Master's Thesis:

CONSTRAINTS FOR URBAN PUBLIC TRANSPORT AUTHORITIES IN IMPLEMENTING BRT PROJECTS

Cases of Istanbul, Mexico City and Delhi

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Abstract

This study examines the success factors in Bus Rapid Transit (BRT) systems and intends to explore what kind of constraints and challenges can occur during implementation by analyzing the cases of İstanbul, Mexico City and Delhi.

The objectives are to contribute to scientific literature on urban governance by addressing BRT specific constraints and also provide a source for urban practitioners working in BRT projects.

Keywords: Urban Transport, Transport Authorities, BRT Systems

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I. INTRODUCTION AND PROBLEM STATEMENT

Fast pace of urbanization in the world since the beginning of the 20^{th} Century has made the urban mobility notion more important. Local governments are now spending nearly half of their annual budgets on transport services and infrastructure investments and this is partly because public transport is a responsibility of local governments in many cities around the world. Rapid urbanization combined with the need for mobility has led to the invention of a new public transport system in the last century. Called as Bus Rapid Transit, this concept has been adopted by many cities around the world with some differences in the form of application. Bus Rapid Transit systems, or BRTs, are basically bus routes; however, in order to increase passenger capacity and commercial speed, BRT routes generally use a dedicated lane with special station designs and vehicle models.

When we look at the literature, it is put forward that the first BRT concept emerged in Curitiba, Brasil in 1974 (S. C. Wirasinghe L. K., 2013). But as of today, there are about 206 cities with BRT systems or priority bus corridors around the world (Global BRT Data, 2016). These figures demonstrate that BRT has become a popular concept around the world in the last three decades. But we should also look at why it has become so popular. The first reason can be the low investment cost when compared with LRT and underground metro systems. As Hensher and Golob (David A. Hensher, 2008) describes: "*There is renewed interest in many developing and developed countries in finding ways of providing efficient and effective public transport that does not come with a high price tag*." When we take into consideration the components of a BRT lane we see that, other than station designs and barriers to make a dedicated lane, any regular bus can do the job. Also, usually BRT lanes use the existing road infrastructure and this reduces the investment cost a lot when compared to underground metro systems. Another important reason is the time factor. BRT projects can be planned in 12 to 18 months whereas planning and implementation of railway systems usually take more time (Institute for Transportation & Development Policy, 2007). It is because of these reasons that local governments, which are faced with the outcomes of rapid urbanization, tend to consider BRT lanes a quick and easy solution. Moreover, BRT projects have generally paid off with steadily increasing ridership figures and economic impacts along the route. Successful examples have become a model for other cities and this relatively new system has also brought performance studies with it. There are several approaches from the academicians and international organizations to measure and compare the performance of BRT lanes and the criteria used are often similar. For example service planning, infrastructure, station design, vehicle types and integration are common benchmarks (L. K. S. C. Wirasinghe, 2013). But success of these systems also lies in the hands of those who implement and operate it. Having a dedicated lane and not getting affected by the outside vehicle traffic can determine a lot for a BRT system in some places and not being able to integrate the lane with other public transport services can reduce ridership. Looking at the phenomenon with a broader view, it can be said that involved actors tend to favor taking care of what is important for them but, with many sub systems, cities are complex and overall success of a new system such as BRT may get compromised due to overlooked factors. So, in this study, the aim is to define **what kind of competencies urban transport authorities should have or develop in order to attract passengers to a BRT system, encourage people to leave their private cars or create a sustainable urban transport system. Then, constraints for these urban transport authorities in implementing BRTs will be scrutinized.** The focus, therefore, will be on BRT success elements and what are the constraints for public authorities in planning and executing these projects. It is an important topic in that the number of BRT systems is increasing globally but there is a common lack of holistic approach among practitioners and academicians towards constraints in BRT even if there is now substantial literature on this subject.

Methodology

This study will be a qualitative and exploratory research as success of urban public transport authorities in implementing BRT projects differs according to context and there is not a one shot global solution for each city. However, these projects are generally initiated with similar objectives such as reducing the share of private car use, mitigating traffic congestion and reducing greenhouse gas emissions; so our analysis can shed light on future projects. We will use cases because linking our theoretical findings with practice should help us reach to more concrete conclusions. Moreover, case studies are deemed to be useful in investigating a contemporary phenomenon in its real-world context (Yin, 2014) and BRT concept is relatively new.

In order to conduct our research, we will first realize a literature review to define success elements and different dimensions of success in BRT systems. Review of literature will be in three main parts. First, we will take a look at urban transport and then BRT phenomenon will be examined. In urban transport we will make use of published books and academic journals to understand the definition and importance of the term. Other sub-topics in this part will be public policies and governance aspect. We will examine and compare different public policies practiced around the world by central and local governments within the scope of urban transport and search for clues for the implementation of BRT systems. Then, governance of urban transport systems will be under focus. We will try to understand who the stakeholders are in these systems and their roles.

Second main part will be dedicated to BRT systems. First, we will look at where, when and how this concept emerged. Through empirical material; archival data of international organizations such as GIZ, UITP and WRI, academic journals and published magazines and books we will try to understand the advantages of these systems and reasons to choose over other urban transport solutions. Technical features and cost items will also be addressed. After we have a detailed idea about BRTs, we will take note of success elements through *ex post* analyses in literature. Here, different approaches to success in BRT will be demonstrated. Because, it is important to look from as many different angles as we can to have a more holistic view. For example, from users' perspective, important aspects of an urban transport system are generally speed, cost and comfort but from authorities' point of view it may be environmental outcomes or performance. At the end of this part, governance angle will again be elaborated but this time it will be BRT specific.

Urban public transport systems, including BRTs, are usually developed and operated by urban transport institutions, or private parties do the job under the supervision of these institutions. The last, or namely the third part of literature review will scrutinize the roles of these institutions in BRT project development, implementation and operation. In this chapter we will try to define what these institutions can do in their own capacity to create a financially and environmentally sustainable BRT system and encourage private car users to shift to public transport by doing so. So, our BRT success criteria in this study are triggering modal shift, mitigating traffic congestion and creating a sustainable and integrated public transport system that is enjoyed by its users.

We will then write about Istanbul, Mexico City and Delhi BRT systems, by structuring our cases with the actors involved in BRT systems development and implementation. These cities are in developing countries and have similar populations. In Mexico City, the first BRT line was established in 2005 and until now five more lines were added to the system. Today, daily passenger count is approximately 1,100,000. İstanbul has a similar history of BRT. First line was opened in 2007 and this line was extended with additional 3 phases until 2012. Daily passenger count is also approximately 900,000. Delhi followed the same path as others and first line of BRT was opened in 2008 but after strong criticism from pedestrians and private car users about road congestion and due to some station accessibility problems authorities decided to close the line recently. We will analyze these cases through the success factors that we have derived from our literature review. Urban public authorities' roles, their capacity and policies in implementing these systems will be studied.

II. LITERATURE REVIEW

A. Urban Public Transport

We will start reviewing literature with the broad concept of urban public transport. Objective here is to give insights about its definition, history and related public policies adopted around the world. We will try to understand stakeholders of transport activities in cities in line with governance notion. Transport is generally regulated and, to some extent, provided by local authorities, so these authorities' roles will also be analyzed.

1. *Definition of urban public transport*

Moving and changing location have always been an important aspect of human history. We needed to walk or run to find food or shelter, or to escape from threats. Then, we started to create settlement areas and invented wheel. We were able to move in plural forms with this invention and since then the shape and usage of these vehicles have evolved. It is usually argued that transport started with the moving of goods from one location to the other and cities were formed as centers of commerce and defense. Transport and cities affected each other's development. However, urban transport as we know it started in cities around 1600 with 'hackney coaches' in London. Early forms of public transport relied on horses and with the invention of steam engine in 1765, railway services started. Trams, streetcars and omnibuses emerged and these vehicles evolved with inventions such as combustion engine, electric motor and diesel engine (Vuchic, Urban Public Transportation - Systems and Technology, 1981).

The need for urban transport solutions grew exponentially as cities became areas where jobs and education concentrated. But, cities were not formed for these purposes at first. Natural challenges and threats forced people to stay together and then there came the need to protect themselves from others against invasions etc. Tsay and Herrmann explain the formation of cities and evolution of transport as such: "(…) *cities were created for mutual defense as well as for market exchange. Transportation was by foot or oxcart, so trade required the dense clustering of populations. However, as regional and national states came into existence and took over the job of civil defense, cities grew organically, though they were still limited in scale. Then came the Industrial Revolution, and soon transportation included canals, steam-boats, rail, transit, and, finally, private motorized transport*" (Tsay & Herrmann, 2013, p. 4). Today, cities no longer serve as defense hubs but they are still centers of trade, education and work. Böhler-Baedeker et al. support this idea by noting that cities are the engine of innovation and economic growth. Also, there is this magnet effect as employment opportunities and social services attract people from rural areas and other regions (Böhler-Baedeker, Kost, & Merforth, 2014, p. 1).

There are different terms that have been devised to conceptualize the movement of people and there are various modes and ways of moving, especially in cities. Oxford Dictionary defines public transport as: "Buses, trains, and other forms of transport that are available to the public, charge set fares, and run on fixed routes" (Oxford University Press, 2016). But there is a nuance between 'public transport' and 'urban public transport'. Public transport includes intercity bus services, national railways or air travel but 'urban public transport' refers to transportation activities carried out inside cities through subways, bus services, trams, BRT systems, cable car etc. Here, we should also mention the term 'mobility' that became popular recently. It refers to the movement of people but this notion includes not just public transport but also walking, cycling and private cars. Vella-Brodrick and Stanley states that mobility can occur by foot (e.g., walking), through the use of natural forces (e.g., bikes) or by using mechanical or motorized methods of transportation (e.g., cars and trains) (Vella-Brodrick & Stanley, 2013, p. 237) and as referenced in their article mobility is defined as the physical movement and the realisation that one can potentially extend this physical movement to undertake a variety of trips and activities which occur outside of the home (Mollenkopf, 2005). Another term used in this regard is 'mass transit' and it refers to 'a large-scale system of public transport serving a city or metropolitan area, characterized by fast running speed, high passenger-carrying capacity and mostly operating on an exclusive right-of-way' (Deng & Nelson, 2010, p. 70). Metros (MRT), light rapid transit (LRT), monorails, suburban rails and bus rapid transit (BRT) belong to this category as these systems are designed to carry large numbers of people in a fast way. In this study, focus will be on BRT that is a form of urban public transport.

2. *Importance of urban public transport*

Cities have been centers of commerce, industry, education and social events and transport plays a key role in facilitating these activities. Subways, buses, trams and paratransit modes (minibuses, shuttles, taxis etc.) are the connection between homes, jobs, education and social circles for urban dwellers.

Coupled with the fast urbanization rate, transport is becoming a major concern for all stakeholders of cities. World's population reached 6 billion in 2000 and it is expected to be 9 billion in 2050. According to a joint report of OECD and ITF, if infrastructure and energy demands are met, there will be around 3 to 4 times as much global passenger mobility (passenger-kilometers travelled) in 2050 (OECD - ITF, 2011, p. 5). These trends are also evident in city statistics. In 2010, more than 50 percent of people lived in cities for the first time in human history and each week 1 million rural residents migrate to cities globally (Tsay & Herrmann, 2013, p. 3). According to The United Nations' assumptions 60 percent of the global population will live in urban areas by 2030 (Fishman, 2012, p. 6). However, figures have not been and will not be the same for every city. Some will be affected more from this trend and some will stay roughly at their present state. For example, one of the fastest population increases was observed in Greater Mumbai. From 2001 to 2011, its population increased from 12 million to 21 million and it is a situation that has not been generally experienced by Western countries (Tsay & Herrmann, 2013, p. 6). The urbanization and transport outlook for OECD and non-OECD countries also differ. Mobility growth in OECD countries is expected to be slow but it is argued that it can increase 5 or 6-fold until 2050 compared to 2000 levels (OECD - ITF, 2011, p. 14).

These statistics on urbanization and mobility tells us that we will live in more dense areas and we will move between A to B more frequently. Urban public transport's role today and in the future should be considered within this scope. This increase in population and urban density translates into traffic congestions, slowdown in economic and social activities and an overall decay in city functions where there is an inability to meet with transport demand and necessary measures are not taken. So, urban public transport is actually competing with private cars because people tend to buy cars if there is no other means of transport they can use. Moreover, it is tempting to buy a car because of comfort and flexibility dimensions. Fishman, in this regard, quotes one General Motors director's words: "*No other means of transportation offers the same valued combination of safety, comfort, convenience, utility and choice of route and schedule. Americans go every which way every day, and cars help us get where we want to go when we want to go. Whether because of personal choice or community design, the vast majority of Americans consider everything else—at least for their daily trips—a second-best option*" (Fishman, 2012, p. 6). It is because of these reasons that private car use is still the dominant mode of urban transport in most of the world even if urban public transport is rapidly gaining popularity. But, as stated earlier, private car use usually means congested roads, waste of time, energy and money. According to the Texas Transportation Institute, the average American commuter spent 34 hours delayed in traffic in 2010, up from 14 hours in 1982 and the annual cost of congestion now exceeds 100 billion USD in US (Fishman, 2012, p. 7). Also, thinking that cities consume 60–70 percent of the world's energy supply and emit 70–80 percent of total global carbon emissions (Tsay & Herrmann, 2013, p. 1) it can be inferred that urban public transport can play an important role in economy, energy savings and environmental protection. As for the economic side of cities, it should also be mentioned that they generate more than 80% of global GDP (Dobbs, Smit, Remes, Manyika, Roxburgh, & Restrepo, 2011, p. 1) and at the age of globalization they are hubs for multinational companies, workforce and talent. So, cities role in economy exceed local contexts and becomes a national or even global phenomenon. It means that how well a country manages its cities will determine its global competitiveness (Tsay & Herrmann, 2013, p. 5) and urban public transport is an important component in a whole city system.

It has been observed that urban transport has also been analyzed through social and psychological aspects by scholars and non-governmental organizations. Some studies also dealt with the justice side of this subject. City residents have different incomes and for far distances private car is the only option other than public transport. But, it is evident that not everybody has the means to buy a car and travel with it unless they have the public transport option. Robin Chase, founder of car sharing apps such as Buzzcar and Zipcar, comments on this situation and advises as this: "*We must have a wide range of options in transportation, because people go from being 0 years old to being 90; they have different amounts of money, different amounts of ability to move, different amounts of independence, different amounts of income. How you move a 2-year-old is not how you move a 28-year-old, or a 48-year-old with children (…) To answer transportation issues we really, truly do need to have a variety of possibilities*" (Fishman, 2012, p. 16). As Chase emphasizes, it is crucial to have different transport options inside cities for people belonging to different income groups. Cities which have been designed for private cars and which neglect public transport options may end up restricting the mobility of those who do not have the means to buy cars or choose not to own one. Hananel and Berechman state that being able to move freely and safely from place to place is a core function of transportation and they list different approaches and opinions on this case in their study titled '*Justice and transportation decision-making*'. As quoted, Wismaldi et al. stress the term '*equity*' and argue that level of opportunity and choices available to all include non-income factors as transportation. On the other hand, Nussbaum and Sen underline accessibility and put forward that poor access to transport in cities impairs residents capability to realize their full potential in life (as cited in Hananel & Berechman, 2016, p. 79). As can be understood from these views, scholars regard transportation services as a right and consequences of not having this option in cities will be negative. Mobility capacity of the disadvantaged will decrease and they may not be able to access important services or opportunities. As Tsay and Hermann states: "*cities new and old have newfound pressures from billions of urban dwellers seeking to make a brighter future. Urban transport will define their access to wealth and well-being*" (Tsay & Herrmann, 2013, p. 12).

Other notions connected to urban public transport include health, well-being, psychology and social life. Although it is not the primary topic in urban public transport literature, there are studies that examine urban transport from users' perspective. Vella-Brodrick and Stanley touch upon the relation between well-being and urban public transport in their paper and they list other scholars' views in this regard. Mollenkopf et al. state that '*mobility and transportation are necessary for coping with distances, enabling access to essential services and goods, and for engaging in a range of activities outside of the home*', similarly, Schaie argues that *'mobility also enables individuals to participate in social and community life and to engage more fully with others and the world, thus making it an important antecedent of well-being and consideration for social and health policy'* (as cited in Vella-Brodrick & Stanley, 2013, p. 236). Same study also draws attention to urban transport's reflection on human psychology. Metz and Spinney et al. state that having a transport mobility option in case of emergency can provide a feeling of security among users and older people who have access to opportunities away from home benefit from perceptions of freedom (As cited in Vella-Brodrick & Stanley, 2013, p. 237).

From these readings on the importance of urban public transport we infer that it is interconnected with various other fields and it has effects on individuals, cities, nations or even world as it supports global competitiveness of cities.

3. *Public policies in urban public transport*

Mitigating traffic congestions, reducing carbon emissions, promoting well-being and facilitating mobility are universal objectives in launching urban public transport projects. Also, '*transport is often considered as a lever of economic and social change*' (Kaufmann, Jemelin, Pflieger, & Pattaroni, 2007, p. 17) because accessibility plays an important role in housing development and commercial activities. Two prominent reasons for building urban transport systems are to reduce traffic congestion and stimulate development according to a study that examines 9 cities in UK (Edwards & Mackett, 1996, p. 227). On the other hand, Berechman and Hananel argue that congestion reduction and accessibility were planning goals for most of the 20th century but there have been a paradigm shift towards planning of mobility for the disadvantaged and taking the relation between sustainable development and transport into account since 1970s and 1990s respectively (Hananel & Berechman, 2016, p. 80).

Public transport services in urban settings are generally under the responsibility of local governments. These services are either provided by local governments themselves or private sector does the job under the local governments' supervision or authority. National and local policies define how, where and when these services will be provided. For example, national policies can affect the choice of public transport mode in a city even if it is a local matter because there may be a national program for using a specific mode, such as underground metro, in line with a national environmental program. National and local urban public transport policies may differ from country to country and city to city but current debates generally focus on financing, sustainability, integration, land use and environment when it comes to urban public transport.

It is better to look at planning of urban transport to understand how national and local policies play a role in urban transport projects. Transport systems in cities are usually developed according to 'Urban Mobility Plans'. These plans are (UMPs) usually for 5 or 10 years and "*it is a tool with objectives and measures towards safe, efficient and accessible urban transport systems*" (Böhler-Baedeker, Kost, & Merforth, 2014, p. 2). Majority of countries around the world have national frameworks that encourage or oblige UMPs and it is a prerequisite for federal funding of urban transport in some cases such as Brazil and India (Tsay & Herrmann, 2013, p. 23). It is argued that increasing private car use in cities, congestion and environmental concerns plays an important role in cities' developing UMPs voluntarily or central governments' devising nation-wide compulsory frameworks. Moreover, the assumption is that if mobility is planned right, it can improve the access to job opportunities and social services (Böhler-Baedeker, Kost, & Merforth, 2014, p. 25). These plans define the mobility projects that are going to be implemented in cities, include assumptions for future and integration with land use plans is often advised to have more concrete results (Tsay & Herrmann, 2013, p. 42). However, the effect of UMPs may be limited at the end. For example, Fre`re et al. (2000) criticize '*Plans de de'placements urbains*' (PDU) that became compulsory for all French cities with more than 100,000 habitants in 1996 by stating that '*its capacity to resolve environmental problems associated with mobility*' is weak (As cited in Kaufmann, Jemelin, Pflieger, & Pattaroni, 2007, p. 14).

