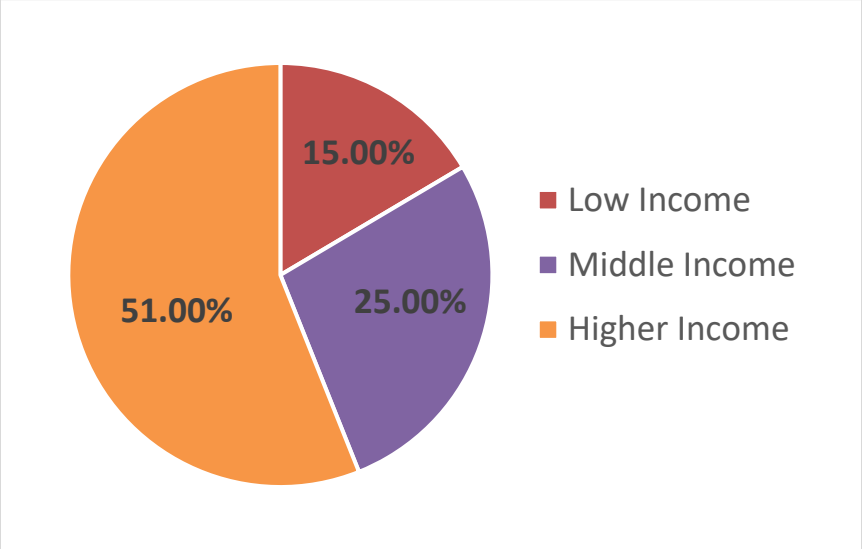


Figure 6.11: **Private Vehicle Use by Income**
from: (EOD, 2017)

Another factor that needs to be considered is in regards to the makeup of businesses in Medellín and why you may find that there is such a high percentage of the population that utilizes mass transit. The majority (86%) of businesses are at the 'Micro' scale which is less than U.S. $13,000 per year [Figure 6.12]. Most of these are single proprietor businesses, who may not have the income to purchase and maintain a private automobile or possibly even a motorcycle. Also,

nearly half of Medellín's businesses are not registered (Colombia Reports, 2019, July 28). Medellín's transportation system has allowed the poor to work in more distant areas and to set up informal microenterprises to sell their products in the more prosperous markets in the city center (Bateman et al., 2011).

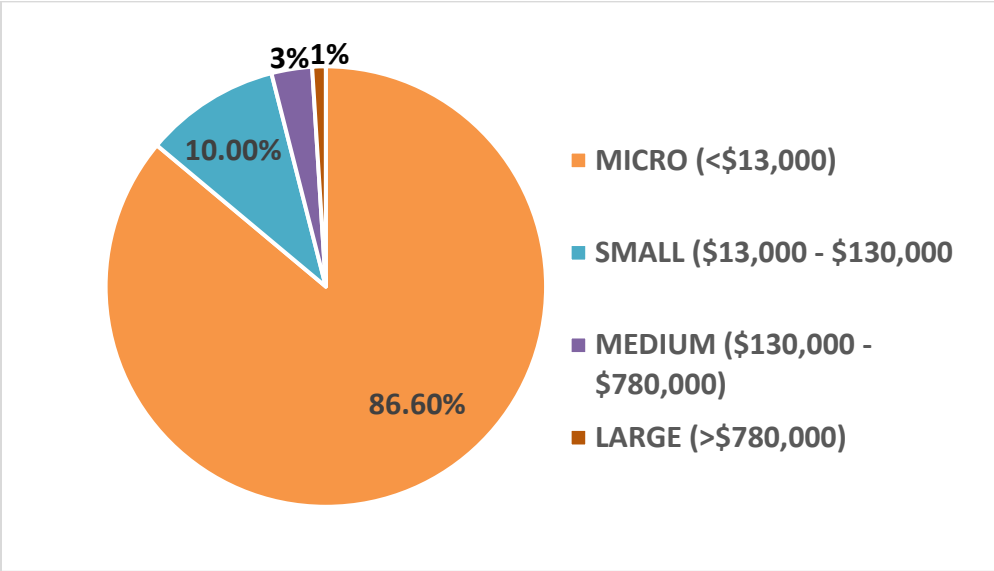


Figure 6.12: **Medellín Business Size and Income**
from: (Colombia Reports 2019, July 28)

6.1.2 Medellín Cómo Vamos (MCV) – Quantitative/Qualitative Survey

Medellín Cómo Vamos (MCV) is a 'citizen perception survey' done by a private-institutional alliance comprised of nine institutions which include the University EAFIT (a renown Colombian private university), the Medellín Chamber of Commerce, the media, and various important businesses whose main objective is to evaluate and monitor the quality of life in the city. The study is targeted mainly toward the head of the household or individual in the family who is more apt to travel. This yearly study provides information associated with perceived travel times, individual preferences in the matter of modes of transport, satisfaction with different aspects of transit, and citizen satisfaction with the neighborhood public space and centrality, among other aspects.

Additionally, MCV seeks to promote an effective and transparent government as well as an informed, responsible, and participatory citizenry. It also encourages the formation of partnerships to promote and enhance the quality of life in the city. A part of the MCV study includes 'Urban Habitat', which includes mobility and environment, housing, public services, and public space. Its unique position as a transparent private entity helps to ensure that the results of its studies are not tainted by political pressures.

The MCV studies analyze and extrapolate data taken from sources such as the City of Medellín, and the various city planning departments. It sets goals related to the improvement of public transport and universal access to the quality of open space. MCV evaluates mobility based on objective and subjective indicators related to travel times and modes, safety and security, automobile and motorcycle use, transportation availability as well as citizen satisfaction. The information regarding mobility and public space can be found in MCV's 'Movilidad -Informe Encuesta de Percepción Ciudadana Medellín 2017' (Medellín Cómo Vamos, 2020, March 4).

MCV's yearly study is done annually based on interviews primarily with heads of households taken at approximately 1,500 respondent homes in six urban zones and based on three socioeconomic levels. It also sources some data from the city's 'Encuesta Origen-Destino' (EOD) which is a mobility survey carried out in the Aburrá Valley since 1990 and which is updated every five years, with the last one completed in 2017. The EOD study is the fundamental instrument for the city's medium-term mobility planning.

It is important here to note that MCV surveys are conducted yearly, are more limited, and mostly target heads of households and those more apt to travel, while EOD provides mobility surveys that include all household members in five (5) year intervals with the last one completed in 2017.

Medellin covers a surface area of 380.64 km2 (146.97 sq. mi) just for the city proper. The last census was in 2005 and showed a population of 2,214,494 with a population density of 6,746.8 people per square kilometer. Estimates by the United Nations show the 2018 population of Medellín at 3,933,652, which is a population density of 10,351 residents per square kilometer (Medellin Population, 2020).

The Medellín Cómo Vamos (MCV) study for 2019 shows that 44% of respondents indicated that it took them more time in 2019 for their trips than it took them in 2018, with 33% the same and 23% less time [Figure 6.13] (Medellin Como Vamos. 2020, March 5).

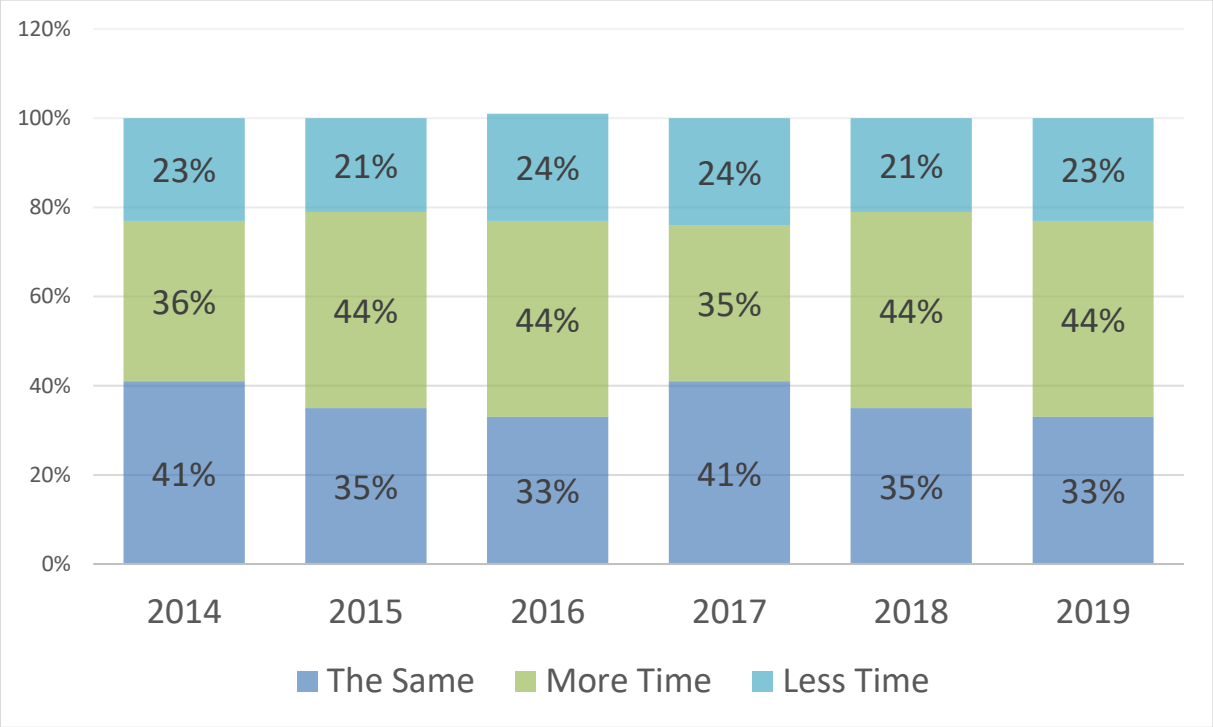


Figure 6.13: **Percentage of people who consider that their usual journeys take longer, less time or the same time, 2014-2019**
from: (Medellin Como Vamos. 2020, March 5)

The MCV study of 2017 also looked at travel time based on low, medium and high-income levels and showed that 46% of respondents in the higher income levels considered their trips took longer than in 2016. This analysis was not founded for 2018-2019. This is in contrast to lower

income levels at 39% and 28%, even though these residents have homes located farther from the city center [Figure 6.14] (Medellín Cómo Vamos, 2020 March 4). Individuals in the higher income Estratos 5 & 6 tend to commute by car, especially in the El Poblado area of Estrato 6, which is located in the Southeast of the city.

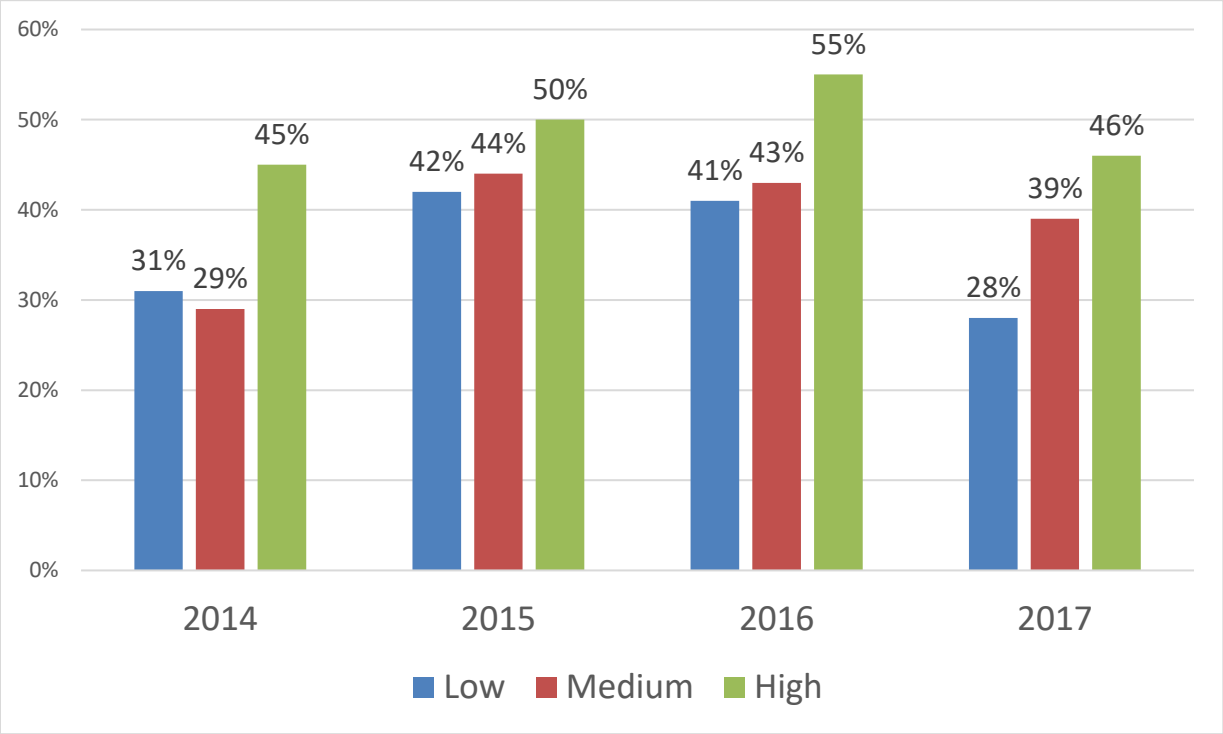
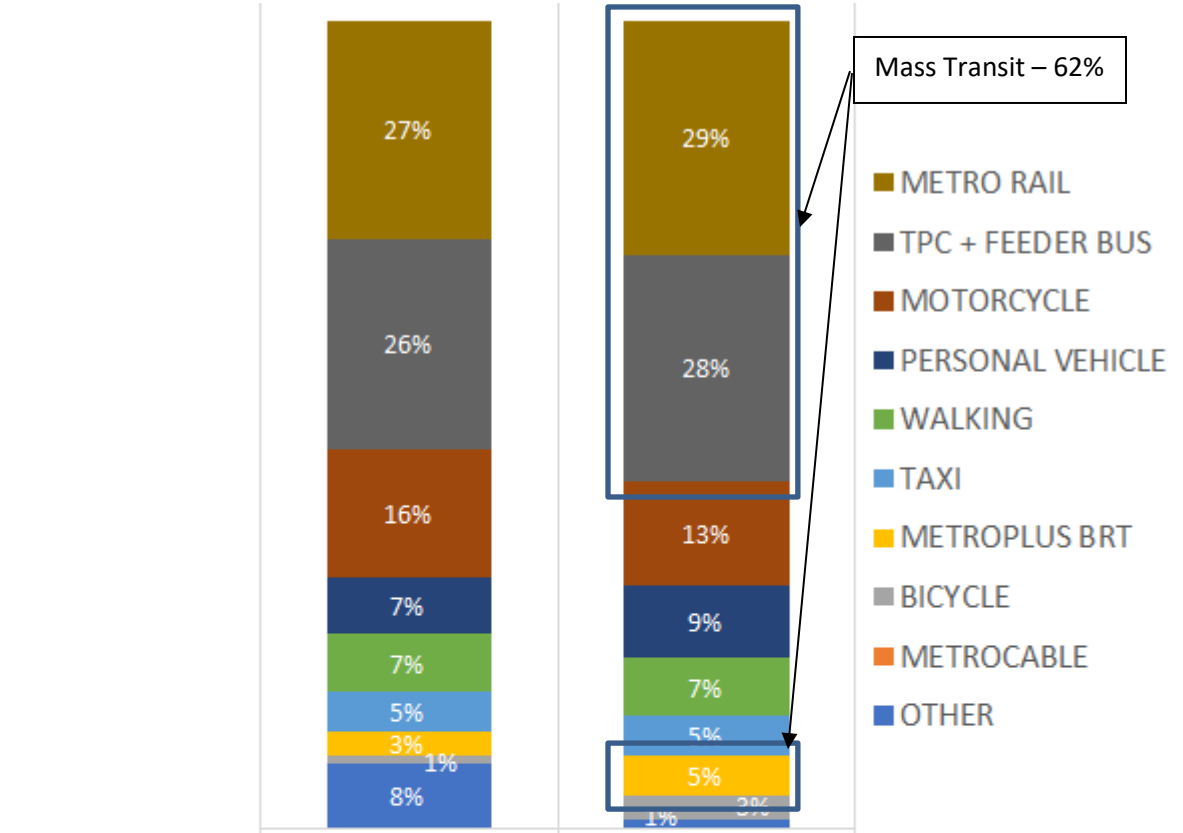


Figure 6.14: **Percentage of people who consider that their usual journeys take longer based on socioeconomic level (NSE), 2014-2017**
from: (Medellín Cómo Vamos, 2020 March 4).

MCV's yearly analysis for modes of travel distribution for the years 2018 and 2019 is shown in Figure 6.15. Metro rail saw an increase of 2% from 27% to 29%. Buses which include SITVA and TPC buses, saw an increase of 2% from 26% to 28%, Motorcycles saw a 3% decrease while private autos saw a 2% increase. There was a 2% increase for both the Metroplús BRT and bicycle use and a 0% no increase for the Metrocable system [Figure 6.15].

Since this survey only targets heads of households and those more apt to travel, it is interesting to note the low percentage (7%) of these respondents that walk to where they are going in 2019. A high percentage (62%) here use Metro, bus and BRT (29%+28%+5%).

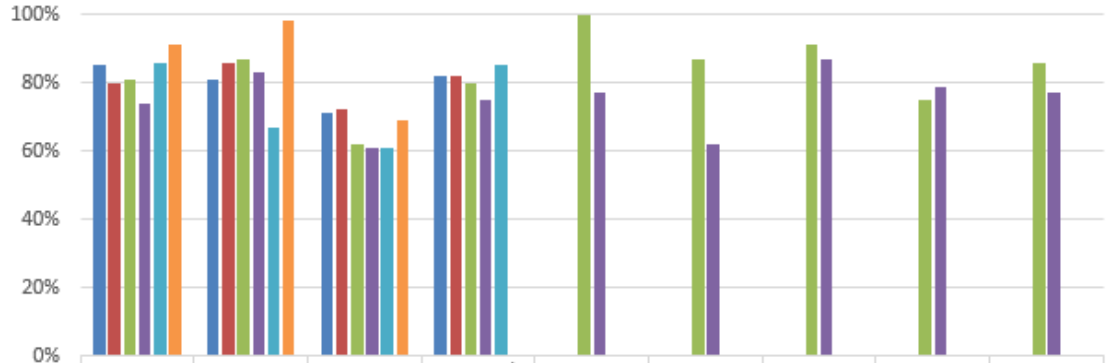


	2018	2019
METRO RAIL	27%	29%
TPC + FEEDER BUS	26%	28%
MOTORCYCLE	16%	13%
PERSONAL VEHICLE	7%	9%
WALKING	7%	7%
TAXI	5%	5%
METROPLUS BRT	3%	5%
BICYCLE	1%	3%
METROCABLE	0%	0%
OTHER	8%	1%

***Figure 6.15*: Percentage of people that use various modes of transport**
from: (Medellin Como Vamos. 2020, March 5)

MCV analyzed citizen satisfaction with the various modes of transport. The following Figure 6-16 shows data that was compiled from the 2019 study for the years 2019 and 2018, and the 2017 study for the years 2017, 2016, 2013 and 2010 ('Metro' data for 2018-2019 includes both Metro rail and Metrocable). Satisfaction with Metrocable in 2019 would probably be rated higher if shown separately. There was a decrease in satisfaction for the Metro from a high of 91% in 2010 to a low of 85% in 2019. This can be mostly due to increased crowding and wait times during peak periods. Satisfaction with Metrocable (cable cars) reached a high of 100% in 2017 (the 2019 data did not show Metrocable separately). This is a result of good security, seating comfort (no standing or crowding), and the addition of new cable car lines. Satisfaction with the motorcycle and car use was relatively high at 91% and 86% in 2017. No data was found for 2018-2019.

The least citizen satisfaction came from TPC private bus transportation with a low of 62% in 2017. Bus transportation in general can be uncomfortable with tight seating, crowded conditions, and long waits during peak periods. However, the city's integrated feeder bus service (part of SITVA) had increased ridership satisfaction from 62% in 2016 to 87% in 2017 (TPC and SITVA buses were aggregated in the 2018-2019 figures). Pedestrian satisfaction was reduced from 79% in 2016 to 75% in 2017. Only the 2016 and 2017 studies included all the means of transport. It is interesting to note the high level of satisfaction with motorcycle use at 91% in 2017 [Figure 6.16] even though the safety of these vehicles is considered low at 21% for 2017 [Figure 6.17] (Medellín Cómo Vamos, 2020 March 4 & 5).

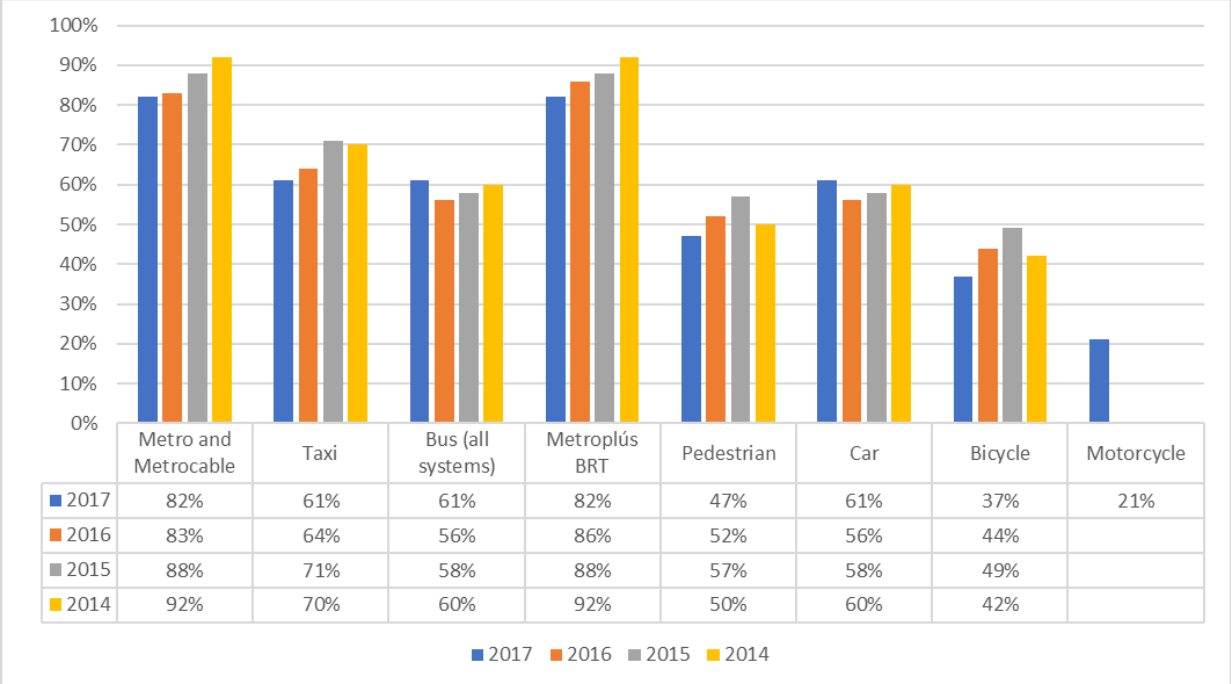


	Metro	Taxi	Bus	Metroplús BRT	Metrocable Cable Cars	Feeder buses	Motorcycle	Pedestrian	Car
2019	85%	81%	71%	82%					
2018	80%	86%	72%	82%					
2017	81%	87%	62%	80%	100%	87%	91%	75%	86%
2016	74%	83%	61%	75%	77%	62%	87%	79%	77%
2013	86%	67%	61%	85%					
2010	91%	98%	69%						

Figure 6.16: **Citizen Satisfaction in Modes of Transportation**
from: (Medellín Cómo Vamos, 2020 March 4 & 5).

Safety and Security: Figure 6.17 from MCV compares citizen's perceived level of security for the various transportation systems. Data extrapolated from MCV and shown here are for the years 2014, 2015, 2016 and 2017. Data for 2018 and 2019 was not found. Of particular note is how riders view the city's Metro/Metrocable and Metroplús BRT systems as being the most secure in 2017 at 82% for all three systems. However, this perception has dropped from a high of 92% in 2014. This can possibly be attributed to overcrowding on these systems during peak periods. This is still in sharp contrast to cars and buses at 61%. Safety for pedestrians has decreased from 50% in 2014 to 47% in 2017. Taxi safety/security has decreased from 70% in 2014 to 61% in 2017. Bicycle safety/security decreased from 44% in 2016 to 37% in 2017. The only data for motorcycles is that 21% of all respondents consider the motorcycle as safe for 2017 [see Figure 6.17] (Medellín Cómo Vamos, 2020 March 4).

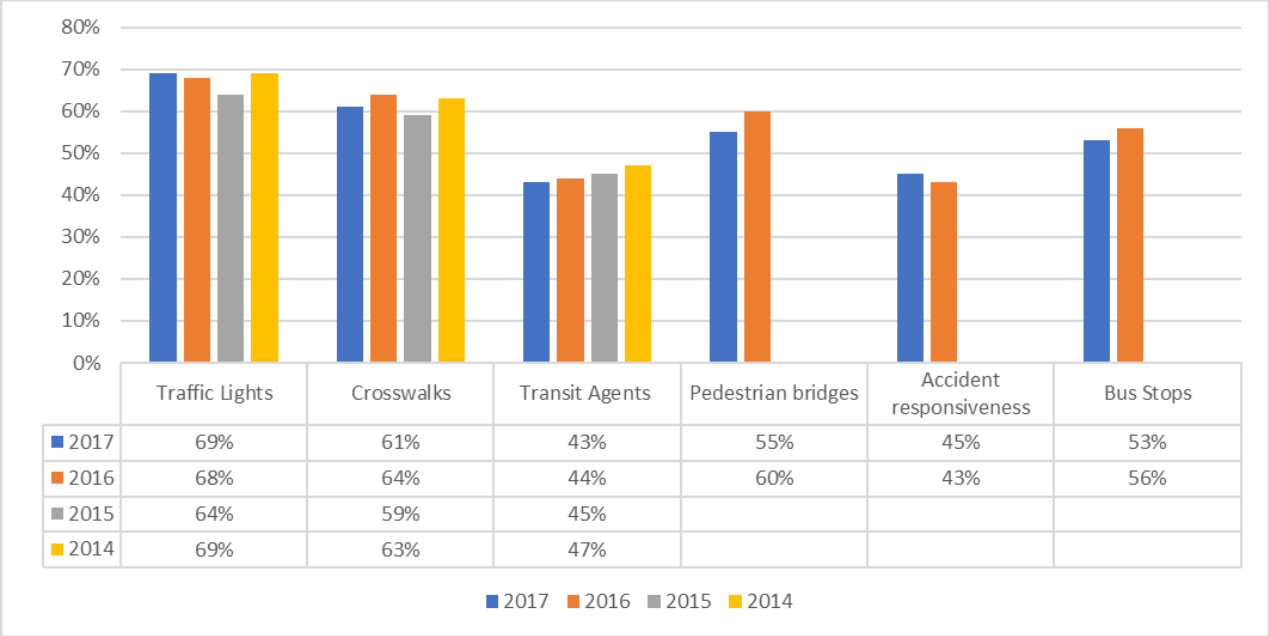
In order to increase the levels of physical and operational security of the system and to guarantee greater tranquility to users, the Medellín Metro has made progress in installing security cameras on the system's trains. The plan was expected to be completed at the end of 2013 with cameras in all rail cars at the cost of more than six billion pesos (around the US $2 Million). The cameras that are installed are state-of-the-art and allow the driver to see in real-time what is happening inside the train so that he can notify the Control Center in case of irregularities. As of 2014, the Metro had 599 security cameras throughout the system (stations, platforms, trains, workshops, offices, and new stations) (Medellin Como Vamos, 2016, April 8). The Metrocable has also installed security cameras in each one of its cable cars that are powered by photovoltaic panels (Revista Metro, 2011) as well as cameras at public areas and station platforms.



	Metro and Metrocable	Taxi	Bus (all systems)	Metroplús BRT	Pedestrian	Car	Bicycle	Motorcycle
2017	82%	61%	61%	82%	47%	61%	37%	21%
2016	83%	64%	56%	86%	52%	56%	44%	
2015	88%	71%	58%	88%	57%	58%	49%	
2014	92%	70%	60%	92%	50%	60%	42%	

Figure 6.17: **Citizen Satisfaction – Safety and Security Based on Means of Transport**
from: (Medellín Cómo Vamos, 2020 March 4)

Satisfaction with Various Aspects of Transit: Several aspects of this MCV study were not included for 2014-2015 and no data was found for 2018 and 2019. By and large, there seemed to be satisfaction with the traffic light system of the city with 69% approval and a moderate 61% approval for pedestrian crosswalks. There was 55% approval for pedestrian bridges, and 53% for bus stops in 2017, but only 43% satisfaction for the sufficiency and training of transit agents [Figure 6.18].



	Traffic Lights	Crosswalks	Transit Agents	Pedestrian bridges	Accident responsiveness	Bus Stops
2017	69%	61%	43%	55%	45%	53%
2016	68%	64%	44%	60%	43%	56%
2015	64%	59%	45%			
2014	69%	63%	47%			

Figure 6.18: **Satisfaction with Various Aspects of Transit**
from: (Medellín Cómo Vamos, 2020 March 4).

An almost doubling of the population of the Medellín metropolitan area since 1990 to approximately four million has resulted in increased pressures on its mass transportation system resulting in overcrowding during peak periods and long waits for trains and transfers. The more affluent citizens have bought cars and motorcycles, increasing vehicle congestion. However, there is still overall satisfaction with the SITVA (Metro/Metrocable/Metroplús) functioning and security (over 80%) with much less satisfaction with TPC's private bus system (around 60%). Citizen

satisfaction with SITVA feeder buses had a significant increase from 62% in 2016) to 87% in 2017 [Figure 6.16, pg. 97]. The MCV data for 2019 saw 28% of riders used TPC buses + SITVA feeder buses while 34% used Metro rail and Metroplús BRT (29%+5%). 22% used autos and motorcycles (9%+13%). [Figure 6.15, pg. 94]. This shows a high percentage of utilization for public transport.

Of concern is the large increase in the use of motorcycles from 2005 of 207% and autos of 46%, which have resulted in increased congestion in the city and more accidents. Much of the automobile traffic comes from the more affluent areas of Estratos 5 & 6. The most affluent area of El Poblado in Estrato 6 has narrow, winding roads that curve up the hillsides to high-rise apartment developments and become choked with traffic during peak periods. These areas have minimal access to public transit. The following is a summary of the EOD and MCV data analyzed:

Demographics:

- Medellín saw a large population increase from 2.1 Million (1990) to 4 Million (2020) (projected).
- There was a lowering of the level of poverty which has translated into increased purchasing power.

Transportation:

- A substantial increase from 2005 to 2017 in vehicular use by motorcycles (+207%) and autos (+46%).
    - Increased purchasing power has allowed more people to buy cars and motorcycles.
    - The majority of auto ownership is in the most affluent Estratos 5 & 6 with a high percentage of these higher income groups using private vehicles [figure 6.6, pg.85].
- An increase in trip time from 25 min. (2005) to 36 min. (2017).
    - More people are now living farther away from the central city.
- A 26% increase in the number of trips that take place from 4.87 million (2005) to 6.13 million (2017).
- An increase in the percentage of people that take trips from 65% (2005) to 74% (2017).
- EOD - From 2012 to 2017, Metro+Metrocable+BRT use increased from 10% to 16% while bus ridership decreased from 28% to 18%. This period also saw an increase in motorcycle ridership from 11% to 12%. [Figure 6.5, pg. 84].
    - Mass transportation usage increased in 2017 as a result of improvements in infrastructure and efficiency, technical modernization, as well as expanded coverage for the multi-modal system. [Figure 6.15, pg. 94].

Citizen Satisfaction:

- Citizen satisfaction was high with the Metro rail + Metrocable system at 85% (2019) but lower than what it was at 91% (2010) for just the Metro rail system.
    - This is primarily due to overcrowding and wait times during peak periods.
    - Citizen satisfaction was as high as 100% for Metrocable in 2017.
- Citizen satisfaction for the city's SITVA feeder buses increased from 62% (2016) to 87% (2017). Data for 2018-2019 included both TPC private and SITVA feeder buses.
    - Data for 2019 for TPC+SITVA buses shows satisfaction at 71%.
    - The city has been proactive in extending bus routes and frequency of service.

