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TRANSLATIONAL ARTICLE

Bus Rapid Transit: End of trend in Latin America?

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Abstract

Bus Rapid Transit (BRT) has grown fast in the last 25 years, promising low-cost, rapid implementation, and large positive impacts. Despite advances, many systems in middle- and low-income countries face operational and financial issues, particularly in Latin America. Some practitioners, researchers, and decision makers, and the media are questioning its ability to provide quality services. Is this the end of a trend? To answer this question, this paper explores the status of the BRT industry and literature on the topic, with a focus on Latin America, as well as the emblematic cases of Curitiba, Quito, Bogotá, Mexico, and Santiago. Overcrowding, lack of reliability, fare evasion, issues of safety and security, and poor maintenance are evident problems in these and other cities. They seem to be a result of institutional and financial constraints, as well as technical limitations of surface-based transit modes. BRT has been able to deliver high-capacity and fast and reliable services, but requires permanent management and investment to face growing demand and aging infrastructure and vehicles, just like rail systems do. In addition, attention needs to be provided to data, technology innovation, urban integration, and public participation to keep BRT as an integral part of multimodal high-quality sustainable mobility networks in the future.

Policy Significance Statement

Bus Rapid Transit is one component of the mass transit development toolbox. The number of cities adopting BRT grew fast in the first 15 years of the twenty-first century but then stagnated, following a similar deployment pattern as tramways at the beginning of the twentieth century. This paper explores issues faced by BRT systems, particularly in Latin America. Several problems with BRT are common across several applications, and most of them seem to be the result of financial and institutional limitations and political debates that hindered progress, rather than the mode itself. The paper provides recommendations to improve service quality and increase public acceptance of this component of multimodal transit networks, facing broader issues of transit decline, particularly after the pandemic.

1. Introduction

BRT systems are now part of public transport systems in 187 cities worldwide (Global BRT Database, 2023). Most of the growth in implementing such systems occurred in the last 20 years. This type of bus systems has become a new way of providing medium and high-capacity transit (Munoz and Paget-Seekins, 2016), and is bringing mobility, environmental, social, and road safety benefits to the cities in which they have been implemented. Nevertheless, BRTs have also faced important difficulties worldwide, such as problems during roll-out (Lindau et al., 2014), persistent congestion, and low user ratings. Issues have resulted in planners questioning the ability of BRT to fulfill the promises of low cost, rapid implementation, and high performance which made them attractive in the first place (Wright and Hook, 2007).

The media has also asked the question, "Is this the end of a love affair with buses in Latin America?" (Delgadillo, 2016; Hidalgo, 2017). Data shows a reduction in both the number of new cities adopting BRT and the number of kilometers built in the last 5 years. Adoption of BRT follows an "S"-shaped curve, common in most technological adoption patterns (Briscoe et al., 2011). This was also the case of electric tramways in the first decades of the twentieth century.

This paper shows the status of the BRT industry using data, and highlighting recent declaration of progress around the world. It also reviews research on the positive impacts, drawbacks, and limitations of BRT. Then it presents general data of BRT in Latin America as well as five short case studies of iconic bus systems. The paper closes with conclusions and ideas for the way forward, especially the role of data for improving planning and operations. BRT is one element that may help the global transit crisis, resulting from ridership decline during and after the pandemic.

2. Methodology

This study reviews key characteristics of BRT across different geographies from a complete database on these systems (Global BRT Database, 2023). The data is used to review progress over time and establishing trends. Progress is then compared to the expansion and further decline of tramways in first half of the twentieth century. While the conditions for expansion of these two types of transit systems are quite different, tramways had a renaissance by the end of the last century, which may provide some lessons for the improvement of BRT.

The study then reviews global evaluations of BRT to identify contributions to sustainable mobility and common issues. Data of BRT across Latin America and five short case studies, conducted across Curitiba, Quito, Bogotá, Mexico City and Santiago, are then used to find elements that created problems in expanding and maintaining systems in these cities. The selected cities have been recognized as very relevant in the development of BRT (Levinson et al., 2003; Munoz and Paget-Seekins, 2016): Curitiba has been regarded as the first to implement large-scale bus corridors; Quito was the first city outside Brazil that replicated the BRT; Bogotá was the first very high-capacity BRT; Mexico City has shown continued expansion over two decades; and Santiago is a relevant case study on large-scale transit transformation, including bus corridors. The information from global studies and the selected case studies is then used to discuss the technical, financial, institutional, and political elements that may be preventing the evolution of BRT. The discussion is then used to provide recommendations on the way forward for BRT as part of integrated transit systems.