Financing and economics of urban public transport systems are other subjects that are discussed by scholars, governments and NGOs frequently. In this regard, cost recovery and financing the infrastructure are the main topics. Ableson states that three main ways to raise capital for public transport systems are taxation, public sector borrowing and private sector financing (Abelson, 2008, p. 360). It means that national governments can transfer financial resources to municipalities, municipalities can get loans or private sector can make investment to implement such projects. Resources to be transferred to municipalities by national governments or states may be in the form of 'cash payments, grants of land, buildings, or other physical assets' and national governments raise revenues for funding urban transport from taxes such as 'national excise taxes on gasoline, freight-related fees for trucks, or sales taxes on purchases of commercial vehicles and equipment' (Tsay & Herrmann, 2013, pp. 30-31). There are also other forms of taxes around the world to raise capital such as 'value capture taxes' as implemented in Sydney, Australia and it requires land developers to pay $15,000 per lot developed as a contribution to transport infrastructure (Abelson, 2008, p. 360). Value capture tax can also be post-implementation in that local or central governments may demand some part of the value added to the area where a public transport system is established but it is emphasized that a strong land-use management is needed in order to do this (Tsay & Herrmann, 2013, p. 36). Other than resources transferred by national governments and private sector investment, local governments use their own resources or apply for loans to finance urban transport projects and it is usually the case. As Litman also states '*although federal and state/provincial funds often help finance transit improvements, additional local funding is generally needed'* (Litman, 2016). Cities can increase the revenues that come from fares, rent buildings or use advertising to raise funds for public transport. It is put forward that 10% of Taipei's Rapid Transit Corporation's income comes from such revenues (Tsay & Herrmann, 2013, p. 37). Nevertheless, local governments do not always have enough funds and this may hinder the provision of these services as main income for public transport is fares but it is usually insufficient to cover capital and operating costs (Wetzel, 2006). It can be said that this situation is one of leading reasons why public-private partnerships or PPPs gained popularity in public transport projects recently. PPP is defined as '*a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance*' (World Bank Group, 2015). It is pointed out that potential benefits of PPPs for urban transport projects are diverse and efficiency gains in project implementation, the ability to share project risk with private investors, and the ability to complete projects more quickly are some of them (Tsay & Herrmann, 2013, p. 39). Partnerships with private sector also include performance based contracts made between local governments and public transport service providers where local governments do not choose to provide these services directly. London is a good example in this regard as local authority does not own and operate buses but purchase this service from private sector under performance based contracts. It is a model which is gaining popularity around the world as it reduces the costs borne by local governments. For example, it is stated that Guangzhou in China negotiated a performance-based contract for the operation of its BRT that could serve as a model for national policy (Tsay & Herrmann, 2013, p. 50).

4. *Governance in urban public transport*

Planning, construction, project implementation, operating and supervision processes of urban public transport systems involve different stakeholders and coordination between these is one of the factors that affect the success at the end. Here, governance notion plays a role. Razaghi and Finger define governance as '*the kind of order that is achieved among several actors who are interacting* *with each other about a common issue of mutual interest for the involved parties even though they might have conflicting interests*' (As cited in Audouin, 2015). Urban public transport systems generally require a governance structure among central governments, supervising authorities (e.g. those that enforce legislations), local governments, urban public transport authorities (if there is a separate body), technology / infrastructure suppliers, private operating companies (where present), residents and users. Environment can also be considered as a stakeholder as there is an environmental impact after each project. This understanding can be linked to the Systems Theory and systems thinking. It is an '*approach that attempts to view the world in terms of irreducibly integrated systems*' (Laszlo & Krippner, 1998, p. 57). An urban public transport system is integrated to other systems in cities such as parking facilities at stops, roads, ports or other public transport systems. It is an understanding that is also supported by practitioners and researchers. For example, according to SMART's (A research project undertaken by University of Michigan) Managing Director Susan Zielinski, "*Transportation is not simply one mode that moves a person or a good from A to B. It is much more interesting and useful than that. It is a system, or rather a 'system of systems' connecting modes, services, technologies and designs according to the best option for the purpose*" (As cited in Fishman, 2012, p. 18). Thinking in this way, we can argue that if a bus service at a given route is a small system, then it is a part of greater systems such as whole bus network, whole urban systems inside that city respectively and the city itself is a part of greater national management system. So, we can infer that sub-systems can have their effects on greater systems and a change in a greater system can change how sub-systems work. In urban public transport context greater systems may be central governments and downwards, there are local governments and public transport operators respectively. There are also horizontal relationships between sub-systems such as a port and road network as goods delivered to a port by ships can create truck traffic on road network in a city. A good example to demonstrate that systems and authorities affect each other is SUMPs or Sustainable Urban Mobility Plans. It is European Commission's decision to promote the application of these plans in member states and now we see they are gaining popularity in member states (Böhler-Baedeker, Kost, & Merforth, 2014, p. 45). Here, we see that an intergovernmental organization's policies can affect urban public transport systems at the local level.

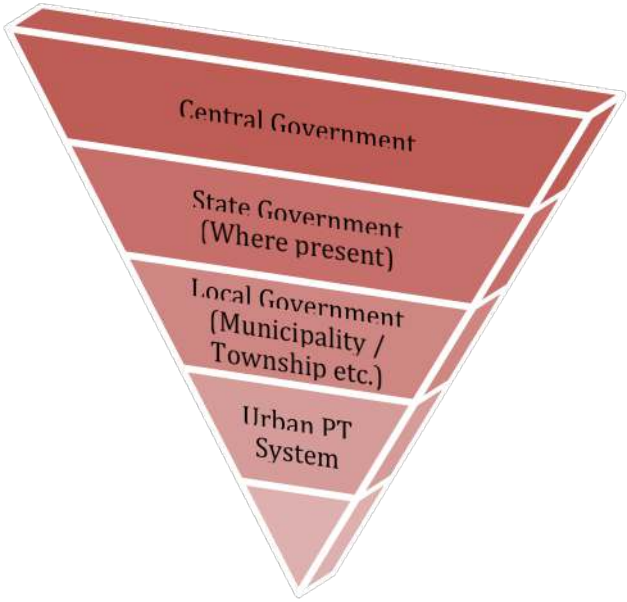

Figure 1: A typical management hierarchy in urban public transport systems.

When we analyze the management of an urban public transport system in this way we can understand that a good coordination or governance between stakeholders is needed for successful implementation and operations. Tsay and Herrmann touch upon the importance of good governance in urban public transport projects stating that '*cities cannot construct sustainable transport systems alone. Creating these systems requires the simultaneous cooperation, construction, and funds of multiple actors, including the national government*' (Tsay & Herrmann, 2013, p. 10). On the other hand, Böhler-Baedeker et al emphasizes the role of different stakeholders in the implementation of urban transport projects by saying: "*Transport projects are often politically controversial; in particular on the local level (…) changes have factual and putative advantages and disadvantages for particular groups. There are commercial, private and institutional actors as well as transport system users (e.g. pedestrians, cyclists, drivers, local businesses) and secondary interest groups like resident and tourists (…) Several target conflicts may occur in the planning of transport interventions such as expressway vs. the desire for a quiet neighborhood*" (Böhler-Baedeker, Kost, & Merforth, 2014, p. 6). In this regard, we see that Kaufmann et al. draw attention to experts' power in the decision-making process of projects: "*Traditionally, the handling of nonhuman agents (technical aspects of transport system) falls to the experts, who define the impact that these agents are likely to have. The expert, therefore, is a central figure in transport-related decision-making.*" (Kaufmann, Jemelin, Pflieger, & Pattaroni, 2007, p. 15). As can be understood from these quotes, an 'actors analysis' and governance point of view is important in urban public transport systems. We will look at the actors involved in the implementation of BRT systems in our case cities.

5. *Roles of Public Authorities in Urban Transportation Systems*

Around the world, generally local governments or urban transport institutions set up for this purpose are responsible for the movement and transportation of people inside cities. Exceptions include city-states such as Singapore, Hong Kong, Bahrain and Monaco where urban public transport services may be directly under the authority and responsibility of transport ministries, in other words, central governments.

It changes from city to city and nation to nation on which governmental structure urban public transport authorities and responsibilities are vested in. However, size, in terms of population and area, may require specialization and it is observed that special institutions have been established in some cities to deal with public transport issues. Since the beginnings of last century there has been a trend of setting up separate institutions to manage urban public transport in large urban areas. In order to regulate and integrate, independent services '*have been united into regional transit authorities, districts and other forms of public agencies*' (Vuchic, Urban Public Transportation - Systems and Technology, 1981, p. 53). STIF is an example in this regard. The Transport Syndicate of the Paris Region (STIF) is responsible for all modes of transport in the region of Ile de France; and the city of Paris is also located in its area of authority. It is put forward that it was originally set up and chaired by the central government as a separate body but due to a decentralization process presidency of it was transferred to the elected president of Paris region later (Desclos, 2013, p. 79).

It is a safe guess that with growing populations and cities urban transport becomes harder to manage so specialized and integrated institutions may increase in number. Public transport modes also change with city size and bigger cities need bigger solutions. For example, while public buses or paratransit modes will suffice for small populations, in cities with multimillion inhabitants, modes with fully controlled rights-of-way are needed (Vuchic, Urban Public Transportation - Systems and Technology, 1981). Therefore, authorities try to answer this massive transport demand with modes such as MRT and BRT.

GTZ's sourcebook on urban transport institutions includes an extensive study on the roles of public authorities within this scope (Meakin, 2004). Regardless of the organizational structure in cities; urban transport responsibilities are generally as such:

-Planning and development of transport infrastructure -Management of roads and road use, licensing of vehicles and drivers -Public transport organization, development and regulation -Financing and investment -An interface with land use and urban planning

Table 1: Urban Transport Responsibilities (Source: GTZ)

Public authorities, whether a separate transport institution or a transport department inside the local government, undertake urban public transport operations under abovementioned responsibilities by relying on their own resources or outsourcing from private sector. The decision to build a metro or BRT line can be taken by local governments or central governments according to transport demand at first but answers to questions such as 'who is going to pay for it?' or 'who will operate it?' get diverse from setting to setting. Market rules, funding capacities or local policies play a role when these questions are to be answered. First option is to rely solely on public funding and expertise to build and operate public transport lines or routes. In this way, a local authority will pay for infrastructure, purchase vehicles and employ people to operate these services. The other option is private sector involvement and there are different approaches around the world in this regard. Tendering and concession schemes are common forms. Preston touches upon three practices with regard to tendering of public transport services (Preston, 2005). There is the Scandinavian model in which routes are tendered; French model that involves the tendering of public transport network and Adelaide (hybrid) model through which some tactical and operational functions such as fares are tendered (Preston, 2005, p. 66). Public authorities may use these models to outsource the public transport services from private sector and it is generally through performance based contracts that define the roles. Options are similar in the case of BRT; local authorities may purchase vehicles and operate them by themselves or tender the service by allocating a route but success or performance factors will remain the same.

Legal, organizational and financial capacities of authorities and governance with other actors inside cities will affect what kind of roles they can play in public transport projects. Literature and archival data emphasizes the importance of integrating different modes and organizational structure. For example, it is generally argued that Singapore and Hong Kong have advanced public transport networks and, when examined, it is seen that both have integrated transit agencies with expanded authorities such as planning and managing roads, traffic, parking and non-motorized transport together with public transport management, construction and operation authority (Meakin, 2004, p. 2). In Hong Kong, moreover, the transport agency even has land development authority so it is able to plan and develop public transport services and neighborhoods together. This approach is linked to the 'transit oriented development' notion which has also become popular recently. Within this notion, it is put forward that most of the trips inside the city occur between homes and jobs or schools so if these centers grow close to each other than it will reduce trips with private cars so traffic congestion will be decreased. However, examples like Hong Kong are a few and most of authorities around the world face authority problems. One operator's being able to operate a public transport mode but not being able to have a direct control over other vehicle traffic inside the city is an example in this regard. Because, public transport will be very much affected by traffic congestions and informal transport services. This kind of problems can be categorized as governance problems in urban transport and it is often overlooked in literature; so we will also focus on this side when examining our cases.

Directly or indirectly, urban public transport authorities can play a role in transport success elements such as passenger satisfaction, application of ITS for operations and informing passengers, maintenance of vehicles, accessibility, affordability, safety and security (Vuchic, Urban Transit: Operations, Planning, and Economics, 2005, p. 315). As mentioned in BRT success elements chapter, these factors affect ridership of public transport systems and increasing the public transport ridership is important because private car use is becoming widespread with undesirable consequences. Authorities or contractors that are working under the terms defined by authorities can enhance passenger satisfaction, for example, with clean vehicles, frequent service or accessible stations. Similarly, operating bodies' maintenance discipline and policies will improve the level of safety.

B. BRT Systems

Our literature review continues with BRT systems. The aim of this part is to facilitate our understanding of BRTs position in urban transport systems with information on its definition, history and components. We will look at its advantages, performance criteria, costs and stakeholders.

1. *Definition / History of BRT*

Urban transport systems comprise of rubber wheel, rail, marine and cable modes. Under the rubber wheel category examples are buses, BRT systems, taxis, jitneys and shuttles. Rail systems are trams, MRTs, LRTs, monorails and funicular systems. Ferries and amphibuses that run on sea or rivers are marine transport solutions and there are some cable car applications in some cities. BRT is a different case among these modes in that service is provided through buses, i.e. rubber wheeled vehicles, but it usually has a dedicated lane and it is operated with rail system standards. As defined by Wright and Hook, BRT or Bus Rapid Transit is '*a high-quality bus based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations*' and it '*emulates the performance and amenity characteristics of a modern rail-based transit system*' (As cited in F. Golob & Hensher, 2008, p. 502). We see similar definitions when we look at the literature. For example, in another study Deng and Nelson define BRT as '*an emerging form of mass transit, which ties the speed and reliability of a rail service with the operating flexibility and lower cost of a conventional bus service*' (Deng & Nelson, 2010, p. 70).

BRT systems are renowned for low capital costs; short implementation periods and they are usually compared to rail-based systems in operating conditions as we see in the definitions above. Flyvbjerg et al. argue that '*rapidly worsening traffic congestion has prompted decision-makers to look for high-capacity and high-quality transport modes to mitigate traffic problems*' and high capital costs, long implementation time and financial risks have led decision-makers to look for other solutions than Metro and LRT (As cited in Deng & Nelson, 2010, p. 92). BRT took the stage due to these reasons.

When we review the literature it is observed that appearance of BRT systems as we know it today happened in recent past but there was a transition from bus only lanes to dedicated BRT systems. It is argued that '*the origins of the BRT concept can be traced back to the first exclusive bus lane on a city street in Chicago in 1939*' (Deng & Nelson, 2010, p. 73). Bus lane applications give priority to public transport buses in cities against other vehicles so that they can provide a faster and reliable service. Common view is bus lanes eventually evolved to BRT systems. According to multiple sources first BRT system is regarded as Curitiba, Brazil which was initially designed as a bus lane in 1974 (Deng & Nelson, 2010, p. 73) (Wright & Hook, 2007, p. 21) (Hidalgo & Gutiérrez, 2012, p. 8). Since then the concept has gained popularity in Latin America and then all over the world and there are BRT systems in 206 cities globally today amounting to 5,347 km in total (Global BRT Data, 2016).

2. *Advantages of BRT Systems / Reasons to Choose BRT*

As mentioned earlier, fast urbanization rate, accessibility issues and traffic congestions are some reasons for urban public transport solutions inside cities and BRT is a matter of choice for many cities due to factors such as '*being an effective mode of transport for low and high income people; fast planning and* *construction; more flexibility and adaptability; higher speed with little or no delay for bus; being able to operate according to the culture and needs of the city and being an environment friendly*' (As cited in Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 149).

Advantages of BRT can change from which point of view we are looking at. Those who are responsible for public transport in cities generally consider cost and capacity before they start a new urban transport project and as mentioned earlier BRT has rail-like characteristics but it costs much less then rail-based systems. So, capacity and cost advantage are the prominent reasons to choose BRT over other modes for those who are going to implement a project. Hensher and Golob argue that '*natural evolution from a bus in mixed traffic through to heavy rail in terms of passenger capacity per hour (seating and standing) is no longer strictly valid*' and '*BRT systems such as the TransMilenio have shown that a BRT system can, if appropriately configured, carry more passengers per hour than many rail systems*' (Hensher & Golob, 2008, p. 502). So, we understand that BRT has a comparable capacity to rail systems and it typically cost '*4-20 times less than a LRT system and 10-100 times less than a metro system*' (S. C. Wirasinghe L. K., 2013, s. 21). From public authorities perspective, implementation time is also a driving force to go for BRT. It is generally under the responsibility of elected local governments to apply such projects inside cities and mayors take office for a limited period of time. According to a study of International City/County Management Association (ICMA) the most common mayoral term length around the world is four years (National League of Cities, 2016). This implies that mayors would have a reason to be reluctant to apply long-term projects such as an underground metro and a quick solution would be more desirable because a successful public transport project can be an advantage for the next election race. In this regard, Hidalgo and Gutierrez gives the example of Guadalajara-Mexico, a 16 km long BRT corridor, and they state that from idea to implementation it only took 2 years (Hidalgo & Gutiérrez, 2012). It is a relatively short time considering that the construction of a 16 km underground metro would mean many more years before completion. It is mainly because of these reasons that those countries that were going to host big events such as World Cup or Olympics also chose BRT as a solution. Böhler-Baedeker et al. gives the example of World Cup in Brazil within this scope. It is stated that '*with a length of 23 km, the MOVE corridor provided access to the football stadium and transported more than 5000 fans each game (10% of the stadium's capacity)*' in Belo Horizonte and this project is accepted as one of the successful outcomes of World Cup (Böhler-Baedeker, Kost, & Merforth, 2014, p. 10).

As in other urban public transport projects, BRT systems have environmental outcomes and they support development along the route. Decreasing private car use or decreasing the number of public transport vehicles operating on fossil fuels thanks to a BRT system means less carbon emissions and less human exposure to these chemicals. According to a study carried out by Wöhrnschimmel *et al.* (2008), implementation of the BRT system in Mexico City effectively reduced human exposure to traffic related air pollutants (Deng & Nelson, 2010, p. 87). Though the studies are limited, scholars also touch upon the development aspect in BRTs. It is argued that BRT corridors support housing development, increase the value of existing housing and boost commercial activities. According to a study carried out by Levinson, Zimmerman, Clinger, Rutherford, *et al.* (2003) and Levinson, Zimmerman, Clinger, Gast, *et al.* (2003) Ottawa's Transitway resulted in $675 million investment around bus stations from the time of its launch in 1983 to the mid-1990s (Deng & Nelson, 2010, p. 89).