Security:

- 82% of riders view Metro/Metrocable & Metroplús as most secure in 2017.
- 61% of riders saw TPC buses as secure in 2017.
- 61% of riders saw cars as secure and only 21% saw motorcycles as secure in 2017

6.2 Comparative Analysis – EOD & MCV Mobility Surveys

Comparing 2017 data, the methodology used in the EOD (Encuesta Origen-Destino) and MCV (Medellín Como Vamos) surveys regarding mobility differ as follows:

- EOD: 5-year intervals – All family members surveyed [Figure 6.19]
  - 16,340 households surveyed
  - 10 municipalities in the metropolitan area surveyed

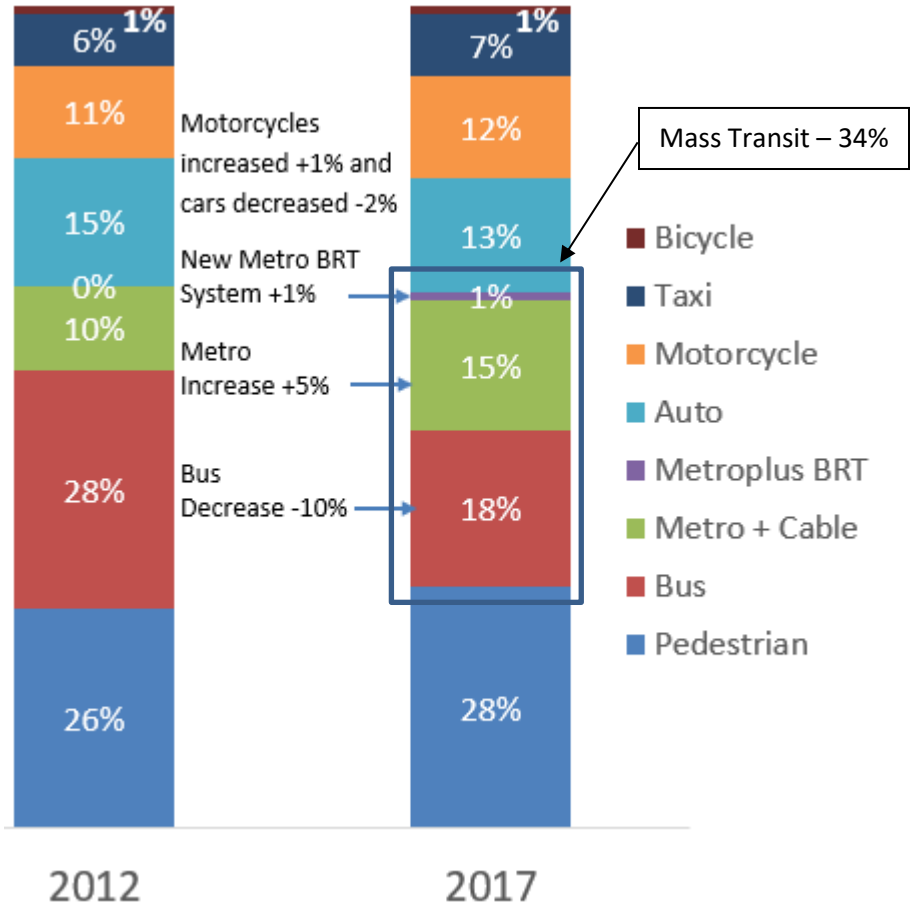


Figure 6.19: **Comparison-EOD Survey 2017**
from: (EOD, 2012) (EOD, 2017)

- MCV: Yearly – Survey targets heads of households and those more apt to travel [Figure 6.20].
    - 1,500 households surveyed
    - 6 urban zones surveyed and based on 3 socioeconomic levels

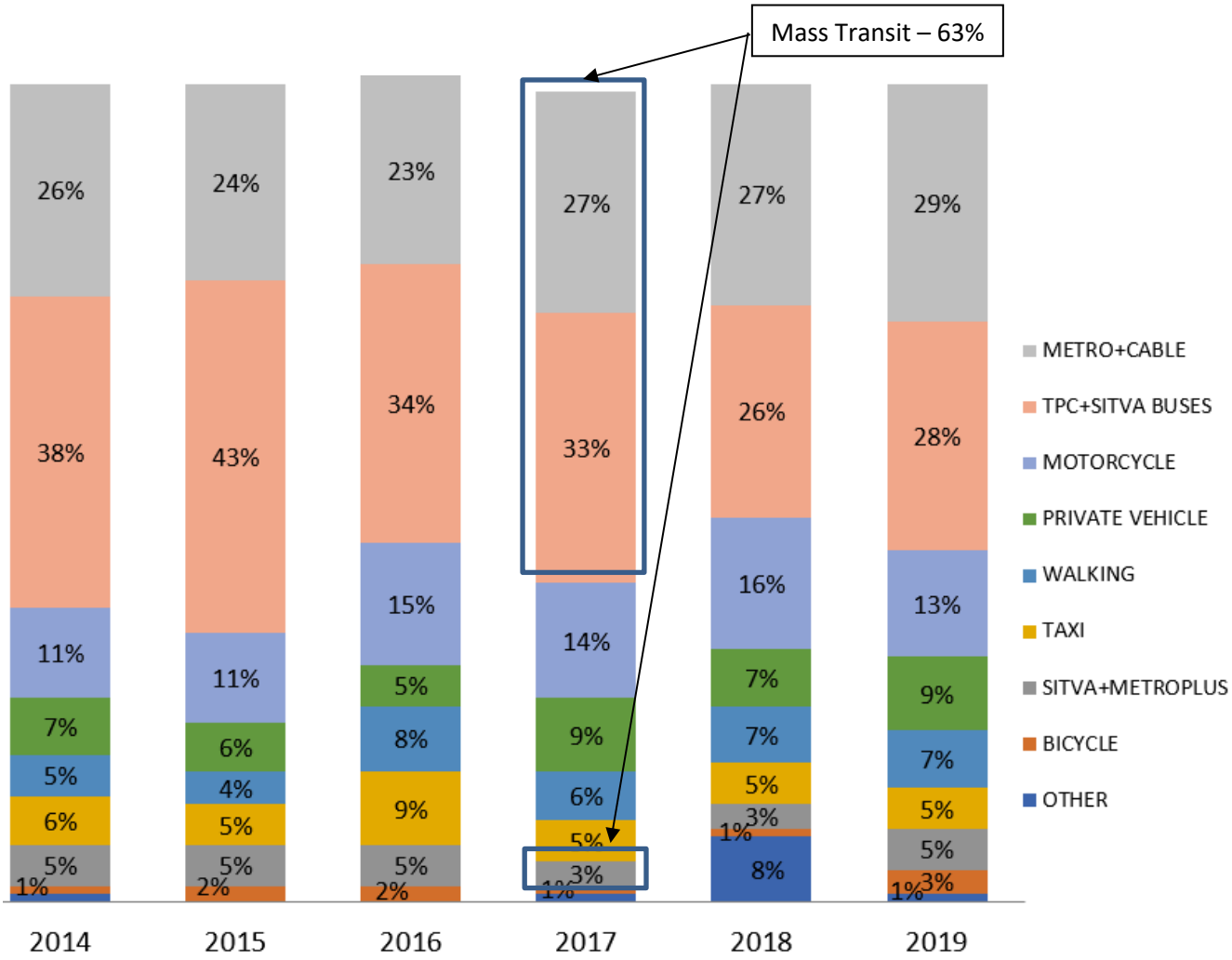


***Figure 6.20*: Comparison-MCV Survey 2017**
from: (Medellin Como Vamos. 2020, March 4 & March 5)

Both studies show that Medellín has a high percentage of the population that travels using Mass Transit. Comparing the 2017 data for the two surveys shows the following:

- EOD: 34% of ALL household members use Mass Transit
    - 15%: Metro + Metrocable
    - 18%: Bus
    - 1%: Metroplús BRT

- MCV: 63% of heads of households/those more apt to travel that use Mass Transit
  - 27%: Metro + Metrocable
  - 33%: TPC + SITVA buses
  - 3%: SITVA + Metroplús BRT

The high percentage of heads of households and those more apt to travel that utilize Mass Transit in the MCV survey may help to explain the overcrowding on the Metro and buses during peak travel periods as these individuals are usually going to and from work. They also would tend to walk less (6%) as compared to the EOD survey (28%) which surveys all household members.

6.3 Personal Interviews:

In October of 2019, this author conducted seven (7) personal interviews with planners, city transportation officials, and academics who were chosen based on their knowledge and involvement in the development of Medellín's transportation system in order to obtain their assessment of the system. The Questionnaire can be found in Appendix 'B'. The full transcripts by interview number in the translated English version and the original Spanish transcribed interviews that can both be found in Appendix 'C' and 'D'. Following is a review and table summarizing responses [Table 6.1, pg. 107]. All of the respondents reviewed and edited these transcripts and have agreed to allow me to include these interviews in this dissertation. The individuals interviewed included the following:

1. Rafael Nanclares -Civil Engineer – Director of Transit (2008-2012)
2. Claudia Marcela Aldana Ramirez -Professor of Civil Engineering, U. of Antiochia
3. Marta Lucia Suarez Gómez -Director of Mobility, City of Medellín
4. Carlos Alejandro Echeverri Restrepo -Architect/Planner, URBAM – University EAFIT
5. Roberto Bayardelle Morales -Senior Civil Engineer, Medellín Metro
6. Javier Enrique Rivero Jerez -Professor of Urban Planning, U. of Antiochia
7. Iván Sarmiento Ordosgoitia -Professor of Urban Transport, U. of Colombia

6.3.1 Personal Interview Reponses:

A reference for the individual respondent and date that the interviews were conducted can be found in Appendix 'A', the Interview Questionnaire in Appendix 'B', and full interview text in Appendix 'C' and 'D'. The following responses are keyed by interview number to that individual's response. All respondents have given their approval for the interviews to be included in this study.

All seven interview respondents felt that Medellín's transportation system has been successful in that it moves almost 1 million passengers which is 40% of the more than 2.3 million public transport passengers in the metropolitan region (Interview 7). It is also more advanced as compared to other cities in Colombia. It also gives the poorer informal settlements access to reach the center of Medellín. It has also been successful because of social involvement from the outset beginning with planning, construction, and management of the transportation system (Interview 6). However, even though the system has worked well, it is now insufficient and has not grown enough due to political and economic reasons (Interview 1).

Its success has been fueled by its development as an integrated multi-modal transportation system with high demand due to high population density. It has incorporated technological components that include entrance scanners and tariff integration with one transportation 'CIVICA' card, and the development of mobile applications to inform the user (Interview 3). Although SITVA integration has been successful, the TPC private bus system has not been integrated into the city's multi-modal system (Interview 4). There is a need for increased coverage of integrated transport systems by adding SITVA feeder routes since a large volume of the population is serviced by TPC non-public transport companies whose routes are poorly designed (Interviews 2 & 4). These routes and the lack of system integration with the city's SITVA transportation system network are still far from providing the service that the city needs (Interview 4).

System revenues are generated by ticket fare and government investment, as well as some advertising. However, most respondents felt that the SITVA system is not self-sustainable as ticket payment covers the cost of operation and equipment replacement but not the cost of construction or repair of infrastructure (Interviews 4 & 5). Private TPC operators have to sustain themselves completely from the ticket fare (Interview 3).

Interview respondents felt that road congestion from cars and motorcycles, a high vehicular accident rate, and environmental pollution are the most pressing transportation issues facing Medellín. There is also a problem with congestion at peak times with the delivery and distribution of large transport loads (Interviews 5 & 6). There is also high private vehicular use in the more affluent areas and some people resort to buying a second car to get around the 'pico y placa' restrictions for vehicle use based on alternating days and time of use (Interview 5).

Solutions and improvements proposed include determining how people move, what their needs are, and providing the infrastructure for a transportation system that is comfortable for the citizen and that better manages and decreases their travel time as less than 20% of the population moves in a private vehicle (Interview 4). Transportation alternatives need to be provided for the more affluent areas that have the greatest number of vehicles per person (Interview 1). Developing intermodality to allow for increased integration of bicycle routes with Metro systems (Interview 6) and the regulation of transport loading and unloading by promoting nighttime distribution was also recommended (Interview 7). Discouraging vehicle owners from driving into the city by raising parking fees was also discussed, but this would be difficult to implement since many of these parking lots are privately owned.

All seven respondents felt that there are poor that cannot afford the transportation system and that transportation subsidies should be provided for these people. Subsidies should be matched

to the economic condition of the user as an integrated round-trip transportation ticket can be as much as 20%-25% of the Colombian daily wage of $35,000 pesos [U.S. $9.79] (Interview 5). Bicycle use should be promoted and given priority to reduce transportation costs by adding bicycle carriers to the Metro and Metrocable cars (Interview 6).

All respondents felt that there are serious air quality issues in Medellín associated with particles smaller than 2.5 microns which is most severe during October, due to the city's location that is ringed by mountains. The vehicular congestion with trucks that burn lower quality diesel fuel, cars, and 4 stroke motorcycles all contribute to the city's diminishing air quality. Solutions proposed include clean energy transportation systems for the Metro, electric bicycles, possible incentives for the purchase of electric cars, and the restriction of movement of all vehicles during critical air quality periods. Also, the establishment of a firm policy for the renewal of older cargo vehicles was recommended, as replacing 20% of these vehicles would reduce pollution by 50% (Interview 7).

I have summarized below the main takeaways from these interviews, by interview number, in Table 6.1 below. I have also included a SWOT Analysis found in Appendix 'E'.

Table 6.1: **Summary of Interview Responses**

Question Number	Description	Interview Number.		Interviewee Comments
1	Do you think the transportation system has been successful?	1,2,3,4,5,6,7	**YES**	
		1		Has worked well but not grown enough due to political and economic reasons.
		2		Allows people access to reach the center of Medellín.
		3		The Metro is successful as a structuring axis for the integrated system for the Aburrá Valley.
		4		Successful as compared to other cities in Colombia but is a process in transition.
		5		Successful but insufficient.
		6		Transportation system helped to regularize the poorer informal settlements in the hillsides and connect the city.
		7		Moves large numbers of people.
1a	If successful, what makes it successful?	1		The development of a multi-modal transportation system along with other public facilities. A sense of respect for the system by the public.
		2		Success fueled by high demand due to high density and its integration with the other transportation systems.
		3		Integrated transportation alternatives, technological components including mobile applications to inform the user, tariff integration using only one electronic transportation card.
		4		The Medellín process is more advanced as compared to other Colombian cities due to implemented technologies, programs and policies; but has not achieved a whole integrated transport system that responds to the needs of the city.
		5		When industry migrated to other areas of the department of Antiochia and of Colombia, the system began to serve

				restaurants, banks, shops and commercial enterprises. The large growth of the system occurred due to these changes.
		6		It is successful because of social involvement beginning with planning, construction, and management. It provided transportation to points of the city where there was much violence.
		7		The system mobilizes almost 1 million passengers, which is 40% of the more than 2.3 million public transport passengers in the metropolitan region and increased the reach of citizens within their city. The electrified systems also lower pollution.
1b	What was your involvement	1		Civil Engineer and X-Director of Transportation helped set up a traffic control center, the Metroplús BRT and bikeway system.
		2		Professor of Civil Engineering at the University of Antiochia, setting up a sustainable mobility laboratory. Worked in the mobility secretariat on improvement projects in relation to the Metroplús BRT system.
		3		Secretary of Mobility for the City involved in everything that has to do with the implementation of the transportation system.
		4		He is an Architect and Planner heading URBAM and supporting the Metro company in reviewing future expansion plans by 2030. Was Director of Urban Projects for Major Sergio Fajardo developing the strategy called 'social urbanism'.
		5		Civil engineer for the city on cable car and tram projects from coordination of design, technical, legal and financial structuring and subsequently in construction and commissioning.

		6		Professor, faculty of Engineering at the University of Antiochia. Establishing intermodality initiatives with the transport system to make the system more efficient and include private vehicle parking, linking bike lanes and bicycle parking, as well as reconditioning feeders to the Metro to make them more efficient and comfortable.
		7		Professor in charge of urban transport course in civil engineering at the National University of Colombia. Involved in transportation planning in the city through consulting projects for the University. Advisor for the Master Plan for the Aburrá Valley (2004/2006), mobility surveys (2006,2012) and supervision of the restructuring for the BRT bus route.
2	What are the most pressing transportation issues for Medellín?	1,6,7		Environmental pollution
		1		Developing public transport to neighboring municipalities.
		1,2,7		Road congestion from cars and motorcycles.
		2		Motorcycle fatalities.
		3		To have attractive travel times in order to motivate citizens to use public transport.
		4		Routes and system integrated transportation networks are still far from providing the service that the city needs. We are in an initial phase of a much more powerful integrated system.
		5,6		The problem at the peak time of distribution of transport loads, which is quite complex to solve. Need to increase capacity.
		7		High accident rate.
2a	How can these issues be resolved?	1		Engender political will to change
		2		Determine how people move and what their needs are.

		2		Provide systems that are comfortable for the citizen, and that better manages their time.
		3		Restructuring of transport by incorporation of technological components that would determine whether a route needs to be abandoned, speeding, overcrowding and passenger mobilization.
		4		Increase coverage of integrated transport systems with feeder routes. The large volume of the population serviced by non-public transport companies that are poorly designed.
		5		The transport system is a trunk with many feeders. The load on the trunk needs to be reduced.
		6		Implement other branches of the Metro.
		7		Education and speed reduction will reduce accident rates. Develop exclusive left lanes for BRT. Increase the cost of parking and regulation of loading and unloading times.
2b	How can the transportation system be improved?	1,2		Develop a more walkable city with access to transportation as well as develop bikeways for pedal and electric bicycles that can access the city's slopes.
		1		Reduce transportation demand by working from home, utilizing drones for delivering packages, integrate autonomous vehicles into the mobility mix, add more cable cars especially in the El Poblado neighborhood, and add more trams and BRT lines.
		2		Integrate public collective transport routes that are operated by private companies.
		3		Develop infrastructure to decrease travel time. Users need to use designated bus stops and not just flag a bus down at any point.

		4		Generating clean and integrated mobility for the percentage of the population that does not use private vehicles as less than 20% of the population moves in a private car. How to keep them from moving to private vehicles such as motorcycles.
		5		A massive transport system needs to be developed to lower the load on the trunk system and discourage the use of private vehicles.
		6		Develop intermodality to allow people to not limit themselves to only using the Metro but also other transport systems such as bicycles.
		7		Develop new public transport lines and service routes to cross-connect north/south and north/west, south/west locations. Give the poorest rate reductions financed by overcharges on parking lots or congestion free zones and commitment of private sector companies.
3	Are there poor that cannot afford ridership in the transportation system?	1,2,3,4,5,6,7	**YES**	
		1		Transportation costs should be matched to the economic condition of the user.
		2		People with low resources settle on the hillsides where access is more difficult and where there are people who cannot afford the system.
		4		There is a sector of the population of extreme poverty that is outside of the purchasing power of the system.
		5		The integrated round-trip transportation ticket as much as 20%-25% of the daily wage of a Colombian (35,000 pesos).
		6		Discounts for people from low income strata.
		7		Many walk and others buy motorcycles that, in the long run, is cheaper.

3a	How would you make the system affordable for the people?	1,2,4,7		Provide transportation subsidies for the poor.
		1,7		Lower rates for collective public transport.
		1		Investigate the possibility of free public transport
		3		Promoting the use of public bicycles to reduce transportation costs.
		5		Generate more integration with other modes of transport that are built and financed by the city but as a losing proposition. For the community, it is more beneficial to ride in an integrated transportation system than individual mobility.
		6		People using bicycles given priority so they can ride the Metro for free. Also, have bicycle carriers on the Metro and cable cars.
4	Does the current system pay for itself?	1,2,3,6	**NO**	
		1		The system is not self-sustainable and doesn't have to be as it fulfills a social, economic, environmental, and cultural function that cannot be calculated only by the cost of the fare or the cost of operation.
		3		The Metro, Metroplús and cable cars are operated directly by the state and contributions from the city of Medellín to be sustainable, while the rest of the operators have to sustain themselves via fare.
		4,5		Ticket payment covers the cost of operation and equipment replacement but not the cost of construction of the infrastructure. The Metro company is very well managed and with good technical support.
		7	**YES**	Except for BRT which receives a $10 million dollar subsidy per year.
4a	What are the sources of revenue for the various systems?	1,2,3,4,5,6,7		Ticket fare.

		1		Advertising, exploitation of big data such as done by Google, and an increase in property taxes as a result of valuation increases near the stations.
		2,3,4,5,6,7		Government investment (state and city of Medellín)
5	Is there vehicular congestion in Medellín?	1,2,3,4,5,6,7	**YES**	
		3,4		Very high congestion especially at peak periods.
		5		Motor vehicle for every 4 or 5 inhabitants that generate approximately 1.9 trips/day by each person.
		6		Vehicular congestion, particularly in the main arteries.
		7		Due to infrastructure being used to its highest potential.
5a	What contributes to this congestion?.....	1,2,3,4		Personal vehicles.
		2,3,4		Trucks and motorcycles
		2		Very difficult to grow road network due to topographic conditions.
		3		More infrastructure for pedestrians and cyclists being generated which forces reduction of road sections thus reducing their capacity.
		5		Vehicle use and size in more affluent areas. People here buy the second car to get around 'pico y placa' limitations.
		6		Driving culture and not following traffic rules. Parking in areas that are not for parking. The public transport system has not efficiently organized the use of roads.
		7		The mobility pattern (origin/destination) which is difficult to change and misuse of the spaces in the vehicle lanes which used for parking. Also, accidents contribute to congestion.
	.....How would you solve this problem?	1		Provide transportation alternatives for more affluent areas that have the greatest number of vehicles per person.

		2		By becoming more sustainable for food and the things, we don't manufacture in order to reduce truck traffic into the city.
		4		Developing improved public transport, more efficient networks, develop infrastructure for transportation alternatives like the electric bicycle.
		5		Developing medium-capacity transportation in parallel to the trunk (Metro) line. Private operators to increase parking fees. Declare certain parts of the city as 'vehicle-free' areas. Develop pedestrian districts.
		7		Increasing speed for public transport buses, using a single tariff system, regulating loading/unloading, promoting nighttime distribution, and reducing speed in the city thus reducing accidents and saving time.
6	Are there currently problems with the air quality in Medellín?	1,2,3,4,5,6,7	YES	
		1,2,3,4		Serious air quality problems due to the city being located in a valley ringed by mountains.
		5,7		Air quality problems associated with particles smaller than 2.5 microns and not as much with CO^2.
		6		Most severe during the month of October.
6a	If so, what do you think is the cause of these problems?.....	1,3		Fossil fueled private vehicle and collective transport congestion.
		2		Factories, even some run on coal that should move out of the city.
		2,3		Vehicles that circulate on the road network including trucks. No 'pico y placa' for 4 stroke motorcycles.
		5		Burning lower quality diesel fuel in older vehicles.
		6		Due to topography of the city and the industrial zone of the city to the north.
		7		Transport emissions with freight transport having the highest emissions, followed by buses, motorcycles, and cars/taxis.

	…….How do you propose to solve them?	1		Clean, electrical energy public transport must improve, the transition to electric motorcycles and bicycles, and provide incentives for purchase of electric cars.
		2		Suburban, multipurpose train that can also carry trash to disposal site located 2 hours from the city.
		3		Unite the private sector in a commitment of co-responsibility and the implementation of some complementary restrictive measures, and to continue strengthening the collective public transport system. Restrict the movement of vehicles, including transport and cargo vehicles, during critical air quality periods.
		4		Accelerate the implementation of less polluting fuels and transitioning to cleaner technologies. Transform road corridors to provide better alternatives for pedestrians and develop a network of cycle routes that integrate with Metro stations.
		5		Develop a transport mesh to discourage the use of private vehicles. The city is growing now in its use of electric vehicles, and the transport system, public as well as private, should be forced to have a percentage of their fleet convert to electric vehicles.
		6		Encourage industries to relocate to other areas and to see what emissions controls are being done. Also, to control emissions in transportation systems and implement the use of alternatively fueled vehicles. Take older vehicles off the roads by subsidizing newer vehicles for the user.
		7		Develop a strong policy for the renewal of older cargo vehicles. It is believed that replacing 10% of these would reduce particle pollution by 50%.

6.4 Chapter summary

The means used for assessing Medellín's mass transportation system have included the quantifiable data from 'Encuesta Origen-Destino' (EOD), the yearly quantitative/qualitative survey undertaken by 'Medellín Cómo Vamos' (MCV), and the seven Personal Interviews (PI) taken by the author. From these, we can summarize:

There is still a high citizenship satisfaction with the city's SITVA transportation system's operations and security at over 82%, although not as high as previous years due to overcrowding. TPC private bus operations rated lower in 2017 at around 60% on both counts. The SITVA system handled approximately 34% of all daily ridership in 2017, which is over 2 million trips per day. The almost doubling of the population and outward growth of the metropolitan region is taxing the mass transportation system, and there is increased congestion from vehicular traffic. Also, air pollution has become a serious problem due to the city's location in a valley ringed by mountains.

Overall, all the interview respondents considered Medellín's mass transportation system successful and affordable for the majority of riders but also felt that the very poor needed to have their transportation needs subsidized. The majority of respondents wanted to see increased use of a sustainable means of transportation, including adding electric buses to the fleet, as well as providing incentives for electric cars, motorcycles, and bicycles.

Chapter 7. CONCLUSION

The purpose of this case study was to analyze and assess the city's transportation system, how it evolved, the challenges it faces going forward, and how the concept of 'equity' has and continues to play an important role in the development of the system.

There have been impressive accomplishments in mass transportation and inclusivity by Medellín since the 1990s. At that time, mass transportation was expensive, hastily put together by city council members and businessmen, and poorly regulated by local/national authorities. The study aimed to analyze the case of Medellin's transportation improvements and assess its success levels, hindrances, and challenges. The research first studied the broader sociopolitical context and background for the changes in the urban area by analyzing the implementation of Sergio Fajardo's 'social urbanism' in the city, which aims to integrate space, transport, and develop a sense of belonging and equity for its residents. This was followed by an analysis of the city's transit improvements, the EOD and MCV surveys and the personal interviews.

The study shows that while there has been tremendous successes in some of the problem areas, the city continues to refine the operation and inclusivity of its multi-modal mass transportation system. However, poverty and inequality persist. 80% of the city's residents are still within the lower three socioeconomic classes, 'Estratos' [Figure 6-9, pg. 88] (Lowenthal & Mejía, 2010) where some of the very poor cannot afford to use the city's transportation system (Interviews 1,2,3,4,5,6 & 7). There is also a continuing strain on the city's basic services and transportation infrastructure stemming from population growth and migration into undeveloped areas. This is apparent during peak commuting periods when there can be lengthy delays at Metro stations and where overcrowding on walkways and platforms getting to and on the trains is apparent [Figures 7.1 & 7.2].

***Figure 7.1*: El Poblado Metro Station**
from: F. Kessler, 2019

***Figure 7.2*: Metro during peak period**
from: F. Kessler, 2019

There are Pros and Cons inherent in the assessment of Medellín's mass transportation system. The question becomes whether in this case study, the Positives outweigh the Negatives. The following is a summary of the factors considered:

Positives:

- Medellín was nominated as the 2012 'Most Innovative City of the Year' by the Urban Land Institute and the Wall Street Journal[6], commending what the city has done within a relatively short period of time in mass transportation.
- Ridership in SITVA's multi-modal system has increased.
- Transit mode share for Metro, Metrocable, Metroplús, and the Tranvía streetcar have all increased as well as for SITVA feeder buses.
- Passenger amenities have improved with the CIVICA card and automated systems for multi-modal 'one fare' transfers.
- Passengers are comfortable with the security of the SITVA systems, and the system has given the poor in the established hillside 'communas' access to the city center, thereby increasing their quality of life.
- Metro and Metrocable are electrically driven and sustainable. Metroplús BRT buses are incrementally being converted to electrical propulsion. SITVA is also planning to convert its feeder buses to electrically driven.
- The various SITVA systems are, for the most part, reliable and well maintained.
- There are reduced fees for seniors and students and they are affordable for the majority of the city's residents.
- SITVA and TPC are able to provide service to outlying districts of the metropolitan area.
- Medellín's 'EnCicla' bikeway system has eighty kilometers (80km) of bikeways being planned with forty kilometers (40km) now completed.
- MCV conducts yearly passenger surveys to gauge passenger's level of satisfaction with the transportation system. EOD conducts its more extensive mobility surveys every five years.

[6] https://www.bbc.com/news/world-latin-america-21638308

Negatives:

- Due to population pressures the system is insufficient and has not grown enough (Interviews 1,2,5,6 & 7). Quality of service has decreased as trains and buses have become increasingly crowded, and people are experiencing long delays for boarding and transfers during peak periods.
    - Metro delay during peak periods needs to be shortened, and transfer delays between modes of transportation need improvement.
    - The delay in the frequency of Metro trains during peak periods added to delays in rail-to-BRT or rail-to-Metrocable connections can add significantly to travel time.
- Improvements need to be made in wheelchair/disadvantaged accessibility. Even though most stations have 'stair railing' for wheelchairs, an attendant is required to work the system, and these types of systems do not allow for disabled individuals to be self-reliant [see Figures 7.8 a & b]. Presently, some stations are retrofitting elevators for the disabled.

a **b**

Figures 7.8 a&b: **Metro Stair Rail for Wheelchairs**
from: F Kessler, 2019

- Transportation subsidies for the very poor need to be considered.
- Rider comfort is lacking during peak periods in overcrowded and hot trains that are not air-conditioned. Bus seating is uncomfortable with a very tight seat pitch. Metrocable is the exception in that only seated passengers are allowed. However, the cabins are also not air-conditioned.

- Although bus service is available via TPC (private collective transport system) and SITVA (feeder buses) to some of the outlying municipalities, transit time to the center of the city can be long and require multiple transfers. These systems require better integration (Interviews 2 & 4).
- There are currently efforts underway to change TPC into a model that integrates with the city's SITVA system; however, the government has few binding measures it can impose on these companies to meet these requirements (da Silveira-Arruda, et al., 2017).

In conclusion, the following paragraphs are in response to the fundamental research question formulated in Chapter 3: "What were the elements that contributed to the success of Medellín's transportation system and what were the most important urban factors that contributed to this success?"

'Social Urbanism' and Equity: Mayor Sergio Fajardo's concept of 'social urbanism' providing transportation access to the poor, integrated public services adjacent to transportation nodes (Lowenthal & Mejia, 2010) (Interview 6) and the design and implementation of a multi-modal metropolitan (SITVA) transportation system that allowed for one fare and transfers to access the urban fringes of the city (Brand & Davila, 2011) (Interview 3) were the primary elements that have contributed to the success of the transportation system.

The city has developed a strong participatory element in its policies that resonates with the neoliberal agenda in terms of communitarian ideals and which allows for further opening of policies for progressive interventions (Maclean, 2015). Integrated urban Projects (PUIs) have become part of the 'social urbanism' approach developed between 2004 and 2012 (Ferrari et al., 2018), where PUIs that develop schools, housing, and open spaces are planned and developed integrally with transportation infrastructure.

The public/private partnership with the local utility company (EPM) that channels 30% of profits to the municipality to help pay for infrastructure improvements (Bateman, Duran Ortiz, & Maclean, 2011) was also an important contributing factor to the system's success. All the

individuals that were interviewed considered Medellín's mass transportation system successful and affordable for the majority of riders but also felt that the very poor needed to have their transportation needs subsidized.

The success of Medellín's transportation system has been recognized by various awards which include the 2012 'Innovative City of the Year' award from the Wall Street Journal and the Urban Land Institute, the 2016 'Lee Kuan Yew world City Prize' from the government of the City of Singapore, and the 2019 'World's Smartest City' from Newsweek (see pg. 2).

The role of planners, political and private entities: 'Social Urbanism's' political approach to local government involvement was able to deliver physical and infrastructure change through a more active form of community participation, and through *equity planning* which was different than the top-down approach usually present in widespread patron-client practices (Davila, 2013). The equity represented in this approach to planning fostered social inclusion through community consensus for the poor neighborhood *communa* area residents. It has also helped to address poverty through increased mobility for residents commuting to the city center (Interview 6). The municipally owned EPM public utilities helped fund many of these improvements, while the private sector also brought investment to social programs in the city's violent and marginalized neighborhoods (Lowenthal & Mejia, 2010) (Interview 3).

Effect of population growth and vehicular use on planning decisions: The growth in population and vehicular use has resulted in congestion in the Metro during peak periods which result in lengthy delays at Metro stations and overcrowding on Metro trains and buses. Environmental pollution due to vehicular congestion have also become pressing issues for the city (Interviews 1,2,5,6 & 7). There is a continuing strain on the city's basic services and transportation infrastructure from this population growth and as well as migration into undeveloped areas.

The MCV study for 2019 shows a high satisfaction of 82% for the SITVA metropolitan transportation system but not as high as previous years [Figure 6-16, pg. 96] (Medellín Cómo Vamos, 2020 March 4) largely as a result of these delays and overcrowding, which is similar to what we have seen is happening with the TransMilenio BRT in Bogota [Table 5.5, pg. 70].

The city is also facing environmental issues and the need to address urban renewal and the mobility needs of the informal settlements that are being constructed up on its hillsides due to an almost doubling of its metropolitan population from approximately 2.1 Million in 1990 to 4 Million in 2020 (DANE, n.d). Also, the comfort, frequency, and availability of TPC and SITVA buses need to be addressed. These buses can become packed during peak periods with standing room only. Also, seat pitch on these buses is very uncomfortable unless you are short of stature [Figures 7.3 & 7.4].

Figure 7.3: **SITVA feeder bus**
from: F. Kessler, 2019

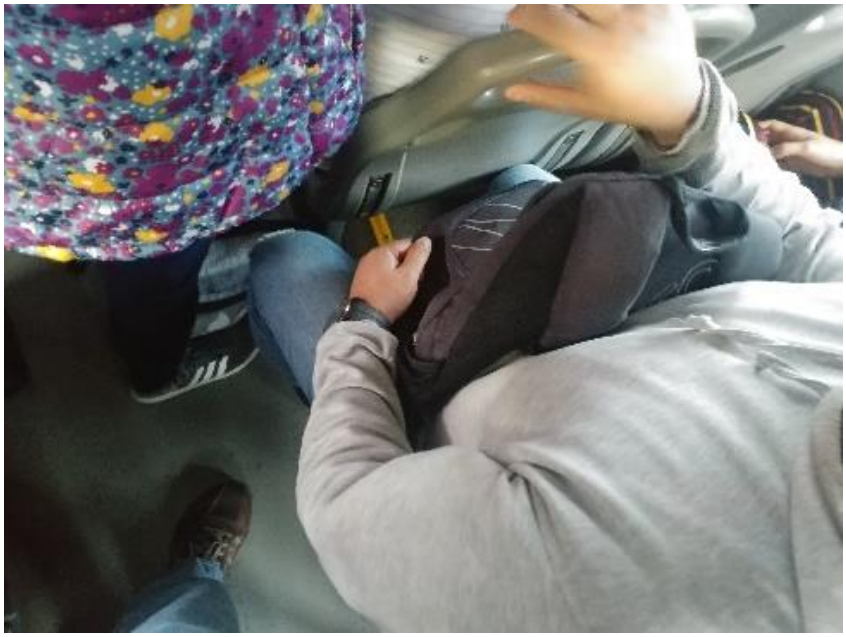


Figure 7.4: **SITVA feeder bus – seat pitch**
from; F. Kessler, 2019

These issues have spurred a continuing Metro modernization program with more energy-efficient trains now running at shorter intervals, the addition of electric feeder buses and the development of a Metro app for trip planning (Soto, 2019 Oct 16). Also, the 2014 Territorial Ordinance Plan (POT) encourages development towards the city center (Ferrari et al. 2018) and sustainable transport as well as encourages walkability and cycling (Alcaldía de Medellín, 2014). More dense development toward the city center would allow for a more compact city that would be easier to service by an integrated multi-modal transportation system.

The growth of informal settlements is also being addressed by the government with the 'Cinturon Verde del Valle de Aburrá' (Aburrá Valley Green Belt), a 46-mile-long park located along the upper slopes of the valley that surrounds the city and is designed to contain and curb these settlements. However, residents that have settled above the park line would need to be resettled which has spurred criticism of the project (McLaren & Agyeman, 2015).