3. The BRT Global Database

This public database is a very complete repository of information, maps, images, and videos about bus corridors around the world. It is maintained since 2012 by several organizations working in sustainable mobility and public transport. It keeps up-to-date data on BRT implementation and system characteristics at a system and corridor level around the world. The database records 73 indicators, including socioeconomic data (GDP, population), design characteristics (length, stations, type of preferential treatments), vehicle fleet (type of buses and their characteristics), and performance (passenger demand, maximum loads). Each data point has links to original sources, making it an adequate resource for this analysis.

4. BRT Status and Progress

As of August 2023, the BRT Global Database reported 469 bus corridors in 187 cities along 5,618 km, serving more than 34.9 million passengers every day (Global BRT Database, 2023). The largest number of cities, kilometers, and passengers is found in Latin America, with one third of the cities and corridor length, and 60% of the passengers, followed by Asia (Table 1).

This high concentration in Latin America is expected since the BRT concept was first introduced in Curitiba (Lindau et al., 2010) and adopted as a relatively low-cost and rapid implementation solution for medium- to high-capacity transport corridors in multiple cities. There are notable applications of Quito (1995), Bogotá (2000), and Mexico City (2005). Cities in Brazil replaced basic bus priority corridors with BRT and introduced new corridors in preparation of the FIFA World Cup 2014 and the 2016 Summer Olympics. Of interest are the new corridors in Belo Horizonte (2014) and Rio de Janeiro (2014–2016).

The idea was adopted in multiple geographies and with different scopes: low- to medium-demand corridors in Northern America, Europe, and Oceania, bus priority and some advanced applications in India and China and other countries in Asia, and some applications in Africa (Wright and Hook, 2007; Hidalgo and Gutiérrez, 2013).

Global growth of BRT seemed to reach a tipping point in the year 2000 with the implementation of the TransMilenio system in Bogotá, but the number of cities added in the last 5 years presents a strong declining trend (Figure 1), as well as the number of kilometers added (Figure 2).

These curves follow the most common pattern of innovation adoption (Briscoe et al., 2011), and somehow resemble the rapid growth of tramways during the first half of the twentieth century as indicated in Figure 3 (Martínez, 2012; Schmucki, 2012; Guarnieri, 2020). Tramways had a decline after World War II (Doménech-Carbó, 2019), but faced a renaissance in the form of light rail transit by the end of the century, especially in Europe, Australia, and Northern America. A focus on service quality, well-designed vehicles and stations, and integration with the urban fabric (Topp, 1999) helped a new wave of light rail transit implementations. More recently, light rail resurgence has been associated with environmental benefits, as well as improvements in effectiveness, efficiency, economy, and equity (Van Der Bijl et al., 2018). While the conditions in which tramways were initially adopted are quite different to the conditions in which BRT has been implemented, the decline of tramways and the recent experience with LRT growth may help in identifying ways to help BRT progress as part of multimodal transit networks.

5. Common Issues with BRT

Multiple reviews regard BRT and its European counterpart, Buses of High Level of Service (BHLS), as innovative concepts to complement rail systems in large cities or provide the backbone of public transport in medium-sized and small cities (Levinson et al., 2003; Wright and Hook, 2007; Diaz and Hinnebaug, 2009; Finn et al., 2011; Hidalgo and Gutiérrez, 2013; Munoz and Paget-Seekins, 2016). BRT has been showcased as an alternative to improve mobility, reduce harmful emissions, and improve access to low-income areas (Carrigan et al., 2014; Venter et al., 2018). Some studies indicate that BRT

Table 1. *Bus Rapid Transit corridors by region*

Regions	Passengers per Day	Number of Cities	Length (km)
Africa	491,578 (1.4%)	6 (3.2%)	152 (2.69%)
Asia	9,238,060 (26.49%)	45 (24.06%)	1,691 (30.1%)
Europe	2,914,113 (8.35%)	46 (24.59%)	919 (16.36%)
Latin America	20,785,206 (59.6%)	63 (33.68%)	2003 (35.65%)
Northern America	1,005,796 (2.88%)	22 (11.76%)	744 (13.24%)
Oceania	436,200 (1.25%)	5 (2.67%)	109 (1.94%)

Source: (Global BRT Database, 2023)