3. *Technical Features of BRT Systems*

BRT systems share characteristics of urban bus services and rail services. It is because the service is provided by buses but operations are like railway systems. With overtaking lanes and multiple-stops at stations a BRT line can carry as many as 55,170 passenger one direction in an hour whereas it is 30,760 for LRT and 89,950 for metro or regional rail and a system's operating speed can be more than 40 km/h whereas it is 40 km/h for LRT and 60 km/h for metros (Carrigan, King, Velasquez, Raifman, & Duduta, 2013, p. 31).

Main physical components of a BRT system are the bus route, buses and stations. But service is usually upgraded with the use of intelligent transport systems such as smart cards, automatic / smart fare collection systems, control centers. Buses run on a fixed route but traffic signal priorities, exclusive lanes, tunnels, flyovers etc. are used in order to provide a reliable and fast service to users. These are also what make BRT systems different than normal public bus services. Cain *et al.* (2009) divides BRT systems into four groups: running in mixed traffic (with signal priority), using shoulder bus lanes, using median busways and using exclusive busways (Deng & Nelson, 2010, p. 72). Existing road infrastructure and buses can be used to form BRT lanes and it is usually the case. In these circumstances, infrastructure investment will be limited to bus stations. In addition to physical infrastructure there are operational, financial and institutional aspects in these systems. Wright and Hook (Eds) define overall features of BRT systems under 5 topics:

a. Physical infrastructure
b. Operations
c. Business and institutional structure
d. Technology
e. Marketing and customer service (Wright & Hook, 2007, pp. 11-13)

Deng and Nelson also categorize the main components and refer to a study by Levinson, Zimmerman, Clinger, Rutherford, *et al.* (2003) and Canadian Urban Transit Association's definition (2004). They emphasize the topics such as:

a. Running ways
b. Stations
c. Vehicles
d. Services
e. Route structure
f. Fare collection
g. Intelligent Transport Systems (As cited in Deng & Nelson, 2010, p. 71)

It can be argued that these categorizations are made because BRT systems differ from each other in choice of route infrastructure (median, shoulder, exclusive etc.), stations (interval length, facilities at stations etc.), vehicles (electric buses, articulated buses etc.), fare collection (pre-boarding, on board etc.), ITS (control centers, GPS, GPRS systems, on-board cameras, signalization etc.) and integration with other modes (subways, tram lines, feeder routes, paratransit modes etc.). It is observed that a distinction between systems is also made with terms such as Full BRT, BRT or bus lane and this is measured according to system's exclusiveness and advancement (i.e. separation from other vehicle traffic, particular station designs) (Wright & Hook, 2007, p. 14).

4. *Costs in BRT*

Costs in BRT can be categorized in two main groups as investment and operational costs. As for the investment cost, it was mentioned earlier that it is relatively lower compared to metros even if passengers/hour capacity of both systems are similar. Hidalgo states that initial costs vary between US$5-20 million per kilometer for a full BRT and US$30-160 million per kilometer for metros (As cited in Hensher & Golob, 2008, p. 502).

Investement costs, undoubtedly, will vary a lot according to project plans. Constructing a new road vs. using an existing road and purchasing new buses vs. using existing ones in stock can decrease or increase investment cost in BRT to a great extent. Here, Hensher and Golob also emphasizes the effect of terminals in investment costs. Findings of a study they carried out on a number of BRT systems imply that number of terminals can change the initial cost considerably (Hensher & Golob, 2008, p. 513). We can understand main investment cost items in a BRT from the example of Porto Alegre, Brazil. In a study, listed items are vehicles, construction of terminals, retrofitting sections of the existing busway corridors, stations along the corridors, constructing tunnels and viaducts, implementing ITS devices (user's information, automatic fare collection, controlling traffic signals, BRT centralized operational control and dispatching) and implementing a personal security monitoring system (Lindau, Senna, Strambi, & Martins, 2008, p. 59). In this example, there is an existing busway and BRT route replaces that so construction of a new road is not needed. However, tunnel and viaduct construction is planned so this can increase the total investment cost.

After a BRT route is constructed and necessary equipment (i.e. vehicles, ITS systems) is purchased, operational costs comes into the picture. These costs arise from operations and may be borne by local transport authorities or private operators depending on who operates the system. Operational costs are defined as 'operating and often maintaining the buses, depots, stations and infrastructure' (Carrigan, King, Velasquez, Raifman, & Duduta, 2013, p. 29). Salaries of drivers and managing personnel, fuel expenses etc. are main cost items. Operators, public or private, compensate these costs through operating incomes and in BRTs it is mostly fares. However, '*all too often the prices paid by transportation system users are markedly less than the costs of providing the transportation services they use*' and operators may need subsidies (Fishman, 2012, p. 15). It is especially true for other modes such as regular bus routes and metros but in their study Deng and Nelson argue that for BRT systems there is no need for that in many cities and some examples show that private sector firms even have profit without subsidies (Deng & Nelson, 2010, p. 87).

5. *Performance / Success Elements in BRT*

Success of a BRT can be evaluated from several different angles. It can be technical, operational or the system can be regarded as succesful from user's perspective. In this study, attracting passengers to the system; decreasing private car use and creating a sustainable urban transport system are regarded as overall success factors in BRTs. In order to increase the overall success a combination of good governance, adequate planning, financing, solid policies, service quality and appropriate design is needed.

It is observed that there is a particular focus on ridership when we look at public transport performance literature. What increases the ridership, external factors that effect it have been studied. Paulley *et al.* emphasizes the importance of service quality and lists the quality specific and external factors affecting urban public transport performance:

- Access time to boarding point and egress time from alighting point
- Service intervals
- Time spent on board the vehicle

- The waiting environment
- Effect of vehicle or rolling stock characteristics
- Public transport interchange
- Reliability
- Information provision
- Effect of income
- Effect of fares (Paulley, et al., 2006, pp. 300-305)

We can argue that effect of income is an external factor in this list and operational side of a transport system is important in increasing ridership. Currie and Delbosc, in this regard, also made a study an examined 77 BRT and non-BRT bus routes in Australia for ridership drivers (Currie & Delbosc, 2011). First, they made an empirical research and it shows other scholars' findings and here we can cite them. Ridership drivers for public tansport systems in general are stated as:

- High service levels (frequent buses)
- The density of urban development
- Low car ownership
- Low fares (Currie & Delbosc, 2011, p. 756)

It is observed that external factors such as population density and car ownership are also mentioned here and importance of operational side is stressed once again. As for the importance of service quality and operations another interesting study examines values of time in public transport and finding is that '*value of walk and wait time is on the increase according to past*' and '*commuters do not want to walk and wait at stops anymore*' so '*in order to tempt car users it is essential to provide faster, more frequent and accessible services*' (Wardman, 2004, p. 376). The emphasis in this statement is on frequency and design. It is implied that urban public transport systems should be designed in a way that reduces walking time to stations. As a component of an urban public transport system these listed factors are also valid for BRTs. Ridership in BRT is an important aspect because it will have positive effects such as reducing private car trips and in line with that a decrease in fuel consumption and carbon emissions.

Today, there is a range of academic and practical studies that examine performance elements in BRTs and outputs of these systems. There are also archival data by NGOs or international institutions that evaluates systems around the world. Institute for Transportation & Development Policy's (ITDP) 'The BRT Standard' is an example. The aim is defined as 'creating a common definition of bus rapid transit and recognizing high-quality BRT corridors around the world' in the annual report (ITDP, 2016, p. 6). A BRT evaluation model has

BRT Basics

- Dedicated Right-of-Way
- Busway Alignment
- Off-board fare collection
- Intersection Treatments
- Platform-level boarding

Service Planning

- Multiple Routes
- Express, Limited-Stop, and Local Service
- Control Center
- Located in Top Ten Corridors
- Demand Profile
- Hours of Operations
- Multi-Corridor Network

Infrastructure

- Passing Lanes at Stations
- Minimizing Bus Emissions
- Stations Set Back from Intersections
- Center Stations
- Pavement Quality

Stations

- Distances Between Stations
- Safe and Comfortable Stations
- Number of Doors on Bus
- Docking Bays and Sub-stops
- Sliding Doors in BRT Stations

Communications

- Branding
- Passenger Information

Access and Integration

- Universal Access
- Integration with Other Public Transport
- Pedestrian Access and Safety
- Secure Bicycle Parking
- Bicycle Lanes
- Bicycle-Sharing Integration

Table 2: A Balanced Scorecard of Positive BRT System Elements (Source: ITDP – The BRT Standard)

been developed and BRT systems in different countries are evaluated according to this model. Then, evaluated BRTs are certfied as Bronze, Silver or Gold Standard. Indicators used for this evaluation can help us understand what is regarded as a success or good performance.

As can be seen in the boxes above, 6 categories have been defined and related BRT elements are listed. In this model, BRT elements have different scores so the argument is that some elements have higher values. For example, elements in 'BRT Basics' category on top left have scores ranging between 7-8 whereas elements in 'Infrastructure' category on middle left have scores between 2-3. In this model the highest score is 100. Therefore, dedicated right of way, busway alignment, off-board fare collection, intersection treatments (traffic prioritization) and platform-level boarding are regarded as most important indicators of good performance. There are also elements that lead to point deduction in this scorecard and they are as such:

Operations Deductions

- Commercial Speeds
- Peak Passengers per Hour per Direction Below 1,000
- Lack of Enforcement of Right-of-Way
- Significant Gap Between Bus Floor and Station Platform
- Overcrowding
- Poorly Maintained Infrastructure
- Low Peak Frequency
- Permitting Unsafe Bicycle Use
- Lack of Traffic Safety Data
- Buses Running Parallel to BRT Corridor
- Bus Bunching

Table 3: Elements for Point Deductions in BRT Standard Scorecard (Source: ITDP)

In the deductions, poorly maintained infrastructure and commercial speeds have higher values than others with -14 and -10 respectively. From this scorecard we understand that prominent factors in BRTs are seen as dedicated right of way, off-board fare collection, busway alignment and commercial speeds. In addition to this model there are also academic studies that support the prominence of these factors. For example, Hensher and Golob addresses the importance of high commercial speeds, totally dedicated corridors and off-vehicle fare payment within the scope of BRT systems in their study that compares 44 BRT systems around the world (F. Golob & Hensher, 2008, p. 505). Similarly, Deng and Nelson argues that rights-of-way for vehicles in BRT systems is a 'critical issue' and quality of busway is more important than advanced vehciles or ITS applications (Deng & Nelson, 2010, p. 72). In their study, Currie and Delbosc also examine BRT specific ridership drivers and they are also in parallel with the scorecard above:

- Running Ways
- Stations
- Vehicles
- Intelligent Transport Systems
- Service Levels (Levinson et al., 2003) (As cited in Currie & Delbosc, 2011, p. 756)

After they retrieved these factors from literature, Currie and Delbosc applied these to Australian BRT and non-BRT bus routes and the results support the idea that stations, design features and segregated ways do play a role in BRT ridership (Currie & Delbosc, 2011, p. 761).

As can be seen, archival data and academic literature show similarities in performance/success elements in public transport systems and more specifically, BRTs. Now we can have a look at what are the expected outcomes from these routes. WRI – EMBARQ's (a global NGO) study of BRT systems summarize related positive impacts as travel time reduction, decrease in greenhouse gas emissions and local air pollutants, increase in road safety and physical activity, urban development, land value changes, increase in employment, tax and a decrease in crime rates along the routes (Carrigan, King, Velasquez, Raifman, & Duduta, 2013, pp. 38-43). Some of these impacts can also be the reason for central or local authorities to take the decision to implement a BRT system inside a city at the first place. But, WRI's assesment includes a number of systems around the world and all of these impacts may not be observed wherever a BRT route is implemented because there are too many variables that can affect the results. In addition, these impacts can also be observed in other urban public transport systems and we mentioned this earlier.

Until now, literature we examined focused on infrastructure and operations but there are also political, social and cultural aspects in BRTs. Filipe and Macario touch upon those and draw a more holistic picture with their 'BRT policy package'. In that, they list other factors such as service integration, policy integration, stakeholder involvement and business model (Filipe & Macario, 2014, p. 153). These are more qualitative than quantitative but can affect the overall success. Even if a BRT line is an operational, technical and infrastructural success itself it is still a component of an urban public transport system with regular bus routes, underground metro lines, trams or ferries. Thinking in a broader sense, it is even a component of all urban systems **so integration of services, policies, stakeholders and, in this regard, governance among all systems and parties should also be taken into consideration. Now, we see that other than technical, the bodies of literature we reviewed do not immediately take these aspects into consideration and they do not focus on the constraints for urban public transport authorities' in implementing BRT projects. So, in our study we will focus on the constraints that may arise and we will also make use of our cases in doing that.**

6. *Governance in BRT*

As mentioned in the 'governance in urban public transport' part and through 'systems thinking' in that regard, it is evident that there are different stakeholders involved in implementation of BRT projects, users that benefit from these systems and other systems inside cities that are affected from the operations of these routes. Bus producers, ITS companies, road construction companies, municipalities, urban public transport authorities that are responsible for these routes, transport planners working for these authorities, other transport operators and users play different roles in BRTs. With all of these stakeholders in place, a kind of coordination is needed and this makes governance in BRT an important subject.

As a specific form, urban governance is defined as '*an adjustment form to solve urban problems by cooperation and consensus among acting subjects, while stakeholders, such as urban government, the public, companies, civic organizations and professional associations, create partnerships and networks*' (Sik, Chul, & Seok-Hwi, 2014, p. 81). Within this scope, if traffic congestion is a problem and BRT is considered as a solution then related parties should act in coordination so that the system works properly without any disruption. This disruption can start at the beginning and reflect itself as a resistance of the public and private car users towards the BRT project. Because, cost of moving inside cities is relatively low and '*any change will look like a stick, rather than carrot*' (As cited in Fishman, 2012, p. 30). Filipe and Macario also draw attention to public acceptance in BRT and warn that if stakeholders feel their expectations are not taken into account then it may cause antipathy towards the project (Filipe & Macario, 2014, p. 154). It has been observed that public acceptance of a public transport project is usually overlooked in academic literature and archival data but it can be argued that it is an important aspect in good governance because these systems are planned and implemented for the public in the first place.

In addition to general public and private car users, resistance can be from people whose jobs or businesses will be affected due to a new BRT route. These kinds of probable stakeholders that need to be addressed in BRT projects can be people working in paratransit industry (informal transport sector) and land owners (Kumar, Zimmerman, & Agarwal, 2012, p. 14). It is because a BRT route may mean expropriation with low land valuation or a decrease in paratransit passengers, so a reduction of income. In these circumstances, urban transport authorities may get into a conflict with these stakeholders and innovative solutions may be needed.

Coordination with those responsible for other urban public transport modes inside the city is also crucial as public transport passengers will make transfers to reach their destination; so they will switch between metro, regular buses or BRT. An expected perspective for each urban transport authority or operator in this regard would be ‘public transport network thinking’. In other words, individual successes or failures of each mode will affect the whole network. Logical integration with other modes is as important as physical integration and subjects such as tariff integration, institutional integration, and regulatory integration should be on the agenda in BRT projects (Filipe & Macario, 2014, p. 153). It can be said that, success in this type of governance will have effects on passenger count, emergency actions and passenger satisfaction.

Until now, we have carried out a literature review and learned about the notion of public transport, its history and related public policies around the world. We also reviewed Bus Rapid Transit systems’ definition, history, components and performance factors in line with our thesis’s specific focus on these systems. **There is a long accumulated literature on how operating agencies and authorities can enhance ridership figures and what the success elements can be but there is not a specific focus on constraints and risks that public authorities may encounter in implementing public transport projects, especially BRT. In this study we will focus on this side and we will make use of our cases in doing that. So, the next part is dedicated to our cases and then we will make an analysis.**

III. CASES

A. Istanbul BRT System

Istanbul is the first city in Turkey to implement a BRT project. The corridor extends from the Eastern part of the city to the Western part by passing through micro centers and it has a relatively high ridership. The context in Istanbul, actors in urban transport and the project will be evaluated and then will list our findings in terms of BRT constraints in our analysis part.

1. *Context*

Istanbul is a city in the Republic of Turkey and it is the most populated one in the country with 14.6 million people (TSI, 2016). Turkey, with a GDP per capita of 9.130 USD in 2015, is governed with a parliamentary republic and it has a civil law legal system (Encyclopedia, 2007). İstanbul is vital for Turkey's overall economy in that it generates 43% of Turkey's tax revenues and 28% of total national income. It also accounts for nearly half of Turkey's export (TSI, 2016).

Having been the capital of Roman/Byzantine, Latin and Ottoman Empires, İstanbul has a long history. Even if there are findings of settlements dating back to 3000 years ago, İstanbul's becoming a city starts with Greek colonists' establishing fishing villages around 700 BC (Lonely Planet, 2016). After that it became the capital of Byzantine, Latin and Ottoman Empires respectively. Later, when the Republic was established in 1923, Ankara became the capital of this new government and İstanbul remained as a center for economic activities (University of Michigan, 2016). Starting from the last century, it has also been affected from the globalization trend and played a prominent role in Turkey's integration to international markets (Yazıcı B. , 2013, p. 519).

Geographically, İstanbul is divided into two parts with the Bosphorus Strait which connects Black Sea and Marmara Sea and it is the only water crossing for Black Sea countries to reach the Mediterrenean. The eastern part is called the Asian Side and the western part is the European Side as two continents meet here. It has been argued that even if it is a natural and cultural asset this Strait created traffic problems and influenced land-use patterns (Alpkökin, Black, İyinam, & Kesten, 2013, p. 65). European Side has more business districts than the Asian Side and this led to %10 of population (1.2 million people in 420.000 vehicles) crossing from one side to the other every day, thus creating a traffic burden on bridges connecting two sides (Yazıcı B. , 2013, p. 520). It is put forward that, rather than a planned development, a separation between two sides in terms of land use choice is the result of market forces shaping the settlement pattern of the city (Alpkökin, Black, İyinam, & Kesten, 2013, p. 66). In order to meet with this crossing demand, three bridges have been built over Bosphorus, with the last one having been built in 2016 (ICA, 2013).