Lessons learned from Curitiba and Bogotá: The study also looked at the lessons learned in an analysis of the BRT systems of Curitiba, Brazil and Bogotá, Colombia, Curitiba was able to develop articulated densities with higher FARs (floor area ratios) along its BRT corridors (Suzuki, et al. 2013) and has consistently continued to innovate the city's bus-based transit system through performance and capacity improvements and created the first full bus rapid transit system in the world with high capacity bi-articulated buses and electronic fare ticketing systems (Lindau, Hidalgo, & Facchini, 2010, October).

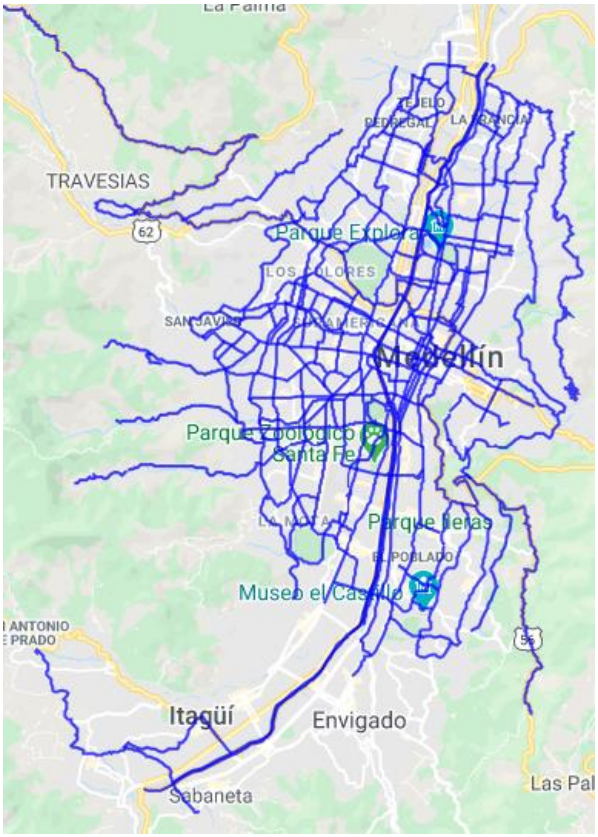
In contrast, Bogotá's 'TransMilenio' BRT system, although highly successful at the outset is now facing demand that exceeds ridership projections and has not expanded as initially planned (Bocarejo, et al. 2014 January). This has resulted in a decrease in user satisfaction due to crowded buses, low frequency in trunk and feeder lines, insecurity mostly due to theft, as well as delayed routes. Also, non-subsidized private system operators for these buses have increased fares more quickly than the rate of inflation making the system less affordable for the poor (Bocarejo & Oviedo, 2012).

The lessons learned from these systems is the necessity for Medellín to continuously plan for upgrades to its system accompanied by zoning ordinances that would allow for higher FARs along its transportation corridors with the possible development of Transit Oriented Developments (TODs) at its transportation nodes. The integration of the TPC private buses with the SITVA system as a 'one fare system' is also necessary. The fact that SITVA is a municipal system allows for the government to set and subsidize ridership fares that are able to more closely align with what people are able to pay. This is in contrast to Bogotá's private system operators that are funded with fare revenues and no operation subsidies from the government (Hidalgo et al., 2007).

7.2 Future Directions: The continuing success of Medellín's transportation system relies on a proactive government continuing to make the necessary improvements in infrastructure and technology. The Medellín Sustainable Mobility Symposium ('Simposio Taller de Movilidad Sostenible') held at the University of Antiochia in October of 2019, which I attended, addressed the challenges the city faces and how it is attempting to meet those challenges and included presentations from the city's most renown planners, academics and transportation officials. In these presentations, they outlined continuing improvements to the city's mass transportation system which includes a planned additional elevated Metro electric light rail line along Carrera 80, which runs N-S on the West side of the city and the phased introduction of new electric BRT and feeder buses which is now underway to help mitigate the city's air quality issues.

The first POT – Territorial Ordinance Plan ('Plan de Ordenamiento Territorial') defined the Metro System as the structural axis for transportation in the city (da Silveira-Arruda, et al, 2017). The current POT of 2014 prioritizes sustainable transport systems, walkability, cycling and building higher quality public space (Alcaldía de Medellín, 2014). Medellín's 'EnCicla' system has eighty kilometers (80km) of bikeways being planned with forty kilometers (40km) now completed [see Figure 7.5 & 7.6] (Alcaldia de Medellín, 2019). The system is free to use and currently has 51 stations (32 automatic and 19 manual) and is comprised of a fleet of 1,300 bicycles which are being built in Colombia. Currently, the system has around 58,000 active users (ENCICLA, n.d).

(a)



(b)

Figures 7.5 a&b: **(a) EnCicla current bike lanes & (b) Future bike lanes**
from: https://www.datos.gov.co/Ordenamiento-Territorial/Mapa-de- Ciclorutas-Municipio-de-Medell-n-POT-2014-/j4u2-3iez

Figure 7.6: **Bicycle Lanes – Av. Las Vegas – 2.3km**
from: (Alcaldía de Medellín, 2014)

With 43% of CO^2 emissions coming from transportation (Lopez, 2019 Oct. 16), a pilot program for trucking by requiring nighttime loading and unloading is currently being trialed and supported by major city businesses, which is showing reduced run and wait times. Also, a plan for PM2.5 emissions reduction of 50% is being initialized by the replacement of 20% of the most contaminating vehicles (Area Metropolitana, 2019 October 16). There is also a continuing modernization of the Metro with more energy-efficient trains being added to the fleet, running the trains at more frequent intervals during peak periods, as well as a new 'Metro app' for trip planning and for providing riders the status of transportation operations (Soto, 2019 Oct. 16).

Due to vehicular congestion, there is as much as a 10% loss in value of time as a percentage of GDP in cities such as Beijing and Sao Paulo. The World Resources Institute has determined that a city such as Medellín that is accessible and has more transport options available to its residents will have a better chance of thriving in the coming decades (Rubnitz, 2019).

The current system is being taxed during peak periods, as a result of population growth, the need to provide access to informal settlements on the hillsides, vehicular congestion, and the continued growth of the metropolitan areas to the north and south of the city [Figure 7.7]. The revision to the 2014 POT attempts to develop a compact city model by encouraging development towards the city center (Ferrari, et al, 2018).

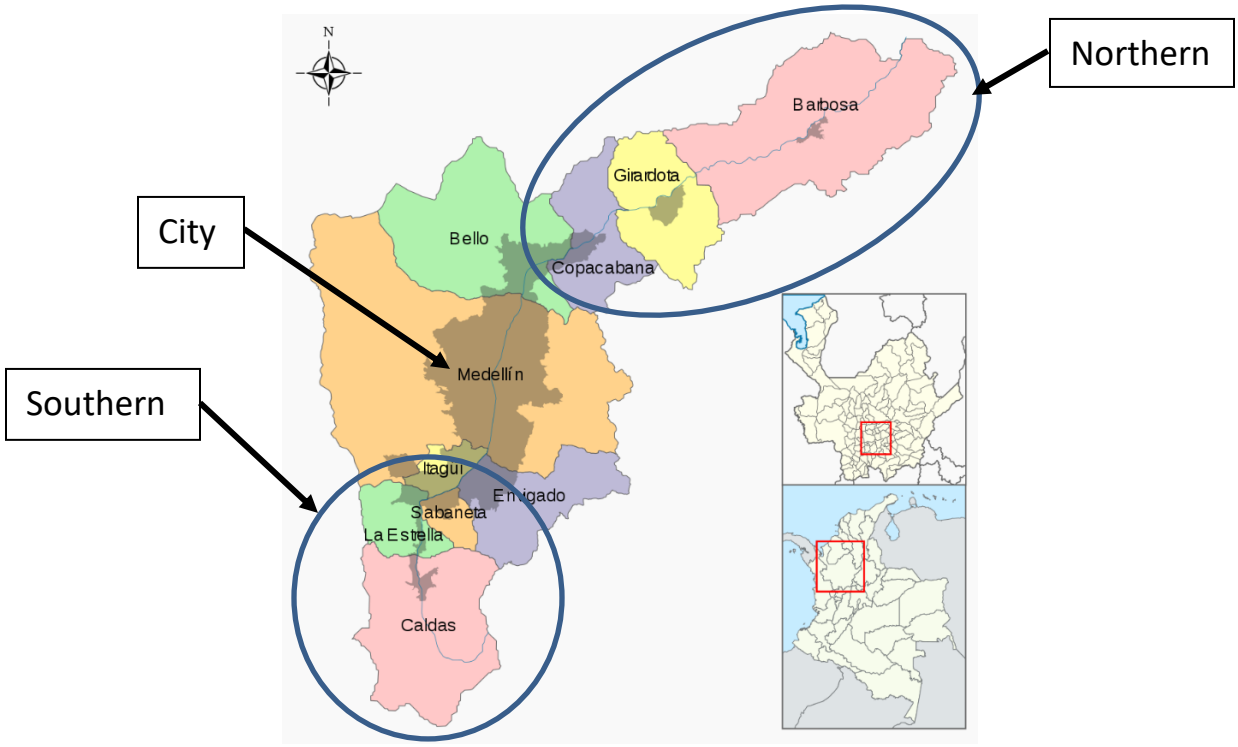


Figure 7.7: **Medellín - Areas of Growth – North & South**
from: https://en.wikipedia.org/wiki/The_Metropolitan_Area_of_the_Aburr%C3%A1_Valley

7.4 Assessment: Based on the factors outlined that contribute to a successful transportation system, the literature, the surveys analyzed and the interview responses, I would consider Medellín's Mass Transportation System successful not only due to the positive assessment provided by users but for the very high percentage of residents that use the system on a daily basis. Medellín's SITVA metropolitan Metro system moves over 1 Million riders per day, is multi-modal, efficient, reliable and is a one-fare integrated system (EOD, 2017). Also, the government continues to take a proactive position with improvements to the system's infrastructure, operational efficiency, and affordability, as well as continuing the planning practice of 'social urbanism' that has been so successful for the fostering of inclusivity in its mass transportation.

Planning programs such as the ‘Cinturón Verde del Valle de Aburrá’ (Aburrá Valley Green Belt) have been initiated to regulate the excessive expansion of urban constructions and limit the encroachment of informal settlements on the slopes and thereby protect the natural habitat and air quality. These programs have substantial ramifications for transportation by helping to increase building density and reducing the radius of transportation operations [Figure 5.4, pg. 34]. This plan, along with the 2014 ‘Plan de Ordenamiento Territorial’ (Territorial Ordinance Plan) that encourages sustainable transportation and development toward the city center, and the ‘EnCicla’ bikeway system expansion, also exemplifies a strong, forward-thinking governance.

For a major city in a developing country, it is formidable what Medellín as Colombia’s second largest city, and nominated as the 2012 ‘Most Innovative City of the Year’, has done within a relatively short period of time in mass transportation. Its accomplishments should serve as an example to many cities in Latin America and other countries of the developing world, and even in North America as they plan for and improve their transportation programs. However, the city’s population growth and the speed and scale of urbanization will continue to bring challenges, including meeting demand for affordable housing, well-connected transport systems, other infrastructure, basic services, and jobs.

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APPENDIX 'A' – Personal Interviews

Held in Medellín in October, 2019:

***Interview 1*;** Nanclares, R. (2019, October 7). Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

Interview 2; Aldana Ramirez, C.M. (2019, October 8. Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

Interview 3; Suarez Gómez, M.L.. (2019, October 8). Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

Interview 4; Echeverri Restrepo, C.A. (2019, October 9). Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

Interview 5; Bayardelle Morales, R. (2019, October 9). Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

Interview 6; Rivero Jerez, J.E. (2019, October 12). Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

Interview 7; Sarmiento Ordosgoitia, I. (2019, October 15). Assessment of Mass Transit in Medellin: Interviewer: Kessler, F. University of Texas at Arlington.

APPENDIX 'B' – Interview Questionnaire

1. How was Medellín's transportation system implemented and do you think its implementation has been successful?
    a. If successful, please define what you think makes it successful.
    b. What was your involvement?
2. What are the most pressing transportation issues that Medellín faces at the present time?
    c. How do you think these issues can be resolved?
    d. How can the transportation system be improved?
3. Are there urban poor that cannot afford ridership in the transportation system?
    e. How would you make the system affordable for these people?
4. Does the current system pay for itself?
    f. What are the sources of revenue for the various systems?
5. Is there vehicular congestion in Medellín?
    g. If so, what contributes to this congestion and how would you solve this problem?
6. Are there currently problems with the air quality in Medellín?
    h. If so, what do you think is the cause of these problems and how do you propose to solve them?

APPENDIX 'C' – English - Interview Translations

INTERVIEW QUESTIONS

Interview No.: 1
Interview Date: Monday, October 7, 2019
Interview Time: 7:00 am
Name: Rafael Nanclares
Title: Civil Engineer
Direction: nanclir@gmail.com
Telephone: 011 57 300 577 1484
Authorization to use your name: Yes

Biography:

Civil engineer, with specialization in construction management. My connection with the city's transportation system was during the administration of Alonso Salazar, between the years of 2008 to the end of 2012, where I worked with Professor Ricardo Smith who was the secretary of transit for the city of Medellín and where he was the mayor's advisor. I then ended up being the transit secretary because he retired and there as the secretary we participated in the development of the transportation system for the city of Medellín in several aspects.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: Well, the Medellin transport system, let's say is successful, but it has multiple stages, different structures, and the initiating element of the Medellin transport system was undoubtedly the construction of the city's Metro light rail, which was the only metro in Colombia at the time and it was done for something that I will repeat in the interview. It was made by a political decision and let's say the obstinacy of the president at the time, who was President Betancourt and that was key. He was from Medellín, and his determination to build the Medellín metro was a very important purpose, that generated a structuring axis throughout Medellín and in the Aburrá valley. It became a metropolitan event, it made us think in another logic, when doing these transportation improvements, after the Medellín metro was inaugurated, The Medellín metro has worked well but has not grown enough, for many reasons, including political and economic issues.

The budget to make the subway is very expensive compared to our budgetary capacity.

a. If successful, please define what you think makes it successful.

Answer: On the issue of the Medellin transport system it was a construct, the first thing in the 80s was the Metro, its construction operation in the 90s, after which there was a stagnation essentially in the transport systems. The buses followed and were integrated into the subway system. At the time, perhaps there was not so much need, as there was not so much congestion. Then a significant change began with the construction of the aerial cable, an aerial cable as an alternative solution, even ingenious for our topography, the mountains, the challenges, the lack of space. Medellín is a very closed city in a valley with little space, then the construction of the aerial cable was transcendental, but the aerial cable was not working well and it was in the administration of Sergio Fajardo where that cable that already existed in Santo Domingo was made an integral urban development, in an integral urban plan, where we connected to the city of Medellín so that people from all over the city could now go to what were the most dangerous areas of the city which now housed symbolic attractions. We endowed these areas with a library, the Spain Library, and that gave a connotation to the transport system. The transport system alone, let's say it is not enough, if the other public facilities that allow the development of the community are not put in. I think that was very interesting, and then they continued with other aerial cables in 2008, 2011 and the tram also after 2012, 2013. The construction that engendered the system, let's say a multimodal transport system that Medellín has today adding to that the public bicycles what I talk about right now in the other question, began to configure a knowledge in the city, of what the public transport has that has to include different modes of transport. In Medellín it happened due to economic, political restrictions and because we began to have a very strong accident rates, sidewalks began to be created in the city. Medellín is a city without sidewalks, there are still many sidewalks to be built for people to walk safely, because in the city's destination survey almost 60% or more than 60% of the city moves by public buses, mass transit and walking, which is a negative potential, with a big challenge for this pedestrian system to not go to cars, which would make private cars grow in use.

Yes, I think that Medellin's transportation system is successful, and I think that a certain feeling of regionalism makes it successful. There is a cultural

issue of appropriation, for example the Medellín metro, and an exercise of citizen culture for people to respect and take care of the Medellín metro. In that sense it is successful, the other, is that we need an important part to make it a solid success, and that is the integration of buses to the mass transit system. In that, we have advanced, but we still have a long way to go.

b. What was your involvement?

Answer: We started to implement an ITS (Intelligent Transportation Systems) intelligent transport systems theme and we started to make a city traffic control center to optimize the movement of the city, that was a role we obtained. Another role was with the metro plus which is a BRT (Bus Rapid Transit) where we worked on the construction and implementation of the metro plus. We were the ones in charge in the Mayor's Office to put into operation the Rapid Transit Bus system in Medellín, also we were involved in the area of aerial cable car coordination, being part of the Medellín metro board. We worked there with the Metro that is key in this matter. We also had to do with the whole issue of accidents and mobility. We started and implemented the public bicycle system of the city with the metropolitan area and a process of sidewalk improvements for the city crosswalks and sidewalks privileging the pedestrian over the other actors of the road and in a negotiation process with the transporters of the collective transport companies, private bus companies as we say here in Medellin, which was not achieved in full, although some important advances were made. Transport terminals for buses were built in different peripheral neighborhoods, especially where they had no place to store the buses and this generated a social problem, of mechanics, of places where they drank liquor, so there is an integral security issue for the community that was achieved by improving the parking of buses in the public space.

2. What are the most pressing transportation issues that Medellín faces at the present time?

Answer: The most important problems that the city of Medellin has in transport, is the environmental pollution generated by private vehicles that are still very dependent on fossil fuels. I am talking about the private vehicle and the bus systems that we have. The transition to renewable energy systems is urgent, that is one. Another is the inequality generated by transport systems, since the cost for poor people to move in the city is much higher than that of rich people and this is something that is very

important. Another issue is political will. Why the political will? -Because transport issues are not popular in political terms and do not give political credits in the short term. Because in 4 years of government it is difficult to implement a transport solution as you need to think in the medium and long term; and there, political will is lacking. Another problem is the planning of collective public transport and transport, in general, not only in Medellín but, throughout the metropolitan area of the Aburrá Valley because they are already problems that transcend the small borders of our municipality and that is very important for neighboring municipalities. Neighboring municipalities of Envigado and Sabaneta are already suffering from a very high densification process. Also, in the north in Bello, Barbosa, we have to think together, as there is a planning problem. The other is road congestion that we say is what you see the most of, which is that of private vehicles. This is a problem that needs to be solved and which are the principal problems that we have.

a. How do you think these issues can be resolved?
Answer: (included in b.)

b. How can the transportation system be improved?
Answer: Well, first this is a challenging question, but the first thing we have to do is have a political will for change by our decision makers, in our mayor, the councilors. The governor also has an important role, the director of the metropolitan area, and that is not to think of immediate political credits if you do not think in the medium and long term. That is the first way to solve this problem. Why? Because you are going to have to start really re-privileging the mobility pyramid, we have to start by generating a city that has the conditions for people to walk, that is so that people can leave the private vehicle, that is a first. Second bet on non-motorized transport, for that we have good sidewalks and crosswalks, and a structure for bicycles to move safely. I move by bicycle in the city and it is really an extreme sport, but well we have advanced, but we must continue on that. You have to put electric bicycles, and it is very cheap and it is very powerful because from children to adults can ride these bicycles, so it is not just to install the bicycle system, but it is to teach people to in that way. Another way is also the subject that I speak as a proposal that is immobility, not moving is a strategy that can be deliberate to not generate congestion, which means that or, it is to make between urban planning the short cities, the oblique cities, that where you live and have access to a lot of the services that a person requires, health, sport,

education, the issues of the state near where you live , bone, is not to concentrate the services in one place because they become great mobility attractors if not atomize them, take them out all over the city so that people have easy short trips, to get what they need for their quiet life, that is a planning issue, a topic of increasing connectivity, we are talking about having 5G, virtual connectivity, fiber optic throughout the city, because if you can take these services and many things can change, in that strategy there is also the issue for example, Telework, work from home, many service companies could start that practice from now on, just talking about the solutions of how to improve the transportation system, The issue of facilitating the appropriation of new ways to solve mobility problems, such as UBER is one, but also home systems, start thinking about how we are going to use drones to carry packages and loads, so as not to congest the roads, and not having to build more roads, autonomous vehicles, key, it is very important for public transport, for the respect of traffic rules, this is a new hope in the world to lower the accident, well I think that those are some, and another very important specifically here in Medellín, what we have to do is continue very precisely and prioritize the resources in the Medellín metro, in more aerial cables, especially in the area of Poblado where there are more vehicles and there is no mass transport system, in Laureles there is also no mass transport, we already know how to do that, that is why we are half famous in the world, for using aerial cables, we can do more Trams, we need to do more trams in our city, we need to do more BRT (Bus Rapid Transit) for many parts and that they have in the expansion plan of the city subway, so we need, I think that configuration, but an actor is missing that very important, which is the motorcycle. The motorcycles became the predominant mode of transport, the number of motorcycles is almost matched with the number of private vehicles, cars, and it is exceeding it, so, today perhaps the main mobility actor is the motorcycle and the motorcycle has a very special configuration. It is the cheapest transportation system for a person from the city of Medellín, they sell it to you immediately, they have impressive financial plans. In order to help on the issue of transportation we must migrate from motorcycles that are gasoline and pollute a lot, at least as a first step from motorcycles, electric bicycles, second, generate a financing plan from the state to that transition, and third, hopefully a gradual system for you to have access to driving a motorcycle, because people do not know how to drive the motorcycle and driving licenses in Colombia are delivered in a way where there is no specific control. We are not well educated to drive, this

generates deaths and impressive health costs to the city by traffic accidents of motorcyclists and motorcyclists with pedestrians.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

   Answer: Yes, they exist because the transport system is part of a structure of a city, it is something that allows the movement of people, but it should be matched to the economic condition of our city, in our city it is deeply unequal, I repeat that word again, it is extremely unequal, so job opportunities do not reach all people, our economy is a very weak economy, so the question is how can we make these people access the system?

   a. How would you make the system affordable for these people?

   Answer: First, it is not only the transport system; it is a system that is integral and holistic. It is to seek and generate a deliberate economic development for these people, that is one thing, and in the transport system there is a way that it can be done. There is a network in the world called Free Public Transport, a worldwide network, where many cities are associated in that network to have transportation subsidies, They will not invest more in roads for private vehicles. They will keep those that exist and ensure that people move by collective public transport. How to achieve that? By lowering the rates of collective public transport, provide incentives for older adults, children, schools, universities. Free transportation is an investment that brings political and economic and environmental credits today, because you teach people to move in a safe, comfortable way. The key is to cease to invest in road interchange construction, because that costs too much and in two or three years with the growth in vehicle use you have the same congestion.

4. **Does the current system pay for itself?**

   Answer: No, in Medellín the system is not self-sustainable, and it does not have to be. Public transport fulfills a social, economic, environmental and cultural function, which cannot be calculated only by the cost of the fare or the cost of the operation. It has other income and other social benefits that are very important for the quality of life of its citizens.

   a. What are the sources of revenue for the various systems?

   Answer: The first is the ticket fare, that is one. Other sources of income can be advertising, the advertising that is used within the system because

millions of people see it, it is very powerful. Another is the exploitation of big data that is generated within transport system. You can know how many people enter the system. With facial recognition you can know the person's age, where they live, where they come from, where they are going and becomes a topic of information use, as Google does and as does any large system that handles a volume of information, that can be explored, so you can undertake an analysis and a value for the Business Intelligence that this information generates. This is a powerful source of revenue for cities. Medellin Metro could tell you what kind of tennis sneakers people use, what type of shirt, what type of backpacks, thermos. These are advertising and trade issues. The metro is an inexhaustible source of information which are ideas that I have to believe are possible. The other is the real estate issue. Living near a subway station is being connected. You can build on top of the subway stations; buildings, shopping centers and all that money generated can go to the transport system, it is a system that has been made in various locations. In Holland I think things like that have been done. Train stations in Berlin, in Holland, in Milan, Italy, with large shopping centers where the money goes toward system maintenance.

5. **Is there vehicular congestion in Medellín?**

Answer: Yes, there is vehicular congestion, and it is a problem that is not solved, that sounds like a resignation and as something fatalistic.

a. **If so, what contributes to this congestion and how would you solve this problem?**

Answer: Congestion is almost a symptom of the development of cities. As purchasing power increases, people have a natural desire to have a vehicle, a great vehicle, and it is something that is part of our capitalist system, it is inevitable. No city in the world prohibits the purchase of vehicles, nor will they prohibit it, so first consider the economic system in which we are in and in that sense what we have to do is to stop worrying about road congestion, which can be self-regulated in the city, I Rafael Nanclares, have this as a very personal vision, but to put systems in place for scrapping, vehicle obsolescence, that a vehicle cannot circulate. A vehicle of more than 5 years is already obsolete, in terms of the engine, combustion, of a number of issues, including fashion. That there be a greater renewal of the car parks but not the growth in number of parking spaces, which is one of the issues of congestion in Medellín. The other is to identify where in the city there are more vehicles per person, and in the case of Medellín it is in el Poblado, Laureles and Envigado. These are the

areas where people with the highest income live. Provide other transportation alternatives such as the Metro, cable cars, trams, BRT, sidewalks, electric bicycles, so when you do that, you are giving the rich people who are not going to leave their private vehicle easily,. If you do not give them a choice of a high level of comfort, they will never do it.

6. **Are there currently problems with the air quality in Medellin?**

Answer: Yes, we have serious air quality problems in the city of Medellín that are exacerbated by our geomorphology, as a result of the shape of our mountains and our valley, since the gases are heated to rise and exceed the height of the mountains. It does not happen when there are colder days, then we do have a problem and it is a very serious problem, and it is the problem that I see is the most urgent.

   a. **If so, what do you think is the cause of these problems and how do you propose to solve them?**

Answer: Public transport must improve, because private vehicle congestion is very annoying but does not kill anyone, but yes, the cause of these problems are private vehicles and collective transport, buses, and motorcycles. 95% or almost 100% are fossil fueled, so that transition to clean energy transport systems is key. The transition to electrical propulsion systems are needed to overcome this. That is the most urgent task that anyone who thinks in mobility in the city of Medellín. That is the first task, how to solve it. I think the market has a lot to do here. Several motorcycle assemblers are in Medellín, there are several, of the most important in Colombia are here. We propose more electric motorcycles, electric bicycles with financing plans, as they do today with fossil fuel bikes. The idea is not to let these businesses fail but for them to keep doing the same business but to sell us some motorcycles that do not contaminate. The same can be said for private vehicles, private vehicles in Colombia had a tax exception, electric private vehicles were entering Colombia with fewer taxes but they subsequently increased taxes on private vehicles by the current government. These current policies instead of favoring the electric vehicle, it is attacking it. This has to be done through political and economic interests, that is why the political will is so important to you, to work with companies to generate economic and financial conditions so that people can access electric transport systems and I believe that the easiest, cheapest, fastest solution to implement in Colombia and anywhere of the world to combat this, it is with bicycles and electric bicycles, because the electric bike is very simple to drive. It will

take a city that has hills and has high slopes and will flatten it, in some way, because you keep riding the bicycle making the same effort regardless of the slope, and it is delicious riding an electric bicycle. I say it in the first person because I do it, so it is much cheaper compared to what you spend on the construction of a road interchange or on the construction of a bridge in a city. For what you spend on these systems you can install an entire system for electric bicycles for a city, listen to me well what I am saying Francisco and you can easily check it, it is very easy.

INTERVIEW QUESTIONS

Interview No.: **2**
Interview Date: **Tuesday, October 8, 2019**
Interview Time: **7:00 am**
Name: **Claudia Marcela Aldana Ramirez**
Title: **Professor, Environmental School**
Address: **University of Antioquia, Medellín**
Telephone: **(+57) (4) 219 5596**
claudia.aldana@uda.edu.co

Authorization to use your name: Yes

Biography:

Civil Engineer from the National University of Colombia, Medellín headquarters, Master in Engineering - Infrastructure and Transport Systems of the same University, currently a professor of the Environmental School in the Civil Engineering program of the Faculty of Engineering of the University of Antioquia. Former official of the Ministry of Mobility and the Metropolitan Area of the Aburrá Valley.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: The Medellín mass transit system was implemented after about 1985 when its construction began. It opened in approximately 1996. The construction of the key metro system has been very successful because it has been able to reach the slopes of Medellin, why ?, because we are seeing it in a social way, we are providing a service to the community and the most important thing is to bring people closer from these slopes, because as you know the topography in Medellín, it is a bit rugged because we have high slopes, if we are going to implement a public collective transport system, such as bus or BRT, we need a lot of space to be able to make the roads, to be able to access these areas and the consolidation of those areas in Medellin is already quite strong. We have three and four-story homes or more, so let's just say we make a transformation for these systems, which are systems that need turning radii, lengths to develop speeds, it is very difficult to reach these points of the city. So if it has been very successful because it makes us put a line that joins some points and where people can access them to reach the center of Medellín. In the case of work or study, it gives people

a lot of confidence and it allows them to economically transport themselves, so it has been very successful.

a. If successful, please define what you think makes it successful.

Answer: The success of the system is that there is demand, due to the spatial location of residential units, in the northern zone and workplaces, mostly located in the southern area of the Metropolitan Area of the Aburrá Valley. Additionally, due to the integration with other systems, such as aerial cables, the tram, the Metroplús system and the feeder routes, you can reach almost the entire city of Medellín and several of the nearby municipalities.

b. What was your involvement?

Answer: The implementation did not touch me directly. I worked in the mobility secretariat, even when Rafael Nanclares was secretary and Martha Suarez was my direct head, then we were working on improvement projects, then, let's say systems here in Medellín, but not directly with the system. We were working in relation to the metro plus, because the metro plus was being formulated to go out to 2010. I hope to participate in projects because at the University of Antioquia we want to set up a sustainable mobility laboratory, so that way I think we can work very closely with the Medellín metro for the next projects.

2. What are the most pressing transportation issues that Medellín faces at the present time?

Answer: One of the biggest problems that Medellín has is the issue of the increase of private transport vehicles, such as an increase in private cars and motorcycles. Medellín due to its climate, also becomes a place where people want to access a vehicle like the motorcycle. so how economical let's say in some way, it seems to me a good well-managed system, because it is a system that is small that can be easily parked, that offers greater capacity to the vehicular lanes, yes, but in Medellín we don't know about that and we take it in another way and we have a lot of accident problems, of fatalities of very young productive people. So what happens, if I don't have a transport system that I actually have or that is solving the needs of the population?, the population will look for ways to find other systems to mobilize like the motorcycle.

a. How do you think these issues can be resolved?

Answer: That is the question, that is, as I was saying now we have to turn more to the population and really know how people move, and what their needs are, because if we do not know about those needs of people, we will never really going to have a good transport system. As I say, we have a Medellin metro which is the main axis that is a backbone, from it other transport systems are detached, but if the system does not offer, let's say comfort for a citizen, whether as a comfortable chair, or for the person with reduced mobility who cannot access, as well for the hot vehicles some cannot tolerate. During peak congestion periods, people will always want to use a system that seems much more comfortable. And also the issue of travel flexibility, when I have to do some very long journeys in a transportation system, surely people for their time who consider it an important thing in their life, time, then they would prefer a system that better managed their time.

b. How can the transportation system be improved?

Answer: Streamlining the use of private motor vehicles and private cars, adapting the pedestrian walkways and paths to improve the connection at the pedestrian level for the users of the different systems, also guaranteeing safety in these pedestrian corridors, proposing complementary electrical systems such as electric bicycles on the slopes of the city, implementing a complete integrated system, that is, with integrated use of public collective transport routes which are operated by private companies.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

Answer: The city of Medellín has a population of roughly around 2,600,000 people, and there is a high population that lives in the peripheries of the city, where people with less resources settle, so we do know that people with low resources settle precisely on the slopes, where access is more difficult, we will always have many mobility problems. Then there are people who if they cannot pay, cannot access the system, but the fact of that is also, not everything is bad in that systems such as the cable car systems have also arrived at these places because people can now access a system with a single ticket and can take a long tour of the city.

a. How would you make the system affordable for these people?

Answer: So if we want an accessible system, it should be a system that would be free for people with low resources, that could somehow be subsidized from the highest estrato (income) levels, or from international efforts to help support the system, because the system works and it works well. So how can we make these people access the system? If the low-income people that are working and that earn a minimum in Colombia, that is around $828,000, which is about 10 dollars a day or so, which is very little money for people to have access to food, housing and transportation, if we want to be equitable and really want to have a equity in Medellin, those people should not pay so much for transporting in the system, so it should be subsidized.

4. Does the current system pay for itself?

Answer: No, the system does not pay for itself.

a. What are the sources of revenue for the various systems?

Answer: The population is the one that has to pay a fee. The system as such is paid by the investment of the government, the national government, the locality and good government development loans, but in reality the user is paying.

5. Is there vehicular congestion in Medellín?

Answer: Yes, a lot of congestion in Medellin.

a. If so, what contributes to this congestion and how would you solve this problem?

Answer: There are many sources of congestion. In Medellín we do not produce any type of food, so more, almost 90% of the trucks that enter the city, bring food and it is very difficult in that way that I can take the circulation trucks out of the city, so what pollutes the most and the most congested is a truck, and trucks arrive every day in Medellin, so they are part of the problem. Second, the motorization we have, the purchase of private vehicles that grew by more than 400% in motorcycles in recent years, then we have more motorcycles than cars, 800,000 motorcycles or so and 750,000 cars, in a road network that does not grow, because the road network for them to grow in Medellín is very difficult due to topographic conditions. So since the road network does not grow we have the same number of vehicles that is growing every day, at a rate of more or less, as more people enter Colombia, of 30,000 vehicles per month.

Those are many vehicles, more or less 500,000 vehicles per year, it is many vehicles that do not get scraped. As these cars enter, they do not come out, certainly none come out. We have many trucks because we have to solve the problems of food delivery and all other cargo. We have all the people who do not want to get on the public transport system and buy their private vehicle and then there are public transport systems that also make congestion, because we don't have exclusive lanes or anything like that, then we have all the problems. We have many problems, and solving them is difficult. We would have to start thinking about how we are going to be more sustainable for the food, for the things that we do not manufacture, we bring in everything, so the fact that we do not produce anything has also made everything to be brought in which is going to be more trucks, so I think that is one of the main problems.