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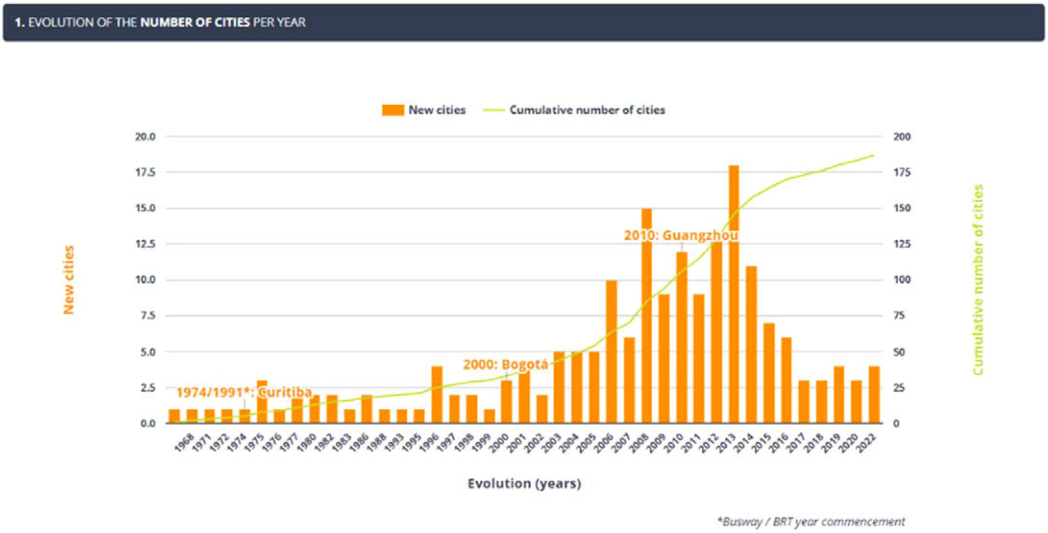

Figure 1. *Evolution of the number of cities with BRT corridors per year. Source: (Global BRT Database, 2023).*

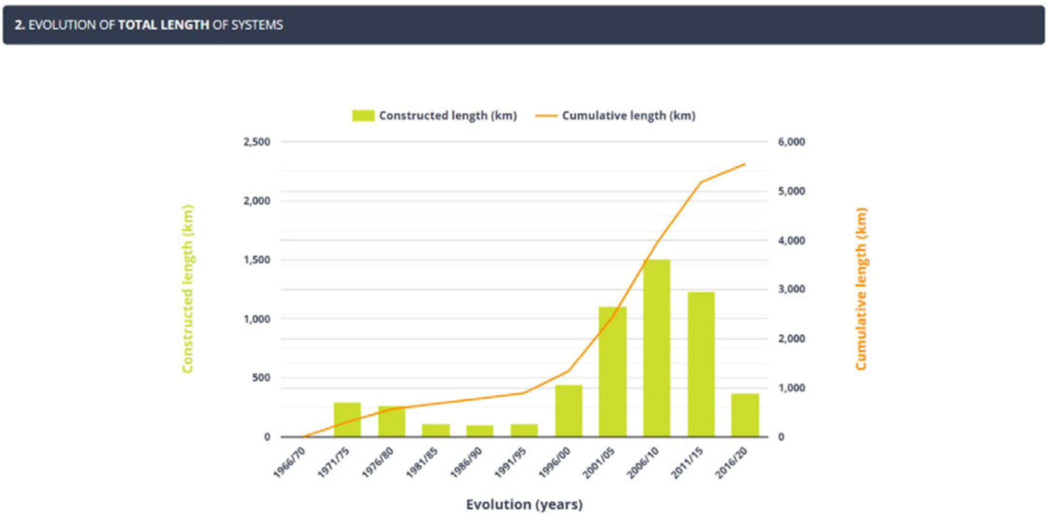

Figure 2. *Evolution of the kilometers of BRT per year. Source: (Global BRT Database, 2023).*

deployment is associated with positive effects on land values and development patterns (Cervero and Kang, 2011; Rodriguez and Vergel-Tovar, 2018), while others highlight positive impacts on road safety (Duduta et al., 2012).

BRT is not always understood in the same way by practitioners and decision makers, and faces three especially contentious issues: (a) institutional arrangements requiring the coordination of multiple agencies and, in many countries, reorganization of private transit service operators (i.e., not an issue concerning just BRT, but transit systems at large); (b) competition for road space traditionally assigned to general traffic; and (c) the misperception of buses as a low-quality mode (Hensher, 2007).

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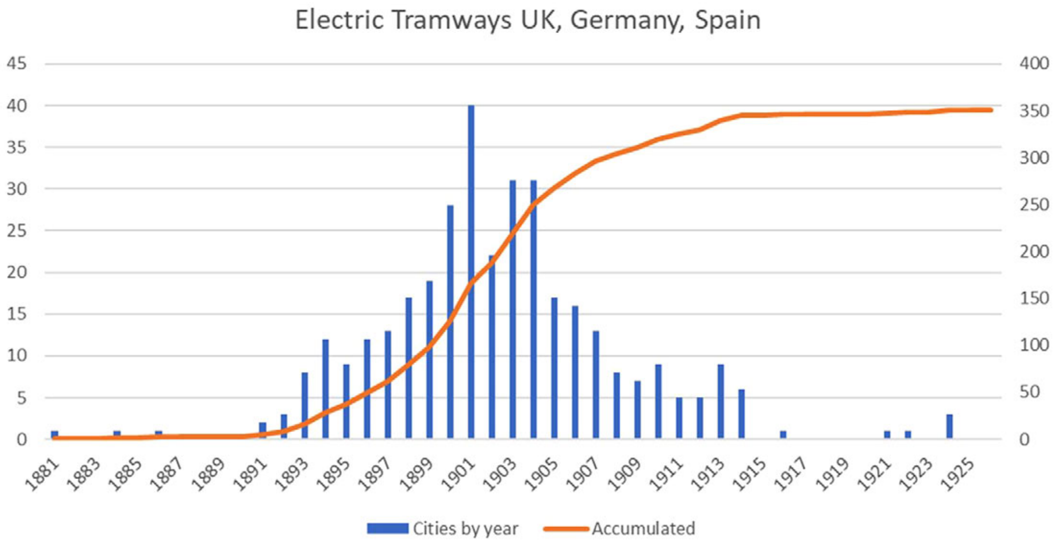