In recent years, İstanbul has witnessed the realization and announcement of large scale projects. In addition to the third bridge mentioned above, Marmaray rail tunnel that goes under the Bosphorus was opened in 2013. It also connects two sides as bridges but was designed for passenger and freight transport (Guardian, 2013). A similar tunnel that connects two sides is under construction; but this one will be for motor vehicle traffic. Called Eurasian Tunnel, it has two layers, each for one direction (ATAŞ, 2016). Another important ongoing project is the third airport. It will have six runways and it is projected to be the world's biggest airport after completion (Flamer, 2016). As can be seen, there is a large scale construction projects trend in İstanbul aimed at intercity and intracity passenger and freight transportation. It can be said that some of these projects have been initated to mitigate the traffic congestion problem that the city has. As put forward by Yazıcı, traffic congestion in İstanbul '*is a limitless subject for idle conversation and reguarly makes it appearance in the media*'. Furthermore, it is stated that residents rank this problem as a more siginificant concern than crime or the cost of living in the surveys (Yazıcı B. , 2013, p. 517). Even if the congestion problem is at this extent, it is surprising to see that ratio of cars to residents is quite low when we look at figures. Gerçek (2009) informs that there is a rapid increase in car ownership in last decades but ratio of cars to residents stands at 139/1000 (As cited in Yazıcı, 2013, p. 532). According to a more recent study, the figure is 150 vehicles per thousand people (Alpkökin, Black, İyinam, & Kesten, 2013, p. 66). It can be argued that İstanbul's being a historic city and not having been built for this much population can be one of the reasons. Limited road space is a common problem in such historic cities. Also, as the Bosphorus crossings are limited to bridges and it can create bottlenecks.

Being a historic city, İstanbul has also experienced different trends in terms of public transport. Taking good practices in cities such as London and Paris as a model, Ottoman Empire initiated horse tramways in 1870s (Alpkökin, Black, İyinam, & Kesten, 2013). Also, world's second oldest metro system, Tünel was built in Beyoğlu district during those times (İETT, 2016). In early 20th Century we see a tendency towards electric trams, ferries and bus transport in line with technological developments in vehicle engines. Taxis, in addition, started to operate in İstanbul (Sezen & Apaydın, 2011, p. 121). Private initiatives in İstanbul's transport was supported with a new approach after the downfall of Ottoman Empire and declaration of the Republic in 1923. Former a French company, Dersaadet Tramway Inititative was expropriated and a new public company called Istanbul Electricity, Tramway and Tunnel Enterprises (IETT) was established. This new government enterprise took over 320 tram cars and 4 buses (İETT, 2016). From 1940s onwards the inclination was towards buses and trolleybuses. Taxis and paratransit modes such as dolmuş (minibus) gained importance and tramways lost their popularity in İstanbul. Provision of rail and bus services remained low and paratransit modes became the main public transport service in the city around 1960s but eventually it became insufficient and authorities were forced to think about other solutions (Alpkökin, Black, İyinam, & Kesten, 2013, p. 68). Unlike other global metropolitan cities such as New York or London, underground metro was not considered as an option until 1980s (Sezen & Apaydın, 2011, p. 301). But, it is generally argued that cities in Turkey have been late in investing metros (Alpkökin, Black, İyinam, & Kesten, 2013, p. 69). In İstanbul, first underground metro line was opened in 1988 (İETT, 2016). From that time on investments to this mode increased.

Today, various public transport modes operate in the city. There are buses, a BRT line, metro lines, tramway lines, ferries, cable cars, shuttles (minibuses and buses that carry company workers or students), minibuses, taxis and funicular systems. Railway network (underground metro and tramway) is 146 km in total (Metroİstanbul, 2016) (Marmaray, 2016) (İETT, 2016). However, the aim of İstanbul Metropolitan Municipality is to increase this to 482 km until 2019 and 1000 km on the long run. There are 8 underground metro lines under construction (IMM, 2016). So, we understand that railway systems is going to be an important mode within the whole public transport system in İstanbul. When it comes to public buses, we see that there are a total of 6135 buses operating in regular routes and the BRT system. Bus operations are carried out by İETT and private operators (İETT, 2016). Although marine transport does not have a big share, paratransit modes such as taxis, minibuses and shuttles have high ridership figures.

	Daily Average Ridership	Share (%)
Railway Systems (Underground Metro, Trams, Funicular Systems, Marmaray, The Tunnel)	2,299,040	17.85
Land Transport (Buses, BRT, Taxis, Shuttles, Minibuses)	9,956,747	77.30
Seaways (Ferries)	625,513	4.86
Total	12,881,300	100

Table 4: Daily Average Ridership Figures for İstanbul in 2015 (Source: İETT)

As we understand from the table above, land transport dominates the public transport sector. But, when we look at the breakdown of land transport passenger trips, we infer that paratransit modes have a bigger share than buses. Bus transport (including BRT) constitutes %29.43 of all public transport passenger trips, whereas the figure for paratransit modes such as minibuses (dolmuş), shuttles and taxis is %47.87 (İETT, 2016). So, nearly half of public transport users prefer paratransit modes. With so many passengers travelling on these modes, it is usually considered as a burden on vehicle traffic on roads together with private cars and when the whole urban public transport system is taken into consideration, scholars criticize İstanbul by saying that provision of rail and bus transport is low when compared to other megalopolises around the world (As cited in Yazıcı, 2013, p. 532).

Another notable subject regarding the public transport system in İstanbul is the fare integration. Even if there are various modes we see that payment system is highly integrated. Users can pay their fares with a smartcard called İstanbulkart on buses, metros, trams, ferries, funiculars and cablecars. Only exclusion is the paratransit modes (İETT, 2016).

2. *Actors*

Urban public transport services are under the authority and responsibility of local governments in the Republic of Turkey (TBB, 2016). There is a two-tiered government system with a central government and municipalities that are responsible for areas not covered by the central government in cities (Uzun, 2007, s. 133). Central government is represented by governors and they are appointed; but mayors and municipal councils are elected by residents thorugh local elections (TBB, 2016).

As a result of the Metropolitan Municipality Law enacted in 1984, a third tier appeared in the Turkish government system (Sorensen & Okata-Eds, 2011, p. 234). Today, cities with populations more than 750,000 have a metropolitan municipality body. There are 81 provinces in Turkey and 30 of them have metropolitan municipalities (TBB, 2016). Metropolitan municipalities' area of authority is extended to boundaries of city. Therefore, district municipalities in these cities are accountable to metropolitan municipalities. In other cities, where the population is lower than 750,000 there is a city municipality but its area of authority is limited to the city center and district municipalities have more sovereignty (TBB, 2016). İstanbul, also, has a metropolitan municipality and there are 39 district municipalities under this umbrella organization (İstanbul Metropolitan Municipality, 2016).

İstanbul Metropolitan Municipality (IMM) consists of sub-departments and urban public transport is managed through Transportation and Rail Systems Departments (Org. Chart 'IMM', 2016). Within this scope, IMM also prepared a transport master plan for years between 2009 and 2023 together with Japan International Cooperation Agency (JICA) but there are some criticisms in this regard and we will touch upon those in the following chapters. Another important authority and operator is İETT. Being a public body, it is responsible for buses and the BRT system. İETT is an operator in that it operates buses on regular bus routes and the BRT system, and it is an authority as private bus operators provide the service according to İETT's transportation plans and standards (Alpkökin, Black, İyinam, & Kesten, 2013, p. 68). Other operators within the scope of bus transport are İstanbul Public Buses Co. and İstanbul Bus Co. (İstanbul Public Buses Co., 2016) (Bus Co., 2016). Currently, these two companies have 3075 buses in total and İETT's fleet size is 3060 (İETT, 2016). An important point here is that Bus Co. belongs to İstanbul Metropolitan Municipality. Municipalities are entitled to set up companies to fulfil their responsibilities and Bus Co. is one of 28 affiliate companies of IMM (Org. Chart 'IMM', 2016). There are two other affiliate companies, namely İstanbul Transportation Co. and İstanbul Ferry Lines Co., that are important actors in urban public transport. İstanbul Transportation Co. operates the railway network and İstanbul Ferry Lines Co. provides ferry services (Alpkökin, Black, İyinam, & Kesten, 2013, p. 68).

Central government is also present in İstanbul with its several institutions. Large scale projects that have been mentioned in the previous section are under the authority and responsibility of the Ministry of Tranportation, Maritime Affairs and Telecommunication. Marmaray project, for example, was initiated by this Ministry and implemented through international loans. It is now operated by Turkish State Railways, a national authority working under the Ministry (UDHB, 2014). In addition to aforementioned projects, the Ministry is a permanent actor for the city because highways and bridges are under its authority with The Directorate of Highways (Alpkökin, Black, İyinam, & Kesten, 2013, p. 68). Also, 2 of the 8 metro lines that are currently under construction are financed by the Ministry (Strategy Development Department of IMM, 2016).

Paratransit modes have an important role in İstanbul's public transport system as mentioned and the Metropolitan Municipality is an authority for them because licence to operate taxis, shuttles and minibuses are obtained from the Municipality (IMM, 2014). As we learned in the previous section, paratransit modes have a long history in İstanbul and they were even the primary mode of transport until recently. In 2015, 63,977 vehicles were granted licence to be used as school or personnel shuttles (IMM, 2015, s. 181). Shuttle and taxi operators have chambers as a union.

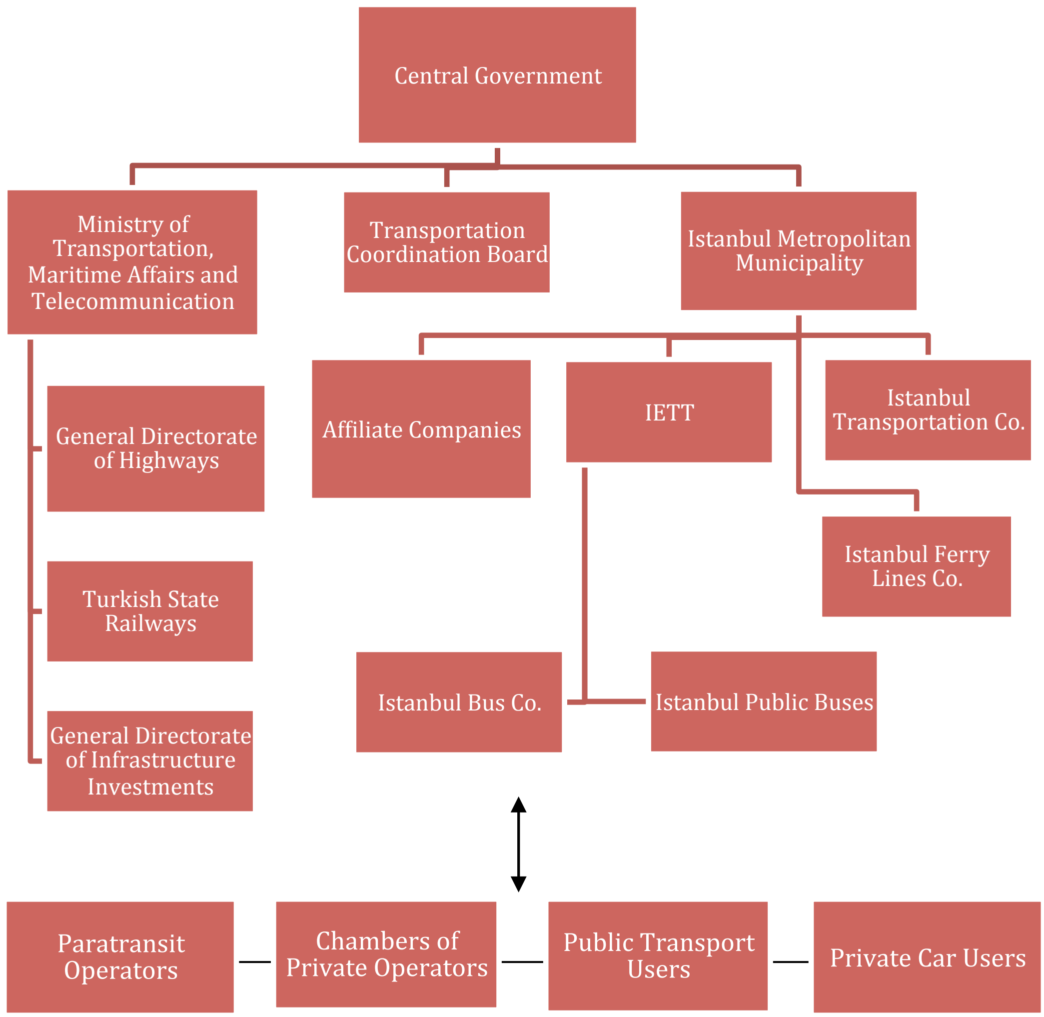

Figure 2 : Actors in İstanbul Urban Transport

There is also an organization called Transportation Coordination Board that brings all these parties together and it is a noteworthy initiative in terms of public transport governance. These boards consist of representatives of government institutions such as municipalities, the Ministry of Defence,

gendarmerie, police, the General Directorate of Highways etc. and, by law, it is required to set up these boards in cities where there is a metropolitan municipality (UKOME, 2016). Important decisions such as public transport fares and expropriation are taken by this board.

Public transport users and residents are also actors affecting the whole system. In the first place, they elect the local government and then they are directly represented by the Municipal Council until mayor's term ends. İstanbul Metropolitan Municipality has also developed other tools for their participation. Users are able to submit their opinions and complaints to the Municipality through The Beyaz Masa (White Desk) online application and 153 Call Center (Beyaz Masa, 2016). However, users' role as an actor can also manifest itself in other ways. A protest staged in 2010 against public transport fares is an example within this scope (Yazıcı B. , 2013, p. 534).

3. *Project*

İstanbul's BRT line (locally called 'Metrobüs') is 52 km long and it is one of the most popular transport modes in the city. The whole lane is dedicated except a part of 2,7 km that goes over the 15th July Martyrs' Bridge (Former 'Bosphorus Bridge') (İETT, 2016, p. 11). It has 45 stations, 535 operating vehicles and 5932 trips per day (max.). Currently, there are 850.000 daily passenger trips on the line during peak seasons and it is more than major metro and tram lines (Strategy Development Department of IMM, 2016).

Starting from 2007, Metrobüs project was completed in 5 years with 4 phases. First phase consists of 18.2 km and it was completed in 2007 within 8 months. Second phase is 11.8 km and it was constructed in 2008 within 77 days. 3rd phase was completed in 2008 within 5 months and it has 11.5 km. The last phase was completed in 2012 and it is 9.7 km long. In total, it is a 52km long single line and the investment was financed by the Istanbul Metropolitan Municipality (İETT, 2016). The capital cost stands at 6 million USD per kilometer (Babalik-Sutcliffe & Cengiz, 2015, p. 797). As can be inferred, construction periods are relatively short and investment cost is low when compared to rail based systems. Concordantly, it is argued that the main reasons behind the decision to commence this project were the short implementation period and low cost (Babalik-Sutcliffe & Cengiz, 2015, p. 794).

In regard to modal shift and environmental impact, Metrobüs has brought in some positive outcomes. 189 public buses and a total of 1,296 minibuses were removed from street traffic because there was no longer a need for them on the highway that the project implemented. Also, 4 percent of car users switched to the BRT system for its convenience on the said route (Yazıcı, Levinson, Ilıcalı, Camkesen, & Kamga, 2013, s. 166-167). It can be said that, with the dedicated line, time spent travelling decreased and this led to more passengers choosing BRT as can be expected from a system like this. Calculations demonstrate that commuters that use the whole line save 52 min in a day when compared to private car users (Babalik-Sutcliffe & Cengiz, 2015, p. 804). Moreover, vehicle reduction and modal shift led to reductions in carbon emissions. According to a study carried out by scholars, reorganization and removal of regular bus routes have resulted in the reduction of CO2 emissions by 125 ton/day and fuel savings by 242 ton-liters/day (As cited in Alpkökin, Black, İyinam, & Kesten, 2013, p. 73).

Through the literature review part, we learned that an important indicator of the success of a public transport system is ridership. When we look at the figures of İstanbul BRT, we see that ridership is increasing steadily on this line from the start:

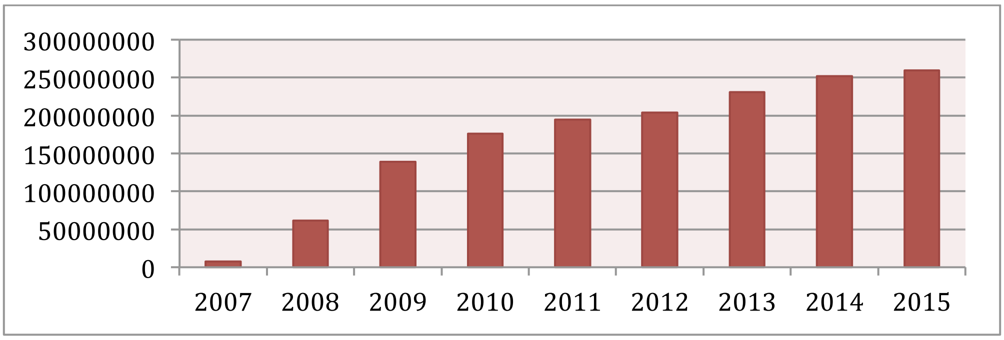

Figure 3: İstanbul BRT Annual Ridership Figures (Source: İETT)

System has achieved an annual 0.25 billion passenger trips since its beginning in 2007. When we look at the features of this system and try to understand the main reasons behind the increasing ridership, we see that system speed and route characteristics are prominent. A study that compares commercial speeds of BRT systems around the world lists İstanbul BRT as the first with 40 km/h (Carrigan, King, Velasquez, Raifman, & Duduta, 2013, p. 27). Location of the route is also important as the highway that was used for the BRT line passes through major centers inside the city. Terminal stations are Söğütlüçeşme in Kadıköy and Beylikdüzü on the European Side. It is emphasized that, already a dense area with different modes of transport present before 2007, on the BRT route there is the Central Business District (CBD - Mecidiyeköy and Zincirlikuyu area) and it is a primary trip generator for the system (Babalik-Sutcliffe & Cengiz, 2015, p. 796).

Service level is another noted positive feature Metrobüs. In addition to commercial speed, headways, real-time passenger information and 24/7 service are the features that affect ridership positively (Babalik-Sutcliffe & Cengiz, 2015, p. 804). During peak hours headways drop to as low as 15 seconds and it is 45-60 seconds at off-peak hours (İETT, 2016, p. 10). It means that passengers are able to board on a bus from stations without waiting too much.

Increasing ridership can also bring problems with it and for Metrobüs it has meant a burden on capacity. As dedicated lines' road capacity is limited and only a limited number of buses can fit in unless a decrease in commercial speed is accepted, more passengers may mean crowding on buses. Metrobüs system uses articulated and bi-articulated buses with high passenger capacity and stations are able to accommodate an average of 3 buses (Carrigan, King, Velasquez, Raifman, & Duduta, 2013, p. 80). However, passengers still experience crowding on stations, buses and there are incidents of bus bunching especially during peak hours (Babalik-Sutcliffe & Cengiz, 2015, pp. 802-809). Sometimes passengers are not able to stations and when they get in the bus it is too crowded so comfort is compromised, also women are sometimes sexually harassed inside crowded buses (Yazıcı B. , 2013, p. 523). There have been criticisms within the scope of capacity and some views focused on the choice of mode. It has been argued that the system is failing to meet the demand and a heavy-rail system should have been chosen at the first place. These debates have led the Mayor of İstanbul to announce that a rail system will be implemented along the corridor in the future (Babalik-Sutcliffe & Cengiz, 2015, pp. 792-794).