6. **Are there currently problems with the air quality in Medellin?**

Answer: Yes

a. **If so, what do you think is the cause of these problems and how do you propose to solve them?**

Answer: Well, here we have to tell you that we have fixed sources, because we still have factories nearby. In Medellín the factories that are here we want to take them out of the city, but we still have large factories, even factories that run on coal, then we have problems with fixed sources, right, and the mobile sources that are all the vehicles that are circulating on this road network that I tell you are coming, as we have so much congestion then all that pollution stays here in Medellin because it does not reach out and more so when we are in winter, when the clouds cover the city because they are in rainy periods and not all pollutants can get out, it is true to dissolve in the air because we are like a cup, we are as like if we put a lid on a cup and we were locked, right, so that's the problem. So since we have so many motorcycles, the motorcycles pollute a lot, 4-stroke motorcycles and 2-stroke motorcycles pollute a lot, more so that the 4-stroke motorcycles for PM2.5, that are 2.5 micron particles, which are the little ones that enter the alveoli and stay there, they don't come out again, so we don't have a regulation because we have ‘pico y placa’ (alternate days of vehicle use by license plate), but we don't have ‘pico y placa’ for 4-stroke motorcycles and there are more motorcycle than cars, right, so there we have a problem, because then they do not go to ‘pico y placa’ too or because they do not have a major restriction, and the trucks that are the ones that pollute the most. We have a lot of trucks that arrive in the city

every day to meet the need for food or whatever we need, so how many trucks are all in the city and garbage collection? We are 2,600,000 inhabitants and we are almost 0.8 kilograms more or less 800 grams of garbage per person, that on the day there are many tons of garbage that has to leave Medellín to the place of disposal that is the meadow, which is about 2 hours from the city, so they collect garbage all the time, they are going there and they return to the city, so that is a vicious cycle, so that is what I said for example at the beginning with the theme of the suburban multipurpose train, that we had a garbage collection system and also that supports the subway with the passenger issue and we could be working on two important issues with the issue of air quality and with the congestion issue, right, but they are slow projects because the construction of a system like those would entail improving a lot the rail system in the city and it is a system that is abandoned, then you have to start rebuilding and that will slow it down in time, but it can be an alternative for the future.

INTERVIEW QUESTIONS

Interview No.: 3
Interview Date: Tuesday, October 8, 2019
Interview Time: 2:30 pm
Name: Marta Lucia Suarez Gómez
Title: Program Leader Planning and Prospective Unit
Secretary of Mobility, Mayor's Office of Medellín
Address: Carrera 64C # 72-58
Telephone: (+57) (4) 445 7718
matal.suarez@medellin.gov.co

Authorization to use your name: Yes

Biography:

Ministry of Mobility of the Municipality of Medellín. Leader of the program of the Prospective and Planning Unit (Plans, programs and projects associated with the administration, regulation and control of the mobility of the city) Year: December 2013 to date.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: It is important to retake history a bit, because talking about the implementation of a transport system requires going back years ago, to the policies and the way in which the provision of public transport service was formulated for Latin American countries or for many countries in South America in particular, where transportation must be self-sustainable, that is, the state does not put resources to subsidize the rate, therefore the operating costs must be covered with the fee charged to the user. This led to the government, in this particular case Colombia, authorizing the provision of the transport service to particular operators under the parameters determined by the governing authority (parameters including operational design that is Number of vehicles and type, frequencies, hours of service provision, routes, and value of the rate to be charged among others). It is important to specify that the provision of the Public Transportation Service is regulated by the National Government; therefore the Municipality of Medellín must comply with all the regulations issued in the matter.

These norms have been evolving in recent years with the purpose of improving the provisioning of the service under the principles of efficiency, economy, sustainability, comfort and safety. For this to take effect in a complementary way some restructuring policies had to be enacted, which implied revising the process for soliciting bids and awards to third parties for the new restructured services under a new model for an integrated and massive transport system. The process for Medellín begins by recognizing the existence for the provisioning of some transport services on the periphery of the city, without proper authorization, called "informal" that generate unfair competition to formal transportation. Therefore, by means of an ordinance issued by the departmental assembly, it was allowed that, without doing the bidding process, they would be legalized and accepted as legal companies providing a collective public transport service. We cannot ignore the history of Medellin and perhaps many cities in the country, in which informality presents overlapping routes with formal routes generating problems for the social order. Once legalized, it continues to be an additional offer and also a competition for the user called the penny war, which is presented in large part by the limitations of the road infrastructure. It is very common that a single corridor allows accessibility to several areas of the city, in which the transport service is served by several companies. On the other hand, the city of Medellín has the privilege of having a Metro which entered into operation in 1995. We consider it successful for the city and it is the structuring axis of the integrated system for the Aburrá Valley that has been shaping up with the passing of the years. We speak of the Aburrá Valley because we cannot ignore that the City of Medellín is part of a Metropolitan Area formed by 10 Municipalities in which the majority are troubled and where mobility and transport are constituted in Metropolitan events, the foregoing by reason that each Municipality in addition to offering transportation service with buses within its jurisdiction also has other services to the city of Medellin and other services that integrate with the Metro, making its operation necessary under an integrated transport system which we call SITVA (Integrated System for the Aburrá Valley) and implemented under policies established by the Metropolitan Area as the authority of metropolitan transport and mass transport.

The system is made up of:
The Metro, with 34.5 km, 27 stations, 80 three-car trains and a mobilization of about 900,000 passengers per day.

5 Cable car systems totaling 10.77 km plus one in the process of construction of 2.8km with a mobilization of approximately 50,000 passengers that cover areas of difficult accessibility due to the topography of the city.

A tram of 4.2 km, 12 trains, with a mobilization of 55,000 passengers.

A BRT of 12.5KM by the segregated line and 13.5 non-segregated with 509 buses and articulated buses with a mobilization of about 160,000 passengers, which allow the connection between the areas of the East and West, which we call the cross basin.

A system of urban and metropolitan buses of approximately 50,000 vehicles including feeders to the Metro. With an approximate mobilization of 1,400,000 with radio services (center-neighborhood and neighborhood-center).

A public bicycle system consisting of 52 stations and 1200 bicycles with 73,000 users.

It is important to highlight that when the Metro operation began, the need to generate services that were integrated in order to expand its coverage was identified since its lines allowed traveling from North to South through 6 municipalities of the 10 of the Metropolitan Area without attending the peripheries or neighborhoods because of their remoteness. Therefore, 50% of the mobilization of the Metro is currently provided by the feeder routes. As you can see, the city and in general the Municipalities that make up the Metropolitan Area have a very good access to public transport, and we continue working so that it is provided with quality and efficiency and committed to sustainable mobility.

a. If successful, please define what you think makes it successful.

Answer: I could say that it is successful, in the sense of what we are offering and the different alternatives, but to reach the summit of success many things are still missing. Today we have also advanced a reorganization of the transport of the city so that this service incorporates technological component elements, where through these devices on board the vehicle we can better inform the user, either by mobile applications or at the bus stops and we have just been doing so, just as a tariff integration could be achieved, that is to say, that the user can have only one card and hopefully it was electronic, then we would say that comparatively with the progress of other cities in the country we would believe that we are on the right track and we are going towards success but we still cannot say that we are in total success.

b. What was your involvement?

Answer: I have been involved since the National government wanted to make a restructuring of public transport and the tendency was that everything should be tendered, everything should be changed as new systems through bidding processes and not continue with the old operators, for in the case of Medellín, I have had to work hard on everything that was the implementation of the system, which we call SITVA, as it was stated in the answer to question 1 (Integrated System for the Aburrá Valley), without classifying whether it is massive or not. either, because the idea is that what the National government has classified as massive, meters or BRT or having said that all the systems became massive in our case, we do a mixer, that mass transport can be perfectly combined with collective transport without the need to be called one way or another, the idea is to achieve its operational, physical and tariff integration while retaining its character and without the need to initiate a bidding process and making clear the competences of each of the authorities in the field of transport taking into account that the metropolitan area has the competence over the mass transit and each municipality has public transport, and in this way to preserve the autonomies of each one, for this, agreements are made between the authorities through agreements signed between the parties. This has allowed to minimize the social impacts that are generated before a bidding process in which the losing operators of the call must withdraw from the service and give way to new operators winning the tender as it has happened in our city and in others in the country, with not very good results. Medellín decided to do it differently which allowed a modification to the national government rule which allowed for business agreements between the mass and public transport improving the quality of service without the need to follow the National order process.

I participated in this process and it was achieved that the National Government included this figure under the understanding that Medellín businessmen would voluntarily submit a reorganization proposal under the same principles of the mass system, that is to say, they joined the companies that competed for passengers when they share the same corridor, renew the fleet toward vehicles with clean technologies and accessible for people with reduced mobility, and incorporate a technological component for the control and management of the operation. This was hard work because it was necessary to ensure a financial closure against the investments and returns that were due the businessmen, therefore it was necessary to grant a term of more than 5 years for this

transformation and so sustainability could be achieved. This scheme adopted by the city has allowed it to work and makes a difference as compared to other cities in the country where it is being tendered and today they are deficient, and concerned about the sustainability of the system. For this reason, we consider that the process carried out by the Aburrá Valley is successful although it was a very complicated process that involved meeting with each operator, and bringing together the operators that served a common area in this way, signed their business agreements and they committed to all the renovation and right now they are doing it.

2. **What are the most pressing transportation issues that Medellín faces at the present time?**

Answer: Ideally, to motivate citizens to use public transport is that the system can have very attractive travel times for the user, but unfortunately due to the difficulties in the road infrastructure we have to generate segregated lanes for the entire transportation system, it is not easy, and where we have done it, there is still no culture, nor respect for the use of these lanes by private vehicles. We have declared these lanes preferential for the preferential use of public transport. This lies in one of the great difficulties. It is a great challenge for us to guarantee short travel times and agility to the users of public transport. We know that the selection of the mode of transport to be used is based on the generalized cost of the trip where travel time and the value of the fare are fundamental for this decision followed by comfort, safety, regularity among others then one of the great challenges is to guarantee them precisely adequate operating speeds. Another complex aspect is the adoption of a new culture in the face of the new model of service provision by businessmen, owners and drivers; for example, the driver's salary was proportional to the number of passengers mobilized by the vehicle driven with more days, 10 hours a day. In this new model they have to hire drivers with their benefits and not for mobilized passengers, and with an 8-hour schedule as established by law. However, there is a strong rejection by drivers to this modality

a. How do you think these issues can be resolved?

Answer: The restructuring of the transport includes the incorporation of a technological component for the control in the provision of the service such as the abandonment of the route, speeding, overcrowding, passenger mobilization among others. This is allowing us to permanently monitor the

provision of the service, adopt corrective measures or initiate investigation processes if necessary. However, this has caused some drivers to reject the technology in some cases with vandalism to the devices located in the vehicle. But we continue in the process with campaigns and generation of a new culture under different communicational and pedagogical strategies.

b. How can the transportation system be improved?

Answer: Basically the problems in transport lies in not having enough infrastructure to guarantee competitive speeds and adequate travel time for the user and chip change by proprietary drivers and users. For example the user must get used to going to the designated bus stop to take your route and not request the bus to stop at any place that is not a designated bus stop. There is a lot of culture but we have been working hard, basically the problem lies in this aspect.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

Answer: We know that there are very difficult conditions for many people and I believe that this is reflected in the high percentage that we have of walking trips. Now we are also promoting among the non-motorized trips the use of the public bicycle, which has had a very good acceptance and use as a complementary way to the transport system or for short distance trips. The city is relatively walkable, although there are peripheries or communes that are very distant due to its slopes and topographic conditions not so easy access.

In Medellín there is a respect and a culture for the payment of the fare; that is, here you do not see people avoiding payment like we have seen in the news of Bogotá, where people evade paying fares to the fullest. The metro system, Metroplús, tram and its feeders give the possibility of a trip on credit. There are alternatives but there are indisputably areas where it is difficult for many because of their economic condition to access transport.

a. How would you make the system affordable for these people?

Answer: We can talk about accessibility in terms of costs and also in terms of people with reduced mobility, which is another condition that these vehicles must meet.

4. **Does the current system pay for itself?**

   Answer: For us, the system is paid in what has to do with private operators and charged to the rate, that is, the collection for the user fee has to give them for the sustainability of the system, however, the Metro of Medellín, metro plus, the tram, the cables are operated directly by the state and have contributions from the city of Medellín to be sustainable, while the rest of the operators have to sustain themselves via fare.

   a. **What are the sources of revenue for the various systems?**

   Answer: The passengers, the payment of the passengers and on the part of the state which has to do with the metro, tram, metro plus, cable car system. The state the Municipality of Medellín provides resources for its sustainability.

5. **Is there vehicular congestion in Medellín?**

   Answer: Very much, precisely one of the great difficulties of our city is a very high congestion especially at peak times.

   a. **If so, what contributes to this congestion and how would you solve this problem?**

   Answer: There are situations that make the city look more congested and it is the execution of the different works that impact the mobilization. Following the principles of POT and development plan, more public space and infrastructure for pedestrians, cyclists and lanes are only being generated which has forced the reduction of the road section of some corridors by decreasing their capacity and consequently increasing congestion. These interventions are being done mainly in the city center to favor non-motorized mobility and public transport. Leaving aside the private vehicle a little, that is, there will be a time when the congestion almost becomes a self-regulation especially for the particular vehicle and that is why they are looking for demand management alternatives, the city has 'pico y placa' but it is thinking about the possibility and some studies have been done to extend that schedule or to generate congestion charging areas that also require proper analysis.

6. **Are there currently problems with the air quality in Medellin?**

   Answer: Indeed, Medellín, due to its topography, due to its high vehicular flow, due to the climatic conditions, goes through some critical episodes. For example, in this time of October we have cloud cover that does not let out all the polluting emissions and they remain below that layer, so that is

why we have critical episodes to implement more drastic measures in restricting the movement of vehicles. The restriction of traffic has increased at this time, including transport vehicles or cargo vehicles and other measures obviously supported with the participation of the private sector are taken, because for us it is important that everything we do is not only of the state but also a joint responsibility that the private sector also has. They have to present sustainable mobility studies. Companies that have More than 200 employees must present a sustainable mobility plan in which they present alternatives to improve mobility conditions and air quality.

a. If so, what do you think is the cause of these problems and how do you propose to solve them?

Anser: It is practically what I tell you, to unite the private sector in a commitment of co-responsibility and the implementation of some complementary restrictive measures, and to continue strengthening the collective public transport system.

INTERVIEW QUESTIONS

Interview No.: **4**
Interview Date: **Wednesday, October 9, 2019**
Interview Time: **10:30 am**
Name: **Carlos Alejandro Echeverri Restrepo**
Title: **Director URBAM University of EAFIT**
Loeb Fellow Harvard University
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Authorization to use your name: Yes

Biography:

I am Alejandro Echeverri, I am an Architect, I did doctoral studies in urban planning and territorial planning in Spain in Barcelona, in the urban planning laboratory of Barcelona. My experience combines the academic field where we are today. I have worked in government from the city, but I also have a private urban project study, that is, I move in three dimensions. URBAM is a center that has slightly different characteristics from the traditional study centers of the universities, URBAM founded it, we started thinking about it in 2009, I was the director of urban projects and the director of the urban development company from Medellín (EDU) working with Mayor Fajardo, and from that strategy we lead the strategy of integral urban projects, the strategy of social urbanism, the integral urban projects closely associated with promoting transport systems such as the cables that began to work at that time, then as I have moved between the academy, the public and private sectors, when I finished with the government at that time we began to think with the rector of the university that it was necessary to create an agency and a study center that could generate a space of connection and mediation between academia, governments, private companies and civil society, that was somehow to a space that could develop projects of collaboration, research, social projection of consulting and training, closely linked to real problems and with real communities to generate somehow a much more comprehensive conversation between these actors, then we founded URBAM in 2010. URBAM with M in the end means urban planning and environment precisely because we found that one of the debts was to generate responses that from the foundation and that from the beginning of the processes conceived the infrastructure and urban planning issues and environmental issues, let's say with a more comprehensive conception, with a more scientific knowledge and also more connected with the problems of people, then URBAM. We work on

academic projects, we have a master's degree program, we have research courses, we have academic line but what moves URBAM really is what we call the projection unit where we work with real cases; with governments, with foundations, communities, with urban and environmental and habitat problems, in Colombia in different regions, not only in Medellín and Antioquia, but also in other places. For example, we are now advising the national government of Costa Rica in the implementation of a strategy of socialy sustainable urban planning strategy projects, urban transformation issues to also prevent violence, we are advising TEC de Monterrey in the implementation of 5 city laboratories in the 5 regions of Mexico, so let's say that URBAM has a different action or let's say ample and our team is not only of architects and urban planners, here there are biologists, there are political scientists, we have an experience and some areas of knowledge that we try to cross, to give some more comprehensive answers.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: Yes, I believe that the word success is problematic in a city as complex as Medellin is with three and a half million people in the metropolitan area. It is better to speak of a process in transition, if one compares it with other Colombian cities, success depends on who you compare it to.

a. If successful, please define what you think makes it successful.

Answer: If you compare it with other Colombian cities, I believe that the Medellin process is more advanced, but it is still far, far from us, to have achieved a whole integrated transport system that responds to the needs of the city, but let's say that there is implementation of a series of technologies and in the same metro company a series of programs and policies that put us ahead of most of the Colombian cities and some of the Latin American cities.

b. What was your involvement?

Answer: In the work that we have in URBAM, we have supported the metro company to review its future expansion plan by 2030, especially evaluating urban and environmental problems in relation to their future corridor expansion plan, that It is what we have done since URBAM. Also from URBAM, we have worked with different projects that transform many of the street networks of public spaces and parks to generate a much

more complete connectivity, and that is a fundamental part of mobility issues, because mobility is not only mechanical systems or systems, but it is the itinerary, the route of the people we would say on all the transport system issues and to do somehow promote a more active mobility, the cycle routes. Then we have worked on proposals from green corridors, from green districts, on issues that are associated with mobility issues. In URBAM, when we worked in the government and I was leading working in the government of Sergio Fajardo, as director of urban projects of the city, we developed the strategies that at that time we called social urbanism and integral urban projects, which basically is to generate processes of transformation and inclusion in some of the poorest and most violent areas of the city. Many of them associated with the systems, with the new transport systems, so we support and work integrally with the first cable metro corridor in the northeastern area in Santo Domingo Sabio, in Anda Lucia, in the popular neighborhood to make a conception of the cable transport system and its much more complete stations in relation to an intervention in the territory that will transform not only the public space, but the daily life itinerary of the people who are going to use that transport system or who they use these urban centers. For example, as a mother takes the child to her school, leaves her house, which route she takes, from the school goes and takes the cable transport system that takes her to her work or we identify a series of those circuits to make a transformation of the public space and a transformation in sequence of the public services that transform the daily life of the people associated with the transport stations. In URBAM another dimension is that there are a number of young people who are one of the strongest leaders of the activism for clean mobility in relation to the whole theme of the bicycle, let's say we are very active in civic platforms and try to promote a little clean mobility, the use of the bicycle and other types of media, as an alternative, as a solution to the city.

2. **What are the most pressing transportation issues that Medellín faces at the present time?**

Answer: The most urgent problem is that the networks of systems and the routes that we have of integrated transport systems that we have in Medellín is still far from providing the service that the city needs. What happens is that obviously you have to understand the economic context with which we are in, but if one compares Medellín with cities of the world, let's say, cities like Paris, Tokyo, other types of economies where the

networks of transport systems cover efficiently a much wider part of the territory. We still really are I would say that in one phase, I do not know if I talked about it, I would not say that we are even intermediate, we are in an initial phase of the implementation of a much more powerful integrated system. Now if you compare yourself with cities like Cartagena, like other Latin American cities, etc. we can be more advanced than them.

a. How do you think these issues can be resolved?

Answer: So the first challenge is to continue to really increase the coverage of integrated transport systems in a much more complete way the feeder routes and above all there are still dual systems that do not work well. We still have a very large volume of the population of Medellín that are mobilized in transport companies that are not public transport, which are called public routes, but are very poorly designed private operations, somehow with very inefficient coverage, with duplicate routes, with very high comparison technologies, then we are in a transition process that should be accelerated more to really begin to somehow make coverage not only more complete, but better in quality, but also much more time and cost efficient and also much more decontaminated.

b. How can the transportation system be improved?

Answer: But the biggest challenge that Medellin has, I think that without any doubt is trying to anticipate really generating an alternative of clean and integrated mobility for the percentage of the population of the city that today does not use private vehicles, which is not as much as in other cities and societies where what is sought is to see how people get out of the car. Here also surely you have to generate alternatives for private vehicles, but less than 20% of the population of Medellín moves in a private vehicle, then the greater challenge is, how do we avoid that the 80% of the population that moves regularly today by public transit, and that does not move very well using this type of transportation, move to using motorcycles or private vehicles and in some way the city manages to generate an alternative to prevent the future in some way from a mobility that is fundamentally supported by private mobility. And most of all, I am talking about the neighborhoods of the north of the city, the center of the city, the north-east and the north-western area that is where the largest volume of middle and low-income population lives, and where there is an explosion of motorcycle shopping and still the popular neighborhoods, it is a phenomenon that is just beginning, but it will accelerate much more

with the increase of economic capacity, the big challenge of the city is how to anticipate that.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

   Answer: Well, the problem of poverty is a much deeper problem. I think that when you talk we would say these questions in relation to mobility, for example, in contexts like ours there are a number of variables that must be incorporated, which do not depend solely on the city and there are a number of variables that must also be incorporated that do not depend solely on technology or on the cost system itself, and which have to do with employment, with purchasing power. So that is why I mentioned it at the beginning, it is important to think in some way that we are in a transition process, not to think that we can give absolute solutions, we still have a lot to do because the challenges are very big in that regard. What has been tried to do in Medellin is to have an integrated ticket, such as the civic card, that in some way, by integrating the system, there is somehow important savings for people who have to have a transfer from its origin, from its home, in relation to taking two or three different media until they reach their destination, but that somehow that solution does not cover the entire population. There is a sector of the population of extreme poverty that is outside somehow of the purchasing power of the system. Several strategies can be explored, at one time there was a strategy in the city that was called the student ticket, which was a subsidy for public school students so that students from public colleges and public universities will pay much less in relation to mobility. So I think you can combine several alternatives. It also has to do with places of employment, and places in some way where people live, to generate greater proximity. There are other types of urban strategies that must be combined but without any doubt there is a very big challenge, Colombia's biggest mobility challenge has no doubt to do with the issue of equity and inclusion, and one of the characteristics of public transport in Medellín is that most of the last metro corridors cables, trams, etc. were built to ameliorate these issues. They are routes that have had a priority of connecting some of the neighborhoods in some way with major social and poverty problems in the city, but that does not mean that we have full coverage today, not even 50%, so I say that it is a process, I do not believe that we are still at 50%.

a. How would you make the system affordable for these people?

Answer: Undoubtedly, the challenge in our society and I am not talking solely about Medellín, is trying to have a more complete public transport coverage, and that somehow the communities and people with less resources can access it. The answer is not easy, nor is it black and white, because in some way we said for example, the metro company has somehow had a policy of having a fare, let's call it acceptable, not ideal, that allows them to also give them economic sustainability over time so that the balance between the revenues of the tariff in relation to the sustainability of the system, with some subsidies or government aids, but that somehow the tariff may cover a very important part of the operation. Now in Colombia there is the issue of socioeconomic stratification, which we are not going to analyze in detail, but I believe that, if it would be feasible to explore more clearly a series of transportation subsidies, to the population sectors in some way more critical, but let's say that this question is always in the balance in relation to the sustainability of the system, so there is no ideal answer to that.

4. Does the current system pay for itself?

Answer: What I understand is that the system manages to cover the operation, I mean, the payment of the ticket manages to cover the operation; but it does not cover the cost of the construction of the infrastructure system, especially the first implementations of the Metro corridors. The implementation of all heavy systems, is not covered in any way by the issue of fares, true, it is what the Metro company has tried to do with its integrated routes and with new systems technologies, which is to try to balance in some way with regard to sustainability in relation to the fact of the fee income. Precisely that is one of the difficulties in having wide coverage, and of lowering the price of a ticket for the populations with fewer resources. One of the achievements he has had, is to generate a really sustainable company, with a very professional support and technical team and a really high-quality management, not like the public companies that one knows in some way that are inefficient, etc. The metro company is very well managed and with good technical support, but they have charges against benefits, and must charge for these services.

a. What are the sources of revenue for the various systems?

Answer: I would not know to tell you in detail, but the fundamental one is the ticketing fees. There are some complementary income when new corridors and routes are made that are not equal in relation to the state investment, in some cases some of the corridors. There was a municipal investment, in the construction of the first Metro routes and the investment was national, in the Metro plus that is the BRT technology, which is also operated by Metro Medellin, which is that of buses in some way of exclusive lanes which I think that was 70% of national investment. The metro cables in the topic of infrastructure I think it was the other way around, 70 or 60% was of municipal investment. But I'm talking to you in very vague terms and possibly with inaccuracies, but it is not a single equation that is given, but it depends on the different corridors and Metro implementation schedules.

5. Is there vehicular congestion in Medellín?

Answer: There is very large congestion, as in many Latin American cities. In 20 or 30 years we will not have congestion. I believe that in the world the issue of mobility will migrate a lot; technologies will change a lot. Let's say the issue of shared car and a series of different issues that come to us, but the question is not that we will have in 30 years, but how we accelerate the solutions for the better.

a. If so, what contributes to this congestion and how would you solve this problem?

Answer: There is very critical congestion and I believe that the reason for this, let's say the strategy to solve it has to be, to continue betting on public transport systems like the ones we are talking about; increasing and making much more complete networks, let's say more efficient, but it also has to do that with a better alternative there is more regulation, and surely it will be required in some way when there are alternatives with certain brokers in the city, there is somehow also a service charge regulation, let us use some type of corridors that cost one money in relation to the private vehicle and a number of alternatives, for example, but it is not an example. I move on an electric bicycle but I used a car before, but it is relatively easy for me here to my house, because I am going through a series of neighborhoods that is not even an effort, the roads of Medellín, the main avenues for bicycles, they are still very dangerous, but there are some routes in my case for example, that it is very comfortable to go to my house, by alternative routes. I take sections of cycle routes, etc. If one

really manages to generate a transport alternative, let's call it closer to those who move to their workplace, who have to move, 1, 2 or 3 kilometers, I mean, relatively closer, with different mobility alternatives. Somehow, an important part of the traffic can also be reduced, but there is a structural mobility problem in Medellín today without any doubt.

6. **Are there currently problems with the air quality in Medellin?**

Answer: There are critical problems with air quality; the major factor is derived from pollution derived from mobility, so we are in a circle that relates to all these dimensions.

a. **If so, what do you think is the cause of these problems and how do you propose to solve them?**

Answer: To solve the problem of air quality, I believe that we have to work in multiple strategies, it is not one. One has to do with accelerating much more in some way, the efficiency in handling we say less polluting fuels in say the transition of cleaner technologies from the point of view of mobility. I do not know how long it will take for that, but in strategies to increase in the efficiency of public transport, to migrate a large percentage of the population to mobility issues of cleaner public transport, the management of schedules in relation to making much more efficient and less concentrated in some way the activities during peak hours, on issues of employment, education, etc. There may be a matter of time management in greatly improving projects, we call it decivilizing the streets in relation to continue increasing the transformation of the road corridors, into corridors that have better alternatives for pedestrians, in which the network of cycle route systems is increased much more and also in facilitating the modal integration, for example, of public transport Metro stations to which one can quickly reach from home by bicycle, let us say the bicycle parking. Let's say what is called 'Parkar Dray' in relation to different modes, including vehicles, for example, you were mentioning now that there is a very big challenge to think not about the mobility of the metropolitan area, but about mobility which links, for example, the valley of San Nicolás or del Oriente and the Aburrá valley of Medellín, because we still don't have systems of public transport, where people who work in Rionegro, or somewhere that need to go down to Medellín can leave their car at a transport station in the upper part of the San Nicolás valley and take a public transport system to Medellín. I believe that there is a big task in relation to public transport issues, also with regulatory issues.

INTERVIEW QUESTIONS

Interview No.: 5
Interview Date: Wednesday, October 9, 2019
Interview Time: 2:00 pm
Name: Roberto Bayardelle Morales
Title: Civil Engineer, Specialist in Project Management and Management and Urban Processes, Medellín Metro
Address: Calle 44 # 46-001, Bello-Antioquia, 9128 Medellín
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Authorization to use your name: Yes

Biography:

Civil Engineering Professional from the Antioquia School of Engineering with specializations in Project Management from the EAFIT University and Urban Management and Processes from the Antioquia School of Engineering. I have 26 years of experience and my work has been focused on the planning, study, analysis and implementation of civil works and transportation projects. My current function here in the Medellín metro is in the area of project execution, this area was created 5 years ago.

Participated as a technical advisor in the litigation processes resulting from the construction of the Medellín Metro system. Participated as coordinator of the technical and financial design and structuring of the Extension project south of the Medellín Metro. Likewise, I participated as coordinator of the detailed, technical and financial structuring of the Ayacucho Tram and I was part of the project implementation team as infrastructure coordinator.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: It is a rather controversial question, because when the system was conceived, the city was very different from what it is now, the conurbation was different and the issue of land use and the type and function of the city was different, we passed during the construction of the metro system, from being an industrial city to being a city of services and now we are a tourist and event city.

We have changed our vocation 3 times in the last 30 years which was also motivated by the transport system.

a. If successful, please define what you think makes it successful.

Answer: At the beginning when we were an industrial city, the transport system did not fit the comfort of the people, we had a large installed capacity, we had a use in the first 5 years of 150 to 200 thousand passengers. It was not until the city to change the vocation from being industrial and the industry migrated to other areas of the department and of Colombia that the system began to serve and be of general use to serve restaurants, banks, shops and all commercial enterprises. Due to these changes the large growth of the system occurred.

Today it is a very successful system for the city, but insufficient.

b. What was your involvement?

Answer: When I arrived at the company it was during the final part of the construction of the original system. I arrived at the company in the year 1995, as a contractor, before the inauguration of the system that was on November 30, 1995 and I play in the participation of the reception and in the litigious problems of construction. I learned a lot from that. Later in the expansion of the system I worked on projects of extension to the south, helped to structure the project both technically and financially and during the start of construction, then participated in the cable car projects and from 2009 on the tram system, from the coordination of design and technical, legal and financial structuring, and subsequently in construction and commissioning. So let's say that in the complementary or feeder systems my participation has been very active.

2. What are the most pressing transportation issues that Medellín faces at the present time?

Answer: Medellín at the moment has a problem with the modes of transport in the peak hours, and as the city has a unique schedule for all schools at the same time, work at the same time, trade at the same time, the peak hours are insufficient for everything in the transport system. The metro system then reaches a density of more than 7 or 8 passengers per square meter. All bus systems are full, the roadways are impossible. So we have a problem at the peak time of distribution of transport loads which is quite complex to solve. One of the big problems we have is that people

think that the infrastructure, by itself, is the one that should solve the problem, while there is also an issue of education, of changes in schedules that could improve or mitigate that issue, but here the political decision on these issues has not been taken.

a. How do you think these issues can be resolved?

Answer: We have a transport system analogous to a fishbone which is a trunk that is the metro system and a lot of feeders. The Metro rail system as a trunk on occasion has failures, delays or some technical issue which causes the city to collapse. The Aburrá Valley is a narrow valley, it is a valley almost 100 km long where its widest part is 20-25 km wide and the rest are already very rugged places with very high slopes.

b. How can the transportation system be improved?

Answer: All the different modes of transport converge towards the Metro rail or converge towards the roads that are next to the river. We must create a transport mesh that collects before, on both sides of it, with massive transport systems to try to lower the load and to discourage the use of private vehicles. It is an issue that we, due to individual mobility, do not achieve and we have to achieve it by promoting and placing the mass transit system making it even more affordable.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

Answer: Here we have two components, indeed many of the transport systems are very expensive for people, almost bringing the integrated round-trip transportation ticket to almost 20% -25% of the daily wage of a Colombian, which is at 35 thousand pesos and that translates to almost 5 thousand pesos for the ticket.

a. How would you make the system affordable for these people?

Answer: The solution that we have found here is without subsidizing the fare, since the Medellín metro system is not subsidized by the state. The fare we have allows us to operate and leave a small remnant to save for technological changes and equipment replacement. The only thing we can do is to generate more integration with other modes of transport that are built and financed by the city, but as a losing proposition. The reason is very simple the more the city grows, we become more inefficient as a company because we lose working capital, we lose EBITDA, we lose some financial issues, but for the community it is more beneficial to ride in an

integrated transportation system than individual mobility. Medellín there are many locations to service too, so that you have economic resources that don't have access to the transportation system, so we are also working on increasing coverage.

4. **Does the current system pay for itself?**

   Answer: The system has two components, the construction is not paid with the ticketing fee, this only covers the equipment replacement operation, which is the technical rate that is used to establish the cost of the ticket. As we are not subsidized, it pays the transport operation and the recovery of equipment.

   a. **What are the sources of revenue for the various systems?**

   Answer: The initial investment has other sources of payment that are usually established by the municipality that is the one that uses these resources as a lost fund, that is, we separate here the issue of construction and implementation, basically using externalities that finance its implementation and the operation is already handled with financial criteria EBITDA, TIR and those remnants of the technical fee are used to pay for equipment replacement and technological upgrades.

5. **Is there vehicular congestion in Medellín?**

   Answer: Obviously Medellín has notorious vehicular congestion; we have a motorization problem that is too high. There is a motor vehicle for every 4 or 5 inhabitants. We generate approximately 1.9 trips per day by each person so it is a city that moves a lot. These results are given to us by the origin/destination survey studies, that is, here we use software called EMME-2 for transport modeling, so that modeling tells us that a family is 3.7 people with movement of 1.9 trips a day, utilizing different modes of transport.

   a. **If so, what contributes to this congestion and how would you solve this problem?**

   Answer: We are a city with a very high economic imbalance. We have a high class that is relatively large with enough purchasing power, so all vehicle control measures such as ‘pico y placa’ license plate restrictions, are resolved with them buying another vehicle. Another issue is vehicle size. Medellin towards the 70s was still a European city and in the 70s we migrated to make it into more of an American city, so we stopped having the smaller Japanese or European vehicles into bigger cars/suv’s/pickup

trucks for one or only two people, with the aggravating result that in Medellín there is congestion. These vehicles come with sufficient equipment, sound equipment, air conditioning, seating, and all things to be able to withstand uncomfortable congestion. So this does not help us to stimulate the use of public vehicles. Another of the big problems we have is that since we are a city with quite a few topographical levels, the people who live in the flat part of the city are few because there is where the industry and commerce is concentrated, so people live in the high parts of the mountain, so then walking or using a bicycle or other means of transport becomes quite complicated. Also, there is the high level of rain. We have more than 270 days of rain a year, so people opt for other types of mobility.