Figure 3. *Evolution of electric tramways in the UK, Germany, and Spain 1881–1925. Source: authors based on data by Schmucki (2012), Martínez (2012), and Guarnieri (2020).*

As a result, several bus systems confront challenges in planning, implementation, and operation. A review of 13 bus systems in Latin America and Asia (Hidalgo and Carrigan, 2011) indicated that projects brought social, economic, and environmental improvements, but

- "No project was perfectly executed, due to a combination of institutional, technical, financial and/or politically induced time constraints.
- Initial implementation was generally rushed, causing operational and user problems.
- Financial and institutional sustainability was not necessarily assured.
- Bus Rapid Transit routes were often not fully integrated into the rest of the cities' public transport system.
- Many projects faced extensive challenges in accommodating regular city traffic.
- In cities where BRT services were new, or expanded quickly, public information and user education was poor."

Given the growing interest in BRT, successive Thredbo Conference Series hosted Workshops on Bus Rapid Transit (Muñoz and Hidalgo, 2013; Finn and Muñoz, 2014; Currie and Hidalgo, 2018). The workshops revised several case studies, mechanisms to improve performance and operations, contracts, and integration with other modes and with the urban structure. While BRT was recognized as a transit option with great attractiveness, it was acknowledged that it also has limitations. Transition to BRT, particularly in low- and middle-income countries, was difficult due to institutional and financial barriers. In these contexts, new bus systems are often asked to solve problems beyond the technical dimension, like the formalization of para-transit services, expansion of the capacity for general traffic, or the reconstruction of utility networks. These issues generate cost escalation, delays, and frustration.

Also, a review on barriers to planning and implementing Bus Rapid Transit systems (Lindau et al., 2014) concluded that "implementing a successful BRT has never been -and will probably never be- an easy task!", identifying several barriers:

- "Local institutions are geared to road construction, not to transit operations. There is not enough capacity in local government and in local consultancies to face the complexity of high-performance transit projects operating on the surface.

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- There is also lack of alignment among stakeholders, which include potential users, businesses, landowners, administrators, politicians, existing bus operators and affected non-users. This lack of alignment causes protracted planning processes, where most of the time and energy is spend in negotiations rather than in conceiving and designing projects.
- Even when presenting equivalent performance, BRT is still perceived as a lower quality mode than rail systems, as commonly presented in textbooks and industry guidelines. (…)
- The fact that BRT may reduce road space for cars to travel and park is often used by media, political adversaries, business, and landowners as an argument against its implementation. (…)
- Advocates for nonmotorized transport, may oppose BRT when planning fails to incorporate improved safety standards."

Several of these issues are not exclusive to BRT, but of planning and implementation of mobility improvements at large, particularly in developing countries. Problems particular to BRT refer to reallocation of space traditionally assigned to general traffic, lack of guidelines for design and operations, and misperception of buses as a low-quality and cheap mode. Many BRT implementations were also part of transformations on the way buses were regulated, from semiformal to formal arrangements. This institutional change resulted in additional difficulties for system implementation, operations, and funding.

These general observations placed a burden on the expansion of BRT. The concept was well received in several cities that reported initial successes, but have aged unfavorably, as indicated in the following sections.

6. BRT in Latin America and the Caribbean

The region leads BRT implementation in the number of systems, kilometers, and passengers (Figure 4, Table 1). Brazil leads the region with 26 systems (41%), 883 km (44%), carrying 10.7 million passengers per day (Table 2). It is followed by Mexico (12 systems, 416 km, 2.7 million passengers per day), Colombia (7 systems, 225 km, 3.1 million passengers per day), and Argentina (5 systems, 122 km, 1.6 million passengers per day).