The Metrobüs Project was implemented and has been operated by the General Directorate of İETT working under the İstanbul Metropolitan Municipality. There is control center in Edirnekapı Bus Depot (İETT, 2016). As we learned in the previous chapter there are various actors in terms of public transport in İstanbul and İETT is the one that is responsible for regular buses and the BRT system. Within the scope of governance of Metrobüs, a major criticism is the lack of coordination among actors. This reflects itself in physical integration with other modes, fares and Bosphorus crossing. It is argued that this line was not proposed in the 1990 and 2000 transport plans and this led to a poor integration with other modes (Babalik-Sutcliffe & Cengiz, 2015, pp. 795-800). We can infer that it was devised as a quick solution to an increasing demand. As for the fare policy, even if the system is integrated to the smartcard system so that passengers can use their cards on this mode too, Metrobüs uses a distance-based approach unlike regular buses and metros. So, the line stands out from other modes with this feature. In addition, passengers are not able to benefit from a reduced fare when they make a transfer to Metrobüs whereas they can on other modes (Babalik-Sutcliffe & Cengiz, 2015, p. 800). It has also been argued that fragmented authorities and a lack of good governance are main reasons behind the Bosphorus crossing subject. As we learned earlier, the BRT line is not fully segregated and buses cross the 15th July Martyrs' Bridge by mixing with general vehicle traffic. Bridges being under the authority of the General Directorate Highways under the Ministry of Transportation, the road here is subject to a different legislation than the ones under the authority of the Metropolitan Municipality (remaining parts of the BRT line). So, as the Ministry's legislation prohibits lane segregation, Metrobüs line has not been able to enjoy a full segregation.

B. Mexico City BRT System

Mexico City is a big agglomeration and it has suffered from common urban problems such as air pollution and traffic congestion. There have been several efforts to mitigate the effects and BRT is one of these measures. Since the first corridor, 5 more corridors have been added to the network and we will analyze this process from different aspects.

1. *Context*

Mexico City is the capital city of Mexico and it houses one of the largest urban populations around the world with 20.446 million (IndexMundi, 2014). Mexico is governed with a federal republic system and there are 31 states within the country borders (Tsay & Herrmann, 2013, p. 14). GDP per capita in Mexico stands at 9.009 USD (The World Bank, 2015).

Not being a part of any other state, the area where Mexico City is located is called the Federal District. Historically, Mexico City was a center for Aztecs and it remained as an important settlement after the Spanish invasion in 1521. The area was called New Spain and it was the center of Spanish Colonial Empire until 1824 when it became independent (Encyclopedia, 2000). With the independence, Distrito Federal was established and city grew in size. Distrito Federal originally included other towns around the center but as settlements became connected it became a large urban area itself and in 1928 surrounding municipalities were abolished. Thus, whole metropolitan area has been called Distrito Federal since then (A&E Networks, 2016). Today, the district still houses the central government (federal) and management of this large metropolitan area was under the authority of the Federal Government until recently. Before 1997, mayor of this area was appointed by the Federal Government but as the city started to face problems such as crime and pollution between 1970s and 1990s, residents demanded a change and specialization in municipal affairs. So, mayoral elections have been held starting from 1997 and mayorship of Mexico City is considered to be the second most important position after the federal presidency (Encyclopedia, 2000).

Mexico City, or Distrito Federal, consists of 16 boroughs and the metropolitan area has settlements that are located inside the jurisdiction area of other states. Together with them it is called the Greater Mexico City. This large metropolitan area includes 60 municipalities from the State of Mexico and one from the State of Hidalgo (Goberno del Estado de Mexico, 2009, p. 3). The city is situated on a high plateau between two volcanoes and the altitude is 2200 m. Geographically, this creates some constraints as there is not a water outflow to a sea and there is little wind to cleanse the air (Lead, 2008). Air pollution, in this regard, has been noted as an important problem for Mexico City. According to United Nations, the city had the worst air quality in the world in 1992 (Harvard University, 2014). Moreover, it is argued that the reason for the hospitalization of a million people in 1999 were respiratory problems (Encyclopedia, 2000). Due to these conditions, several steps have been taken in order to reduce emissions. Renewal of bus fleet and promoting the use of bicycles are noted as some initiatives. Ecobici bike-sharing program, in this regard, was commenced in 2010 and today there are a total of 4,000 rental bicycles in its fleet (Harvard University, 2014).

As the metropolitan borders now cover a wide area and Distrito Federal has expanded into neighboring states' borders, residents tend to travel long distances during the day to go to work or school and come back home. With private car and taxi trips combined, Mexico City comes first in terms of distance travelled with these modes during the day when compared to other major metropolitan areas in Latin America. Figures are 21.3 million kilometers for Bogota, 90 for Buenos Aires, 52.2 for Rio de Janeiro and 96.1 for Sao Paulo but when it comes to Mexico City it is 100.5 million kilometers (Jiron, 2011, p. 27). This situation also reflects itself in private car ownership. There are 5,592,239 cars and it translates into 290 cars per 1000 inhabitants; which is also higher than most of Latin American cities (As cited in Jiron, 2011, p. 26). Domestic immigration is noted as one of the reasons for irregular settlements and slums on the fringes and consequently the expansion of metropolitan borders (Connolly, 2003).

When it comes to public transport, we see that its share in all transport trips is high in spite of the aforementioned figures on private car use and ownership:

Mexico City Modal Share	Individual Transport (Cars, Motorcycles, Taxis and Bicycles)	Public Transport	Non-motorized Transport
	%23	%52	%25

Table 5: Transport Modal Share in Mexico City (Source: CTSEMBARQ 2012)

From the figures above we understand that mobility in Mexico City is dominated by public transport and when the contrast with private car use figures is taken into consideration, the implication is that total transport trips in a day is relatively high as private car constitutes only a low portion. It is put forward that there are 48.8 million daily trips in the metropolitan area and 32 million in Distrito Federal (Varela, 2015, p. 8). When we look at the breakdown of public transport trips we see that paratransit modes have the biggest share:

	Mode	Trips	Total
Breakdown of Trips by Mode in Distrito Federal	Non-motorized	8,600,000	26.9%
	Private vehicles	4,800,000	15%
	Microbus	9,448,800	29.5%
	Metro	4,984,800	15.6%
	Bus	1,878,600	5.9%
	Taxi	1,041,600	3.3%
	BRT	762,600	2.4%
	Trolleybus	204,600	0.6%
	Suburban train	167,400	0.5%
	Light Rail	111,600	0.3%
	Total	32,000,000	100%

Table 6: Breakdown of Trips by Mode in Distrito Federal (Source: CAF 2011, figures from 2007)

It is important to note here that these figures are from the year 2007 and as we will see in the Project chapter, BRT ridership has increased since then. But, still we can say that paratransit modes such as microbus and taxi are important in Mexico City context. Past figures also cite the increase of paratransit modes' share in the city. In 1983 the share of taxis, minibuses and other local paratransit modes such as combis and colectivos in public transport was %10.2. However, it increased steadily and reached to %55.1 in 1995. Buses, in the same period, lost its share by %37.6 (Zegras, Makler, Gakenheimer, Howitt, & Sussman, 2000, p. 16). Today, there are 45,996 microbuses in Mexico City (Jiron, 2011, p. 19). Paratransit modes and private cars being this common, a burden on road infrastructure can be expected. In line with this density, Mexico City built elevated highways inside the city to ease the problem (World Highways, 2016). Also, a plate restriction program was commenced in order to reduce the congestion and emissions. Called 'Hoy No Circula' locally, vehicles can be used according to plate numbers inside city during weekdays under this program (Ciudad de Mexico, 2016).

Even if their share is small within all trips, regular public transport modes also carry a high number of passengers. In addition to suburban train, there is a 226 km long metro network and with an annual 1.6 billion passengers it is the busiest one in Latin American cities (UITP, 2014, p. 2). With a share of %10.1 in public transport trips, there are 8,240 public buses (Varela, 2015, p. 8). Also, there are 6 BRT lines which we will look at in detail later. Another important aspect of Mexico City transport that we should mention here are taxis. There are 140,000 official and some 45,000 illegal taxis providing service inside the city. In addition, there are approximately 10000 vehicles that offer taxi service through mobile apps such as Uber and Cabify and it is quite popular among residents (Gorbea, 2015). Lastly, public transport fares are noted as cheap in Mexico, and Mexico City is the cheapest with a one way ticket being 0.23 USD on average (Dodero, Planning Public Transport Improvements in Mexico: Analysis of the Influence of Private Bus Operators in the Planning Process, 2013, p. 36).

2. *Actors*

There is a three tiered government structure for Mexican cities with the Federal Government on top and then state governments, municipalities respectively. However, for the Mexico City, the situation is different than other cities. As we learned in the previous section, the Federal Government is located in Mexico City and municipal services had been provided by the directly appointed mayor and the Federal Government itself until recently. So, it can be inferred that the Federal Government can influence city affairs more than it does in other states. Also, Distrito Federal, which constitutes a big portion of the Mexico City metropolitan area, is not a part of any state administration and with this structure it has a special condition among other cities of Mexico. But, even so, the metropolitan area has expanded into neighboring states' borders and it makes these states an actor for the whole metropolitan region's municipal affairs. It is argued that services such as public transport are provided by the city government, neighboring states and some 50 local authorities together within the metropolitan region; however the coordination among them is minimal (UN-Habitat, 2016, p. 113).

The Federal Government of Mexico regulates urban public transport services with related laws. Public Transportation Federal Support Program (PROTRAM) is an urban mobility law that was enacted in 2009 and it defines responsibilities of cities in terms of public transport. It also acts as a development program. Together with this law, 2.694 billion USD was allocated for years 2010-2017 and National Development Bank (BANOBRAS) was defined as the authority for this fund (Tsay & Herrmann, 2013, p. 17). PROTRAM is a framework designed for cities with a population of over 500.000. But cities need to prepare Comprehensive Urban Sustainable Mobility Plans (PIMUS) in order to receive funds. It is put forward that 42 cities started planning urban mobility projects after this program and most of them focus on launching BRT routes (Böhler-Baedeker, Kost, & Merforth, 2014, pp. 27-43).

Ciudad de Mexico, or Mexico City Municipality is the local authority that is the second tier of authority for the Distrito Federal area. It is responsible for the provision of public transport services and an authority for private operators. Paratransit mode operators receive working permissions and licenses from the

Municipality. Ciudad de Mexico has secretaries that are responsible for different municipal affairs and urban mobility is under the secretariat of Secretaria de Movilidad (SM) (CDMX, 2016). Public companies responsible for transport are overseen by this Secretariat. These are Sistema de Transporte Colectivo (STC) that operates the metro network, Servicio de Transportes Eléctricos del Distrito Federal (STE) that operates trolleybuses and light rail and Red de Transporte de Pasajeros del Distrito Federal (RTP) which is responsible for buses and the BRT system.

When we examine the railway system in the city we see that it is dominated by the public sector. 226 km long metro network is operated by the municipal company STC and light rail by STE. There is also a suburban train called *El Tren Suburbano* and it is operated by a private company. This 27 km long railway line was constructed through a PPP and the Federal Government supplied %55 of the investment cost. Taken into service in 2008, this line's contract was signed with a consortium led by CAF and contractors are expected to build, operate and maintain the route (Railway Gazette, 2008)

On the rubber wheel road transport section, namely buses, BRT, microbuses, vans etc., governance structure is more complicated. RTP is the public bus authority of the CDMX and it was established in 2000. In that year, it started providing service with 860 buses on 75 routes (RTP, 2016). In addition to these buses, paratransit modes and buses operated by private sector have an important place in the whole urban transport system. It is put forward that there are approximately 30,000 private operators and they have some 300,000 vehicles in total. Within this fleet, buses make up 18.9%, minibuses 13.5% and vans 67.6% (As cited in Teunissen, 2014, p. 33). Also, as mentioned before, there are taxis, illegal taxis and individuals providing taxi services through mobile apps.

Scholars frequently touch upon the mostly private structure of paratransit and bus transport in their studies. Effects of the private operators' strength on the transport system and some disadvantages that have been observed are mentioned in academic works. In the first place, it makes systematic transport planning initiatives harder as passenger volume data is hard to obtain. Also, it reduces the commercial transparency of urban transport operations (Dodero, Guerrero, Rodriguez, & Heras, 2016, p. 83). Moreover, it is argued that there are more than 100 organizations that represent these paratransit operators and it reduces local government's ability in transport planning because of continuous negotiations (As cited in Teunissen, 2014, pp. 32-33). This situation also reflected itself in the BRT project. It is put forward that fear of protests forced local government to involve existing private operators in the planning phase of the line (Hidalgo & Graftieaux, 2008, p. 83).

Funding is also cited as a problematic subject in bus transport operations of Mexico City. Traditionally, bus services are mostly contracted and operators are expected to cover their operating costs from operating revenues. However, fares can be kept low with political reasons at the same time and operators can have an unsustainable financing scheme as a result. Moreover, private bus operators bear the financial risk of obtaining buses and it is argued that as most of the private operators have low creditworthiness, international banks do not consider public transport projects bankable (Dodero, Guerrero, Rodriguez, & Heras, 2016, p. 79). So, it is usually the local banks that provide funds to these operators. Also, these private operators can suffer from the competition on their routes as government authorities may not be able to prevent unauthorized services (Dodero, Guerrero, Rodriguez, & Heras, 2016, p. 83). In addition to these actors, NGOs are cited as an important actor in the development of public transport systems in Mexico City. For example, there are incidents in which they helped local government create travel surveys (Tsay & Herrmann, 2013, p. 25).

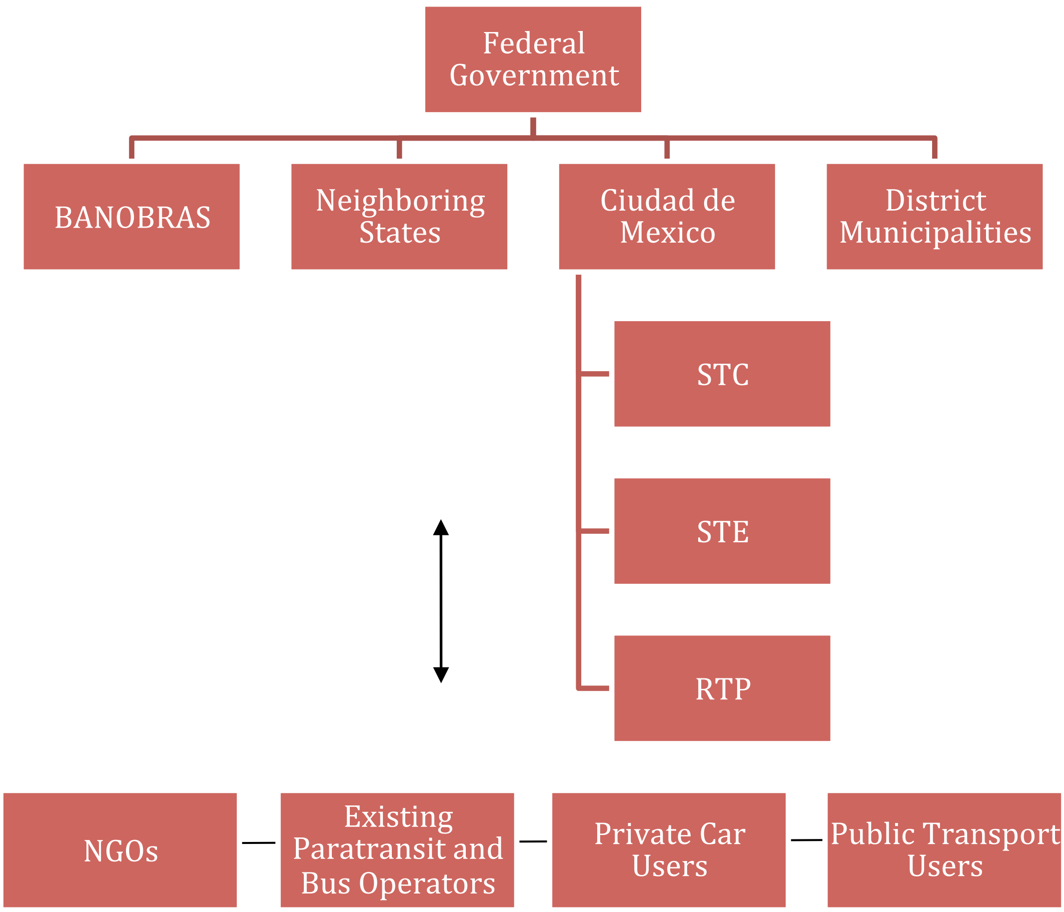

Figure 4: Actors in Mexico City Urban Transport

3. *Project*

Mexico City BRT system is called Metrobus locally. There are 6 lines in operation as of 2016 and there is an average of 1.1 million daily passenger trips. Total system length is 125 km there are 177 stations (BRTData, 2016). First BRT line was opened in 2005 at Avenida Insurgentes and this route goes from the northern part of the city to the south. It is considered to be the most important section of the system as it connects with other lines and main economic centers are located along this route (Dodero, Rocha, Hernandez, & Cerezo, 2014, p. 88). Eje 4 Sur is the second line and it started operating in 2009. Line 3, 4, 5 and 6 were opened in 2011, 2012, 2013 and 2016 respectively (BRTData, 2016). Together with other systems in other cities, the estimation is that 2.5% of all transport trips in the country are made with BRT systems (Dodero, Guerrero, Rodriguez, & Heras, 2016, p. 79).

BRT lines brought some positive outcomes in Mexico City within the scope of road safety, travel time savings, environmental protection, private car use and physical health. It is estimated that CO2 emissions were reduced by 27,000 tons a year thanks to Line 1 and accidents on this route decreased by 84% (Carrigan, King, Velasquez, Raifman, & Duduta, 2013, p. 36). Also, %17 of passengers that use the system is former private car users so the system succeeded in encouraging modal shift (Teunissen, 2014, p. 35).

Ridership of the BRT system increased steadily from the start and system's popularity among users can also be inferred from the additional 5 lines after the first one. According to a study, passenger demand increased by 300% from 2005 to 2014 (Dodero, Rocha, Hernandez, & Cerezo, 2014, p. 88). However, this also brought capacity problems with it. Because of the congested stations and buses, travel time savings and passenger comfort started to deteriorate after some time. In order to increase the capacity, investments were made and optimization studies were carried out. Articulated and bi-articulated buses were purchased, new terminals were constructed and some amendments on the route layout were carried out (Dodero, Rocha, Hernandez, & Cerezo, 2014, p. 89).