As I told you, the best way to solve this is by generating massive medium-capacity transportation systems parallel to the trunk of the Medellín River, that is, cross-sectional systems on the mountain that cut off all the feeders we have, which go from east to west, and to go from north to south on each side of the river which will help to generate a transport mesh to which people will understand that it is easier to use this means of transport than move in another way. Another component is that parking areas here are not as expensive as in other parts of the world, so it does not discourage, on the contrary, it encourages vehicular use because you have where to leave it, so parking sites are not a deterrent. They are not operated by the state, with a rate of one dollar an hour. Then this is not a restrictive issue as I have seen in other cities like Toronto, New York, or Washington, where parking areas in the central city is expensive. Another thing that would help a lot is to declare certain parts of the city as vehicle-free areas. There are certain places that are commercial, tourist or office related that could be generated as pedestrian districts. At the time we generate these pedestrian areas, we can show the futility of arriving in a private vehicle to those places.

6. **Are there currently problems with the air quality in Medellin?**

Answer: Obviously there is a contamination problem in Medellín, but it is basically associated with particles smaller than 2.5 microns of nitrogen oxide and other elements of particulate materials. Here we do not have as much problem of CO2 or other gases, as in other parts of the world. This phenomenon happens to us due to the burning of fossil fuels both for the kitchen, due to cooking with natural gas, as well as for vehicles. It helps that we are in a narrow valley with high slopes. The valley height is 1450

meters for Medellín and the height of the mountains is 2500-2600 meters. There is an atmospheric phenomenon that occurs, in the months of March and October mainly, where trade winds stop blowing and do not carry away the pollution. Then the pollution continues to occur, it does not escape the valley and recirculates, because those months are the rainy season of the Aburrá Valley, so we begin to generate those particles smaller than 2.5 microns and are not able to rise up enough to be dragged by the wind and it remains in the valley increasing in concentration. The measures they took in this administration, the last one because this is a phenomenon that has been known in the city for about 20 years, but only this last administration took measures to generate an environmental 'pico y placa', a rather demanding vehicular restriction, with the old vehicles and other vehicles, such as trucks at certain times. This helps to mitigate the impact, but really the problem is the massive use of fossil fuel that we have in the city. Colombia has a problem with diesel, we do not have a good quality diesel, we have a diesel with enough sulfur component, we do not have fuel of Euro 5, Euro 6 that could help with the issue, with the complication that the diesel fuel is much cheaper in Colombia, than ordinary or extra gasoline. So here having a large and inefficient vehicle, or diesel bus, is economically more profitable than having a gasoline bus or a gasoline truck. The combination of less cost for diesel, more old vehicles, and the need to move in the city in vehicles with fuels that are not adapted for a city of this type generates many problems. Additionally, Medellín, as I told you before, is located at high altitude, 1450 meters on average, so internal combustion engines are not as efficient as those at sea level, emitting more particles than they would emit if they were at sea level. It becomes a matter then of replacing inefficient vehicles rather than placing restrictions on their mobility.

a. If so, what do you think is the cause of these problems and how do you propose to solve them?

Answer: I go back and repeat that if we make a transport mesh then we discourage the use of the vehicle. We could not only generate areas of non-vehicular use, but also areas of non-internal combustion vehicle use. This city already has many electric vehicles. This city has been growing exponentially their use and there are many kinds of electric vehicles of all kinds. There are quad-cycles like the Twizy, but there are also large vehicles like the BMW, the i3, the Nissan Leaf, the Renault ZOE, because we have a great European influence on the subject of vehicles. We have a Renault vehicle assembly plant here and dealers are used to dealing with

European technologies and obviously with Ford and Chrysler a lot, but here people really like the European car. There is also a measure that is very particular and that is that they should force the public transport system as well as a percentage of the fleet, whether private or public, to be electric. That would help a lot with the issue of pollution.

INTERVIEW QUESTIONS

Interview No.: 6
Interview Date: Saturday, October 12, 2019
Interview Time: 10:30 am
Name: Javier Enrique Rivero Jerez
Title: Urban Engineering Coordinator
Faculty of Engineering, University of Antioquia
Address: U. de Antioquia, Sectional Oriente, Office 5-103
Headquarters: Calle 67 # 53-108, Medellín, Colombia
Telephone: 57 (4) 219.8332 ext. 2916
jriveroudea@gmail.com

Authorization to use your name: Yes

Biography:

My name is Javier Enrique Rivero Jerez; I work as coordinator of the urban engineering program at the University of Antioquia. I also teach in the engineering faculty in civil engineering undergraduate curriculum with a construction course and particularly within the urban engineering program I teach the courses of accessibility, mobility, planning and city design. As for my academic training, I have completed an undergraduate degree in architecture in Colombia, and an undergraduate degree in higher architecture in Spain. I then completed a specialization in design and composition, a specialization in sustainability and energy efficiency, a postgraduate degree in accessibility, a master's degree in urban planning, a master's degree in construction management, a master's degree in environmental engineering and a doctorate in architecture and art with an emphasis on urban planning. I am now pursuing a master's degree in interior design and architecture.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: Particularly with the transport system, speaking in this case of the Medellín Metro which is the one that I think has been most successful, from my point of view. I have considered that it has been the first attractor that transformed the city. As we know, Medellín was one of the most violent cities, we had around one thousand homicides in the 90s. We are talking about Escobar's era, in that sense, Salazar and Fajardo's strategies defined keeping in mind those irregular

settlements that were in the city and somehow create a transportation system that could regularize these informal settlements and connect the city at different scales, that's when the metro system was implemented.

a. If successful, please define what you think makes it successful.

Answer: The metro system, from my point of view, was successful because there was social involvement from three points or three factors. First from planning, then from construction and then from management. That is, people who were in those places were involved in the project and as such generated a sense of belonging or what we call the metro culture in Medellín. The design of the metro as you well know evolved along the Medellín river. It took advantage of the city's N/S topography and it has a E/W transversal right at the San Antonio station, which goes up to commune 13. In that case the transportation system not only had its benefit in terms of rapid transit of users, but also interconnected with certain points in the city where there was a lot of violence. The strategy of Fajardo and Salazar at the time was, especially that of Fajardo as "Medellín the most educated". For that he created strategic points, in this case with educational institutions and with libraries to reestablish a type of order in those nodes that were nerve centers in the city and he connected them in this case with another transport system that was the cable car (Metrocable). Then Metro rail was seen as strengthened with the addition of cable cars and with those points of action, in the form of urban acupuncture in those nerve centers in the city.

b. What was your involvement?

Answer: Right now, from the urban engineering program, what we are trying to establish are intermodality initiatives with the transport system that has had in this case greater benefit for society, which has been the Metro rail. It is to implement in the stations of the Metro, intermodal systems that can make the initial transport system more efficient such as private vehicle parking, the linking of bicycle lanes and bicycle parking and also in this case the feeders that work with the Metro and recondition them so that they will be more efficient and comfortable.

2. **What are the most pressing transportation issues that Medellín faces at the present time?**

   Answer: As for transport, this is also related to air quality and pollution. The biggest problem that the main transportation system, that is the Metro rail is having now, is the collapse of capacity. Although they have bought several wagons for the system to increase the capacity of the Metro, they are having problems in the case of the flows, they are not enough. Taking the Metro at 7 in the morning is chaos, just as it happens in Tokyo. The capacity or demand already exceeds in this case the system as such. That is one of the most serious problems that the Metro is having, because the Metro does become necessary for people and is very accessible, but the problem is that the capacity limit is being reached. I don't know if it will reach a point that to implement more lines in the Metro becomes a solution. That would be another option or for another transport system. But other transport systems implemented such the tram and cable cars are all connected to the Metro. The Metro is the main artery and if the main artery collapses, the others will collapse sooner or later too, because of course the transportation flow arrives but there it will remain.

   a. How do you think these issues can be resolved?

   Answer: So I think that one of the possibilities is to implement other branches of the Metro. I think it is necessary to start designing other Metro branches.

   b. How can the transportation system be improved?

   Answer: I think that intermodality would be something very interesting, because intermodality will allow people to not limit themselves to only using the subway, but also to use other transport systems. Suddenly even using more sustainable systems such as the bicycle. Keep in mind that bicycle use in Medellín because of its topography is very complicated because there are very steep slopes, so suddenly we would have to go to assisted bicycles in this case.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

   Answer: Usually in Medellin this is very accessible as people with needs are prioritized. There are discounts for people from low income strata. In Colombia we have a classification by strata, strata is a socioeconomic classification of people since public companies, since about 40 years,

where the city has been sectorized taking into account the purchasing power of people and with that they are charged for public services. In that sense with that segregation has been taken into account for people of low strata (1, 2 and 3 transport subsidies), they are charged less.

a. How would you make the system affordable for these people?

Answer: I believe that one of the initiatives that we had proposed is that when the person uses a sustainable transport system such as the bicycle, they are allowed to access the Metro as well. What happens is that, as you well know the poorest areas of Medellin are in the worst places, because of course, informal settlements are made in areas that are not habitable, in areas with too much slope, or next to ravines. Those areas are usually very isolated from the Metro, because the Metro is in the flat part of the city, which is in the valley. Then one of the things we were thinking about is to what extent can we motivate these people to use sustainable transport systems such as bicycles, where they can be given a priority so that they can access the transport system for free. That would be an encouragement for them to use a sustainable means of transport by giving them free access to another mass transport system. For example, we were thinking that the subway cable that are the cabins, to include a compartment where they could place their bicycle and take it to the Metro and thus have a means to ride to their place of work. Another option is allow for bicycle parking at cable car or Metro stations. They can leave the bicycle in the parking lot. That person is given free access to Metro/cable cars for using the bicycle and that they then use the cable cars to reach the Metro rail. There are several dynamics here that you have to keep in mind.

4. Does the current system pay for itself?

Answer: I understand it has a subsidy, in this case from the government of Antioquia, that helps a lot and the volume of repeat users makes the system economically efficient.

a. What are the sources of revenue for the various systems?

Answer: Particularly the Metro is subsidized with a contribution in this case of the government and especially with the purchase of user tickets. We must see that the subway is usually used with people from lower economic strata 1 to 4. There are also people from stratum 5 but the greatest recurrence is from people in stratum 3 where their cost of a ticket is accessible. Fom an economic point of view a Metro ticket is worth almost the same as a bus, and as I commented the demand (volume of

passengers) that the Metro has makes it efficient to the point that it can be maintained.

5. **Is there vehicular congestion in Medellín?**

   Answer: From the point of view of public or private transport? For Private: there is congestion. In Medellín there is a lot of vehicular congestion, but particularly in the main arteries. We are talking about the Regional, 33, the Oriental and of course the avenue to el Poblado.

   a. **If so, what contributes to this congestion and how would you solve this problem?**

   Answer: I believe that one of the ways to solve is to reevaluate the state of those roads and the use of the roads. We also have another problem in Colombia, is the issue of driving culture, we have a lot of problems. When receiving the driver's license, in terms of the requirements that should be demanded as in other countries from the point of view of the knowledge of vehicle driving and traffic rules. Then of course you see that sometimes the flows do not work very well, or the roads do not work very well because people instead of going ahead on the left, go on the right, or park in areas that are not for parking. Even the public transport system has not efficiently organized the use of roads. I think that could also be reassessed for improvement of the transport system here in Colombia.

6. **Are there currently problems with the air quality in Medellin?**

   Answer: Yes, there are problems right now, even today where we use 'pico y placa'. During the month of October, even without indicators it is already known that there will be contamination, but months before the decision of environmental 'pico y placa' is initiated which restricts the use of vehicles in this case depending on the number of the plate, due to indications of polluting factors that have been perceived in the air.

   a. **If so, what do you think is the cause of these problems and how do you propose to solve them?**

   Answer: So what is done is to take momentary measures in this case, by limiting the flow of vehicles; but of course as I said, pollution has developed a lot in Medellin, partly to the location of the industrial zone of the city that usually being in the north and due to the topography of the city that is a valley, then what it does is that when the pollution that is generated in the north of the city, the winds also come from the north. These winds transport all those particles along the course of the valley and

then in the area of el Poblado there is a topographical break and pollution is trapped even more. The issue of pollution in the city is complicated because of the valley's topographical configuration. Beyond that, the location of certain industries is harming even more.

So how could it be improved, first working with these industries to see if they can suddenly relocate to other areas that are not polluting. For example, in the south, in the part of Bello, Sabaneta, so that all that pollution, do not go through everything, in this case the Aburrá Valley, but are located in other areas. The other would be to work with these companies to see how much emission control is being done, because here there is no emission control, nor control of particles. What is controlled is that there is pollution, but to what extent that control is being reached in companies? The other is also the control of emissions in transport systems. I do not know if you have seen buses emitting black smoke, which are seen to be particles that are emitting, and that one of the solutions would be to control those vehicles or the other is to implement other types of vehicles fueled with other energy; for example, with gas or electricity. This would be another option. Now, regardless of the two options, if it would be good to reevaluate to what extent in Colombia we have the useful life of a vehicle in mind, I don't know if you have realized that, in other countries, for example, at 10 years of a vehicle the government gives you a subsidy to change it, because it defines that the vehicle is already starting to generate more pollution. Even technology goes against this, so to what extent in Colombia we are also taking into account the useful life of a vehicle, because you can find here vehicles of 20 years or 22 years. Then of course those vehicles were designed at the time and emit certain emissions in this case.

INTERVIEW QUESTIONS

Interview No.: 7
Interview Date: Tuesday, October 15, 2019
Interview Time: 2:00 pm
Name: Iván Sarmiento Ordosgoitia, Ph.D.
Title: Professor - Department of Civil Engineering
Faculty of Engineering, National University of Colombia
Address: National University of Colombia, SEDE Medellín
65th Street No. 78-28, M1-223
Telephone: 57 (4) 425.5166 - 425.5150
irsarmie@unal.edu.co

Authorization to use your name: Yes

Biography:

My company is called the National University of Colombia, Medellín headquarters. There are several campuses or offices in Colombia, I work in Medellin. My role in the university is that of a full professor, which is the highest category achieved here in the university. I am in charge of the Urban Transport course for civil engineering and I also teach postgraduate courses, which are the programs of specialization in roads and transport, masters in infrastructure and transport systems and the doctorate of civil engineering in transportation. The subjects for graduate students are Economics and evaluation of transport projects or transport demand models. I have also been involved in transportation planning in the city through consulting projects that the university carries out for public institutions, such as the municipality of Medellín and the Metropolitan Area of the Aburrá Valley, which is the metropolitan area of the city of Medellín.

Questions:

1. **How was Medellín's transportation system implemented and do you think its implementation has been successful?**

Answer: The Medellin system has a history since the early 20th century, a century ago, and a recent history. That first system had an Antioquia railway that connected the small city of less than one hundred thousand inhabitants with the region and the country, and there was an electric tram of almost 70 km (45 km of tram and other electric buses) that toured its main neighborhoods. These systems went into disuse and were dismantled, being replaced by bus routes in the middle

of the 20th century. Recent history began almost 25 years ago when the Metro was inaugurated (1995) and the transformation began until today.

a. If successful, please define what you think makes it successful.

Answer: Its implementation has been successful because the system (Metro + BRT + tram + cable cars) mobilizes almost one million passengers, 40% of the more than 2.3 million public transport passengers in the metropolitan region. It has been successful because it has increased the transportation reach of citizens within their city and also with great benefits in preventing accidents and pollution, in addition to time savings.

b. What was your involvement?

Answer: My participation has been as an advisor from the National University for the Metropolitan Area of the Aburrá Valley in the first Master plan of this entity in 2004/2006, the realization of the mobility surveys of the region in 2006, 2012 and in the supervision of the 2017 survey. In addition, I participated in the supervision of the bus route restructuring study for the implementation of the BRT (Metroplús) in 2009, and with the municipality of Medellín restructuring of bus route study that was carried out in 2013- 2015. Finally, the comprehensive mobility plan for Medellín was carried out, regarding the diagnosis and formulation of public transport between 2017 and 2018. I have also participated in studies that have given light on traffic management (2011) or fleet provisioning of Taxis or buses (2006-2009).

2. What are the most pressing transportation issues that Medellín faces at the present time?

Answer: The urgent problems facing Medellín are the pollution that causes about a thousand premature deaths yearly, the accident rate with 220 premature deaths yearly, and the congestion that wastes time (money) on the economy.

The first problem that is pollution is that it is more due to transport emissions (80%, especially that of PM2.5 particles), with freight transport being the one with the highest emissions, followed by buses, motorcycles and finally cars and taxis. The solution is through a strong policy to achieve the renewal of older cargo vehicles. It is believed that replacing 10% of these would reduce particle pollution by 50%. There are other measures

that add to the solution such as the introduction of electric buses and taxis, but the solution is still slow in being implemented.

The second problem of accident rates is solved with a higher road education both re-educating current drivers and with greater control so that a good road education for new generations is fulfilled. Efforts should be made to introduce points for traffic violations as exists in Europe. Another important element is to reduce the maximum speed in the city to at least 55 km/hr. instead of 60 km/hr. That reduction of almost 10%, could achieve reductions in deaths of at least 30%, which added to the aforementioned education and greater control with technology could reach the goal of 50% reduction, which, although still not close to the Zero Vision, it would be a breakthrough in that direction.

The third problem is that of time is also difficult to solve, but it is less important than the previous two, although it causes the loss of competitiveness of the city. The 1.5 million trips on foot per day and the million trips in the SITVA (Integrated Mass Transportation System of the Aburrá Valley) have almost guaranteed transport time (I say almost, because some Metro trips have a share in feeder modes suffering congestion). These two modes account for almost 2.5 million daily trips, or 40% of the 6.3 million trips in the metropolitan area. The rest are more exposed to congestion. For the 1.3 million trips (20%) by bus of the Metropolitan Area (AMVA) to improve their times, some corridors and some sections where there is more space availability, exclusive left lanes for left-sided buses, must be built. That could reduce times by at least half for those users. Then, it can be said that with those lanes and with the SITVA and those on foot, almost 50% of the congestion could be eliminated. The rest of the traffic, that is, taxis, cars, motorcycles, cargo vehicles, and special vehicles (school, service), etc. that are the other 50% are condemned to congestion, unless restrictions are imposed on the particular vehicle by increasing the costs of parking in the city center and in the golden mile (in el Poblado) and that in in parallel with this, incentives be applied so that there is a certain part of the distribution of merchandise during non-conventional hours (night or early hours), as well as other logistic measures such as the construction of bays and the regulation of loading and unloading times.

a. How do you think these issues can be resolved?

Answer: (It was answered in each of the 3 problems in question 2)

b. How can the transportation system be improved?

Answer: The transport system can be improved by making new public transport lines and service routes that cross-connect the distant north-south and north-west-south-west locations. In addition, to study how to finance a fully integrated transport system where the poorest are given rate reductions, financed from the collection of any overcharges to parking lots or congestion zone fees, or contaminated areas; but also from the commitment of private sector companies. In addition, the transport system would improve by reducing the accident rate, since each accident generates time wasted for compliance with public transport route schedules.

3. **Are there urban poor that cannot afford ridership in the transportation system?**

Answer: Yes, there are poor people in the urban area who find it difficult to pay for the transportation system, and that is why many walk and others buy a motorcycle that in the long run is cheaper for them in time and money.

a. How would you make the system affordable for these people?

Answer: In order for the system to be accessible to them, it must reduce ticket prices with some subsidy for these people as mentioned in the improvement measures in the previous question.

4. **Does the current system pay for itself?**

Answer: Currently, the system pays for itself, except the BRT that receives a subsidy for its operation from the municipality of about $10 million dollars per year.

a. What are the sources of revenue for the various systems?

Answer: The rest of the system is self-sustaining in its operation, but it is necessary to obtain extra financing for two purposes: first, to reduce the rate for the poorest, and second so that there is a single integrated rate in which people can perform one or more transfers between all the systems without having to pay again, and in this way attract the new generations so that they do not continue opting for the motorcycle.

5. **Is there vehicular congestion in Medellín?**

Answer: There is congestion, and although I have already commented on the problem and its solution, it is important to talk about the sources.

Congestion is inherent in any system that begins to work at its best, which is not entirely negative, since the infrastructure is being used to its fullest potential. However, there is frustration when productivity expectations are not met for certain economic growth, and it is therefore necessary to make some interventions. The first is to separate the most efficient flows. This has already been done and has been done with pedestrians by improving the sidewalks, also with the large flows that move through with mass transport (Metro, BRT) and its associated systems (tram, cable cars). Then it has been also done with the cyclists, but you also have to do it with the buses in the main corridors, as said before.

a. If so, what contributes to this congestion and how would you solve this problem?

Answer: The sources of congestion are diverse. One is the mobility pattern, which in terms of origins-destinations is difficult to change, but in the long term you should try to build a more compact city. A second cause is the misuse of the spaces on the vehicle lanes, which are often used for parking on the road, so promoting the construction of parking lots and adjusting their prices to discourage the use of the car is important to control its use. A third cause is accidents and the time it takes to clear each of them. In Medellín there are about 44 thousand accidents annually, and in 50% of them there are injuries.

Congestion solutions have already been discussed and are summarized in giving more commercial speed to public transport by buses, a single tariff system, regulation of loading and unloading and promoting nighttime distribution, reducing the maximum speed in the city and therefore reduce accidents, and thus save everyone time.

6. Are there currently problems with the air quality in Medellin?

Answer: Yes

a. If so, what do you think is the cause of these problems and how do you propose to solve them?

Answer: Already answered in the second question that was the main problem to solve at this time, and some solutions were discussed.

Additional Audio Commentary: The metropolitan area of the Aburrá Valley issued a resolution that is mandatory for companies with more than 200 workers, or employees. They have to make a business plan or a

strategic plan for sustainable mobility, it is called PEMS for its acronym in Spanish (Sustainable Mobility Business Plans), so these PEMS seek to reduce the carbon footprint of CO2 by 10% in the first year. Companies have to do a survey among their workers to know how they travel daily to the company and based on that survey, propose strategies to reduce the carbon footprint of the company, looking for workers to use shared vehicles, bicycles, public transport or a bus designed for company workers, etc. As of October 2019, of approximately 1,000 companies that had to comply with this requirement, there are about 350 who have submitted their sustainable mobility plan and the metropolitan area is responsible for reviewing those plans and visiting companies to see how they are going with their projects, with their initiatives, with changes in the mobility of its workers. This is a good initiative that seeks and is aimed at reducing trips or changing travel modalities by companies.

In Medellín, 30% of people do not travel on an average working day according to the mobility surveys carried out from 2000 to 2017. There have been 4 large surveys of more than 15,000 to 20,000 households surveyed and always the constant is that 30% of people do not travel. It does not mean that they are the same people every day, but they can be people who one day were sick, one day they had a day off and were at home or on vacation and did not go out that day, or are housewives that on a given day they did not need to leave the house, sometimes they are sick, other times they are people with disabilities than in those cases if often do not travel, especially in our city that has many architectural barriers or difficulties for accessible mobility. There are also elderly people, some retirees who may have little income or who did not receive a retirement pension and others who, because of their socioeconomic conditions or poverty, had no money to mobilize or had nothing to go to, or they had no money to spend where they were going, so they preferred to stay at home. In summary, for all these reasons the percentage is high, which in Bogotá is 15%, in New York we saw a survey that is 15% and in London surprisingly a little higher is 20% because of the cost of transport, but Medellin is still high 30% of people who do not travel, which is socially worrisome.

The following excerpt is from an April 20, 2020 email from Profesor Sarmiento clarifying MCV methodology used: "….MCV surveys those who travel the most because it treats the person who is put on the phone as the head of the household,"

APPENDIX 'D' – Spanish - Interview Transcriptions

PREGUNTAS DE ENTREVISTA

Entrevista No.: **1**
Fecha de Entrevista: **Lunes, 7 de Octubre, 2019**
Hora de Entrevista: **7:00 am**
Nombre: **Rafael Nanclares**
Título: **Ingeniero Civil**
Teléfono: **011 57 300 577 1484**
nanclir@gmail.com
Autorización para usar su nombre: Si

Biografía:

Ingeniero civil de formación, con especialización en gerencias de construcciones y mi vinculación con el trasporte de la ciudad fue en la administración de Alonso Salazar, que una administración del 2008 a finales del 2012, donde estaba con el profesor Ricardo Smith que era el secretario de transito de la ciudad de Medellín y donde era su asesor, luego termino siendo el secretario porque él se retiró y allí en la secretaria de transito nosotros participamos en el sistema de transporte de la ciudad de Medellín en varios aspectos.

Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

Respuesta: Bueno, el sistema de transporte de Medellín digamos que es exitoso, pero tiene múltiples etapas, diferentes estructuras, el hecho detonante del sistema de transporte de Medellín sin duda alguna fue la construcción del metro de la ciudad, inclusive es el único metro que hay en Colombia y se hizo por algo que voy a ser reiterativo en la entrevista, se hizo por una decisión política y digámoslo una obstinación del presidente de su momento, que era el presidente Betancourt y eso fue clave. Él era de aquí de Medellín, pues de Antioquia, Paisa, y su determinación de hacer el metro de Medellín fue un propósito muy importante, eso genero un eje estructurante en todo Medellín y en el valle de Aburrá, se volvió un hecho metropolitano, nos puso a pensar en otra lógica al hacer estas cosas del transporte, después de que se inauguró el metro de Medellín, el metro de Medellín ha funcionado bien pero no ha crecido lo suficiente, por muchas razones, temas políticos y asuntos también económicos, el presupuestos para hacer el metro es muy costoso comparado a nuestra capacidad presupuestal.

a. Si tiene éxito, defina lo que cree que lo hace exitoso.

Respuesta: En el tema del sistema de transporte de Medellín fue un constructo, ósea lo primero fue en la década de los 80s el metro, la construcción y la puesta de operación en los 90s, después de eso hubo un estancamiento esencialmente en los sistemas de transporte, siguió el metro y los buses integrados al sistema metro, quizás no había tanta necesidad, no había tanta congestión. Luego empezó un cambio significativo con la construcción del cable aéreo, un cable aéreo como una solución digámoslo alternativa, inclusive ingeniosa por nuestra topografía, las montañas, los retos, la falta de espacio, Medellín es una ciudad muy muy cerrada en un valle con poco espacio, entonces la construcción del cable aéreo fue trascendental, pero el cable aéreo no estaba funcionando bien y fue en la administración de Sergio Fajardo donde a ese cable que ya existía en Santo Domingo se le hizo un desarrollo urbano integral, en un plan urbano integral, donde conectamos a la ciudad de Medellín para que las personas de toda la ciudad pudieran ir a las zonas más peligrosas de la ciudad con atractivos simbólicos, lo dotamos de biblioteca, la Biblioteca España, y eso le dio una connotación al sistema de transporte, el sistema de transporte solo, digámoslo que no es suficiente, si no se ponen los otros equipamientos públicos que permitan el desarrollo de la comunidad, creo que eso fue bien interesante, y después se continuaron con otros cables aéreos en el 2008, 2011 y el tranvía también después del 2012, 2013, la construcción que género el sistema, digámoslo un sistema de transporte multimodal que hoy tiene Medellín sumado a eso las bicicletas públicas qué te hable ahorita más tarde en la otra pregunta, empezó a configurar un conocimiento en la ciudad, de qué el transporte público se tiene que abordar desde diferentes modos de transporte, por muchas cosas, en Medellín sucedió por restricciones económicas, políticas y porque empezamos a tener accidentalidad muy fuerte, se empezó a crearse también los andenes en la ciudad, Medellín es una ciudad sin andenes, aún faltan muchísimos andenes por hacer para que la gente camine de forma segura, porque en la encuesta origen destino de la ciudad casi el 60% o más del 60% de la ciudad se mueve en transporte público colectivo, masivo y caminando, lo cual es un potencial negativo, con un reto grande para este sistema de peatones no se vayan a los carros, lo que haría que los carros puedan crecer más, los vehículos particulares.

Sí, creo que si tiene éxito el sistema de transporte de Medellín, y creo que lo hace exitoso cierto sentimiento de regionalismo, hay un tema cultural de apropiación, por ejemplo del metro de Medellín, y un ejercicio de cultura

ciudadana para que la gente respete y cuide el metro de Medellín en ese sentido si es exitoso, lo otro, nos falta una parte importante para que sea un éxito digámoslo sólido, y es la integración de los buses al sistema de transporte masivo, hemos avanzado, pero todavía nos falta mucho en ese camino.

b. ¿Cuál fue o será su participación?

Respuesta: Empezamos a implementar un tema de ITS (Sistemas inteligentes de transporte, las siglas en inglés) intelligent transport systems y empezamos a hacer un centro de control de tránsito de la ciudad para optimizar el movimiento de la ciudad, ese fue un papel que obtuvimos. Otro papel fue con el metro plus que es un BRT (Bus Rapid Transit) donde nosotros trabajamos en la construcción e implementación del metro plus, éramos los encargados por parte de la Alcaldía para poner en funcionamiento el sistema de Bus Rapid Transit en Medellín, también estuvimos en los temas de los cables aéreos en la coordinación, haciendo parte de la junta del metro de Medellín, trabajamos allí con el metro que es clave en este asunto, también tuvimos que ver con todo el tema de la accidentalidad, la movilidad, empezamos e implementamos el sistema de bicicletas públicas de la ciudad con el área metropolitana y un proceso de recuperación de los andenes o la banquetas, los andenes de la ciudad privilegiando al peatón por encima de los otros actores de la vía y en un proceso de negociación con los transportadores de las empresas del transporte colectivo, ósea los buses como aquí le decimos en Medellín, que no se logró en su totalidad, aunque se hicieron algunos avances importantes, se construyeron terminales de transporte para los buses en diferentes barrios periféricos sobre todo, donde no tenían donde almacenar los buses y esto generaba un problema social, de mecánicos, de lugares donde tomaban licor, entonces hay un tema integral de seguridad para la comunidad que se logró al mejorar el estacionamiento de los buses en el espacio público.

2. **¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?**

Respuesta: Los problemas más importantes que tiene la ciudad de Medellín en el transporte, uno es la contaminación ambiental que generan los vehículos particulares, todavía son muy dependientes de los combustibles fósiles, estoy hablando del vehículo particular y los sistemas de los buses que tenemos, entonces, la transición a sistemas energéticos es urgente, ese

es uno. Otro es la desigualdad que generan los sistemas de transporte, dado que el costo para las personas pobres desplazarse en la ciudad es mucho mayor qué el de las personas ricas y esto es algo muy importante, otro tema es la voluntad política. ¿Por qué la voluntad política? -Porque los temas de transporte no son populares en términos políticos y no dan créditos políticos en el corto plazo porque en 4 años de gobierno es difícil implementar una solución de transporte entonces se necesita pensar en mediano y largo plazo, y ahí, falta voluntad política otro problema es la planeación de transporte público colectivo y del transporte, en general, no sólo en Medellín sino, de todo el área metropolitana del Valle de Aburrá porque ya son problemas que trascienden las pequeñas fronteras de nuestro municipio y eso es muy importante para municipios con Envigado, Sabaneta qué están sufriendo un procesos de densificación muy alto, también en el norte en Bello, Barbosa, tenemos que pensar en conjunto, ósea hay un problema de planeación, y el otro es la congestión vial que digamos que es la que más se ve, la de los vehículos particulares, es un problema que hay que solucionar yo creo que son los principales problemas que tenemos.

a. ¿Cómo cree que se pueden resolver estos problemas?
Respuesta: (incluido en b.)

b. ¿Cómo cree que se puede mejorar el sistema de transporte?
Respuesta: Pues primero es una pregunta retadora, pero lo primero que tenemos que hacer es una voluntad política de cambio en nuestros tomadores de decisiones, en nuestro alcalde, los concejales, el gobernador también tiene un papel importante, el director del área metropolitana, y es que no piensen en créditos políticos inmediatos si no que piensen a mediano y largo plazo, esa es la primera manera de resolver este problema, ¿Por qué? Porque tú vas a tener que empezar a privilegiar realmente la pirámide de la movilidad, tenemos que empezar por generar una ciudad que tenga las condiciones para que las personas caminen, eso es para que las personas puedan dejar el vehículo particular, esa es una primera, segundo apostarles a los transportes no motorizados, para eso tenemos tener buenos andenes y una estructura por ejemplo para las bicicletas segura, yo me muevo en bicicleta en la ciudad y es realmente un deporte extremo, pero bueno hemos avanzado, pero hay que seguir en eso, hay que poner bicicletas eléctricas, una manera y es muy barata y es muy poderosa porque pueden montar en bicicleta desde los niños hasta los adultos, entonces, no es solo poner el sistema de bicicletas y ya, es enseñarle a la

gente a moverse de esa manera, otra manera también es el tema que yo hablo como una propuesta que es la inmovilidad, no moverse es una estrategia que puede ser deliberada para no generar congestión, que significa esto, es hacer que entre la planeación urbanística las ciudades cortas, las ciudades oblicuas, que donde tú vives y tengas acceso a gran cantidad de los servicios que requiere una persona, salud, deporte, educación, los temas del estado cerca de donde se vive, ósea, es no concentrar los servicios en un solo lugar porque se vuelven grandes atractores de movilidad si no atomizarlos, sacarlos a toda la ciudad para que las personas tengan fácil desplazamientos cortos, para obtener lo que requieren para su vida tranquila, eso es un tema de planeación, un tema de aumentar la conectividad, estamos hablando de tener 5G, conectividad virtual, fibra óptica por toda la ciudad, porque si tú puedes llevar estos servicios y muchas cosas pueden cambiar, en esa estrategia también está el tema por ejemplo, el tele trabajo, trabajar desde la casa, muchas empresas de servicios podrían empezar desde ya esa práctica, esto solo hablando de las soluciones de cómo mejorar el sistema de transporte, el tema de facilitar la apropiación de nuevas formas de solucionar los problemas de movilidad, como UBER es uno, pero también los sistemas de domicilios, empezar a pensar en cómo vamos a utilizar a los Drones para llevar paquetes y cargas, para no congestionar más la vías, y no tener que construir más vías, vehículos autónomos, clave, es muy importante para el transporte público, por el respeto a la normas de tránsito, esto es una nueva esperanza que hay en el mundo para bajar la accidentalidad, bueno yo creo que esos son unos, y otro muy importante específicamente aquí en Medellín lo que tenemos que hacer es continuar de manera muy precisa y priorizando los recursos en el metro de Medellín, en más cables aéreos, sobre todo en la zona de Poblado donde hay más vehículos y no hay sistema de transporte masivo, en Laureles tampoco existe transporte masivo, ya sabemos hacer eso, por eso somos pues medio famosos en el mundo, por utilizar cables aéreos, podemos hacer más tranvías, necesitamos hacer más tranvías en nuestra ciudad, necesitamos hacer mas BRT (Bus Rapid Transit) por muchas partes y eso lo tienen en el plan de expansión del metro de la ciudad, entonces necesitamos, yo creo que esa configuración, pero falta un actor muy importante, que pena Francisco, que es la motocicleta, las motos se convirtieron en le modo de transporte predominante, ya están casi igualado el número de motos con el número de vehículos particulares, automóviles, y lo está superando, entonces, hoy quizás el principal actor de la movilidad es la moto y la moto tiene una configuración muy especial, es muy, es el sistema de transporte mas barato

más barato para una persona de la ciudad de Medellín, te la venden inmediatamente, tienen planes financieros impresionantes, entonces, ahi tenemos una invitación, para poder ayudar sobre el tema de transporte debemos migrar de las motos que son de gasolina y contaminan mucho, por lo menos como un primer paso a motos eléctricas o bicicletas eléctricas, segundo, generar un plan de financiación desde el estado a esa transición, y tercero, ojala un sistema gradual para usted poder tener acceso a conducir una motocicleta, porque la gente no sabe conducir la motocicleta y las licencias de conducción en Colombia se entregan de cualquier manera, ósea, no hay un control especifico, no estamos bien educados para conducir, esto genera muertes y costos en salud impresionantes a la ciudad por accidentes de tránsito de los motociclistas y de los motociclistas con los peatones.