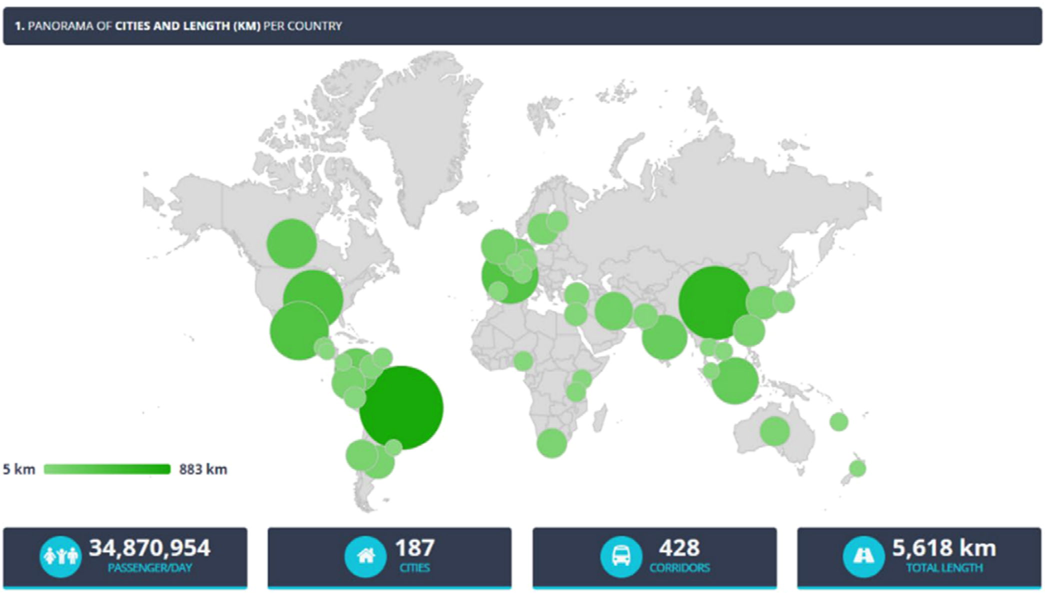

Figure 4. *BRT by number of cities and length (2023). Source: (Global BRT Database, 2023).*

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Table 2. *BRT systems in Latin America and the Caribbean by County (2023)*

Countries	Passengers per Day	Number of Cities	Length (km)
Argentina	1,563,000 (7.51%)	5 (7.93%)	122 (6.08%)
Brazil	10,752,147 (51.72%)	26 (41.26%)	883 (44.08%)
Chile	476,800 (2.29%)	2 (3.17%)	105 (5.25%)
Colombia	3,071,541 (14.77%)	7 (11.11%)	225 (11.22%)
Ecuador	1,055,000 (5.07%)	2 (3.17%)	117 (5.83%)
El Salvador	27,000 (0.12%)	1 (1.58%)	6 (0.31%)
Guatemala	210,000 (1.01%)	1 (1.58%)	24 (1.19%)
Mexico	2,659,137 (12.79%)	12 (19.04%)	416 (20.79%)
Panama	n.a.	1 (1.58%)	5 (0.24%)
Peru	704,803 (3.39%)	1 (1.58%)	26 (1.29%)
Trinidad and Tobago	n.a.	1 (1.58%)	25 (1.24%)
Uruguay	25,000 (0.12%)	1 (1.58%)	6 (0.31%)
Venezuela	240,778 (1.15%)	3 (4.76%)	42 (2.1%)

Source: (Global BRT Database, 2023). Abbreviation: n.a., not available.

Table 3. *Top BRT systems in Latin America – Key statistics (2023)*

Country	City	Population, city	Peak load (passengers per hour per direction)	Daily demand (passengers per day)	Corridors	System length (km)
Brazil	Rio de Janeiro	6.476.631	65.400	3.535.466	17	168,00
Brazil	São Paulo	12.252.023	6.725	3.300.000	12	129,10
Colombia	Bogotá	8.181.047	49.000	2.192.009	11	112,90
Mexico	Mexico City	8.851.080	12.000	1.240.000	7	140,00
Argentina	Buenos Aires – M.A.	12.806.866	n.a.	904.000	6	42,80
Ecuador	Quito	1.619.791	11.700	745.000	3	71,40
Brazil	Curitiba	1.948.626	20.500	721.500	7	74,10
Peru	Lima	7.605.742	22.800	704.803	1	26,00
Brazil	Porto Alegre	1.476.867	16.800	540.000	11	54,60
Argentina	Buenos Aires	3.075.646	3.500	522.000	9	62,00
Colombia	Cali	2.445.281	13.000	471.361	6	36,07
Brazil	Recife	1.633.697		409.620	3	49,50
Mexico	Mexico City – M.A.	19.152.258	9.000	380.000	3	55,80
Chile	Santiago	6.119.984	13.500	340.800	13	90,15

Source: (Global BRT Database, 2023). Abbreviation: M.A., metropolitan area; n.a., not available.

The top 14 systems in the region have more than 300,000 passengers per day (Table 3). The largest system is in Rio de Janeiro, with 17 corridors combining bus priority and full BRT corridors with a total length of 168 km carrying 3.5 million passengers per day. Its Bus Rapid System BRS corridor in Avenida Brazil has 65,400 passengers per hour per direction (four bus lanes and long bus stops). São Paulo bus priority corridors carry 3.3 million passengers per day, in 129 km (12 corridors).