The responsible authority for the BRT system is RTP, Mexico City's public bus authority, and Metrobus, which is a public company established for BRT operations (Hidalgo & Graftieaux, 2008, p. 82). Even if RTP operates some buses on these lines, most of the operations are carried out by a number of private operators. Fare collection, data processing and surveillance systems are also outsourced. A trust fund was created for each line and private operators receive their km-based remuneration through these funds (Teunissen, 2014, p. 36) (CDMX Metrobus, 2016). It is argued that the system is close to breaking even through fare revenues (Hidalgo & Graftieaux, 2008, p. 82). But, passenger demand is not the same on each line and funding is a subject that is discussed often in Mexico City case.

Corridor	Daily Passenger Demand (Av.)	Length
Line 1	480,000	30 km
Line 2	180,000	20 km
Line 3	155,000	17 km
Line 4	65,000	28 km
Line 5	70,000	10 km
Line 6	150,000	20 km

Table 7: Average Daily Passenger Demand in Mexico City BRT (Source: BRTData)

Before the first line was opened, there were private operators working on this Avenue and, as mentioned earlier, they were included in the planning process in order to diminish a possible resistance. This relationship continued as these private operators were persuaded to switch to BRT operation. It is argued that this process was compelling and drivers that own a single bus were less willing to cooperate than those who have bigger fleet as they feared losing their business (Teunissen, 2014, p. 35). Moreover, we understand that private operators still affect future plans, as there is a resistance towards expansion (Hidalgo & Graftieaux, 2008, p. 83). After the project was finished and first line started operating then came the issue of remuneration because fares are defined by local government and it is emphasized that politically they are kept low for the disadvantaged population (Hidalgo & Graftieaux, 2008, p. 86). This issue was solved through RTP. Mexico City municipality purchased its buses to operate on this line so it did not need to invest and it received less compensation so that private operators receive the set amount (Teunissen, 2014, p. 36) (Hidalgo & Graftieaux, 2008, p. 83). However, as a result of incorporating existing users to the system and using an existing avenue, total investment cost remained low. According to a study that compares 42 systems around the world, Mexico City BRT is in the 12^{th} place in terms of investment cost per kilometer (F. Golob & Hensher, 2008, p. 504).

There are some criticisms to the system in that it is not a result of a transport plan and license plate number scheme was not devised by taking BRT use into consideration (Babalik-Sutcliffe & Cengiz, 2015, pp. 798-799). It is also argued that the idea to implement a high capacity corridor had been discussed for a long time but feasibility studies were done only after the project was initiated and because of this the corridor remains isolated (Hidalgo & Graftieaux, 2008, p. 86). But, it is put forward that after the suburban rail system and additional BRT lines, integration to other modes increased (Dodero, Rocha, Hernandez, & Cerezo, 2014, p. 89).

Problems that have been observed in terms of governance involved residents and users. It is pointed out that the intersection between Insurgentes Avenue, on which Line 1 BRT operates, and Reforma Avenue is a common area for demonstrations and more than 100 such incidents occur during the year, which results in halting of operations (Dodero, Rocha, Hernandez, & Cerezo, 2014, p. 91). On the users' side, the problem was adaptation. When the Line 1 was opened there was a big confusion and passengers were not able to understand how to use the system. It is noted that user education and contingent plans are important in this regard (Hidalgo & Graftieaux, 2008, p. 83).

C. Delhi BRT System

New Delhi is the capital in India and it was decided to implement a BRT line in one of the most congested roads inside the city. Population is increasing fast and the only public transport mode was buses until recently. There is a widespread motorcycle and bicycle use and, as Mexico City, Delhi also suffers from traffic congestion and air pollution. The BRT project had some success in terms ridership and passenger satisfaction after inauguration but there was also a heavy resistance from private car users, which, at the end, led to the closing down of the system. We will analyze this case as others and try to understand the reasons of failure at the end.

1. *Context*

Delhi is the capital of India, which is the second most populated country with a population of 1.2 billion (The World Bank, 2016). Delhi's metropolitan population is 21,753,486 according to 2011 census and it makes the city 3rd largest urban area in the world (Gov. of India, 2011) (Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 149). With GDP per capita standing at 1,581 USD, India belongs to lower middle income countries group (The World Bank, 2015).

India is a federal parliamentary republic and Delhi, "*as the National Capital Territory of the country, enjoys a special status under the Indian Constitution – it is neither a full-fledged state nor a centrally administered Union Territory*" (Kumar, Zimmerman, & Agarwal, 2012, p. 61). Throughout its long history, Delhi passed into the hands of a number of empires; however its present status was mostly thanks to the British Empire. In 1911 the British changed the capital to Delhi from Calcutta and until today it has remained as a central location. With the law that was enacted in 1991, Delhi gained the 'national capital territory' status (Gov. of Delhi, 2016).

As in other cities around India, Delhi has experienced a fast urbanization during last 50-60 years due to migration from rural areas. Its population grew 18-fold in this period (Badami & Haider, 2007, p. 962). Studies underline that population of urban areas in India increased from 17.3% to 27.8% between 1951 and 2001 (Ponnaluri, 2011, p. 269) and when we consider the total population of India, we can say that the effect is more severe than countries with lower populations. In parallel, the burden on local authorities is a common topic of discussion among scholars and representatives of NGOs. It is argued that migration and growing urban population '*is testing the government's ability to meet the growing demand for quality road infrastructure and public service*' (Ponnaluri, 2011, p. 269) and it '*outpaces the government's ability to provide enough basic services*' (Tsay & Herrmann, 2013, p. 15).

Fast urbanization has also brought problems with it in terms of transport, infrastructure and environment. In Delhi, slum population increased and it created a poly centric city structure with different hubs spread over a large metropolitan area. It is pointed out that approximately half of the population lives in slums (As cited in Badami & Haider, 2007, p. 962). Increasing transport demand, coupled with low income and insufficient public transport service provision, resulted in a huge increase in private vehicle use. Number of motorcycles in the city increased 16-fold and private car ownership 7-fold between 1981 and 2002 (Puchera, Korattyswaropama, Mittala, & Ittyerahb, 2005, p. 188). Even if it is relatively low when compared to cities in the Western countries, Delhi is the most motorized city in South Asia. There are 7 million vehicles and the ownership rate is 275 per 1000 persons (Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 149) (Badami & Haider, 2007, p. 962). Moreover, it is argued that as the city only has a few arterial roads, it makes managing the traffic harder (Kumar, Zimmerman, & Agarwal, 2012, p. 59). According to archival data, the motorization trend is not specific to Delhi and in India itself the number of motor vehicles doubles every four year (As cited in Badami & Haider, 2007, p. 961).

Traffic congestion, long travelling times, road accidents and low air quality are cited as the negative effects of rapid motorization that we mentioned. It is pointed out that travel demand grows by 9.5% annually in Delhi and average vehicular speed fell from 20-27 km/h in 1997 to 15 km/h in 2002 (Puchera, Korattyswaropama, Mittala, & Ittyerahb, 2005, p. 190). However, the emphasis is that the main reason behind is not cars but motorcycles and bicycles. For example, when it comes to road fatalities, pedestrians, cyclists and motorcycle users account for %42 of the total figure. In addition, this increasing trend of vehicles is linked with greenhouse gas emissions and it is argued that particulate levels exceed World Health Organization's guideline limits almost every day in Delhi (Badami & Haider, 2007, p. 962). The subject of air quality is so imminent that Delhi ordered all buses, taxis and trucks to switch from petrol and diesel engines to CNG in 2002 (Puchera, Korattyswaropama, Mittala, & Ittyerahb, 2005, p. 190).

Public transport is also an important means of transport in India. Approximately 80% of all trips in Kolkata, 60% in Mumbai, %42 in Chennai and Delhi are by public transport modes. When we look at the services we see that buses play an important role. Other important modes are rickshaws and taxis. It is argued that buses account for %90 of all public transport trips around the country and rail transport is not common (Puchera, Korattyswaropama, Mittala, & Ittyerahb, 2005, p. 189). Furthermore, it is pointed out that in the near future buses are likely to dominate public transport sector in India (Badami & Haider, 2007, p. 961). Cycling and walking are also important in national context. Here, the income level is emphasized and it is put forward that most of the population is too poor to afford other means of transport, so they walk or ride bicycles. It is more common in smaller cities and there, it accounts for over two-thirds of all trips (Puchera, Korattyswaropama, Mittala, & Ittyerahb, 2005, p. 187).

In Delhi, buses have been the main mode of public transport historically. Service is provided by the public authority Delhi Transport Corporation (DTC), private operators and Delhi Metro Rail Corporation (DMRC). DTC's bus fleet showed fluctuations in the past and in 1990s, Delhi saw a decline in DTC's services. However, it is argued that number of private buses rose in that period and bus remained as a central figure in public transport (Puchera, Korattyswaropama, Mittala, & Ittyerahb, 2005, p. 189).

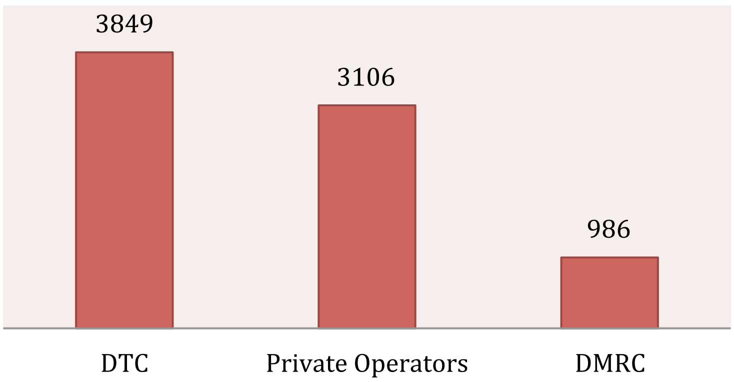

Figure 5: Delhi's Public Bus Fleet
(Source: Delhi Integrated Multi-Modal Transit System Limited 2009)

DTC also initiated a BRT system in the city and we will look at it in detail later. Other than bus, rail is also gaining popularity in Delhi but it is relatively new. First metro line was opened in 2002 and since than a network of 213 km has been constructed. System is managed by DMRC, a joint venture of India Government and NCT Delhi Government (DMRC, 2016). The plan is to extend the network and from the ridership figures we can understand that rail is going to be a major mode in Delhi's public transport system.

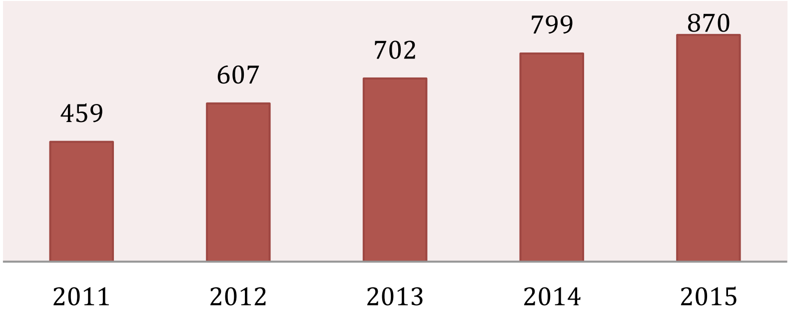

Figure 6: Annual Passenger Trips in Delhi Metro Network – in Millions (Source: DMRC 2015)

In addition to public buses and metro; rickshaws, bicycles and walking are also important in Delhi as it is in all India. As we understood, affordability of motorized services is a subject of discussion in the country and in line with that archival data also mentions Delhi's disadvantaged population. It is pointed out that for a worker that lives on the outskirts of Delhi, a daily round-trip with buses can cost up to 25% of his/her salary (Badami & Haider, 2007, p. 964). So, we can understand that walking, cycling and motorcycle use can continue to be an option in this setting. It is argued that public transport, especially bus based systems can be a solution in terms of affordability and deterioration in this service may again lead to an increase in motorcycle use.

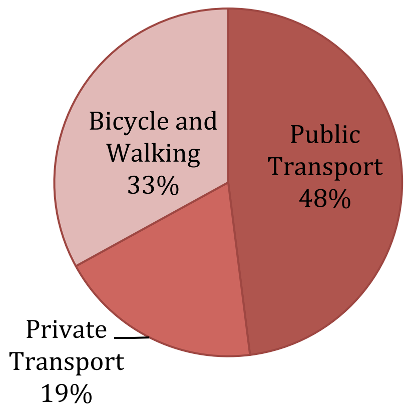

Figure 7: Modal Split in Delhi Transport (Source: EMBARQ 2008)

As we see on the chart above, bicycle and walking accounts for %33 of all trips in Delhi and it supports the views about the affordability of public transport.

2. *Actors*

India is a federal republic run by Common Law as mentioned before and it is argued that it is the largest democracy in the world due to its population (The World Bank, 2016). There are 28 states and 456 cities (Tsay & Herrmann, 2013, p. 14).

Government of India adopted a framework in 2005 to develop services in urban areas with over a million residents and some of the projects that have been implemented since then originated from this program. Called 'The Jawarharlal Nehru National Urban Renewal Mission' (JnNURM), the program encourages the development of new infrastructure such as BRT systems and renewal of older services (Ponnaluri, 2011, p. 269). Under the JnNURM, 20 billion USD was allocated for years between 2005 and 2011. In line with the program, India also enacted a law in 2006. This urban mobility law is titled National Urban Transport Policy (NUTP) and it '*outlines a fundamental shift that clearly prioritizes moving people over moving vehicles'* (Tsay & Herrmann, 2013, p. 16). It also '*promotes investments in infrastructure and reformation of state transport units (STUs)*' (Ponnaluri, 2011, p. 269).

This new law requires local governments to develop a Comprehensive Mobility Plan (CMP) to be entitled for funding from the federal government. It is argued that 50 cities prepared CMPs until 2014 and but only 30% of funds had been disbursed until 2011 (Böhler-Baedeker, Kost, & Merforth, 2014, p. 27) (Tsay & Herrmann, 2013, p. 56).

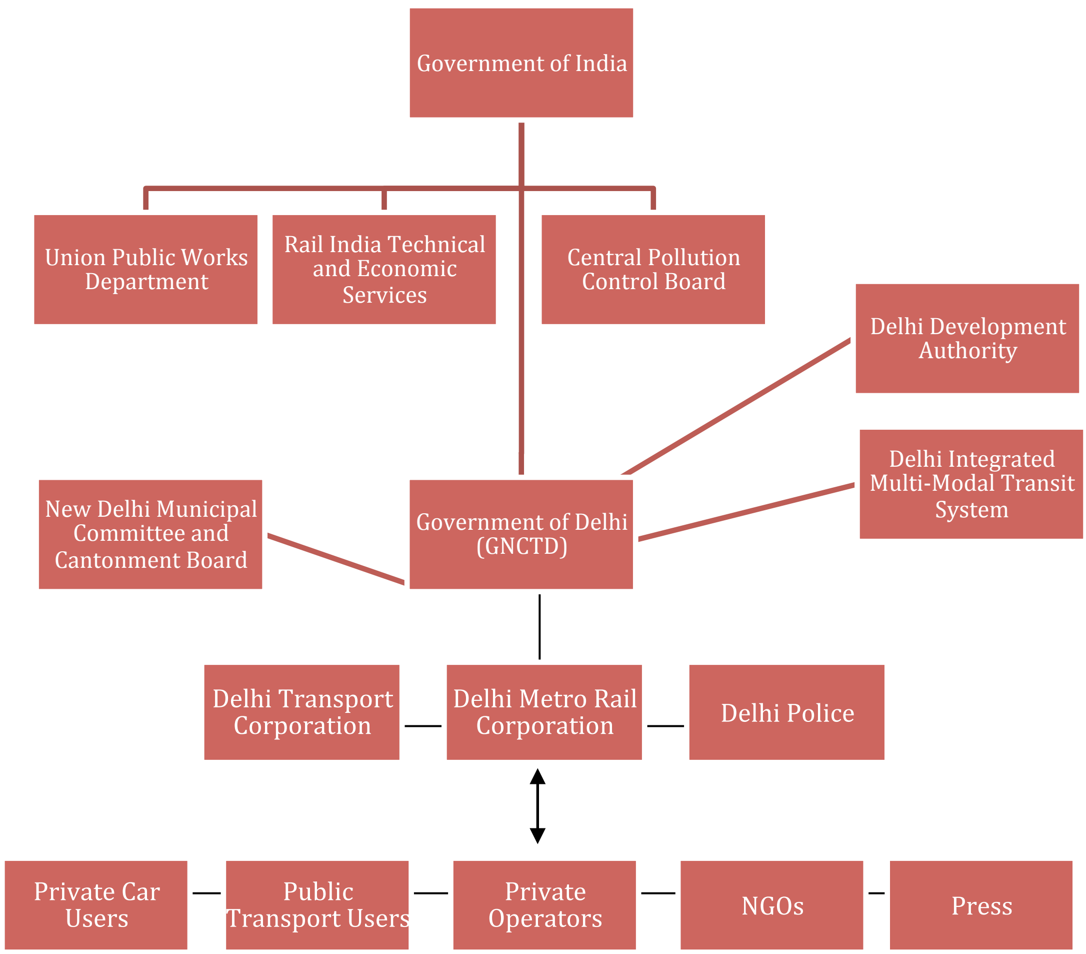

Figure 8: Actors in Delhi Urban Transport

Ideally CMPs require a comprehensive approach and details such as pavements, walking and cycling infrastructure need to be addressed. India Government has also supported the local governments in preparing the plans (ITDP, 2014, p. 28). However, in the end, allocation of funds remained low as mentioned before. Archival data emphasizes 'the lack of capacity' here. '*Weak institutional frameworks to oversee the administration of the policy*' and bureaucracy are cited as the main shortcomings. In addition, it is argued that simply requiring a plan as such to receive funding proved to be insufficient and public was not engaged in the preparation processes, which resulted in low support for projects (Tsay & Herrmann, 2013, pp. 22-56). Other criticisms emphasize '*a lack of political priority-setting and ownership of the plans*' (Böhler-Baedeker, Kost, & Merforth, 2014, p. 32).

We understand that after the Government of India, the second tier of managing authorities is states and in the case of Delhi it is the Government of National Capital Territory of Delhi (GNCTD) (Ponnaluri, 2011, p. 272). Other than these greater authorities there are also other governmental institutions that shape urban public transport developments. For example in the case of BRT, involved actors are cites as Transport Department of GNCTD, Central Pollution Control Board (CPCB) of the Federal Government, Delhi Transport Corporation (DTC), Rail India Technical and Economic Services (RITES) and Delhi Police. Here, there is a also a noted governance problem and it is argued that roads in Delhi can fall under the authority of several different governmental bodies such as Union Public Works Department, the Delhi Development Authority, Municipal Corporation of Delhi, New Delhi Municipal Committee and Cantonment Board. Thus, planning and implementation of urban public transport projects can be complicated (Kumar, Zimmerman, & Agarwal, 2012, p. 61).

Local urban public transport authorities are Delhi Transport Corporation (DTC) that operate public buses and regulate private bus operators and Delhi Metro Rail Corporation (DMRC) which constructs and operates metro lines. DMRC also operate buses but it is only feeder routes to the metro network. As mentioned before DTC's services fluctuated in the past and balance between private bus operators and DTC changed over years.