3. **¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?**

   Repuesta: Si, existen porque el sistema de transporte hace parte de una estructura de una ciudad, es algo que permite el movimiento de las personas, pero está condicionado a la condición económica de nuestra ciudad, en nuestra ciudad es profundamente desigual, otra vez repito esa palabra, es desigual en extremo, entonces las oportunidades de trabajo no llegan a todas las personas, nuestra economía es una economía muy débil, como hacer que estas personas puedan acceder al sistema.

   a. ¿Cómo haría que el sistema sea accesible para estas personas?

   Respuesta: Primero, no es solo del sistema de transporte, es un sistema digámoslo integral y holístico, es procurar, generar un desarrollo deliberado económico para estas personas, eso es una cosa, y en el sistema de transporte se puede hacer de una manera, es, existe una red en el mundo que se llama Free public transport, hay una red mundial, donde muchas ciudades se asocian en esa red para tener subsidios de transporte, entonces hacen esto, no voy a invertir más en vías para vehículos particulares, voy a dejar de invertir, voy a conservar las que existen y voy a procurar que las personas se muevan por transporte público colectivo, como lograr eso, bajando las tarifas del transporte público colectivo, incentivos a los adultos mayores, a los niños, para los colegios, para las universidades, gratis el transporte, es una inversión que trae unos créditos políticos y económicos y ambientales hoy, porque le enseñas a la gente a moverse de una manera segura, confortable y la clave es dejar de invertir en construcciones de

intercambios viales, porque eso cuesta demasiado y a los dos, tres años con el crecimiento de los vehículos otra vez tienes la misma congestión.

4. **¿El sistema paga por sí mismo?**

   Respuesta: No, en Medellín no es auto sostenible el sistema, y no tiene porque serlo, el transporte público cumple una función social, económica, ambiental y cultural, que no se puede calcular solo por costo de la tarifa o el costo de la operación, esto tiene otros ingresos y otros beneficios sociales muy importantes para la calidad de vida de los ciudadanos.

   a. **¿Cuáles son las fuentes de ingresos para los diversos sistemas?**

   Respuesta: El primero es la tarifa de los tickets, ese es uno, otro las fuentes de ingresos pueden ser la publicidad, la publicidad que se utiliza dentro del sistema porque eso lo ven millones de personas, es muy poderoso, otro es la explotación del big data que genera un sistema de transportes, tú sabes cuantas personas ingresan al sistema, con reconocimiento facial puedes saber, o con el mismo ticket sabes la edad, donde viven, de donde vienen, hacia donde van y se vuelve un tema de aprovechamiento de información, como lo hace Google y lo hace cualquier gran sistema que maneje un volumen información, eso se está explorando, entonces como se le hace un análisis y un valor de Business Intelligence a este tema, hay ahí una fuente poderosa para las ciudades, el metro de Medellín te podría decir que tipo de sneakers, de tenis que utilizan las personas, que tipo de camisa, que tipo de morrales, de termos, ósea, temas de publicidad y comercio, el metro es una fuente inagotable de información, entonces esa es otra mirada, eso son ideas que yo tengo que creo que son posibles, lo otro es el tema inmobiliario, mira, vivir cerca de una estación del metro es estar conectado, se puede construir encima de las estaciones del metro, edificios, centro comerciales y toda esa plata puede ir al sistema de transporte, es un sistema que se ha hecho en varias partes, en Holanda creo que se han hecho cosas de esas, las estaciones de tren en Berlín, en Holanda, en Milán, en Italia, con grandes centros comerciales y ese dinero va al mantenimiento del sistema

5. **¿Hay congestión vehicular en Medellín?**

   Respuesta: Si, hay congestión vehicular, y es un problema que no se soluciona, eso suena como una resignación como algo fatalista.

a. **De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?**

Respuesta: La congestión es casi un síntoma de desarrollo de las ciudades, aumenta el poder adquisitivo, las personas tiene un deseo natural en occidente, en todo occidente de tener un vehículo un gran vehículo, y es algo que hace parte de nuestro sistema capitalista, es inevitable, en ninguna ciudad del mundo prohíben la compra de vehículos, ni la van a prohibir, entonces primero tener en consideración el sistema económico en el que estamos y en ese sentido lo que hay que hacer es, dejar de preocuparnos por la congestión vial, que ella se autorregule en la ciudad, eso creo yo, Rafael Nanclares, es una visión muy personal, pero poner sistemas por ejemplo de chatarrización, de obsolescencia de los vehículos, que un vehículo no pueda circular, un vehículo de más de 5 años ya es obsoleto, en términos del motor, la combustión, de una cantidad de situaciones, inclusive de la moda, es que exista una mayor renovación del parque automotor pero no el crecimiento en número del parque auto motor, esa es una para el tema de la congestión en Medellín, lo otro es identificar donde en la ciudad se tienen más vehículos por persona, y eso se identifica, en el caso de Medellín es en el Poblado, en Laureles y Envigado, ósea las zonas donde vive la gente con mayor ingresos económico y llevar a esas zonas otras alternativas de transporte, metros, claves aéreos, tranvías, BRT, andenes, bicicletas eléctricas, entonces cuando tú haces eso, le estas brindando una oportunidad a las personas más ricas, que no van a dejar el vehículo particular fácilmente, si tu no les pones una opción de un alto nivel de confort, sino no lo van hacer jamás.

6. **¿Hay problemas con la calidad del aire en Medellín?**

Respuesta: Si, tenemos problemas de calidad del aire serios en la ciudad de Medellín que se ven agudizados por nuestra geomorfología, ósea por la forma de nuestras montañas y nuestro valle, dado que los gases tienen que calentarse para subir y superar la altura de las montañas, no sucede cuando hay días más fríos, entonces si tenemos un problema y es un problema muy serio, y es el problema para mi más urgente.

a. **De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?**

Respuesta: El transporte público debe mejorar, porque la cogestión de los vehículos particulares es muy molesta pero no mata a nadie, pero eso sí, la causa de estos problemas es el parque automotor ósea los vehículos tanto

particulares como transporte colectivo, los buses, las motos, son el 95% pues, casi el 100% son de combustibles fósiles, entonces, esa transición a sistemas de transporte de energías limpios es clave, la transición al sistema eléctrico para vencer esto, esa es la tarea más urgente que tiene cualquier persona que piense en movilidad en la ciudad de Medellín, esa es la primer tarea, como resolverla, uno, creo que el mercado tiene mucho que ver aquí, es que las ensambladoras de motocicletas que están en Medellín, hay varias, de las más importantes de Colombia están aquí, nos propongan más motos eléctricas, bicicletas eléctricas con planes de financiación, como hoy lo hacen con la motos de combustibles fósiles, ósea, la idea no es que deje que el negocio se acabe, no, sigan haciendo el mismo negocio pero véndanos unas motos que no contaminen, lo mismo para los vehículos particulares, los vehículos particulares en Colombia tenían una excepción de impuestos, los vehículos particulares eléctricos estaban entrando a Colombia con menos impuestos pero de manera incomprensible, les aumentaron los impuestos a los vehículos particulares por parte del gobierno actual, ósea esas políticas en vez de favorecer al vehículo eléctrico, lo está atacando, ahí tiene que hacerse a través de intereses políticos y económicos, que por eso, la voluntad políticas es tan importarte, trabajar con las empresas para generar las condiciones económicas y financieras para que las personas puedan acceder a los sistemas de transporte eléctrico y creo yo, que la solución más fácil, más barata, más rápida de implementa en Colombia y en cualquier parte del mundo para combatir esto, es con las bicicletas y las bicicletas eléctricas, porque la bicicleta eléctrica es muy sencilla de manejar y conducir, es como si tu cogieras una ciudad que tiene colinas y tiene pendientes altas y la aplanaras, de alguna manera, porque tú sigues conduciendo la bicicleta realizando el mismo esfuerzo sin importar la pendiente, y es delicioso montar una bicicleta eléctrica, lo digo en primera persona porque yo lo hago, entonces es muchísimo más barato compardo con lo que tú te gastas en la construcción de un intercambio vial o en la construcción de un puente en una ciudad, montas todo el sistema de bicicletas eléctricas de una ciudad, escúchame bien lo que estoy diciendo Francisco y fácilmente se puede comprobar, es muy fácil.

PREGUNTAS DE ENTREVISTA

Entrevista No.: **2**
Fecha de Entrevista: **Martes, 8 de Octubre, 2019**
Hora de Entrevista: **7:00 am**
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Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

   Respuesta: Entonces, el sistema de transporte masivo de Medellín se implementa después de más o menos 1985 cuando empieza su construcción, cierto, su apertura en el 1996 aproximadamente, la construcción del sistema metro clave que fue muy exitoso, digamos que el sistema ha sido muy exitoso debido a que ha podido llegar a las laderas de Medellín con el metro clave, ¿Por qué?, porque lo estamos viendo de una forma social, ósea si estamos prestando un servicio a la comunidad y lo más importante es acercar a las personas desde las laderas, porque como tú conoces la topografía en Medellín, es un poco agreste porque tenemos altas pendientes, si vamos a implementar un sistema de transporte público colectivo, ósea tipo bus o BRT necesitamos mucho espacio para poder hacer las vías, para poder acceder a estas zonas y la consolidación de esas zonas en Medellín ya es bastante fuerte, cierto, tenemos viviendas de tres y cuatro pisos o más, entonces digamos que hacer una transformación solamente para el sistema, que son sistemas que necesitan digamos, radios de giro, cierto, unas longitudes para desarrollar velocidades, es muy difícil llegar a estos puntos de la ciudad. Entonces si ha sido muy exitoso porque le hecho de que nosotros

pongamos una línea, cierto, que une unos puntos y donde las personas pueden acceder a ellos para llegar al centro de Medellín o a sus diferentes pues en este caso trabajo o estudio, da mucha confianza y les permite a las personas tener mayor economía para poder transportarse, cierto, entonces sí ha sido muy exitoso.

a. Si tiene éxito, defina lo que cree que lo hace exitoso.

Respuesta: El éxito del sistema es que existe la demanda, debido a la ubicación espacial de las unidades residenciales, en la zona norte y los lugares de trabajo, ubicados en su gran mayoría en la zona sur del Área Metropolitana del Valle de Aburrá. Adicionalmente debido a la integración con otros sistemas, como los cables aéreos, el tranvía, el sistema Metroplús y las rutas alimentadoras, puedes llegar a casi toda la ciudad de Medellín y a varios de los municipios cercanos.

b. ¿Cuál fue o será su participación?

Respuesta: Cuando en la implementación, a mí no me ha tocado directamente, yo trabaje en la secretaría de movilidad, cierto, incluso cuando Rafael Nanclares estuvo de secretario y Martha Suarez fue mi jefa directa, entonces estuvimos trabajando pues en proyectos de mejoramiento, pues de, digamos sistemas aquí en Medellín, pero no directamente con el sistema, trabajábamos en relación con el metro plus, porque el metro plus se estaba formulando para salir al 2010, pero espero participar en proyectos porque en la Universidad de Antioquia queremos montar un laboratorio de movilidad sostenible, entonces de esa forma creo que podemos trabajar muy en conjunto con el metro de Medellín para los próximos proyectos.

2. ¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?

Respuesta: Entonces, uno de los problemas más grandes que tiene Medellín es el tema del aumento de los vehículos de transporte privado, ósea los particulares, como aumento en autos y aumento en motos, Medellín por su clima también se vuelve en un lugar que la gente quiera acceder a un vehículo como el tipo moto, entonces cómo es económico digamos de alguna forma, a mí me parece un buen sistema bien manejado, porque es un sistema que es pequeño que se puede estacionar fácilmente, que ofrece mayor capacidad a la vías, sí, pero en Medellín no sabemos de eso y lo tomamos de otra forma y tenemos muchos problemas de accidentalidad, de muertos de gente muy joven, gente productiva, entonces que pasa, si yo no tengo un sistema de transporte en realidad que tenga o que esté

solucionando las necesidades de la población, la población buscara la forma de encontrar otro sistemas para movilizarse como la moto.

a. ¿Cómo cree que se pueden resolver estos problemas?

Respuesta: Esa es la pregunta jeje, ósea como le decía ahora nosotros tenemos que volcarnos más a la población y saber en realidad la gente como se mueve, y cuáles son sus necesidades, porque si nosotros no sabemos de esas necesidades de la gente en realidad nunca vamos a tener un buen sistema de transporte, ósea como te digo, tenemos un metro de Medellín que es el eje principal que es una columna vertebral, a partir de él se desprenden otros sistemas de transporte, pero si el sistema no ofrece, digamos la comodidad para un ciudadano, así sea como una silla cómoda, para la persona con movilidad reducida que no puede acceder, como para el calor que no puedo, tengo la gente encima, la congestión en horas pico, entonces la gente siempre va a querer utilizar un sistema que le parezca mucho más cómodo, cierto. Y también el tema de la flexibilidad en los viajes, cuando yo tengo que hacer unos recorridos muy largos en un sistema de transporte, seguramente la gente por su tiempo que lo considera una cosa importante en su vida, el tiempo, entonces prefiere más bien tener un sistema propio para poder manejar el tiempo, cierto.

b. ¿Cómo cree que se puede mejorar el sistema de transporte?

Respuesta: racionalizando el uso de los vehículos privados tipo moto y auto particular, adecuando los andenes y senderos peatonales para mejorar la conexión a nivel peatonal para los usuarios de los diferentes sistemas, garantizando también la seguridad en estos corredores peatonales, proponiendo sistemas eléctricos complementarios como bicicletas eléctricas en las laderas de la ciudad, implementando un sistema completo integrado, es decir con uso integrado de las rutas de transporte público colectivo el cual es operado por empresas privadas.

3. ¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?

Repuesta: Aja, la ciudad de Medellín cuenta con una población de más o menos alrededor de 2’600.000 personas cierto, y hay una población alta que vive en las periferias de la ciudad, donde se asientan las personas de menos recursos, cierto, entonces sí sabemos que las personas con bajos recursos se asientan precisamente en las laderas, donde es más difícil el acceso, vamos a tener muchos problemas de movilidad siempre, cierto,

entonces hay gente que si no puede pagar, no puede pagar por el sistema pero el hecho de que también, no todo es malo, que también haya llegado sistemas como el metro cable a estos lugares a echo que las personas si pueden acceder a un sistema, con un solo tiquete y puedan hacer un recorrido largo en la ciudad.

a. ¿Cómo haría que el sistema sea accesible para estas personas?

Respuesta: Entonces si queremos un sistema accesible debería ser un sistema que fuera gratis para las personas con bajos recursos, que se pudiera de alguna forma subsidiar con los estratos más altos o se hacen gestiones a nivel internacional también para poder apoyar el sistema, porque el sistema funciona y funciona bien, entonces como podemos hacer que estas personas puedan acceder al sistema, si pudiéramos entonces que las personas de bajos recursos que digamos están trabajando y que se ganan un mínimo en Colombia, lo que hablábamos, si se ganan un mínimo en Colombia que esta alrededor de $ 828.000, que estamos hablando de 10 dólares día más o menos, que es muy poco dinero para que las personas puedan tener acceso a la alimentación, a vivienda y además al transporte, si queremos ser equitativos y queremos de verdad tener una equidad en Medellín, esas personas no deberían pagar tanto por transportarse en el sistema, cierto, entonces debería ser subsidiado.

4. ¿El sistema paga por sí mismo?

Respuesta: No, el sistema no paga por sí mismo.

a. ¿Cuáles son las fuentes de ingresos para los diversos sistemas?

Respuesta: La población, ósea la población es la que tiene que pagar una tarifa, el sistema como tal se paga por la inversión del gobierno, el gobierno nacional, la localidad y bueno los préstamos, pero en realidad el que paga es el usuario.

5. ¿Hay congestión vehicular en Medellín?

Respuesta: Si, mucha congestión en Medellín.

a. De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?

Respuesta: Hay muchas fuentes de congestión, en Medellín no producimos ningún tipo de alimento, entonces más, casi el 90% de los camiones que ingresan a la ciudad, traen alimentos y es muy difícil de esa forma que yo

pueda sacar los camiones de circulación de la ciudad, entonces lo que más contamina y lo que más congestiona es un camión, y los camiones llegan todos los días a Medellín, entonces hacen parte del problema. Segundo, la motorización que tenemos, la compra de vehículos particulares que creció en más de 400% en motos en los últimos años, entonces tenemos más motos que carros, 800.000 motos más o menos y 750.000 automóviles, en una malla vial que no crece, porque la malla vial para que crezcan en Medellín es muy difícil debido a las condiciones topográficas, entonces como no crece la malla vial tenemos el mismo número de vehículos que está creciendo todos los días, a una tasa más o menos de, en Colombia entran más o menos 30.000 vehículos mes, esos es muchos vehículos, más o menos 500.000 vehículos año, es muchos vehículos y no se chatarriza, ósea que entran muchos carros, no sale, cierto no salen ninguno, tenemos muchos camiones porque tenemos que resolver los problemas de alimento y de todo lo demás de carga, tenemos toda la gente que no quiere montarse en el sistema de transporte público colectivo y compra su vehículo particular y además pues están entonces los sistemas de transporte público que también hacen congestión, porque no tenemos carriles exclusivos ni nada de eso, entonces tenemos todos los problemas, tenemos muchos muchos muchos problemas, resolverlos es difícil, tendríamos que empezar a pensar cómo vamos nosotros también a ser más sostenibles para el alimento, para las cosas que nosotros no fabricamos, todo lo traemos, entonces el hecho de que nosotros no produzcamos nada también ha hecho de que todo se tenga que traer y cada vez somos más, entonces yo tengo que traer cosas, pues seguramente cada vez van a haber más camiones, entonces bueno yo creo que eso es uno de los problemas principales

6. **¿Hay problemas con la calidad del aire en Medellín?**

   Respuesta: Si.

   a. **De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?**

   Respuesta: Bueno, entonces aquí hay que contar que tenemos fuentes fijas, porque nosotros todavía tenemos fábricas cercanas, en Medellín las fábricas que hay las quieren ir sacando de la ciudad, pero todavía tenemos, cierto, fabricas grandes, incluso fábricas que funcionan con carbón, entonces tenemos problemas con fuentes fijas, cierto, y ya vienen las fuentes móviles que son todos los vehículos que están circulando por esta malla vial que te digo, como tenemos tanta congestión entonces toda esa polución se queda aquí en Medellín porque no alcanza a salir y más cuando

estamos en épocas de invierno, cuando las nubes tapan la ciudad porque están en periodos de lluvias y no alcanzan a salir todos los contaminantes, cierto ah disolverse en el aire porque nosotros somos como una tasa, somos como si una tasa como que le ponemos una tapa encima y nos quedamos encerrados, cierto, entonces ese es el problema. Entonces como tenemos tantas motos, las motos contaminan mucho, motos de 4 tiempos y motos de 2 tiempos contaminan mucho, más ese las motos de 4 tiempos para el PM2.5, ósea que son las partículas de 2.5 micras, cierto que son las más pequeñitas que entran a los alveolos y se quedan ahí, no vuelven a salir, entonces no tenemos una regulación porque tenemos pico y placa, pero no tenemos pico y placa para las motos de 4 tiempos y hay más motos de carros, cierto, entonces hay tenemos un problema, porque entonces no salen a pico y placa también o porque no tienen una restricción mayor, y los camiones que son los que más contaminan, entonces hay vuelve y juega nosotros tenemos un montón de camiones que llegan a la ciudad todos los días para suplirnos la necesidad de comida o de lo que necesitemos, entonces como son tantos esos camiones todos están circulando en la ciudad y además la recolección de basuras, nosotros somos 2’600.000 habitantes y estamos casi en 0.8 kilogramos más o menos 800 gramos de basura por persona, que eso en el día son muchas toneladas de basura que tiene que salir de Medellín a el lugar de disposición que es la pradera, que está más o menos a 2 horas de la ciudad, entonces ellos recogen todo el tiempo, están recogiendo basura todo el tiempo, están yendo hasta allá y vuelven a la ciudad, entonces ese es un ciclo vicioso, entonces que es lo que decía por ejemplo al principio con el tema del tren multipropósito de cercanías, que tuviéramos un sistema de recolección de basuras y también que le apoye al metro con el tema de pasajeros y podríamos estar trabajando dos temas importantes con el tema de calidad del aire y con el tema de congestión, cierto, pero son proyectos lentos porque la construcción de un sistema de esos tendría que mejorar mucho el sistema férreo en la ciudad y es un sistema que está abandonado, entonces hay que empezar a reconstruir y eso lo hará lento en el tiempo, pero puede ser una alternativa que tengamos a futuro, listo.

PREGUNTAS DE ENTREVISTA

Entrevista No.: **3**
Fecha de Entrevista: **Martes, 8 de Octubre, 2019**
Hora de Entrevista: **2:30pm**
Nombre: **Marta Lucia Suarez Gómez**
Título: **Líder de Programa Unidad de Planeación y Prospectiva Secretaria de Movilidad, Alcaldía de Medellín**
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Autorización para usar su nombre: Si

Biografía:

Secretaría de Movilidad del Municipio de Medellín. Líder del programa de la Unidad de Prospectiva y planeación (Planes programas y proyectos asociados a la administración, regulación y control de la movilidad de la ciudad) Año: Diciembre del 2013 a la Fecha.

Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

   Respuesta: Es importante retomar un poco la historia, porque hablar de la implementación de un sistema de transporte requiere retrocederse a años atrás, a las políticas y a la forma como se formuló la prestación del servicio de transporte público para los países latinoamericanos o para muchos países de sur América en especial, donde el transporte debe ser auto sostenible, es decir, el estado no pone recursos para subsidiar la tarifa, por lo tanto los costos de operación se debe cubrir con la tarifa que se le cobre al usuario. Esto llevó que el estado en el caso particular de Colombia autorizara la prestación del servicio de transporte a operadores particulares bajo los parámetros determinados por la autoridad (diseño operacional es decir Número de vehículos y tipología, frecuencias, horarios de prestación del servicio, rutas, valor de la tarifa a cobrar entre otros). Es importante precisar que la prestación del Servicio de transporte público está regulada por el Gobierno Nacional, por lo tanto el Municipio de Medellín se debe acoger a todas las normas que este expida en la materia.

   Estas normas han venido evolucionando en los últimos años con el propósito de mejorar la prestación del servicio bajo los principios de eficiencia, economía,

sostenibilidad, comodidad y seguridad, para ello de manera complementaria ha trazado algunas políticas de reestructuración, lo que ha implicado adelantar procesos licitatorios para adjudicar a terceros los nuevos servicios reestructurados bajo el modelo de un transporte integrado y masivo. , El proceso para Medellín inicia reconociendo la existía de la prestación de algunos servicios de transporte en la periferia de la ciudad, sin la debida autorización, denominados " informales", generando competencia desleal al transporte formal. Por lo tanto mediante una ordenanza expedida por la asamblea departamental se permitió que sin hacer el proceso licitatorio se legalizaran y se acogieran como empresas legales prestadoras del servicio de transporte público colectivo. No podemos desconocer la historia de Medellín y quizás de muchos ciudades del país, en el que la informalidad presenta superposición de recorridos con las rutas formales generando problemas de orden social. Una vez legalizadas no dejo de ser una oferta adicional y también una competencia por el usuario denominada la guerra del centavo, la cual se presenta en gran parte por las limitaciones de la infraestructura vial. Es muy frecuente que un solo corredor permita la accesibilidad a varias zonas de la ciudad, en el que el servicio de transporte es atendido por varias empresas. De otro lado la ciudad de Medellín tiene el privilegio de contar con un Metro el cual entró en operación en el año 1995,lo consideramos exitoso para la ciudad y es el eje estructurante del sistema integrado para el Valle de Aburrá que se ha venido conformando con el pasar de los años. Hablamos del Valle del Aburrá pues no podemos desconocer que la Ciudad de Medellín forma parte de un Área Metropolitana conformada por 10 Municipios en los que la mayoría se encuentran conurbados y donde la movilidad y el transporte se constituyen en un hechos Metropolitanos, lo anterior por cuento a que cada Municipio además de ofrecer servicio de transporte con buses al interior de su jurisdicción también posee otros servicios con destino a la ciudad de Medellín y otros servicios que integran al Metro, haciéndose necesaria su operación bajo un sistema integrado de transporte el que denominamos SITVA (Sistema integrado para el Valle de Aburrá). Implementado bajo unas políticas establecidas por el Área Metropolitana como autoridad del trasporte metropolitano y el transporte masivo.

El sistema lo conforman:
El Metro, con 34.5 Km, 27 estaciones, 80 trenes de tres coches y una movilización cerca de 900.000 pasajeros diarios.

5 Cables que suman 10.77 Km más uno en proceso de construcción de 2.8Km con una movilización de aproximadamente 50.000 pasajeros que dan cobertura a zonas de difícil accesibilidad por la topografía de la ciudad.

Un tranvía de 4.2 Km, 12 trenes, con una movilización de 55.000 pasajeros.

Un BRT de 12.5KM por la troncal y 13.5 por pretroncal con 509 vehículos tipo bus busetas, padrones y articulados y una movilización de cerca de 160.000 pasajeros, que permiten la conexión entre las zonas del oriente y Occidente, el cual denominamos cuenca cruzada.

Un sistema de buses urbanos y metropolitanos de aproximadamente 50000 vehículos incluidos las alimentadoras al metro. Con una movilización aproximada de 1.400.000 con servicios radiales (centro-barrio y barrio-centro).

Un sistema de Bicicletas públicas conformado por 52 estaciones y 1200 bicicletas con 73.000 usuarios.

Es importante resaltar que cuando inició la operación del Metro se identificó la necesidad de generar servicios que se integraran con el fin de ampliar su cobertura dado que sus líneas permitían viajar de Norte a Sur pasando por 6 municipios de los 10 del Área Metropolitana sin atender las periferias o barrios por su lejanía. Por ello actualmente el 50% de la movilización del Metro son aportadas por las rutas alimentadoras. Como puede observarse, la ciudad y en general los Municipios que conforman el Área Metropolitana tienen una oferta muy buena de transporte público. Y seguimos trabajando para que éste se preste con calidad y eficiencia, comprometidos por una movilidad sostenible.

a. Si tiene éxito, defina lo que cree que lo hace exitoso.

Respuesta: Podría decir que es exitoso, en el sentido de la oferta que estamos ofreciendo y las diferentes alternativas, pero para llegar a la cumbre del éxito todavía faltan muchas cosas, hoy también hemos adelantado una reorganización del transporte de la ciudad para que este servicio incorpore elementos como el componente tecnológico, donde nosotros a través de esos dispositivos a bordo de vehículo podamos tener más informado al usuario, bien sea por aplicativos móviles o en los paraderos y apenas lo venimos haciendo, lo mismo que se pudiese lograr una integración tarifaria, es decir, que el usuario pueda tener una sola tarjeta y que ojala fuera electrónica, entonces diríamos que comparativamente con el avance de otras ciudades del país creeríamos que

vamos por buen camino y vamos hacia el éxito pero aún no podemos decir que estamos en el éxito total.

b. ¿Cuál fue o será su participación?

Respuesta: Yo he estado desde que el gobierno Nacional quería hacer toda una restructuración del transporte público y la tendencia era que el transporte todo se debía licitar, todo se debía cambiar como sistemas nuevos a través de procesos licitatorios y no seguir con los operadores antiguos, para el caso de Medellín me toco, fuertemente trabajar en todo lo que fue la implementación del sistema el cual llamamos SITVA como se expuso en la respuesta a la pregunta 1 (Sistema Integrado para el Valle de Aburrá), sin clasificar de que sea masivo o no lo sea, porque la idea es que lo que el gobierno Nacional ha clasificado como masivo, metros o BRT o haber dicho que todo los sistemas se volvían masivos en el caso nuestro no, nosotros hacemos un mixer, que el transporte masivo se puede unir perfectamente con el transporte colectivo sin necesidad de que se tenga que llamar de una forma o de la otra, la idea es lograr su integración operacional, física y tarifaria conservando su carácter y sin necesidad de iniciar un proceso licitatorio y dejando claro las competencias de cada una de la autoridades en materia de transporte s teniendo en cuenta que sobre el masivo la competencia la tiene el área metropolitana y en el transporte público colectivo lo tiene cada municipio, y de esta manera conservar las autonomías de cada uno, para ello se hacen acuerdos entre las autoridades mediante convenios firmados entre las partes Esto a permitido minimizar los impactos sociales que se generan ante un proceso licitatorio en el que los operadores perdedores de la convocatoria deben retirarse del servicio y dar paso a nuevos operadores ganadores de la licitación como ha ocurrido en nuestra ciudad y en otras del país, con no muy buenos resultados , Medellín decidió hacerlo diferente para lo cual gestionó ante el gobierno nacional una modificación a la norma permitiera la figura de acuerdos empresariales entre el masivo y el transporte público mejorando la calidad de la prestación del servicio sin necesidad de seguir el proceso de orden Nacional.

Participé de este proceso y se logró que el Gobierno Nacional incluyera esta figura bajo el entendido que los empresarios de Medellín presentarían voluntariamente una propuesta de reorganización bajo los mismos principios del sistema masivo es decir uniesen las empresas que competían por los pasajeros cuando comparten un mismo corredor, renovar la flota a vehículos con tecnologías limpias y accesible para personas con movilidad

reducida, incorporar componente tecnológico para el control y gestión de la operación.. Esto fue un trabajo arduo debido a que era necesario garantizar un cierre financiero frente a las inversiones que debían realizar los empresarios, por lo tanto, fue necesario conceder un plazo de más de 5 años para esta transformación y se pudiera lograr la sostenibilidad. Este esquema adoptado por la ciudad a permitido que funcione marca la diferencia frente a otras ciudades del país donde se licito y hoy están deficitados, preocupados por la sostenibilidad del sistema. Por ello consideramos que el proceso adelantado por el Valle de Aburrá es exitoso aunque fue un proceso muy complicado esto implicó reunirse con cada operador, y hacer que se unieran los operadores que atendían una zona en común de esta manera , firmaron sus acuerdos empresariales y se comprometieron con toda la renovación y en este momento lo están haciendo..

2. **¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?**

   Respuesta: Lo ideal para motivar a los ciudadanos a usar el transporte público es que el sistema pueda tener unos tiempos de viaje muy atractivos para el usuario, pero lamentablemente por las dificultades en la infraestructura vial que tenemos generar carriles segregados para todo el sistema de trasporte no es fácil, y donde lo hemos hecho, aún no existe la cultura , ni el respeto del uso de estos carriles por parte de los vehículos particulares estos carriles los hemos declarado preferenciales para el uso preferencial del transporte público. Esto radica en una de las grandes dificultades. Es un gran reto para nosotros garantizar tiempos de viajes cortos y agiles a los usuarios del l transporte público. Sabemos que la selección del modo de transporte a utilizar está basada en el costo generalizado del viaje donde el tiempo de viaje y el valor de la tarifa son fundamentales para esta decisión seguidos de la comodidad, seguridad, regularidad entre otros entonces uno de los grandes retos es garantizarles a ellos precisamente velocidades de operación adecuadas. Otro aspecto complejo es la adopción de una nueva cultura ante el nuevo modelo de la prestación del servicio por parte de los empresarios, propietarios y conductores por ejemplo anteriormente el salario de conductores era proporcional al número de pasajeros movilizados por el vehículo conducido con jornadas de más de 10 horas diarias En este nuevo modelo tienen que contratar a los conductores con sus prestaciones y no por pasajeros movilizados, y con un horario de 8 horas como lo establece la

ley. Sin embargo, hay un rechazo fuerte por parte de conductores a esta modalidad

a. ¿Cómo cree que se pueden resolver estos problemas?

Respuesta: La reestructuración del transporte incluyo la incorporación de un componente tecnológico para el control en la prestación del servicio como lo es el abandono de ruta, exceso de velocidad, sobrecupo, movilización de pasajeros entre otros. Esto nos está permitiendo hacer seguimiento permanente a la prestación del servicio, adoptar correctivos o iniciar procesos de investigación si es del caso. Sin embargo, esto ha hecho que algunos conductores rechacen la tecnología en algunos casos con vandalismo a los dispositivos localizados en el vehículo. Pero seguimos en el proceso con campañas y generación de una nueva cultura bajo diferentes estrategias comunicacionales y pedagógicas.

b. ¿Cómo cree que se puede mejorar el sistema de transporte?

Respuesta: Básicamente los problemas en el transporte radica en no contar con la suficiente infraestructura que garanticen velocidades competitivas y tiempo de viajes adecuado para el usuario y el cambio de chip por parte de conductores propietarios y usuarios, por ejemplo al usuario debe acostumbrarse a ir hasta el paradero para tomar su ruta y no solicitar la detención del mismo en cualquier sitio que no le está permitido hacer la parada Falta mucha cultural pero venimos trabajando fuertemente, básicamente el problema radica en este aspecto.

3. **¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?**

Repuesta: Sabemos que hay condiciones muy difíciles para mucha gente y yo creo que ahí se ve reflejada el porcentaje alto que tenemos de viajes a pie, ahora estamos promoviendo también entre los viajes no motorizados el uso de la bicicleta publica, el cual ha tenido una muy buena aceptación y utilización como un modo complementario al sistema de transporte o para viajes de corta distancia. la ciudad relativamente es caminable, aunque hay periferias o comunas que son muy distanciadas y por sus pendientes y condiciones topográficas no es tan fácil.