For these 14 BRT systems, there is a strong correlation between system length and passenger demand, controlled by population (Figure 5). On average each kilometer of BRT per million population carries 0.011 passengers per day per capita (R2: 0.8746). Cities in the region tend to have high public transport

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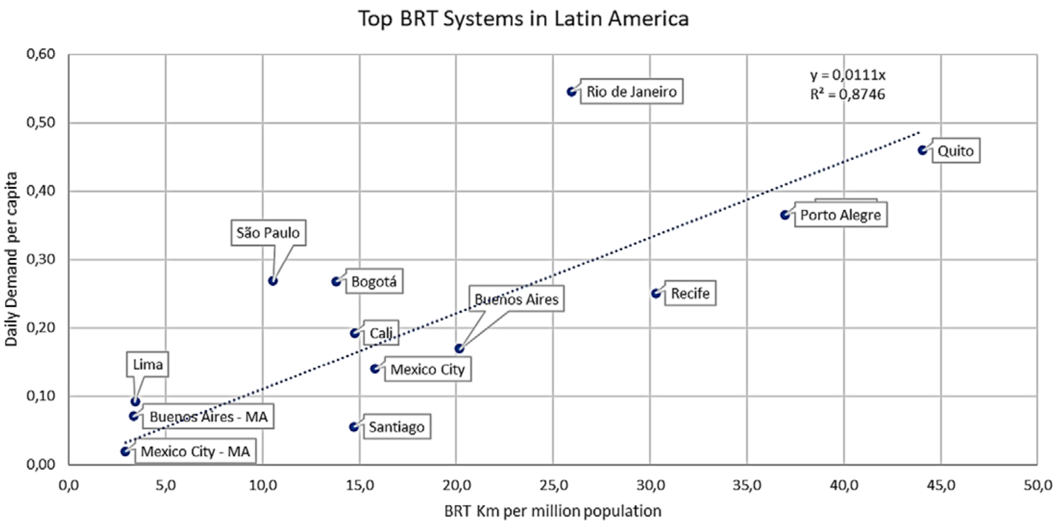

Figure 5. *Top BRT systems in Latin America – relationship between system length and daily passenger demand (2023). Source: elaborated by the authors, data from Global BRT Database (2023).*

share and density. Most of these systems are in cities that also have metro and regional rail (Bogotá has a metro line under construction; Cali is planning a regional rail network).

7. Iconic BRT Examples and Problems in Latin America

Short case studies are included to indicate the progress or lack thereof in selected cities. The cases include a brief description of each BRT, issues with service quality over time, and policy changes that had hindered timely maintenance and expansion.

Curitiba – from fast expansion to stagnation.

Recognized as the cradle of BRT (Lindau et al., 2010), the system in Curitiba became a reference to most applications around the world. The connection to land use planning has been highlighted as its main feature, making it also a reference for transit-oriented development (Dunphy et al., 2004). Between 1974 and 2009, Curitiba developed an extensive BRT system, with seven corridors and 74 km, carrying 721,500 passengers per day in 2019 (Global BRT Database, 2023) (Figure 6).

Despite its international recognition and influence, there are multiple challenges with its operation; see, for example (Secco, 2017), (Lissardy, 2012). The capacity of the main corridors was reached long ago. Buses, stations, and terminals feature high occupancy levels. In 2018 the public transportation user satisfaction was 50% for captive users (without car) and 48% for choice riders (Caracas et al., 2018). Real estate around the corridor was highly valued, but most residents are not necessarily transit users. While the city was very progressive in advancing sustainable mobility options (pedestrianization, bike lanes, the BRT and transit-oriented development), it did not implement demand management policies to reduce car travel. Thus, its main automobile corridors face significant congestion and there are issues with parking.

The idea of replacing BRT corridors with light rail transit was proposed in 1990 and took force in the beginning of the 2000s among politicians, academics, and the public. The Metrô de Curitiba project advanced through planning stages and even a tender process for its construction took place in 2007. The project stalled in 2008 after a judicial decision. It evolved with technical studies on a definitive alignment and a window of opportunity opened in 2014, but the project was again stalled due to financial constraints.

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Figure 6. *Red Integrada de Transporte – Curitiba. Source: EMBARQ Brasil Mariana Gil (Global BRT Database, 2023).*

Currently there are options for advanced BRT (using hybrid electric buses), Light Rail (Vehiculo Leve sobre Trillios, VLT), and monorail (Piva, 2017; Curitiba, 2021).