Years	**1991**	**1996**	**2001**	**2009**
Buses	4403	3206	2911	3849

Table 8: Change in DTC's Bus Fleet
(Source: Badami & Haider, 2007, p. 962 / Delhi Integrated Multi-Modal Transit System Limited 2009)

It is understood that private bus operators are important in Delhi's public transport system and this fact also reflects itself in the BRT project. It is argued that the BRT route was not able to gain an exclusive status and private operators used the route together with DTC's buses (Even if DTC initiated the project) (Kumar, Zimmerman, & Agarwal, 2012, p. 20).

BRT project in Delhi implies the important roles played by different actors in the city. For example, we learn that traffic police have a major effect in urban public transport. It is pointed out that during the implementation of the median BRT lane, traffic police changed junction priorities in the field without a systematic manner and this resulted in reactions from private car users as they had to stop for a prolonged time at traffic lights (Ponnaluri, 2011, p. 272). In this regard, we should also mention the influence of private car users' and, in general, the public in such initiatives. It is argued that India faces challenges in public acceptance of public transport projects because it is a large democracy and government institutions are strongly held accountable in such cases so large urban system initiatives may eventually be compromised because of opposition (Ponnaluri, 2011, p. 272). This argument is supported by the reactions and resistance that happened after the BRT route started to operate. Private car users criticized it by saying that taking median lanes to implement this project and narrowing their space is 'undemocratic' (Kumar, Zimmerman, & Agarwal, 2012, p. 14) and, even more; there were street riots against the project in early phases (Tsay & Herrmann, 2013, pp. 25-26).

3. *Project*

Delhi BRT, or High Capacity Bus Way (HCBS), was a 14.5 km long route and the first 5.8 km long stretch was completed in April 2008. Same year, it was extended to 14.5 km with curb lanes (Kumar, Zimmerman, & Agarwal, 2012, p. 8) (Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 150).

Initially, a metro line was considered for the location in 2003 and the feasibility study prepared by DMRC showed that the cost was higher than the state government could undertake so a BRT line was proposed the same year (Kumar, Zimmerman, & Agarwal, 2012, p. 54). The aim was to integrate this line with the metro system and have a fully integrated mass transit system (Ponnaluri, 2011, p. 273).

Transport Department of GNCTD appointed RITES as the consultant of the project in 2004 and during the planning phase there were initiatives to increase local capacity to implement the system (Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 150). Within this scope, former Mayor of Bogotá, Colombia, Enrique Penelosa was invited to make a presentation for the state government and later, in 2005, a feasibility study was conducted (Kumar, Zimmerman, & Agarwal, 2012, p. 54).

The BRT line started operate in 2008 and there were 66 stations in the middle and 32 stations on the side lanes. Of the total 14.5 km, 5.8 km was median dedicated busway and the remaining part was also dedicated but it is argued that exclusivity was not enforced on this part (Kumar, Zimmerman, & Agarwal, 2012, p. 64). Operators providing bus service on the BRT line were DTC and existing private bus operators. For passenger access, overbridges were constructed and bicycle roads were also added near the dedicated lane in some parts. For passenger information, GIS/GPS based systems were used at stations. Also, buses used for the system were CNG, in line with state government's earlier decision to convert public transport vehicles to this type of engine (Ponnaluri, 2011, p. 272).

It is stated that construction of the whole route was financed by the Transport Department of GNCTD, which is the equivalent of metropolitan municipality in other countries, and maintenance of the route was financed from advertising revenues. Total investment cost stands at approximately 3 million USD per km and for the 14.5 km long first phase it was 44.7 million USD. Costs that arise from operations such as subsidies for operation, depreciation costs of vehicles etc. were financed by DTC or by private operators themselves (Kumar, Zimmerman, & Agarwal, 2012, p. 67) (Daily Mail, 2015).

Number of Corridors	System Length	Segregation Rate	Average Daily Ridership	Average Commercial Speed	Travel Time Savings
1 in operation, 25 more planned	14.5 km	40%	80,000	18 km/h	30% on the segregated part

Table 9: Performance of Delhi BRT (Source: World Bank 2012)

The BRT system had some positive outcomes, for example bus operating speeds in the dedicated part increased from 12 km/h to 18 km/h and according to a survey 83% of the respondents regarded the BRT system as an improvement and a substantial amount of private car users said they can switch to this mode if it becomes more comfortable (Kumar, Zimmerman, & Agarwal, 2012, p. 67) (Ponnaluri, 2011, p. 273). However, from the start, private car users showed a resistance by saying that their road space was decreased. There were also continuous criticism from political leaders and media. For example, an independent survey carried out by a television channel showed that 65% of private car users found the system undemocratic. In order to diminish the effects of this resistance from different stakeholders Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd., a joint venture between the local government and an NGO, prepared a public relations plan and conducted surveys, campaigns and stakeholder meetings (Kumar, Zimmerman, & Agarwal, 2012, pp. 62-64). But, in the end the local government took the decision to shut down the route and dismantle the infrastructure (Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 151) (Daily Mail, 2015).

According to archival data inability to estimate public response and trying to implement the project in a short time are some of the major drawbacks (Ponnaluri, 2011, p. 273). In addition, together with public buses, security personnel, emergency services and school buses were also allowed inside the route and the fare collection was on board, which resulted in long dwelling times at stations. Selection of a route where the dominant mode is private cars is considered to be a wrong decision, too (Kumar, Zimmerman, & Agarwal, 2012, p. 62). Jaywalking of pedestrians and motorcycles entering the lane illegally are also noted as some of the problems that occurred (Kumavat, Sonawane, Patel, & Sakhalkar, 2016, p. 151).

We have completed our cases part with Delhi. Historical development, technical specifications and key indicators of three BRT systems have been presented in this part. Cities that we chose show similarities in population and they are all located in developing countries. **We have seen that, whereas Delhi BRT was terminated, İstanbul and Mexico City BRT systems are still active and they have high ridership figures. Each local authority took a number of measures to provide a quality service and most of these are in line with what we found out in our literature review. However, we have also seen that each example encountered problems during implementation and these change according to context. We will analyze our cases and list the constraints that we may find in the next part.**

IV. ANALYSIS

Until now, we have conducted a literature review and presented the findings on urban public transport and BRT systems. Also, we have made a comprehensive study on İstanbul, Mexico City and Delhi as our cases and provided information about the context, actors and BRT projects implemented.

It is evident that urban public transport will continue to be an important subject together with the current urbanization trend. From the first part of our literature review we understand that as cities grow and density increases, the issue of mobility climbs up to forefront in local agendas. Increasing car ownership, within this scope, is an enduring problem and when we consider the initiatives in urban public transport, we see that these two phenomena are two poles apart. Cities have limited capacities in terms of roads and traffic congestions become more common around the world with increasing number of vehicles each day. It is a frequently discussed topic which is used as a reference in debates about environment, economy, health, energy and time. On the other pole, there is public transport and it is considered to be a solution for mobility problems of cities. It is also a part of these debates and we learn that it has other dimensions such as equity and accessibility.

We also learned about public policies in urban transport through the first part of our literature review. Concerns about cities and social equity have forced governments to take actions on the national and local level. Countries such as India, Mexico, Brazil and France developed national frameworks to mitigate the problems that arise from private car use. Transport taxes and the PPP trend are other popular topics within this scope. It is understood that governmental authorities try to find new mechanisms and partnerships to raise funds for transport projects. In addition, governance notion and its reflections on urban public transport systems are analyzed in this part. We learned that, through the 'systems thinking' that is mentioned, it is crucial to see public transport services as a sub-system within a whole city system; so we must be aware of other sub-systems' effects on public transport and vice versa.

Second part of our literature review brought BRT systems into focus. Origins and definition of the system were analyzed and reasons for its current popularity were presented. It is understood that low investment cost and short implementation period are the two main reasons for cities to choose BRT system as a public transport mode. Moreover, in some cases around the world, BRT routes carry as many passengers as rail based systems and if there is no road construction involved, that is to say if the BRT route will use an existing road infrastructure, costs will be reduced. Here, the investment cost will be limited with construction of stations, over or underpasses for passengers and buses.

More than that, in some examples, costs are further reduced by using existing public buses for the BRT.

Through academic literature and archival data, we sought information about performance and success criteria for BRT systems. Our findings indicate that, according to a number of existing ex-post studies on BRT systems around the world, scholars and NGOs have some common views about this subject. Within this scope, running ways (segregation), service levels (headways, reliability etc.) and off-board fare payment are the most emphasized positive features in the sources that we examined. Even if not as common as this three, vehicle type and stations are also mentioned often.

In this part we will analyze İstanbul, Mexico City and Delhi BRT systems according to performance / success factors that we retrieved from the literature and at the same time will try to find about constraints and challenges that can occur during implementation. As mentioned at the beginning, increasing ridership and modal shift to public transport are regarded as success criteria in our study and we have the intent to fill the gap in literature about constraints in BRT with findings from our cases and analysis.

1. The Case of İstanbul BRT System

İstanbul BRT or Metrobüs, is the first case that we will analyze. We learned that it was completed in four phases and the first line was opened in 2007 after a construction period of 8 months. Second and the third phases were completed in 77 days and 5 months respectively and this supports our findings from the literature review. We learned that city authorities choose BRT systems because it is easy to implement. In addition, 52 km long Metrobüs route uses an existing highway and it can be argued that this also helped İstanbul Metropolitan Municipality finish project phases quickly with a low cost.

Metrobüs route is not fully dedicated and buses join other vehicle traffic on 15th of July Martyrs' Bridge for 2.7 kilometers. Archival data such as the BRT Standard of ITDP and academic studies that examine BRT systems list route segregation as a fundamental feature because it can be inferred that without it a BRT system would risk achieving a core function and that is speed. However, in İstanbul case we understand that this short part without segregation has not affected system's success in ridership. In 2007, there was an annual 7.8 million passenger trips and in 2015 this increased to 259 million but we should note that the length of the route was extended to 52 km in 2012 from a 18,2 km in 2007. Nevertheless, ridership was 203 million in 2012 and it increased to 259 million in 2015 and it proves that the increasing ridership trend continues even if there is not an increase in kilometers.

There are some studies that focus on the outcomes of Metrobüs and we cited them while writing our case. Through the findings of these studies we understand that Metrobüs resulted in shortening or cancellation of previous regular bus and paratransit routes. Consequently, there are reductions in carbon emissions and travel time. As we learned, these are some of the outcomes desired from these systems. In addition, modal shift occurred and 4% of car users switched to BRT because of its convenience and speed. Together with ridership, shift from private cars to public transport are two success criteria for our study and Metrobüs of İstanbul can be regarded as a success from those angles.

Metrobüs route is a single line and terminal stations are located in Söğütlüçeşme-Kadıköy on the Asian side and Beylikdüzü on the European side. The line stretches from one end of the city to the other. There are a number of densely populated and central areas along the route and Central Business District of İstanbul, Mecidiyeköy is one of them. It is argued that it is one of the primary trip generators for the system (Babalik-Sutcliffe & Cengiz, 2015, p. 796). So, it means that passengers that use this line come from suburban parts to central areas by using this route. Here, even if it has not happened in İstanbul's case, the first constraint that we can mention shows itself. We learned that there was a travel demand on this highway as there were previous regular bus and paratransit routes and they were either cancelled or shortened. However, if there had not been an existing demand, ridership figures may not have increased rapidly. In this sense, it can be argued that location and existing travel demand may be a constraint for such BRT projects to accomplish high ridership at the end. Consequently, the system may require higher amounts of subsidies from the local governments or fares may need to be increased if there no mechanism of governmental funding and the system is operated by private operators.

As we learned, ridership of the Metrobüs is increasing steadily and, even if it is a success when we look at it from an authority or operator perspective, this has created some problems in terms of capacity. Bus bunching on stations and passenger crowding on stations and buses are some reported problems. Also, there are incidents of sexual harassment due to on board crowding. It is pointed out that, in order to mitigate the effects, İETT carried out a route optimization study and increased the line's capacity by separating the closed system into sections (İETT, 2016, p. 46). It means that not all of the buses go from end to the other and, for example, buses running in one section carry passengers only for 10 stations and then passengers make transfer to another line within the system to travel further. BRT systems can experience such issues because they have a physical capacity as the roads are segregated. In closed systems like this, capacity can be increased through additional lanes, overtaking spaces and more buses (or higher capacity buses). However, more buses also mean a decrease in speed and as mentioned earlier, it is a core function. In the case of Metrobüs we learned that buses that are used in the system are already high capacity but as the route is on an existing highway, segregated lanes are limited to two. So at the end, capacity problems occurred and it resulted in debates about the choice of mode. Mayor of İstanbul, within this scope, made an announcement by saying that a rail system will be implemented along the route in the future. As we can infer from this example, capacity can also be a constraint for BRT systems.

A major criticism for Metrobüs that is cited in multiple sources is the low physical integration with other modes. It is argued that rather than being a part of the whole public transport system in the city, Metrobüs is designed and operated as a separate transport route. In our study, we will categorize it as a governance constraint because as we infer from our findings it has planning and management dimensions. There are 9 integration points to other modes throughout the line (İstanbul Metrobüs, 2016). However, passengers need to walk for a while at some integration points. For example, Zincirlikuyu is a transfer center and passengers walk 250 m to reach to Hacıosman-Yenikapı metro line. Similarly, the terminal station on the Asian Side is close to Kartal-Kadıköy metro line but here passengers walk for 400 m (İETT, 2016, p. 19). Sources that we examined point out that the BRT line was a quick decision and it was not an outcome of a transport plan. Integration problems arose after the project was finished. We also learned that even if the major authority in İstanbul is the Metropolitan Municipality and public transport sector is dominated by companies and institutions that work under the Municipality, organizationally, these bodies are quite fragmented. İETT is responsible for Metrobüs and regular buses and for other modes there are a couple of authorities and operators. It can be argued that issues such as low coordination in planning, physical integration, fare integration (passengers can use their smart card for Metrobüs but unlike other public transport systems, there is a distance based fare system) can partially be a result of this fragmentation and silo developments. We also learned that this fragmented structure was an obstacle in the path of total segregation because the 15th of July Martyrs' Bridge on which BRT buses join other vehicle traffic is under the authority of the Ministry of Transport. Therefore, we understand that governance related problems can be a constraint for these systems.

2. <u>The Case of Mexico City BRT System</u>

We learned through our research that the first BRT corridor of Mexico City was opened in 2005 and it has become a wide network with 6 operational corridors until now. From this information itself we can understand that BRT has a positive trend in the city and our findings in terms of ridership also support this. It is pointed out that from the beginning to 2014 ridership increased by

300% and today, the network has an average of 1.1 million daily passenger trips. Moreover, we found out that according to calculations 17% of BRT passengers are former private car users; hence a modal shift has also been observed. These are desired outcomes and from our study's perspective and standards the system can be regarded as success. Furthermore, we see that there are also positive outcomes in terms of environment. BRT has resulted in a decrease in CO2 emissions and it is important because air pollution is cited as one of the biggest problems in Mexico City, which is mostly due to its geographical characteristics.

It is understood that even if Mexico City's BRT network has gained popularity and grew in size with additional lines, it was not easy to persuade all actors in the city at the beginning. Paratransit modes have had an important place in city's public transport system. We learned that there are 45,996 microbuses in the city today and the share of paratransit in public transport was 55.1% a short time ago, in 1995. Coupled with private cars, this many vehicles on the road created a heavy traffic load and projects such as elevated highways and plate number restriction (Hoy no circula) have been implemented. We can also infer that BRT was chosen as a solution partly because of these existing problems such as congestion and air pollution. However, existing operators' resistance became an obstacle at the beginning as mentioned and it is argued that this led the local government to integrate them to planning process and also operations afterwards. For example, the first line of BRT is mainly operated by former private bus operators and paratransit operators, and urban public transport operator of the city is only present with a small fleet inside the system. The political power of existing private operators is still high today in that there is a resistance towards the extension of BRT network.

We understand that another challenge for Mexico City in implementing such projects is fragmented authorities. Mexico City is called the Federal District, or Distrito Federal, because the Federal Government is situated here and until recently it was acting like a municipality for the city, appointing the mayor itself. However, the need for a specialized authority emerged and now the city has an elected mayor. Moreover, residential areas now extend beyond the borders of this district and neighboring states have become actors in the management of the urban agglomeration. It is argued that together with the city government and neighboring states, there are approximately 50 local authorities within the metropolitan region and coordination among them is weak. So, projects that go through the jurisdictional areas of different authorities are under risk because of this low coordination. It is clear that existing actors and legislative frameworks can be a challenge for urban public transport and more specifically BRT systems so we will put these challenges under our governance constraints category.

We are able to observe more constraints and challenges in terms of governance as we learn more about Mexico City's story of BRT. In İstanbul case we learned that the BRT was not an outcome of a public transport plan and this resulted in problems about physical integration. There is a similar criticism for Mexico City and it is argued that the project had been discussed for a long time but feasibility studies were carried out just before the project was implemented. Thus, corridor remained isolated from the general public transport network. In addition, we see that users were not able to adapt to BRT in the first weeks because they did not have a BRT experience. So, BRTs can also have governance challenges because of users.

Funding of the system is one other widely discussed topic in regard to Mexico City BRT. We see that financing has been an issue since the planning stage. The local government, with a strong will to open the first BRT line, financed the infrastructure and it even purchased the buses for operators. Furthermore, after the increase in ridership, capacity of the system became a problem and local government once again took the stage by financing new stations, route layout optimization and the purchase of higher capacity buses. In addition, we understand that there is a continuous subsidy scheme as a result of operational costs. There are private operators providing BRT service and it is argued that the local government has had to negotiate with them constantly because not each line is breaking even. It is mainly because of low fares and keeping fares low for the disadvantaged population is a political decision. So, at the end, local government is forced to cover private operators' costs in this regard. It is pointed out that the financing subject gets further complicated with local conditions. One reason is the limited commercial transparency of private operators. It is argued that passenger volume data can be hard to obtain in some cases. The other reason is local government's not being able to prevent the competition on BRT routes. We learned that paratransit modes still operate on locations where there are also BRT lines. Mobile application based services such as Uber is one example. Therefore, it is evident that funding can also be a constraint for BRT systems both at the beginning and during operations.

Location based constraints have also manifested themselves in Mexico City. It is pointed out that there are economic centers located along this route and we understand that there is an existing demand. However, as discussed in the previous section, existing demand's being low may be a constraint for BRT systems to achieve high ridership and popularity in other cities. Also, the location may be a challenge if the corridor runs through a dense area. Reforma Avenue is an example in this regard. It is stated that this location is used for demonstrations in Mexico City and 100 such incidents occur in a year. It results in halting of operations, so external location based factors can also be a challenge as can be understood from this example.

3. The Case of Delhi BRT System

Delhi BRT was shut down and related infrastructure has been dismantled recently but it was chosen as a case for our study so that we would be able to understand more what challenges can come up during the implementation of BRT projects.