En Medellín hay un respeto y una cultura por el pago de la tarifa, o sea aquí usted no ve la gente colándose como muchos eventos que hemos visto en las noticias de Bogotá, donde la gente evade a lo máximo el pasaje. El

sistema metro, Metroplús, tranvía y sus alimentadoras dan la posibilidad de un viaje a crédito se dan alternativas, pero indiscutiblemente hay zonas donde es difícil para muchos por su condición económica acceder al transporte.

a. ¿Cómo haría que el sistema sea accesible para estas personas?
Respuesta: La accesibilidad la podemos hablar en temas de costos y también en tema de personas con movilidad reducida que es otra condición que estos vehículos deben cumplir.

4. ¿El sistema paga por sí mismo?
Respuesta: Para nosotros, el sistema se paga en lo que tiene que ver con los operadores privados y con cargo a la tarifa es decir el recaudo por concepto de la tarifa al usuario les tiene que dar para la sostenibilidad del sistema, sin embargo, el metro de Medellín, metro plus, el tranvía, los cables son operados directamente por el estado y tienen aportes de la ciudad de Medellín para que sea sostenible, mientras que el resto de los operadores tienen que sostenerse vía tarifa.

a. ¿Cuáles son las fuentes de ingresos para los diversos sistemas?
Respuesta: Los pasajeros, el pago de los pasajeros y por parte del estado lo que tiene que ver con el sistema metro, tranvía, metro plus, cables, el estado el Municipio de Medellín aporta unos recursos para su sostenibilidad.

5. ¿Hay congestión vehicular en Medellín?
Respuesta: Muchísima, precisamente es una de las grandes dificultades de nuestra ciudad una congestión muy alta especialmente en las horas pico.

a. De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?
Respuesta: hay situaciones que hace que se vea más congestionada la ciudad y es la ejecución de las diferentes obras que impactan la movilización, Siguiendo los principios de POT y plan de desarrollo se están generando más espacio público e infraestructura para peatones, ciclistas y carriles solo bus lo que ha obligado a reducir la sección vial de algunos corredores disminuyendo su capacidad y consecuentemente incrementando la congestión. Estas intervenciones se están haciendo principalmente en el centro de la ciudad para favorecer la movilidad no

motorizada y el transporte público. Dejando de lado un poco el vehículo particular, o sea que habrá un momento en que casi que la congestión se vuelve una autorregulación especialmente para el vehículo particular y por eso se están buscando alternativas de gestión de demanda, la ciudad tiene pico y placa, pero está pensando en la posibilidad y se han hecho unos estudios de ampliar ese horario o de generar zonas de cobro por congestión que también requieren su debido análisis.

6. **¿Hay problemas con la calidad del aire en Medellín?**

Respuesta: Efectivamente, Medellín por su topografía, por su alto flujo vehicular, por las condiciones climáticas pasa por unos episodios críticos, por ejemplo, en esta época de octubre se nos estaciona una nube que no deja salir todas las emisiones contaminantes y se nos quedan debajo de esa capa, entonces por eso nos toca cuando tenemos episodios críticos implementar medidas más drásticas en la restricción de la circulación de vehículos, en esta época en este momento se ha incrementado la restricción de las circulación, se incluyen vehículos de transporte o vehículos de carga y se toman otras medidas obviamente apoyados con la participación del sector privado, porque para nosotros es importante que todo lo que hacemos no es solo del estado sino una corresponsabilidad que también tiene el sector privado, ellos tienen que presentar estudios de movilidad sostenibles, empresas que tienen más de 200 empleados deben presentar un plan de movilidad sostenible en la que presentan alternativas para mejorar las condiciones de movilidad y la calidad del aire.

   a. **De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?**

Respuesta: Es prácticamente lo que yo le digo, unir el sector privado en un compromiso de corresponsabilidad y la implementación de algunas medidas restrictivas complementarias, y continuar fortaleciendo el sistema de transporte público colectivo.

PREGUNTAS DE ENTREVISTA

Entrevista No.: **4**
Fecha de Entrevista: **Miércoles, 9 de Octubre, 2019**
Hora de Entrevista: **10:30am**
Nombre: **Carlos Alejandro Echeverri Restrepo**
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Biografia: Yo soy Alejandro Echeverri, yo soy arquitecto de formación, hice estudios de doctorado en urbanismo y planeación territorial en España en Barcelona, en el laboratorio de urbanismo de Barcelona, mi experiencia combina digamos el campo académico donde estamos hoy, yo he trabajado en el gobierno de la ciudad, pero también tengo un estudio de proyectos urbanos privado, ósea que me muevo dijéramos en las tres dimensiones. URBAM es un centro que tiene unas características un poco diferentes de los centros de estudio tradicionales de las universidades, URBAM lo fundamos, lo empezamos a pensar en el año 2009, yo fui el director de proyectos urbanos y el director de la empresa de desarrollo urbano de Medellín (EDU) trabajando con el alcalde Fajardo, y desde esa estrategia lideramos la estrategia de los proyectos urbanos integrales, la estrategia de urbanismo social, los proyectos urbanos integrales muy asociados a potenciar los sistemas de transporte como los cables que se empezaron a trabajar en ese tiempo, entonces como yo me he movido entre la academia, el sector público y el privado, cuando termine con el gobierno en esa época empezamos a pensar con el rector de la universidad que era necesario crear una agencia y un centro de estudios que pudiera generar un espacio de conexión y mediación entre la academia, los gobiernos, las empresas privadas y la sociedad civil, ósea que fuera de alguna manera un espacio que pudiera desarrollar proyectos de colaboración, de investigación, proyección social de consultoría y también de formación, muy vinculados con las problemáticas reales y con las comunidades reales para generar de alguna manera una conversación mucho más integral entre esos actores, entonces fundamos URBAM en el 2010, URBAM con M al final quiere decir urbanismo y ambiente precisamente porque encontramos que una de las deudas era generar respuestas que desde la fundación y que desde el principio de los procesos concibieran los temas de infraestructura y urbanismo y los temas ambientales, dijéramos con una concepción más integral, con

un conocimiento más científico y también conectados más con la problemáticas de la gente, entonces URBAM, nosotros trabajamos en proyectos académicos, tenemos una maestría, tenemos cursos de investigación, tenemos dijéramos una línea académica pero lo que mueve URBAM realmente es lo que llamamos la unidad de proyección social que es donde trabajamos con casos reales, con gobiernos, con fundaciones, comunidades, con problemáticas urbanas y ambientales y de hábitat, en Colombia en diferentes regiones, no solo en Medellín y en Antioquia, pero también en otras partes, por ejemplo ahora estamos asesorando al gobierno nacional de Costa Rica en la implementación de una estrategia de proyectos de estrategia de urbanismo sostenible social, de temas transformación urbana para prevenir también temas de violencia, estamos asesorando al TEC de Monterrey en la implementación de 5 laboratorios de ciudad en las 5 regiones de México, entonces dijéramos que URBAM tiene una acción distinta o dijéramos amplia y nuestro equipó no es solamente de arquitectos y urbanistas, aquí hay biólogos, hay politólogos, tenemos una experiencia y unas áreas del conocimiento que tratamos de cruzar, para dar unas respuestas más integrales.

Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

Respuesta: Si, yo creo que la palabra éxito en una problemática tan compleja como una ciudad como Medellín de cuatro millones y medio de habitantes en su área metropolitana, perdón tres y medio en el área metropolitana, es mejor hablar dijéramos de un proceso en transición, si uno lo compara con otras ciudades colombianas, el éxito depende con quien lo compares.

   a. **Si tiene éxito, defina lo que cree que lo hace exitoso.**

   Respuesta: Si uno lo compara con otras ciudades colombianas yo creo que el proceso de Medellín está más avanzado, pero está lejos todavía, lejos de nosotros haber logrado todo un sistema de transporte integrado que responda a las necesidades de la ciudad, pero dijéramos que hay implementando una serie de tecnologías y de la misma empresa metro una serie dijéramos de programas y políticas que nos ponen más adelante que la mayor parte de las ciudades colombianas y de alguna de las latinoamericanas

b. ¿Cuál fue o será su participación?

Respuesta: En el trabajo que tenemos nosotros en URBAM, nosotros hemos apoyado a la empresa metro a revisar su plan de expansión futura al año 2030, sobre todo evaluando integralmente las problemáticas urbanas y ambientales en relación con el plan que tienen ellos de expansión de corredores futuros, eso es lo que hemos hecho desde URBAM, también desde URBAM hemos trabajando con diferentes proyectos que transforman dijéramos muchas de las redes de calles de espacios públicos y parques para generar una conectividad mucho más completa que eso es una parte fundamental en los temas de movilidad, porque la movilidad no es únicamente los sistemas mecánicos o los sistemas, sino, es el itinerario, la ruta de la gente dijéramos en temas de todos el sistema de transporte y de hacer de alguna manera promover dijéramos una movilidad más activa, las ciclo rutas, entonces hemos trabajado en propuestas de corredores verdes, de distritos verdes, de temas que están asociados a los temas de movilidad en URBAM, cuando trabajamos en el gobierno y estuve liderando trabajando en el gobierno de Sergio Fajardo, como director de proyectos urbanos de la ciudad, nosotros desarrollamos las estrategia que en ese momento la llamamos urbanismo social y los proyectos urbanos integrales, que básicamente lo que dijéramos que responden es a generar unos procesos de transformación y de inclusión en algunas de las zonas más pobres y violentas de la ciudad, asociadas muchos de ellos a los sistemas, a los nuevos sistemas de transporte, entonces nos apoyamos y trabajamos integralmente con el primer corredor de metro cable en la zona nororiental en Santo Domingo Sabio, en Anda Lucia, en el barrio popular para hacer una concepción del sistema de transporte del cable y sus estaciones mucho más completas en relación con una intervención en el territorio que transformaran no solo el espacio público, sino el itinerario de vida cotidiana de las personas que van a usar ese sistema de transporte o que usan esas centralidades urbanas, por ejemplo como una mamá lleva al niño a su colegio, sale de su casa, que ruta coge, del colegio va y toma el sistema de transporte de cable que la lleva a su trabajo u nosotros identificamos una serie de esos circuitos para hacer una transformación del especio público y una transformación en secuencia de los servicios públicos que transforman la vida cotidiana de la gente asociada a la estaciones del transporte, ese es un poco los temas que seguramente más nos asocian en eso. En URBAM otra dimensión hay una serie de jóvenes que son uno de los líderes más fuertes del activismo por la movilidad limpia en relación con todo el tema de la bicicleta, dijéramos somos muy activos en las plataformas cívicas y tratar de promover un poco la

movilidad limpia, el uso de la bicicleta y otro tipo dijéramos de medios como alternativa dijéramos como solución a la ciudad.

2. **¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?**

Respuesta: El problema más urgente es que yo creo que los sistemas integrados de transporte que tienen las redes de sistemas y las rutas que tenemos de sistemas integrados de transporte que tenemos en Medellín, dijéramos el sistema está empezando, de alguna manera es una implementación de una red integrada que está lejos todavía de prestar el servicio que necesita la ciudad, lo que pasa es que obviamente hay que entender el contexto económico con el que estamos, pero si uno compara Medellín con ciudades del mundo, dijéramos, ósea ciudades como Paris, Tokio, otro tipo de economías donde las redes de los sistemas de transporte cubre de forma eficiente dijéramos una parte mucho más amplia del territorio, pues nosotros todavía realmente estamos yo diría que en una fase, no sé si la pablara, yo no diría que ni siquiera intermedia, estamos en una fase inicial de la implementación de un sistema integrado mucho más potente. Ahora si tú te comparas con ciudades como Cartagena, como otras ciudades latinoamericanas, etc. podemos estar más avanzados que ellos.

   a. **¿Cómo cree que se pueden resolver estos problemas?**

   Respuesta: Entonces el primer reto es continuar realmente incrementando la cobertura de los sistemas integrados de transporte de una forma mucho más completa las rutas alimentadoras y sobre todo todavía hay sistemas duales que no funcionan bien, nosotros todavía tenemos un volumen muy grande de la población de Medellín de que se movilizan en empresas de transporte que no son transporte público, que son rutas llamémoslas públicas, pero son de operación privada muy mal diseñadas, de alguna manera con cobertura muy ineficiente, con duplicidad de rutas, con tecnologías de comparación muy altas, ósea, entonces estamos en un proceso de transición que debería acelerarse más para realmente empezar hacer de alguna manera una cobertura no solo más completa, sino mejor en calidad, pero también mucho más eficiente en tiempos y costos y también mucho más descontaminada.

b. ¿Cómo cree que se puede mejorar el sistema de transporte?

Respuesta: Pero el reto más grande que tiene Medellín, yo creo que sin ninguna duda es tratar de anticiparse a generar realmente una alternativa de movilidad limpia e integrada para el porcentaje de la población de la ciudad que hoy no usa vehículo privado, ósea no es tanto como en otras ciudades y sociedades que lo que se busca es ver como se baja la gente del automóvil, aquí también seguramente hay que generar alternativas de esto, pero menos del 20% de la población de Medellín se mueve en vehículo privado, entonces el reto más grande es, como evitamos que el 80% de la población que hoy se mueve regular, no se mueve muy bien usando transporte dijéramos de estos operadores privados o transporte publico ofrecido por el metro y la ciudad, como evitamos que ese volumen muy grande de población que se está trasladando también a la motocicletas de alguna manera la ciudad logra generarle una alternativa para evitar que el futuro de alguna manera esa movilidad se apoye fundamentalmente en una movilidad individual y privada, quiero decir en vehículos privados. Y sobre todo estoy hablando de los barrios del norte de la ciudad, el centro de la ciudad y el norte de la ciudad, la zona nororiental y la zona noroccidental que es donde el mayor volumen de población de recursos medios y bajos vive, y donde hay una explosión de compras de motocicletas y todavía los barrios populares, es un fenómeno que apenas está empezando, pero se va acelerar mucho más con el incremento de la capacidad económica, el reto grande de la ciudad es como anticiparse a eso.

3. ¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?

Repuesta: Pues es que el problema de la pobreza, es un problema mucho más profundo, y estamos, yo creo que cuando uno habla dijéramos de estas preguntas en relación por ejemplo de la movilidad, en contextos como el nuestro hay una serie de variables que hay que incorporar, que no dependen únicamente de la ciudad y hay una serie de variables también que hay que incorporar que no dependen únicamente de la tecnología o del propio sistema de costos, tiene que ver con el empleo, con la capacidad adquisitiva, quiero decir, es entonces por eso lo mencione yo al principio, es importante pensar de alguna manera como que estamos en procesos de transición, no pensar que podemos dar soluciones absolutas, nos falta todavía mucho porque los retos son muy grande en ese sentido. Lo que se ha tratado de hacer en Medellín es tener de alguna manera un tiquete integrado, como la tarjeta cívica, que al integrar el sistema exista un

ahorro de alguna manera importante para las personas que tienen que tener un transbordo desde su origen, desde su casa, en relación con tomar dos o tres medios distinto hasta llegar a su destino, pero esa de alguna manera esa solución tampoco cubre a toda la población, ósea hay un sector de la población de extrema pobreza que esta por fuera de alguna manera de la capacidad adquisitiva del sistema, se pueden explorar varias estrategias, en algún momento hubo una estrategia en la ciudad que se llamaba el tiquete estudiantil, que era un subsidio para los estudiantes de colegio público de una cobertura muy importante del valor del costo del tiquete para que pagaran mucho menos los estudiantes de colegios públicos y universidades públicas en relación con la movilidad, entonces yo creo que se pueden combinar varias alternativas, tiene que ver también con los lugares de empleo y los lugares de alguna manera de donde viven las personas, para generar mayor proximidad, ósea hay otro tipo de estrategias urbanas que se deben combinar pero sin ninguna duda hay un reto muy grande de que, el reto más grande de la movilidad en Colombia sin ninguna duda tiene que ver con el tema de la equidad y la inclusión, y un poco una de las características del transporte público en Medellín es que los últimos, la mayor parte de los últimos corredores de metro cables, tranvías, etc. Son rutas que han tenido una prioridad de conectar algunos de los barrios de alguna manera con mayores problemas sociales y de pobreza de la ciudad, pero no quiere decir que tengamos hoy una cobertura completa, ni siquiera el 50%, por eso digo yo que es un proceso, yo no creo que estemos todavía en el 50%.

a. ¿Cómo haría que el sistema sea accesible para estas personas?

Respuesta: Sin duda el reto en nuestra sociedad y no estoy hablando de Medellín únicamente es como tratar de tener una cobertura de transporte público más completa, que de alguna manera las comunidades y las personas de menores recursos puedan acceder a ella, pero la respuesta no es fácil, ni es blanco y negro, porque de alguna forma dijéramos por ejemplo, la empresa metro a tenido de alguna manera una política de tener una tarifa, llamémosla aceptable, no ideal, que permita darles a ellos también una sostenibilidad económica en el tiempo para que el balance entre los ingresos de la tarifa en relación con la sostenibilidad del sistema, con algunos subsidios o ayudas del gobierno, pero que pueda de alguna manera la tarifa cubrir una parte muy importante de la operación. Ahora en Colombia está el tema de la estratificación socioeconómica, que no vamos a entrar a analizarla en detalle, pero yo creo que, si sería factible explorar de forma más clara una serie de subsidios al transporte, a los sectores de población de alguna manera más críticos, pero dijéramos que

esa pregunta siempre está en el balance en relación con la sostenibilidad del sistema, entones no hay una respuesta ideal a eso.

4. ¿El sistema paga por sí mismo?

Respuesta: Yo lo que entiendo es que el sistema logra cubrir la operación, quiero decir, el pago del tiquete logra cubrir la operación, no cubre, ósea la construcción, el costo de la construcción del sistema de las infraestructuras, sobre todo las primeras implementaciones de los corredores del metro, la implementación de todos los sistemas pesados, no los cubre de alguna manera el tema de las tarifas, cierto, es lo que ha tratado de hacer la empresa metro con sus rutas integradas y con las nuevas tecnologías de los sistemas, es lograr tratar de hacer un equilibrio de alguna manera de sostenibilidad en relación con que los ingresos por tarifa, precisamente esa es una de las dificultades para tener una cobertura dijéramos a las poblaciones de menores recursos y de bajar el precio del tiquete, porque dijéramos que uno de los logros que ha tenido, es generar una empresa realmente sostenible, con un soporte y un equipo técnico muy profesional y una gerencia realmente de alta calidad, ósea, no como las empresas públicas que uno conoce de alguna manera, ineficientes, etc. La empresa metro tiene una gestión de gerencia muy bien manejada y también desde su soporte técnico, pero pues tienen otras contra prestaciones, cobra por sus servicios.

a. ¿Cuáles son las fuentes de ingresos para los diversos sistemas?

Respuesta: Yo no te sabría decir en detalle, pero el fundamental es la tarifa, el fundamental es la tarifa, hay algunos ingresos complementarios cuando se hacen nuevos corredores y rutas que no son iguales en relación con la inversión estatal, en algunos casos algunos de los corredores habido una inversión municipal, en la construcción de las primeras rutas de metro y la inversión fue nacional, en el metro plus que es la tecnología de BRT, que también esta operada por metro, que es la de los buses de alguna manera de carril exclusivo, creo que el 70% fue de inversión nacional, los metro cables en el tema de la infraestructura creo que fue al revés, más o menos el 70 o 60% fue de inversión municipal y de la empresa metro, ósea, pero te estoy hablando en términos muy gruesos y posiblemente con imprecisiones, pero no es una sola ecuación que se da, sino que depende de los diferentes corredores y momentos del metro.

5. ¿Hay congestión vehicular en Medellín?

Respuesta: Hay congestión muy grande, como en muchas ciudades latinoamericanas, nosotros en 20 o 30 años no vamos a tener congestión, yo creo que en el mundo el tema de la movilidad va a migrar muchísimo, las tecnologías van a cambiar mucho, dijéramos el tema del carro compartido y una serie de temas distintos que se nos vienen, pero la pregunta no es que vamos a tener en 30 años, sino como aceleramos nosotros las soluciones para mejor.

a. De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?

Respuesta: Si hay una congestión muy crítica y yo creo que la razón para, dijéramos la estrategia para solucionarla tiene que ser, seguir apostándole a los sistemas de transporte público como los que estamos hablando, incrementando y haciendo unas redes mucho más completas, dijéramos más eficiente, pero tiene que ver también que con una mejor oferta exista una mayor regulación, y seguramente se requerirá de alguna manera cuando existan las ofertas con determinados corredores de la ciudad, exista de alguna manera también una regulación de cobro por servicio, dijéramos de usar unas tipo de corredores que le cuesta a uno dinero en relación con el vehículo particular y una serie de alternativas, yo por ejemplo, pero no es un ejemplo yo me muevo en bicicleta eléctrica pero yo usaba carro antes, pero a mí me queda relativamente muy fácil de aquí a mi casa, porque me voy por una serie de barrios que ni siquiera es un esfuerzo, las vías de Medellín, las avenidas principales para bicicleta, todavía siguen siendo muy peligrosas, pero hay unas rutas en mi caso por ejemplo, que es muy cómodo ir a mi casa, por rutas alternativas, cojo tramos de ciclo rutas, etc. Si uno logra realmente generar una alternativa de transporte, llamémoslo de más proximidad para quienes se mueven a su lugar de trabajo, que se tienen que mover, 1, 2 o 3 kilómetros, quiero decir, relativamente más cercanos, con alternativas distintas de movilidad, también de alguna manera se puede reducir una parte importante del tráfico, pero si hay hoy en día un problema estructural de movilidad en Medellín sin ninguna duda.

6. ¿Hay problemas con la calidad del aire en Medellín?

Respuesta: Hay problemas críticos con la calidad del aire, el factor mayor se deriva de la contaminación derivada dijéramos de la movilidad, entonces estamos como en un círculo que relaciona dijéramos todas estas dimensiones.

a. De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?

Respuesta: Para solucionar el problema de la calidad del aire, yo creo que hay que trabajar en múltiples estrategias, no es una sola, una tiene que ver con acelerar muchísimo más de alguna manera, la eficiencia en el manejo dijéramos de combustibles menos contaminantes en dijéramos a la transición de tecnologías más limpias desde el punto de vista de movilidad, no sé cuánto tardaremos para eso, pero en estrategias también de alguna manera del incremento en la eficiencia del transporte público, de migrar un porcentaje grande de la población a temas dijéramos de movilidad de transporte público más limpia, el manejo de horarios en relación con hacer mucho más eficiente y concentrar menos de alguna manera las actividades en las misma horas pico, en temas de empleo, educación, etc. Puede haber un tema de manejo de horarios en mejorar mucho los, de alguna manera los proyectos, nosotros lo llamamos de civilizar las calles en relación con que se siga incrementando mucho la transformación de los corredores viales, en corredores que tengan alternativas mejores para los peatones, en que se incremente mucho más la red de sistemas de ciclo rutas en ese sentido y también en facilitar la integración modal, por ejemplo, de estaciones de metro de transporte público a las cuales uno pueda llegar rápidamente desde su casa en bicicleta, dejar dijéramos el parqueadero de bicicleta, dijéramos lo que se llama Parkar Dray en relación con diferentes modos, incluyendo también los vehículos, por ejemplo, tú estabas mencionando ahora que hay un reto muy grande de pensar no en la movilidad del área metropolitana, sino ya en una movilidad que vincula, por ejemplo, el valle de San Nicolás o del Oriente y con el valle de Aburrá de Medellín, pues todavía no tenemos sistemas de transporte público, donde las personas que trabajen en Rionegro, o en alguna parte que necesiten bajar a Medellín puedan dejar su carro en alguna estación de transporte en la parte alta del valle de San Nicolás y tomen un sistema de transporte público hacia Medellín que lo vinculo, yo creo que hay una tarea grande en relación con los temas de transporte público, también con los temas de regulación.

PREGUNTAS DE ENTREVISTA

Entrevista No.: **5**
Fecha de Entrevista: **Miércoles, 9 de Octubre, 2019**
Hora de Entrevista: **2:00pm**
Nombre: **Roberto Bayardelle Morales**
Título: **Ingeniero Civil, Especialista en Gerencia de Proyectos y Gestión y Procesos Urbanos, Metro de Medellín**

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Biografía:

Profesional en Ingeniería civil de la Escuela de Ingeniería de Antioquia con especializaciones en Gerencia de Proyectos de la Universidad EAFIT y Gestión y Procesos Urbanos de la Escuela de Ingeniería de Antioquia. Tengo 26 años de experiencia y mi trabajo ha estado enfocado en la planificación, estudio, análisis e implementación de proyectos de obra civil y transporte. Mi función actual aquí en el metro de Medellín es en el área de ejecución proyectos, hace 5 años se creó esta área.

Participe como asesor técnico en los procesos litigiosos resultantes de la construcción del sistema Metro de Medellín. Participe como coordinador de los diseños y estructuración técnica y financiera del proyecto Extensión al sur del Metro de Medellín. Así mismo participe como coordinador de los diseños de detalle, estructuración técnica y financiera del Tranvía de Ayacucho e hice parte del equipo de implementación del proyecto como coordinador de infraestructura.

Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

   Respuesta: Es una pregunta bastante controversial, porque cuando se concibió el sistema, la ciudad era muy distinta a como es ahora, la conurbación era distinta y el tema de los usos del suelo y el tipo y función de la ciudad era distinta, nosotros pasamos durante la construcción del sistema metro, de ser una ciudad industrial a ser una ciudad de servicios y ahora somos una ciudad turística y eventos, hemos cambiado 3 veces de vocación en los últimos 30 años motivados también por el sistema de transporte.

a. Si tiene éxito, defina lo que cree que lo hace exitoso.

Respuesta: Entonces al inicio cuando éramos la ciudad industrial el sistema de transporte no encajo con la comodidad de la gente, nosotros teníamos una gran capacidad instalada, teníamos un uso de los primeros 5 años de 150 a 200 mil pasajeros y no fue sino hasta que se integró la ciudad a cambiar la vocación de ser industrial y la industria migro a otras zonas del departamento y de Colombia que el sistema empezó a servir y ser de uso general para el tema de servicios restaurantes, bancos, comercios todas las cosas, a partir de esto ya si se dio la explosión del sistema.

Hoy en día es un sistema muy exitoso para la ciudad, pero insuficiente.

b. ¿Cuál fue o será su participación?

Respuesta: Cuando yo llegue a la empresa a mí me toco llegar a la parte final de la construcción del sistema original, yo llegue a la empresa en el año 95, como contratista, antes de la inauguración del sistema que fue el 30 de noviembre del 95 y me toco en la participación de la recepción y en los problemas litigiosos de la construcción, me toco aprender mucho de eso. Ya posteriormente en la expansión del sistema trabaje en proyectos de extensión al sur, ayude a estructurar el proyecto tanto técnica como financieramente y el arranque la construcción, posteriormente participe en los proyectos del cable y a partir del año 2009 en el sistema de tranvía, desde la coordinación del diseño y la estructuración técnica, legal y financiera, y posteriormente en la construcción y puesta en marcha. Entonces digamos que en los sistemas complementarios o alimentadores mi participación ha sido muy activa.

2. ¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?

Respuesta: Medellín en este momento tiene un problema con los modos de transporte, en las horas picos y como la ciudad tiene un horario único para todos, escuelas al mismo tiempo, trabajo al mismo tiempo, comercio al mismo tiempo, las horas picos son insuficientes para todo el sistema de transporte, el sistema metro llega a una densidad de más de 7 o 8 pasajeros por metro cuadrado todos los sistemas de buses van llenos, las vías son imposibles. Entonces nosotros tenemos un problema en la hora pico de distribución de las cargas de transporte bastante complejo para resolver. Uno de los problemas grandes que tenemos es que la gente piensa que la infraestructura, por si sola, es la que debe resolver el problema, mientras que hay un tema también de educación, de cambios de horario

que nos podrían mejorar o mitigar ese tema, pero aquí la decisión política sobre esos temas no ha sido tomada.

a. ¿Cómo cree que se pueden resolver estos problemas?

Respuesta: Nosotros tenemos un sistema de transporte tipo espina de pescado, una troncal que es el sistema metro y un montón de alimentadores, ese sistema metro como troncal en el momento que tiene fallas, demoras o algún tema técnico hace colapsar la ciudad, el valle de Aburrá, es un valle estrecho, es un valle de casi 100 km de largo donde su parte más ancha tiene 20- 25 km de ancho y el resto ya son lugares muy accidentados de pendientes muy altas.

b. ¿Cómo cree que se puede mejorar el sistema de transporte?

Respuesta: Todos los diferentes modos de transporten confluyen hacia el metro o confluyen hacia las vías que están junto al rio, nosotros debemos crear una malla de transporte que recoja antes, en ambos costados del mismo, con sistemas de transporte masivos para tratar de bajar la carga y desestimular el uso de los vehículos particulares, es un tema que nosotros ya por movilidad individualidad, no lo logramos y tenemos que lograrla fomentando y colocando todavía más asequible el sistema de transporte masivo.

3. ¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?

Repuesta: Aquí tenemos dos componentes, efectivamente muchos de los sistemas de transportes son muy cotosos para la gente, casi que el traer el tiquete de sistema integrado de transporte de ida y vuelta es casi un 20%-25% del jornal diario de un colombiano, está en 35 mil pesos y eso se le vuelve casi en 5 mil pesos.

a. ¿Cómo haría que el sistema sea accesible para estas personas?

Respuesta: La solución que nosotros hemos encontrado aquí sin subsidiar la tarifa, ya que el sistema metro de Medellín no es subsidiado por el estado, la tarifa que tenemos, que tampoco es la técnica, pero es una tarifa que nos permite operar y dejar un pequeño remanente para ahorrar para los cambios tecnológicos y reposición de equipos. Lo único que podemos hacer es generar más integración con otros modos de transporte que se construyen financiados por la ciudad, a fondo perdido. La razón es muy sencilla entre más crezcamos en la ciudad, seremos más ineficientes como empresa porque perdemos capital de trabajo, perdemos EBITDA, perdemos unos temas financieros, pero para la comunidad es más

beneficioso montar en un sistema integrado de transporte que la movilidad individual. Medellín hay muchos lugares también, que así se tenga su recurso económico no tienes el acceso al sistema de transporte, entonces estamos trabajando también en aumentar la cobertura.

4. ¿El sistema paga por sí mismo?

Respuesta: El sistema tiene dos componentes, la construcción no se paga con la tarifa, esta es solamente la operación reposición de equipos, la tarifa técnica que se utiliza para establecer el costo del tiquete y como no somos subsidiados paga la operación del transporte y la recuperación de equipos.

a. ¿Cuáles son las fuentes de ingresos para los diversos sistemas?

Respuesta: La inversión inicial tiene otras fuentes de pago que son usualmente establecidas por el municipio que es el que utiliza estos recursos como fondo perdido, o sea nosotros separamos aquí el tema de la construcción y la implementación, se utiliza básicamente vías externalidades que financian su implementación y ya la operación ya se maneja con criterios financieros EBITDA, TIR y esos remanentes de la tarifa técnica son para pagar reposición de equipos y actualización tecnológicas.

5. ¿Hay congestión vehicular en Medellín?

Respuesta: Evidentemente Medellín tiene una congestión vehicular bastante notoria, nosotros tenemos un problema de motorización demasiado alto, ósea hay un vehículo automotor por cada 4 o 5 habitantes. Nosotros generamos aproximadamente 1.9 viajes al día cada persona entonces es una ciudad que se mueve mucho. Esos resultados nos dan con los estudios de encuesta origen – destino, o sea aquí utilizamos un software que se llama EMME-2 para la modelación del transporte, entonces esa modelación nos dice que las personas se mueven, una familia son 3.7 personas con 1,9 viajes al día, para moverse en los diferentes modos de transporte.

a. De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?

Respuesta: Somos una ciudad con un desequilibrio económico muy alto, nosotros tenemos una clase alta que relativamente numerosa con bastante poder adquisitivo, entonces todas las medidas de control vehicular como pico y placa, restricciones, se resuelven con otro vehículo, otro tema es el

área del vehículo, nosotros, Medellín hacia los años 70 todavía era una ciudad europea y en los años 70 migramos a hacer una ciudad norteamericana, entonces nosotros dejamos de tener los vehículos europeos que son más pequeños y los japoneses, a tener las grandes camionetas para uno o solo dos personas, con el agravante que como Medellín hay tacos o trancones, los vehículos ya de fábrica vienen con el equipo suficiente, equipo de sonido, aire acondicionado, sillas, y todas las cosas para poder soportar el taco. Entonces el tema no nos ayuda a estimular el uso del vehículo público. Otro de los problemas grandes que tenemos es que como somos una ciudad con bastantes niveles geográficos, o sea, la gente que vive en la parte plana de la ciudad es muy poquita porque ahí se concentró la industria y el comercio, entonces la gente vive en las partes altas de la montaña, entonces caminar o utilizar bicicleta u otros medios de transporte es bastante complicado, más el nivel de lluvia, nosotros tenemos más de 270 días de lluvia al año, entonces la gente opta por otros tipos de movilidad.

Como te dije, la mejor manera de resolver esto es, generando sistemas de transporte masivos de mediana capacidad paralelos a la troncal del rio Medellín, o sea sistemas transversales en la montaña que corten todos los alimentadores que tenemos, que van de oriente a occidente, vayan de norte a sur cada costado del rio y eso ayuda a generar una malla de transporte a la cual la gente entenderá que es más fácil hacer esto que moverse de otra manera. Otro componente es que las zonas de parqueo aquí no son tan costosas como en otros lados del mundo, entonces no desestimula, todo lo contrario, la gente estimula el uso del vehículo porque tienes donde dejarlo, entonces no es una medida disuasoria los sitios de parqueo no son operados por el estado, con una tarifa de un dólar la hora, si alguien tiene con qué pagar el whisky tiene para el hielo, así le decimos aquí en Colombia, entonces no es un tema restrictivo como lo he visto en otras ciudades como Toronto , como New york, como Washington, que las zonas de parqueo en las ciudades partes centrales es costoso. Otro que ayudaría mucho es declarar unas ciertas partes de la ciudad como zonas libres de vehículos, hay ciertos lugares que son de nivel comercial, turístico o laboral que podrían generarse como distritos peatonales, en el momento que generemos eso y mostremos la inutilidad de llegar en un vehículo particular a esos lugares, llámese carro o moto, la gente la cogestión va a disminuir porque esos son centros atractores de viajes.

6. ¿Hay problemas con la calidad del aire en Medellín?