While the proposed rail technologies may bring positive impacts to the city, the discussion delayed necessary improvements on the existing system, The last expansion was Linha Verde (Green Line) in 2009, which adopted some of the innovations from other cities, particularly passing lanes at stations to increase capacity (Global BRT Database, 2023). It also adopted biofuels to present itself as environmentally friendly. After 16 years, the Linha Verde corridor is still incomplete, due to financial difficulties and contractual issues; it is expected to be completed in 2024 (Silva, 2020; g1 RPC e PR, 2022). One of the corridors (Boqueirao) was also overhauled with passing lanes at stations, increasing the throughput from 13,000 passengers per hour per direction to 21,000. But overall improvements of the BRT are still needed.

Quito – success with trolleybuses followed by a decline in service quality.

Quito was the first application of BRT outside Brazil, closely following the example of Curitiba. Implemented in 1995, it innovated with the use of trolleybuses, crisscrossing the historic downtown. It was later expanded to two additional corridors (Ecovía and Central Norte), using conventional buses (Hidalgo and Carrigan, 2011; Arias, 2021). Currently, Quito has three corridors, with a total length of 71.4 km and moving 745,000 passengers per day (Global BRT Database, 2023) (Figure 7).

For some time, the trolleybus was regarded a successful project (Ayala and Ibarra, 2019). Nevertheless, its capacity was reached only a few years after initial implementation. The original design included the possibility of expanding the stations, but this expansion was not considered for many years. Only in 2016, with the occasion of the Habitat III Conference, did the city expand the stations and introduce bi-articulated diesel buses. A user survey performed in 2022 indicated a satisfaction level of 50.6% (Oña-Caizaluisa, 2022).

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Figure 7. *Metrobus-Q – Quito. Source: EPMTPQ - SIBRT (Global BRT Database, 2023).*

The preparation and construction of a metro project affected the investment and maintenance of the existing corridors. Quito advanced a metro project, which will greatly improve mobility in the city. It started operations in December 2023 (Arias, 2021; Quito, 2022). The metro will be integrated with the existing bus corridors.

Part of the justification of the metro project was based on the difficulties with the surface BRT system (Salar-Khan, 2016). During the planning and implementation stages of the metro project, the BRT maintenance and expansion was neglected. Service quality for the BRT corridors, particularly the Central North corridor, is low. Infrastructure requires an overhaul, particularly road surface and stations. A projected BRT line in the north (Trole Norte) was indefinitely postponed (Arias, 2021).

Bogotá – high positive impacts followed by service deterioration.

In 2000, Bogotá introduced the first very high-capacity BRT, using large stations with multiple platforms, overtaking lanes and large buses with multiple doors. The system has 11 corridors, is 113 km long, and moves more than 2.2 million passengers per day (Global BRT Database, 2023). Throughput in the main corridor (Avenida Caracas) is above 49,000 passengers per hour per direction, with 7 standing passengers per square meter (Figure 8).

The system received very high user ratings in the first years of operation (satisfaction 96% in 2001 and 82% in 2002 and 2003), but user perception declined (49% in 2008; 28% in 2012; 18% in 2016; 23% in 2019) (Bogota Como Vamos, 2020). The main user complaints involve high occupancy of buses and stations, lack of reliability, and pickpocketing. The BRT system has experienced user protests, blocking operations, and, on occasions, vandalism, damaging buses and stations. Early deterioration of infrastructure due to problems with the design and construction of the initial busways also impacted system performance and user perception (Gómez-Rodríguez et al., 2017). Over time, fare evasion has also increased, which seems to be a response to bad quality service and relative high fares (Guzman et al., 2021). Negative statements toward the BRT amid the political debate since 2004, particularly on its private operations model, and the lack of timely replacement of the bus fleet also exacerbated negative public perception and fare evasion (Alberti and Pereyra, 2020).

The TransMilenio system grew quickly in its first years, but the plan devised in 2000 for 388 BRT is still far from being complete (Alberti and Pereyra, 2020). Delays are partially the result of difficulties in funding and political debates around the reallocation of general traffic lanes for bus lanes. There have been seven attempts to build transit improvements in Carrera Séptima, a key corridor. The projects have not been implemented due to neighbors and political opposition, which includes lawsuits against its construction (Mojica and Gómez-Ibáñez, 2011; Hidalgo, 2020).

Discussion about the first metro line has also impacted BRT expansion. Bogotá's metro is a long-awaited and necessary project, with initial proposals in the 1940s and several cycles of studies and

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Figure 8. *TransMilenio BRT – Bogotá. Source: EMBARQ (Global BRT Database, 2023).*

evaluations. The first metro line was contracted in 2019, and it is expected to be in operation in 2028 (Empresa Metro de Bogotá, 2021). The protracted debate for a metro in Bogotá absorbed local institutional capacity, delayed plans for BRT expansion, and even resulted in a lack of maintenance of infrastructure and operations of the bus system. The situation is now being reversed as new corridors are under construction or being contracted, as it is the case with Carrera Séptima green corridor, along a second metro line.