According to our research, the route that was chosen for BRT was already a dense corridor as in Istanbul and travel demand was high. However, as we also learned, population is increasing rapidly in the city and general travel demand grows by 9.5% annually. So, it can be said that travel demand is less likely to be a problem in urban public transport projects. We can also understand this from the increasing number of vehicles. It is pointed out that in Delhi, and in other Indian cities, motorcycle is more of a problem than private cars in this regard. Number of motorcycles increased 16-fold and private cars 7-fold from 1981 to 2002. So, understandably, air pollution and traffic congestion are common problems.

India adopted a national framework for financing urban public transport projects against deteriorating urban conditions. The country has the second biggest population in the world after China and migration from rural areas to cities is on the rise. It is understood from our research that the need for radical transport solutions in urban areas is imminent because of the fast urbanization and its consequences on mobility. So, a national program has been devised to improve conditions but the archival data we reviewed emphasize the problem of receiving funds through this program. Cities need to prepare a comprehensive urban transport plan to be entitled for federal financing and it is argued that most of the cities, which generally plan to implement BRT systems through this program, have not been able to become eligible. The reason for this situation is argued to be low institutional capacities; in other words, cities are not able to prepare such comprehensive urban transport plans. It is a problem of capacity; more specifically, institutional capacity and we will mention institutional capacity as a constraint in our conclusion part because it also played a role in the failure of BRT. Our findings showed us that the project was not carried out in a systematic way, as authorities in Delhi did not have a former BRT experience.

Ideas to implement BRT in Delhi dates back to 2003 but the line started to operate in 2008. Even if the plan was to have more BRT km's at the end, the first phase consisted of 14.5 km and it was not fully dedicated. We learned that the segregation rate was limited to 40% and it can be argued that it is a negative indicator when we consider that route segregation is cited as a fundamental feature in the literature. Nevertheless, the system was able to achieve as many as 80,000 daily passengers when it was active and it brought positive outcomes within the scope of travel time savings and operating speed of buses. Passengers were able to save time by 30% after the BRT and buses' speed increased to 18 km/h when compared to 12 km/h without segregation. Moreover, passengers were satisfied with the system according to surveys. 83% of the respondents of a survey regarded the system as an improvement and an important amount of private car users showed their intent to switch to this mode if there were enhancements in passenger comfort. In addition, the local authority took some steps to improve the system and these can be evaluated under the success factors that we retrieved from the archival data. For example, overbridges and adjacent bicycle lanes were constructed to enhance accessibility and integration. Also, to improve communications, GIS and GPS based systems were implemented at the stations. Buses used for the system were CNG in accordance with the local legislation and it can be argued that it is a positive indicator in regard to environment friendliness of the system. So, as we understand, there were a number of initiatives in Delhi for a quality service and these are in parallel with our success factors.

If we are to look at challenges and try to understand the reason for termination of service, physical constraints can be a good start. It is pointed out that Delhi has only a few arterial roads even if it is a huge urban agglomeration and it makes managing mobility harder for the local authority. BRT was also affected from this context as the route on which the system was implemented had already been congested by private vehicle traffic. Arguably, it can be inferred that cities can suffer from this kind of physical constraints because rapid urbanization can lead to unplanned settlement areas with roads that are not built with a long-term vision. Urban public transport authorities that want to implement BRTs may need to bear high expropriation costs to add more lanes or they may end up decreasing the capacity for other users if they are not able to enlarge the existing road.

It is observed that, aside from others, governance was the major challenge in Delhi BRT with many different aspects that should be cited in our study. We understand that problems started as early as the project was announced. Private car owners reacted severely and this reaction was further intensified by continuous coverage of the topic in the press. The discussion focused on equality and private car owners argued that the system is 'undemocratic' because two lanes would be taken from them. It is pointed out there were even street riots at preliminary stages. We learned that such cases of opposition towards new projects are common in India context. It is argued that public authorities face this challenge because they are easily held accountable for the outcomes of their initiatives.

There were other governance related problems in addition to resistance from private car users and they resulted from relations with actors such as public transport users, other public service providers, paratransit mode operators and pedestrians. India has a relatively low GDP per capita and it is argued that even public transport can be expensive for a good amount of the population. Sources that we used in writing our case point out that for a worker a daily round trip with buses can cost 25% of the monthly salary. So, we can understand that systems may not be able to achieve high ridership in such contexts no matter how convenient and comfortable the service is. We also learned that traffic police caused some problems during the operations. It is argued that they changed junction priorities randomly and made private car users wait for a long time at intersections so as to speed up the service in BRT. This triggered more reactions from private car and motorcycle users who were already frustrated. Moreover, we learned that authorities had difficulty in enforcing route dedication as vehicles such as motorcycles, school buses and ambulances used the segregated route and pedestrians were often jaywalking. So, at the end services were terminated and segregation infrastructure was dismantled together with stations even though the local government carried out a number of public relations projects to change the public opinion.

4. <u>Comparative Analysis of Cases and Listing of Findings</u>

We reviewed the existing archival data about urban public transport; İstanbul, Mexico City and Delhi BRT systems and then analyzed our cases according to BRT success factors. It can be argued that some of these factors also played a role in our cases. We can say that, as pointed out in the sources we reviewed, dedicated right of way, service levels, passenger information, integration with other public transport, off-board fare collection, bicycle lanes, pedestrian access and passenger comfort are also mentioned in our cases either as improvement factors or ridership drivers.

BRT Cases	İstanbul	Mexico City	Delhi
System Length	52 km	125 km	14.5 km
Av. Daily Ridership	850,000	1,100,000	80,000 (before termination)
Number of Corridors	1	6	1

Table 10: Key Indicators in Our Cases

Moreover, we were able to assess route segregation's impact in all three cases and found out that even if it is a basic feature, total segregation may not be needed for high ridership as we understand from İstanbul's case. Intersection treatment is also regarded as a BRT basic and Mexico City experienced disruptions in service due to intersections but, as in İstanbul's total segregation example, it has not affected network's overall success in terms of ridership.

Our cases show similarities in that their launching times coincide with each other and they were implemented in highly populated cities. İstanbul, Mexico City and Delhi belong to the group of world cities known as megalopolises with borders extending to neighboring cities or states. It is evident that the need for mobility solutions grows exponentially along with population and BRT initiatives are expectable if cities with this size do not have a profound former experience in high capacity public transport service provision. All three systems were initiated by corresponding local authorities but there are some differences in financing the operations. We learned that Istanbul Metropolitan Municipality (IMM) made the capital investment itself and operations are 100% public. Delhi and Mexico City also made the capital investment through their urban transport authorities but they chose to incorporate existing private operators to their systems, so operations are private to some extent.

BRT Cases	İstanbul	Mexico City	Delhi
Project Coordinator	IMM / İETT	CDMX / RTP	GNCTD / DTC
Capital Investment	IMM /İETT	CDMX / RTP / Private Operators (Buses)	GNCTD / DTC / Private Operators (Buses)
Financing of Operations	İETT	RTP / Private Operators	DTC / Private Operators

Table 11: Project Coordinators and Financiers in Our Cases

The object of our study was to search for success factors in BRT systems thorugh literature review and then try to find out what kind of constraints or challenges can occur during implementation by analyzing our cases. It can be argued that ridership drivers and performance factors are widely discussed but constraints are not directly addressed. We understood through our analyses that cities had similar objectives before implementing BRTs and they started these projects in recent years but they encountered some common and some distinctive challenges in the course. So, we have focused on these aspects in our cases and analysis. Our findings indacate that even if cities decide to implement BRT systems and improve their service with a number of initiatives, they may still face challenges and constraints. In general, these can be physical, institutional, financial and governance related constraints and they can be summarized as in the figure below:

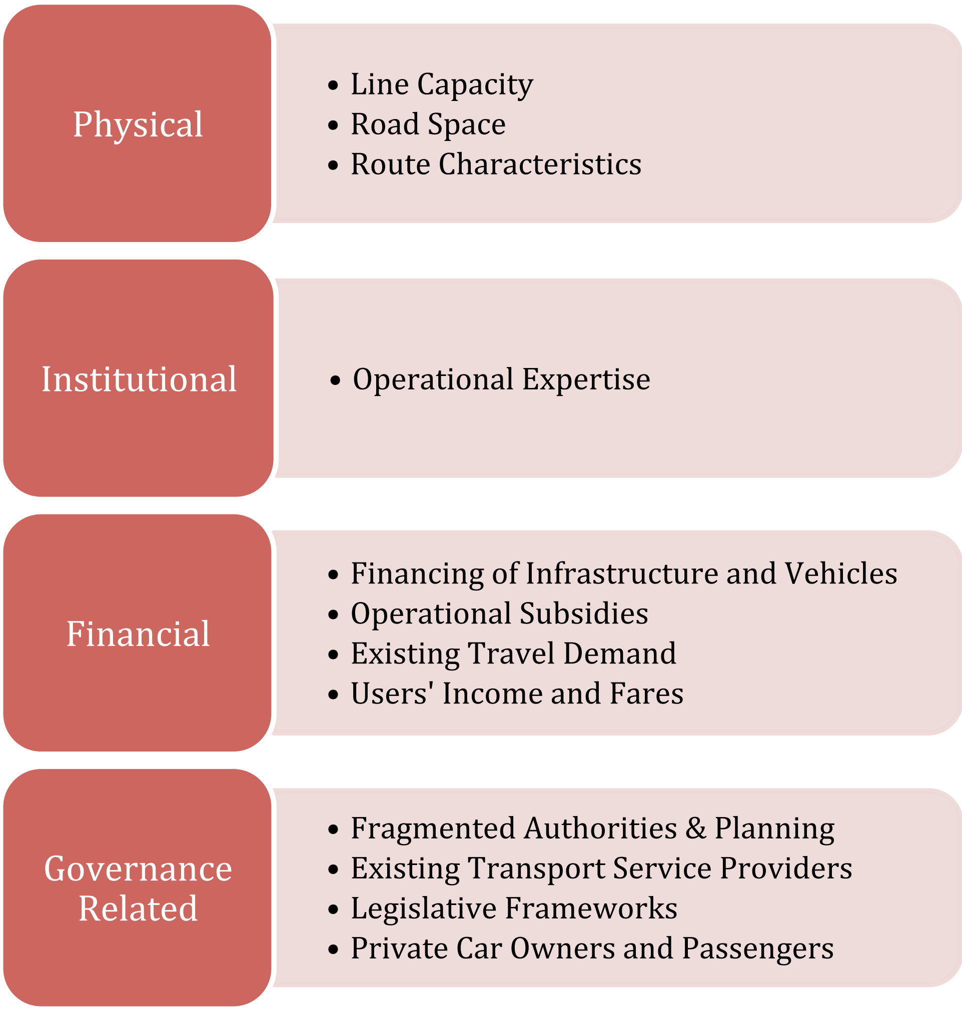

Figure 9: Constraints and Challenges in BRT Projects

On the physical side; limited passenger capacity (overcrowding in İstanbul BRT), insufficient road space to apply a dedicated lane and some route characteristics that can cause disruptions in operations (e.g. Reforma Avenue's being a demonstration area in Mexico City) are found out to be possible constraints in BRTs. Through our literature review and then Delhi case we learned that these systems require an expertise operationally because even if vehicles that are used are buses, it is usually closed system operations and in that sense operators need to pay attention to features such as headways and stations more than they need to in regular public bus transport. So, we can infer that sufficient institutional capacity in terms of BRT expertise is needed to have a successful system. There can also be financial challenges in BRT systems and these can be observed in financing of infrastructure and operational subsidies. Even if there are BRT examples that break even, local authorities may need to subsidize operations at the end because of low demand or fares. For example, we learned that not all 6 corridors are breaking even in Mexico City and there were conflicts with private BRT operators because fares are kept low for political reasons. Users' income level is also important, as we understand from Delhi case, where a good amount of the population is not able to afford riding on BRT. Lastly, we encountered several governance problems in analyzing our cases. We learned that fragmented authorities and fragmented powers make the implementation of such projects harder in all our cases. In İstanbul and Mexico City, failing to do a long-term plan caused corridors being isolated at the end with low physical integration. In İstanbul case we also learned legislative frameworks can play a role because it was an obstacle for İstanbul BRT in achieving total segregation. In addition, with Delhi and Mexico City cases we learned the importance and effect of actors such as existing public transport service providers and private car users. Mexico City was forced to include existing operators in BRT planning and operations because of their local political power and also we learned that extending the system is not easy because of their resistance. In Delhi, resistance was from private car users and their resistance was further multiplied by the support of press and representatives of opposition parties, which led to the closing down of the system.

V. CONCLUSION

Our findings indicate that several constraints or challenges can occur in the implementation of BRT projects but it can be argued that our findings cannot fully be generalized to all systems around the world because we chose three examples from developing countries and there are a number of different systems and contexts. Of course, all of the listed challenges and constraints can be experienced to some extent everywhere but financial challenges such as low income of users and governance challenges such as the effect of fragmented authorities and lack of long-term planning may be less influential in developed countries.

On the other side, our cases can also be a role model for other initiatives in some aspects. Mexico City's incorporating existing paratransit operators to the new BRT system is an example of good governance within this context. Even if it may have started as a necessity, because we learned that the local authority wanted to keep clear of a strong resistance from a large number of paratransit operators, it can be argued that it resulted in a smooth transition from an existing deteriorating context to a more sustainable system for all stakeholders. Paratransit operators have not experienced a loss in their earnings, users have enjoyed time-savings and a more comfortable transport and the city have seen a reduction in air pollutants. However, we understand that no such model was used in our other cases. In Istanbul, the local authority provides the service and private operators were not allowed in the system. Some minibus and private bus routes were cancelled after the BRT and it must have meant a loss of business on their side. Existing operators were allowed to operate in the BRT route in Delhi after the system was taken into service but as we learned it was not done in a systematic way as Mexico City so all vehicles suffered from congestion at the end.

Delhi has a good practice of adjacent bicycle lanes among our cases and it separates it from Mexico City and Istanbul in this respect. BRT system was planned with these lanes and the aim was to regulate dense bicycle traffic along the same route. It can be argued that this increases the sustainability of urban transport as bicycle use itself is sustainable and being promoted around the world because it has good effects on human health, environment and energy use. On the other hand, we can also say that already high use of bicycles and motorcycles in India might have played a role in the choice. Also, bicycle lanes may further narrow down the space for other vehicles and it can increase the resistance from them. But it can still be a good option for cities that have enough space.

Another good example is Istanbul's service policy. Metrobüs route provides around the clock service all the time, which is not the case in Mexico City and

Delhi. We can discuss this in line with social policies and ‘equity in mobility’ notion that we learned through our literature review. In a sense, if public transport does not provide around the clock service, then mobility of residents that only rely on public transport to move around the city may get restricted when compared to those that own private cars. Tourists or transit passengers can also be added to this disadvantaged group. But, providing around the clock service can increase operational costs and also local government subsidies if the travel demand during night hours is not high enough to break even.

Our literature review and cases also helped us focus on generally overlooked factors in BRT. Planning and governance are two examples in this regard. Lack of long term vision in implementing the BRT routes is mentioned as a criticism in Mexico City and Istanbul cases. Learning from these instances can be valuable for other cities that want to implement such projects. It can be argued that similar challenges can emerge in other locations also due to the nature of BRT systems. While reviewing the literature about the advantages of BRTs we learned that the possibility to implement these systems quickly is one of the prominent factors for cities to choose this mode. It is understandable that if traffic congestion or mobility demand increases in a short time then cities may not have other options that can be realized in a short time. But this can also has adverse effects or outcomes within the scope of public transport network at the end. We learned that, because of not having been implemented under the transport master plan, Istanbul BRT remained isolated at the end. It was the case in Mexico City, too. So, we can understand that cities can create new problems while trying to solve one and a holistic thinking and planning is needed for urban infrastructure projects.

The need for a holistic approach is also present in stakeholder management. Delhi experience proves that governance related problems can be highly risky for the whole project itself at the end. Cities are complex and organic structures with various groups that have different backgrounds. We learned about one of the many conflicts that can emerge among these different groups inside cities from the Delhi case. The discrepancy between private car users and the local authority which tried to provide a public transport service for public transport users became severe and led to the removal of the BRT system. Similarly, Istanbul tried to minimize the effects of a possible resistance from private car users by keeping construction periods as short as possible. Private operators were more of a concern in Mexico City and the local authority tried to avoid possible conflicts by opening up the operations to them so that they can continue their business. As we can understand, contexts can differ from city to city but a good stakeholder analysis and related actions may be needed for a successful and sustainable project. Actors should find a common ground so that future disputes can be avoided and this requires a strong leadership and political will on local governments’ side.

Recommendations for Future Research

BRT concept has been analyzed and adopted by many cities around the world and we have seen that there are also many academic studies in line with the popularity of these systems. These studies generally focus on system components, performance factors and ridership drivers. There are also guides that have been prepared for public authorities that plan to implement BRT systems in their cities. Guides written by GIZ and TRB are quite detailed and include different options in terms of system components so that local authorities can customize their systems according their capacity and needs.

While reviewing literature for our thesis we encountered some current notions in public transport such as Transport Oriented Development (TOD) and seamlessness of transport systems. TOD approach suggests that infrastructural components of cities such as recreational areas, car parks, business districts, housing etc. should be planned and developed in tandem with transport plans and projects. This concept is quite new and the results of such local approaches have not been assessed broadly in academia. Similarly, in BRT literature there is a gap in studies that examine the effects of these systems on city development. Such endeavors require an extensive focus because historical data on buildings, an analysis of investment records and their relation with BRT corridors would be needed but it can help us understand the effects of BRT better. Seamless transport concept and its reflections on BRT systems can also be a fruitful effort for researchers. For example, we have found out that lack of this approach resulted in Mexico City and Istanbul BRTs being isolated at the end. Reasons for limited integration in urban public transport systems or the effects of seamlessness on public transport ridership can be studied.

We understood from our research that BRT concept has emerged partly due to rapid urbanization trend and insufficient local resources to go for more costly options such as rail but it is evident that cities are apt to implement more corridors where such systems have become successful in ridership and passenger satisfaction. Within this scope, studies towards the future of BRT would be lucrative. Researchers, for example, can make a survey of existing or former BRT lines and try to find out whether cities that applied BRT changed to other modes after or they have the intent to have more corridors so that we can have a better understanding of the future of this concept. There is also a need for more studies towards paratransit modes such as minibuses, vans, taxis and their historical status in cities within the overall mobility services.

Lastly, it is befitting to touch upon technological developments and their use in urban transport sector. There are numerous intelligent transport systems (ITS) and mobile applications that have been used to improve existing services. Some of these practices, such as Uber, even went far away to change the urban mobility scene permanently. However, the effect of these applications in BRT systems have been analyzed rarely. Integration of these modes to the others through mobile trip planning applications, behavioral change of users after ITS improvements, reflections of these improvements on management and road safety of BRT corridors can be interesting topics to study and also to read.

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