Respuesta: Evidentemente hay un problema de contaminación en Medellín, pero está asociado básicamente a partículas menores de 2.5 micras a óxido de nitrógeno y a otros elementos de materiales particulados, aquí no tenemos tanto problema de CO2 u otros gases, como en otros lados del mundo, este fenómeno nos ocurre se conjuga por la quema de combustibles fósiles tanto para la cocina, porque aquí se cocina básicamente con gas natural, como para vehículos; y ayuda que estamos en un valle estrecho con altos desniveles, el valle, la cota está a 1450 para Medellín y la cota de las montañas esta 2500-2600 metros; el fenómeno atmosférico que ocurre, en los meses de marzo y de octubre principalmente, los vientos alisios dejan de soplar y no se llevan la contaminación, entonces efectivamente se sigue produciendo la contaminación, ella no alcanza a escapar del valle y se recircula, porque esas son las épocas de lluvia del valle de Aburrá, entonces nosotros empezamos a generar esas partículas menores a 2.5 micras y no son capaces de elevarse lo suficiente para que sean arrastradas por el viento y queda en el valle aumentando la concentración de estas. Las medidas que tomaron en esta administración, la última porque esto es un fenómeno que se conoce en la ciudad desde hace unos 20 años, pero solamente esta última administración tomo medidas de generar un pico y placa ambiental, una restricción vehicular bastante exigente, con los vehículos antiguos y otros vehículos, como camiones en ciertas horas, pues ayuda a mitigar el impacto, pero realmente el problema va es por el masivo uso de combustible fósil que tenemos en la ciudad. Colombia tiene un problema con el diésel, nosotros no tenemos un diésel de buena calidad, nosotros tenemos un diésel con bastante componente de azufre, nosotros no tenemos combustible de euro 5, euro 6 que podría ayudar con el tema, con la complicación de que el combustible diésel es muchísimo más barato en Colombia, que las gasolinas corriente o extra, entonces aquí tener un vehículo grande e ineficiente, bus diésel, económicamente es más rentable que tener un bus a gasolina o un camión a gasolina, entonces esa combinación de costos, más vehículos viejos, más la necesidad de moverse en la ciudad en vehículos con combustibles que no están adaptados para una ciudad de este tipo genera muchos problemas. Adicionalmente Medellín como les dije antes está en una cuota muy alta a 1450 en promedio, entonces hace también que los motores de combustión interna tampoco sean tan eficientes como los que están a nivel del mar, emitiendo más partículas que las que emitirían si estuvieran a nivel del mar, es un tema de sustitución de vehículos más que de colocar restricción de su movilidad.

   a. **De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?**

Respuesta: Vuelvo y repito si nosotros hacemos una malla de transporte entonces desestimulamos el uso del vehículo, no solamente podríamos generar zonas de no vehículos, sino también zonas de no vehículos de combustión interna, esta ciudad ya tienen muchísimos vehículos eléctricos, esta ciudad ha ido creciendo exponencialmente su uso y hay muchas clases vehículos eléctricos, de todo tipo, hay tipo cuatriciclos como los Twizy, pero también hay vehículos grandes como los BMW, el i3, el Nissan Leaf, el Renault ZOE, porque nosotros tenemos para el tema de los vehículos, una gran influencia europea, tenemos una planta de ensamblaje de vehículos acá que es de Renault, y los concesionarios están acostumbrados a lidiar con las tecnologías europeas y obviamente pues con Ford, Chrysler, mucho pero aquí la gente le gusta mucho el carro europeo. hay una medida también que es muy particular y es que deberían de obligar a que el sistema de transporte público, un porcentaje de la flota ya sea privada o pública, fuera eléctrica, eso ayudaría mucho al tema de la contaminación.

PREGUNTAS DE ENTREVISTA

Entrevista No.: **6**
Fecha de Entrevista: **Sábado, 12 de Octubre, 2019**
Hora de Entrevista: **10:30am**
Nombre: **Javier Enrique Rivero Jerez**
Título: **Coordinador de Ingeniería Urbana**
Facultad de Ingeniería, Universidad de Antioquia
Dirección: **U. de Antioquia, Seccional Oriente, Oficina 5-103**
Sede Principal: Calle 67 # 53-108, Medellín, Colombia
Teléfono: **57 (4) 219.8332 ext. 2916**
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Autorización para usar su nombre: Si

Biografia:

Mi nombre es Javier Enrique Rivero Jerez, me desempeño como coordinador del programa de ingeniería urbana de la Universidad de Antioquia, también imparto clases en la facultad de ingeniería en el pregrado de ingeniería civil con el curso de construcción y particularmente en el programa de ingeniería urbana imparto los cursos de accesibilidad, movilidad, planificación y diseño de ciudades. En cuanto a mi formación académica, he cursado un pregrado en arquitectura en Colombia, un pregrado en arquitectura superior en España, después lleve a cabo una especialización en diseño y composición, una especialización en sostenibilidad y eficiencia energética, un postgrado en accesibilidad, un master en urbanismo, un master en gestión de la construcción, un master en ingeniería ambiental, un doctorado en arquitectura y arte con énfasis en urbanismo y ahora estoy cursando una maestría de diseño de interiores y arquitectura.

Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

Respuesta: Particularmente con el sistema de transporte, hablando en este caso del metro de Medellín que es el que yo creo que ha tenido más éxito, desde mi punto de vista he considerado que ha sido el primer atractor que transformo la ciudad. Como bien sabemos Medellín fue una de las ciudades más violentas, teníamos alrededor de mil homicidios en los años 90s, estamos hablando de la época de Escobar, en ese sentido, las estrategias de Salazar y Fajardo definieron tener presente aquellos asentamientos irregulares que habían en la ciudad y de

cierta forma crear un sistema de transporte que pudiera regularizar esos asentamientos informales y digámoslo así, conectar la ciudad a diferentes escalas, ahí fue cuando se implementó el sistema metro.

a. Si tiene éxito, defina lo que cree que lo hace exitoso.

Respuesta: El sistema metro desde mi punto de vista, tuvo un éxito debido a que hubo una implicación de la sociedad desde tres puntos o tres factores, primero desde la planificación, después desde la construcción y después desde la gestión, es decir, la gente que estaba en esos lugares se vio involucrada en el proyecto y como tal genero un sentido de pertenencia o lo que llamamos la cultura metro en Medellín, el diseño del metro como usted bien sabe se evoca alrededor de todo el rio Medellín, aprovecho la topografía de la ciudad y tiene una transversal justo en la estación de San Antonio, que sube a la comuna 13, en ese caso el sistema de transporte no solamente tuvo su beneficio en cuanto al tránsito rápido de los usuarios, sino que también se interconecto con ciertos puntos en la ciudad que eran neurálgicos, puntos en este caso donde había mucha violencia, la estrategia de Fajardo y Salazar en su momento fue, sobre todo la de Fajardo "Medellín la más educada" para eso el creo puntos estratégicos, en este caso con instituciones educativas y con bibliotecas para reestablecer un tipo de orden en esos nodos que eran neurálgicos en la ciudad y los conecto en este caso con otro sistema de transporte que fue el metro cable, entonces el metro se vio muy fortalecido con el metro cable y con esos puntos de actuación, a forma de acupuntura urbana en esos sitios neurálgicos en la ciudad.

b. ¿Cuál fue o será su participación?

Respuesta: Nosotros ahora mismo desde el programa de ingeniería urbana lo que estamos tratando de establecer, son iniciativas de intermodalidad con el sistema de transporte que ha tenido en este caso mayor beneficio para la sociedad, que ha sido el metro, entonces es implementar en las estaciones del metro, sistemas de intermodalidad que puedan hacer más eficiente en este caso el sistema de transporte inicial, como estacionamientos de vehículos privados, la vinculación de los carriles bicicleta y estacionamiento de bicicleta y también en este caso los alimentadores que funcionan con el metro reacondicionarlos para que sean más eficientes y cómodos.

2. ¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?

Respuesta: En cuanto al transporte, eso también está relacionado con la calidad del aire, la contaminación, digámoslo así, el problema más grande que está teniendo ahora el principal sistema de transporte que es el metro, es el colapso de la capacidad, si bien se han comprado varios vagones en el sistema para aumentar la capacidad del metro, se están teniendo problemas en este caso de los flujos, no dan abasto, coger el metro a las 7 de la mañana es un caos, ósea está pasando igual que como pasa en Tokio, la capacidad o la demanda ya superan en este caso al sistema como tal, ese es uno de los problemas más graves que está teniendo el metro, porque el metro si se hace necesario para la gente y es muy accesible pero el problema es que la capacidad si se está llegando a un límite, no sé si abra que llegar a un punto que como solución de ya implementar más líneas en el metro, de pronto esa sería otra opción u otro sistema de transporte, pero mira que se han implementado por ejemplo el tranvía, metro cable, pero todo conectan es al metro, el metro es la arteria principal y si colapsa la arteria principal, las otras van a colapsar tarde o temprano también, porque claro llega el flujo pero hay si queda.

a. ¿Cómo cree que se pueden resolver estos problemas?

Respuesta: Entonces yo creo que una de las posibilidades es implementar de pronto otros ramales ya del metro, yo creo que ya es necesario empezar a diseñar otras ramales del metro.

b. ¿Cómo cree que se puede mejorar el sistema de transporte?

Respuesta: Yo creo que la intermodalidad sería algo muy interesante, porque la intermodalidad va a permitir que la gente no solamente se limite a usar el metro, sino que pueda utilizar otros sistemas de transporte, de pronto incluso más sostenibles como la bicicleta, ahora si hay que tener en cuenta que la bicicleta en Medellín por su topografía es muy complicada porque hay pendientes muy abruptas, entonces hay de pronto nos tendríamos que ir a bicicletas asistidas en este caso.

3. ¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?

Repuesta: Por lo general en Medellín esto es muy accesible a ellos se les dan ciertas prioridades, incluso tienen descuentos cuando son personas de estratos bajos, en Colombia tenemos una clasificación por los estratos, los estratos es una clasificación que se ha hecho socioeconómica de la gente desde las empresas públicas, alrededor de unos 40 años donde digámoslo así se ha sectorizado la ciudad teniendo en cuenta el poder adquisitivo de las personas y con eso se les cobran los servicios públicos, en ese sentido con esa segregación se ha tenido

presente para las personas de estratos bajos 1, 2 y 3 unos subsidios para el transporte, a ellos se les cobra más barato.

a. ¿Cómo haría que el sistema sea accesible para estas personas?
Respuesta: Yo creo que una de las iniciativas que nosotros habíamos planteado es que cuando la persona utilice un sistema de transporte sostenible como la bicicleta, se le permita acceder al metro también, lo que pasa es que, como usted bien sabe las zonas más pobres de Medellín están en los lugares más malos, porque claro, lo asentamientos informales se hacen en las zonzas que no son habitables, en zonas con demasiada pendiente, o al lado de quebradas, esas zonas por lo general están muy asiladas del metro, porque el metro está en la parte llana de la ciudad, que es en el valle, entonces una de las cosas que nosotros estábamos pensando es hasta qué punto si les motivamos a esas personas a utilizar sistemas de transporte sostenibles como la bicicleta, que se les pueda dar una prioridad para que puedan acceder al sistema de transporte de forma gratuita, eso sería incentivar un medio de transporte sostenible dándoles acceso gratis a otro sistema de transporte en este caso masivo. Como seria, por ejemplo, nosotros estábamos pensando en que el metro cable que son las cabinas, habilitarle un comportamiento donde ellos pudieran colocar su bicicleta y llevarla al metro y así volver a su sitio de trabajo, utilizar la bicicleta y volver a recoger su bicicleta y llevarla o la otra opción es llegar y dejar unos estacionamientos en este caso en el metro cable, dejar en estacionamiento la bicicleta, que la persona por utilizar la bicicleta se le dé un acceso gratis y que utilice el metro cable para llegar al metro, es que son varias dinámicas las que tocan tener presentes.

4. ¿El sistema paga por sí mismo?
Respuesta: Que yo tenga entendido tiene un subsidio en este caso de la gobernación de Antioquia que le ayuda bastante y la recurrencia de los usuarios si hace que el sistema sea eficiente desde el punto de vista económico.

a. ¿Cuáles son las fuentes de ingresos para los diversos sistemas?
Respuesta: Particularmente el metro se subsidia con un aporte en este caso de la gobernación que yo tenga entendido y sobre todo con la compra de los tiquetes de los usuarios, hay que ver que el metro se utiliza por lo general con personas de estrato 1 hasta 4, también hay personas de estrato 5 pero la mayor recurrencia es de las personas de estrato 3 y el valor de tiquete si es accesible, ósea desde el punto de vista económico vale casi igual que un bus, que un tiquete de bus y como le comentaba la demanda

que tiene el metro lo hace eficiente a tal punto que se puede mantener el mismo.

5. ¿Hay congestión vehicular en Medellín?

Respuesta: ¿Desde el punto de vista de transporte público o privado? - Privado: La congestión si suele haberla, en Medellín hay mucha congestión vehicular, pero particularmente en las arterias principales, estamos hablando de la Regional, de la 33, de la Oriental y claro está la avenida al Poblado

a. De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?

Respuesta: Yo creo que una de las formas para solucionar es reevaluando el estado de esas vías y el uso de las vías, también tenemos otro problema en Colombia, y eso hay que ser claros, es el tema de la cultura al conducir, nosotros tenemos mucho problema, digámoslo así en evaluarnos al recibir la licencia de conducción, o la licencia en este caso para conducir un vehículo, en cuanto a los requisitos que se deberían de exigir como en otros países desde el punto de vista del conocimiento de manejo del vehículo y de las normas de tránsito, entonces claro usted ve que a veces los flujos no funcionan muy bien, o las vías no funcionan muy bien porque la gente en vez de pronto de ir adelantando por la izquierda, va por la derecha, no sé si usted lo ha visto, o aparcan en las zonas que no es, incluso el sistema de transporte público también pasa eso, no tenemos digámoslo así, organizado de una forma eficiente el uso de las vías, yo creo que eso también se podría reevaluar para mejorar el sistema de transporte acá en Colombia.

6. ¿Hay problemas con la calidad del aire en Medellín?

Respuesta: Si ahora mismo hay problemas, incluso hoy estamos en pico y placa, el pico y placa ambiental le llaman, porque supuestamente este pico y placa se proyectó porque durante el mes de octubre, incluso sin indicadores ya se sabe que va haber contaminación, pero meses antes ya se ha tomado la decisión de pico y placa ambiental como se le suele llamar, que restringe el uso de vehículos en este caso dependiendo del número de la placa, debido a factores contaminantes que se han percibido en el aire, a los indicadores.

a. De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?

Respuesta: Entonces lo que se hace es tomar medidas en este caso, momentáneas, limitando el flujo de los vehículos, pero claro como yo le comentaba, esto se ha desarrollado mucho en Medellín, en parte a la

localización de la zona industrial de la ciudad que suele ser en el norte y la misma topografía de la ciudad que es un valle, entonces lo que hace es que la contaminación que se genera en el norte de la ciudad, los vientos acá se encausan desde el norte, pues va en este caso transportando todas esas partículas durante el transcurso del valle y después en la zona del poblado que es donde tiene quiebres topográficamente pues se encauza todavía más, entonces la ciudad topográficamente, digámoslo así, es complicada en cuanto a las contaminación por el valle, en este caso por la configuración topográfica, y fuera de eso la localización de ciertas industrias está perjudicando todavía más. Entonces como se podría mejorar, primero trabajando con esas industrias a ver si se puede relocalizar de pronto en otras zonas que no sean contaminantes, por ejemplo, en el sur, en la parte de Bello, de Sabaneta, de tal forma de que todas esas contaminaciones pues no pasen por todo, en este caso el valle de Aburrá, sino que estén localizadas en otras zonas, lo otro seria trabajar con esas empresas a ver hasta qué punto se está haciendo un control de emisiones, porque acá no hay control de emisiones, ni de partículas, lo que se controla es que hay contaminación , pero hasta qué punto se está llegando ese control en las empresas, y lo otro también es el control de emisiones en los sistemas de transporte, no sé si usted ha visto aquel bus que va con aquel humo negro, que se ven que son partículas que está emitiendo, y que una de las soluciones seria controlar esos vehículos o lo otro, implementar otros tipos de vehículos con otras energías, por ejemplo, con gas o eléctricos, sería otra opción. Ahora, independientemente de las dos opciones, si sería bueno reevaluar hasta qué punto en Colombia tenemos presente la vida útil de un vehículo, no sé si usted se ha dado cuenta que, en otros países, por ejemplo, a los 10 años de un vehículo el gobierno le da un subsidio a usted para cambiarlo, porque define que el vehículo ya empieza a generar más contaminación, incluso la tecnología va en contra de esto, entonces hasta qué punto en Colombia estamos teniendo en cuenta también la vida útil de un vehículo, porque usted puede encontrarse acá perfectamente con un vehículo de 20 años, 22 años, entonces claro esos vehículos fueron diseñados en su momento y emiten ciertas emisiones en este caso.

PREGUNTAS DE ENTREVISTA

Entrevista No.: **7**
Fecha de Entrevista: **Martes, 15 de Octubre, 2019**
Hora de Entrevista: **2:00pm**
Nombre: **Iván Sarmiento Ordosgoitia, Ph.D.**
Título: **Profesor Titular – Departamento de Ingeniería Civil**
Facultad de Ingeniería, Universidad Nacional Colombia

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Autorización para usar su nombre: Si

Biografía:

Mi empresa se llama la Universidad Nacional de Colombia sede Medellín. Hay varios campus o sedes en Colombia, yo trabajo en el de Medellín. Mi función en la universidad es la de profesor titular, que es la máxima categoría que se alcanza acá en la universidad. Estoy a cargo del curso de Transporte urbano para la carrera de ingeniería civil y también imparto cursos en el posgrado, lo que son los programas de especialización en vías y transporte, maestría en infraestructura y sistemas de transporte y el doctorado de ingeniería civil en la línea de transporte. Las asignaturas para los de posgrado son Economía y evaluación de proyectos de transporte o modelos de demanda de transporte. También he estado involucrado en el planeamiento del transporte en la ciudad a través de proyectos de consultoría que la universidad realiza para instituciones públicas, como el municipio de Medellín y el Área metropolitana del valle de Aburrá, que es el área metropolitana de la ciudad de Medellín.

Preguntas:

1. **¿Cómo se implementó el sistema de transporte de Medellín y cree que su implementación ha sido exitosa?**

Respuesta: El sistema de Medellín tiene una historia desde principios del siglo 20, hace un siglo, y una historia reciente. Aquel primer sistema contó con un ferrocarril de Antioquia que conectaba a la pequeña ciudad de menos de cien mil habitantes con la región y el país, y se tuvo un tranvía eléctrico de casi 70 km (45 km de tranvía y otros de buses eléctricos) que recorría sus principales barrios. Esos sistemas entraron en desuso y se desmontaron, siendo remplazados por rutas

de bus a mediados del siglo 20. La historia reciente inició hace casi 25 años cuando se inauguró el Metro (1995) y allí empezó la transformación hasta hoy.

a. Si tiene éxito, defina lo que cree que lo hace exitoso.

Respuesta: Su implementación ha sido exitosa porque el sistema (Metro+BRT+tranvía+cables) moviliza casi un millón de pasajeros, un 40% de los más de 2,3 millones de pasajeros de transporte público en la región metropolitana. Ha sido exitosa porque ha aumentado la apropiación de los ciudadanos sobre su ciudad con grandes beneficios en evitar accidentes y contaminación, además de los ahorros de tiempo.

b. ¿Cuál fue o será su participación?

Respuesta: Mi participación ha sido de asesor desde la Universidad Nacional para el Área Metropolitana del Valle de Aburrá en el primer plan Maestro de esta entidad en 2004/2006, la realización de las encuestas de movilidad de la región en 2006, 2012 y en la supervisión de la encuesta del 2017. Además, se participó en la supervisión del estudio de reestructuración de rutas de bus para la implantación del BRT (Metroplús) en 2009, y con el municipio de Medellín se realizó el estudio de restructuración de rutas de Buses en 2013-2015. Finalmente se realizó el plan integral de movilidad para Medellín, en cuanto al diagnóstico y formulación del transporte público entre 2017 y 2018. También se ha participado en estudios que han dado luces en materia de gestión del tráfico (2011) o de dotación de flotas de taxis o de buses (2006-2009).

2. ¿Cuáles son los problemas de transporte más urgentes que enfrenta Medellín en este momento?

Respuesta: Los problemas urgentes que enfrenta Medellín son la contaminación que ocasiona unas mil muertes prematuras, la accidentalidad con 220 muertes prematuras, y la congestión que hace perder tiempo (dinero) a la economía.

El primer problema que es la contaminación está identificado que es más por las emisiones del transporte (en un 80%, sobre todo el de las partículas PM2.5), siendo el transporte de carga el de mayores emisiones, seguido de los buses, las motos y finalmente los autos y taxis. La solución pasa por una política fuerte para lograr la renovación de los vehículos de carga de mayor edad. Se cree que remplazando un 10% de éstos se reduciría en un 50% la contaminación por partículas. Hay otras medidas que le suman a la solución como la introducción de buses y taxis eléctricos, pero la solución es aún lenta.

El segundo problema que es la accidentalidad se soluciona con una mayor educación vial tanto reeducando a los conductores actuales como con un mayor control para que se cumpla con una buena educación vial para las nuevas generaciones. Se debería hacer esfuerzos porque en el país se establezca la licencia de conducir por puntos, como existe en Europa. Otro elemento importante es reducir la velocidad máxima en la ciudad por lo menos a 55 km/h en vez de 60 km/h. Esa reducción de casi un 10%, podría lograr reducciones en muertos de por lo menos un 30%, lo cual sumado a la educación mencionada y a un mayor control con tecnología podría llegar a la meta de reducción de un 50%, que, aunque aún no está cerca de la Visión Cero, sería un gran avance en esa dirección.

El tercer problema que es el del tiempo es también difícil de resolver, pero es menos importante que los dos anteriores, a pesar de que ocasiona la pérdida de competitividad de la ciudad. Los 1,5 millones de viajes a pie al día y el millón de viajes en el SITVA (Sistema Integrado de Transporte masivo del Valle de Aburrá) tienen un tiempo casi garantizado (digo casi, porque algunos viajes en Metro tienen una parte en modos alimentadores que sufren congestión). Estos dos modos suman casi 2,5 millones de viajes diarios, o 40% de los 6.3 millones de viajes del área metropolitana. Los restantes están más expuestos a la congestión. Para que los 1.3 millones de viajes (20%) en bus del Área metropolitana (AMVA) mejoren sus tiempos hay que construir en algunos corredores y en algunos tramos donde hay más disponibilidad de espacio, carriles exclusivos izquierdos para buses de puerta izquierda. Eso podría reducir los tiempos por lo menos a la mitad de esos usuarios. Entonces, se puede decir, que con esos carriles y con el SITVA y los de a pie, se podría estar librando de la congestión a casi el 50% de los viajes. El resto del tráfico, es decir, los taxis, los autos, las motos, los vehículos de carga, y vehículos especiales (escolares, de servicio), etc. que son el otro 50% están condenados a la congestión, a menos que se impongan medidas de restricción al vehículo particular sea encareciendo los costos de los parqueaderos en el centro de la ciudad y en la milla de oro (en el Poblado) y que en paralelo se apliquen incentivos para que haya cierta parte de la distribución de mercancías en horarios no convencionales (horarios nocturnos o de madrugada), a parte de otras medidas logísticas como la construcción de bahías y la regulación de los tiempos de cargue y descargue.

a. ¿Cómo cree que se pueden resolver estos problemas?

Respuesta: (Se respondió en cada uno de los problemas en pregunta 2)

b. ¿Cómo cree que se puede mejorar el sistema de transporte?

Respuesta: El sistema de transporte se puede mejorar haciendo nuevas líneas de transporte público y rutas de servicio que conecten de forma cruzada los lugares distantes norte-sur y noroccidente-suroriente. Además, estudiar cómo financiar un sistema de transporte totalmente integrado y en el cual a los más pobres se les den reducciones de tarifa, para lo cual debería comprometerse no sólo los recaudos de alguna sobre tasa a parqueaderos o a zonas congestionadas, o contaminadas, sino también el compromiso de las empresas del sector privado. Además, el sistema de transporte mejoraría reduciendo la accidentalidad, ya que cada accidente es un generador de pérdida de tiempo para el cumplimiento de las programaciones de las rutas de transporte público.

3. ¿Hay pobres urbanos que no pueden pagar para usar el sistema de transporte?

Repuesta: Sí, hay pobres en la zona urbana que se les hace difícil pagar el sistema de transporte, y es por ello que muchos caminan y otros compran la motocicleta que a la larga resulta más económica para ellos en tiempo y dinero.

a. ¿Cómo haría que el sistema sea accesible para estas personas?

Respuesta: Para que el sistema sea accesible para ellos debe reducir la tarifa con algún subsidio para estas personas como se mencionó en las medidas de mejoramiento mencionadas en la pregunta anterior.

4. ¿El sistema paga por sí mismo?

Respuesta: Actualmente, el sistema se paga por sí mismo, excepto el BRT que recibe un subsidio a la operación de parte del municipio de unos 10 Millones de dólares por año.

a. ¿Cuáles son las fuentes de ingresos para los diversos sistemas?

Respuesta: El resto del sistema se auto sostiene en su operación, pero se requiere lograr una financiación extra para dos propósitos: primero, el de reducir la tarifa para los más pobres, y segundo para que exista una tarifa integrada única en la que las personas puedan realizar uno o más transbordos entre todos los sistemas sin tener que volver a pagar, y de esa forma atraer a las nuevas generaciones para que no sigan optando por la motocicleta.

5. ¿Hay congestión vehicular en Medellín?

Respuesta: Sí existe congestión, y aunque ya comenté el problema y su solución, es importante hablar de las fuentes. La congestión es inherente a todo sistema que empieza a funcionar a tope, lo cual no es del todo negativo, ya que la infraestructura se está usando al máximo de su potencial. Sin embargo, hay frustración cuando las expectativas de productividad no se cumplen para cierto crecimiento económico, y es por eso necesario hacer algunas intervenciones. Lo primero es separar los flujos más eficientes. Esto ya se ha hecho y se viene haciendo con los peatones mediante la mejora de los andenes, también con los grandes flujos que se mueven por el transporte masivo (Metro, BRT) y sus sistemas asociados (tranvía, cables). Luego se viene haciendo con los ciclistas, pero también hay que hacerlo con los buses en los principales corredores, como se dijo antes.

a. De ser así, ¿cuáles son las fuentes de congestión y como resolverías este problema?

Respuesta: Las fuentes de congestión son diversas, una es el patrón de movilidad, el cual en cuanto a orígenes-destinos es difícil de cambiar, pero a largo plazo se debe tratar de ir construyendo una ciudad más compacta. Una segunda causa es el mal uso de los espacios en las vías, los cuales son utilizados muchas veces para el estacionamiento en vía, por lo que promover la construcción de parqueaderos y ajustar los precios de estos para desincentivar el uso del auto es importante para controlar el uso del mismo. Una tercera causa son los accidentes y el tiempo que se tarda en despejar cada uno de ellos. En Medellín ocurren unos 44 mil accidentes anuales, y en el 50% de los cuales hay lesionados.

Las soluciones a la congestión ya fueron comentadas y se resumen en darle más velocidad comercial al transporte público en buses, un sistema tarifario único, regulación del cargue y descargue y promover la distribución nocturna, reducir la velocidad máxima en la ciudad para que se reduzcan los accidentes y así ahorrar tiempo a todos.

6. ¿Hay problemas con la calidad del aire en Medellín?

Respuesta: Si.

a. De ser así, ¿cuál cree que es la causa de estos problemas y cómo propones resolver este problema?

Respuesta: Ya se respondió en la segunda pregunta que era el principal problema a resolver en este momento. Y se plantearon algunas soluciones.

Audio comentario adicional: El área metropolitana del valle de Aburrá emitió una resolución que es de obligatorio cumplimiento para las empresas de más de 200 trabajadores, o empleados, y es que tienen que hacer un plan empresarial o un plan estratégico de movilidad sostenible, se llama PEMS por sus siglas en español (Planes Empresariales de Movilidad Sostenible), entonces estos PEMS buscan reducir la huella de carbono de CO2 en un 10% en el primer año. Las empresas tienen que hacer una encuesta entre sus trabajadores para saber cómo viajan diariamente hasta la empresa y con base en esa encuesta, proponer unas estrategias para reducir la huella de carbono de la empresa, buscando que los trabajadores usen vehículo compartido, bicicleta, transporte público o un bus diseñado para los trabajadores de la empresa, etc. A octubre de 2019, de aproximadamente 1.000 empresas que tenían que cumplir con este requisito, hay cerca de 350 que han presentado su plan de movilidad sostenible y el área metropolitana se encarga de revisar esos planes y de hacerle visita a las empresas para ver cómo van con sus proyectos, con sus iniciativas, con sus cambios en la movilidad de sus trabajadores, entonces esto es una buena iniciativa que busca y está orientada en reducir viajes o en cambiar modalidades de viaje desde las empresas. En Medellín el 30% de las personas no realizan viajes en un día promedio laboral según las encuestas de movilidad realizada desde el año 2000 hasta el 2017. Se han hecho 4 grandes encuestas de más de 15.000 a 20.000 hogares encuestados y siempre la constante es esa, 30% de las personas no viajan. No quiere decir eso que sean las mismas personas todos los días, sino que pueden ser personas que un día estuvieron enfermas, un día tuvieron un día libre y estuvieron en la casa o estaban de vacaciones y no salieron ese día, o son amas de casa que un día determinado no tuvieron la necesidad de salir de la casa, a veces son personas enfermas, otra veces son personas en condición de discapacidad que en esos casos si son más frecuentes que no viajen. Sobre todo en nuestra ciudad que tiene muchas barreras arquitectónicas o dificultades para la movilidad accesible. También hay ancianos, algunos jubilados que tienen a lo mejor pocos ingresos o que no alcanzaron a recibir pensión de jubilación y otras personas que pues a lo mejor por sus condiciones socioeconómicas o por la pobreza no tuvieron dinero para movilizarse o no tenían nada que ir a hacer, o no tenían dinero para gastar a donde iban, entonces más bien prefirieron quedarse en casa. En resumen, por todas estas razones es un porcentaje que es alto, que en Bogotá es el 15%, en New York vimos una encuesta que es del 15% y en Londres sorprendentemente es un poquito más alto es el 20% por lo costoso del transporte, pero Medellín sigue siendo alto un 30% de personas que no viajan, lo cual es preocupante socialmente hablando.

El siguiente extracto es de un correo electrónico del 20 de abril de 2020 del Profesor Sarmiento que aclara la metodología de MCV utilizada: "…MCV encuesta a los que más viajan porque trata de que el que pase al teléfono sea el cabeza del hogar,".

APPENDIX 'E' – SWOT Analysis

The following analysis is from personal observation and from discussions in Medellín with academics and planning officials and underscores some of the strengths, weaknesses, opportunities and threats in regards to the current Medellín transportation model:

STRENGTHS	WEAKNESSES
Multi-modal transportation solutions have been implemented in the City which includes light rail, cable cars, segregated busways, a streetcar line, electric escalators, bikeways and shared bicycle rental facilities.	The population growth of the City has taxed the capacity of the public mass transportation systems. Light rail, cable cars and the rapid bus systems can be packed during rush hour with long delays.
The transportation system is designed to serve the poorest areas of the City and provides these residents with needed mobility.	Residents of the higher income areas like El Poblado and Laureles generally do not use transit but commute by car instead which adds to congestion.
The transportation system is affordable for the majority.	Urban renewal has displaced people from some poor neighborhoods near the city center to subsidized housing at end of cable car lines with the effect that their limited income makes them unable to afford transportation costs on the cable cars.
The city's high density makes rapid transit economically viable.	Rapid transit ('Metroplús') bus lanes at street level separates neighborhoods.
Key role of government and strong partnership with business and civil communities.	'Pico y Placa' has the effect of having many of the wealthier citizens buying second cars.

OPPORTUNITIES	THREATS
The high density and compactness of the city will allow for the potential of high levels of ridership as multi-modal transportation solutions continue to be developed.	Increased road congestion due to population growth and increase in automobile and motorcycle vehicle ownership.
Solutions based on new technology and to add capacity to existing systems.	Growth of motorcycle ownership as a source of noise and toxic emissions
Shared car or bus options to entice higher income individuals to use mass transit.	Air quality can rise to dangerous levels at certain times of the year. This has required the city at times to curtail vehicle use.
Feeder and rapid bus lines to convert to electric buses.	Long waiting times for Metro with waits as long as 2 or 3 trains during rush hour.
Metro to convert to an automated system with shorter duration of spacing between trains.	Long waiting times for transfers during rush hour.
City center congestion pricing for cars to reduce congestion. Increase in parking fees	Prevent construction of informal settlements high on the hillsides.

APPENDIX 'F' – Ethical Statements

Ethical Considerations: This study intends to protect the confidentiality, anonymity and physical well-being of the participants. The ethical considerations (standards) to be considered for this research are designed to formulate an environment of trust, mutual respect and accountability. The research proposal will initially be presented to the Institutional Review board (IRB) at the University of Texas in Arlington to assure that ethical practices are being utilized. The ethical considerations that will be addressed include:

- ***Proper identification***: Provide details of who I am and what I am doing.
- ***Clear information:*** Provide details as to the type of questions I will be asking and if the participant perceives any of these questions to be sensitive or awkward for him/her to answer.
- ***Concern:*** Be cognizant of the welfare of the participant, e.g. have regard for any potentially embarrassing questions or any questions that may carry organizational or political risk to the participant.
- ***Free and informed consent***: Provide the participant with a full explanation about the research which enables him/her to decide whether or not to take part in the research. Ensure that the participants give informed consent and have them understand that they can withdraw at any time. Not to put any pressure on the participant to answer a question or deceive him.
- ***Right to privacy:*** Not asking any questions regarding participant's private life, sensitive issues or to prod him/her into answering questions they may dislike. I will ensure that:
    - Privacy and confidentiality be respected;

- Personal data will be stored securely;
- Any potential threats to privacy and confidentiality will be addressed in the research plan, and steps taken to minimize the potential;
- Participant is informed about how the data will be used and who will have access to it;
- That any legal requirements and organizational policy will be followed.

- ***The right to anonymity***: Question whether participant would need the interview to remain anonymous.
- ***The right to confidentiality***: Question whether the participant wants his contribution to be made available to other people.
- ***Objectivity vs***. ***Subjectivity***: Ensure that my own personal biases and opinions do not get in the way of my research. When reporting my results I will make sure that I accurately represent what I have observed or what I was told. I will not take interview responses out of context and will not discuss small parts of observations without putting them into the appropriate context.