Mexico City – continued expansion to complement an extensive metro network.

BRT was first introduced in 2005 along Avenida Insurgentes, with the first 16 km. Expansion of the Metrobus BRT system has been steady since then; there are now seven lines in operation, totaling 140 km, and moving 1.24 million passengers per day (Global BRT Database, 2023). User perception was high by 2013 (Comunicación Social CDMX, 2013); nevertheless, there have been growing complaints due to high occupancy of buses, extreme heat, and sexual abuse (Aldaz, 2015; Páez, 2021). The first corridor has reached its capacity (11,000 pphpd with single lane), but no overhaul has been undertaken or planned. The contractual model also has been subject to criticism (Flores-Dewey and Zegras, 2012) (Figure 9).

Quality of service has improved over time according to a user survey by the city agency Metrobus. Between 2013 and 2018, user ratings did not exceed 70%; between 2019 and 2021, the rating exceeded 90% (91.56% in 2021) (Metrobús, 2022).

Despite the continued support by different city administrations, expansion has faced controversies. In January 2017, a federal judge stopped the construction of Metrobus Line 7 following a lawsuit filed by an environmental association, as the project was supposed to affect trees and archeological

Figure 9. *Metrobús BRT Mexico City. Source: CTS EMBARQ México (Global BRT Database, 2023).*

heritage, and generated air pollution (Mosso and Siettin, 2017). By the end of June 2017, the project received a green light from the National Institute of Archeology and History, after adjusting the design (La Jornada, 2017).

BRT is still a strong component of the mass transit plans in Mexico City. The current mobility plan includes five new BRT corridors or extensions, a new elevated trolleybus line, four elevated cable car lines, completing a metro line (Line 12), and recovering existing metro lines (SEMOVI, 2022). Metrobus expansion has benefited from political continuity in Mexico City, with four successive terms under the same political group. The agency in charge of Metrobus had the same director for 13 years (Páez, 2021).

Santiago – fall and rise of a citywide transit reform.

Santiago introduced bus corridors as part of its integrated transportation plan Transantiago in 2007. Priority corridors already existed at that time, notably bus lanes on Avenida del Libertador Bernardo O'Higgins, also known as Alameda, which extends to Avenida Providencia. While Santiago lacks a key component of the BRT concept: permanent stations for off-board ticketing, it still has 13 corridors, totaling 90 km of dedicated busways, some of them totally segregated from the rest of the traffic (Global BRT Database, 2023) (Figure 10).

The initial implementation of Transantiago in 2007 was chaotic (Muñoz et al., 2009). The system, which involves buses and Metro operating under fare integration, improved over time; by 2018 it was considered the best public transport system in Latin America (Van Audenhove et al., 2018). Nevertheless, the legacy of the difficulties in implementation remained, and were used for political campaigning (Peña, 2017). The bus tenders initiated in 2017 to replace the aging bus fleet of Transantiago were declared void in March 2018 (Ministerio de Transporte y Telecomunicaciones, 2018).

The system was rebranded as Red Metropolitana de Movilidad RED, with new bus standards and services, including a large fleet of e-buses (DTPM, 2021). The national government implemented new bidding processes for bus acquisition and operation which was completed in 2022 (DPTM, 2022).

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Figure 10. *Buses Transantiago. Source: Dirección de Transporte Público Metropolitano DTPM, Santiago, Chile.*

The city has now 2000 battery electric buses, the largest e-bus fleet in any city outside China. User satisfaction has improved in the last 6 years. In a scale from 1 to 7, average rating was 4.3 in 2016 (14% good evaluation), and 5.2 in 2022 (37% good evaluation) (IPSOS DTPM, 31 de enero 2023).

Metro expansions have been prioritized over BRT in Santiago. One iconic case is the Alameda-Providencia project, initiated in 2012 and not implemented yet. It is a new urban corridor including a full BRT (Bosch et al., 2016), which had strong community participation and a well-developed urbanism contest. The project was suspended in 2018 (Olivares and Hormaechea, 2019); a new version is expected to start construction in 2023 (Valencia, 2023). Metro provides high-quality transport, but integrated services require excellent quality buses as well.

8. Discussion

The short case studies on BRT evolution in five cities in Latin America show common elements. In all cases except Santiago, BRT enjoyed a good start. But excitement about the new transportation option declined over time, and issues of quality of service, particularly overcrowding and lack of reliability, grew. As most urban projects, BRT systems became politicized (Alberti and Pereyra, 2020). Discontent with service increased, and in the cases of Santiago and Bogotá, it also resulted in high fare evasion and targeted vandalism. Planning of the overall transit network, including new metro corridors or expansions, somehow affected the expansion and improvement of existing BRT corridors. Political continuity in Mexico City helped constant growth, while political changes in other cities resulted in expansion projects being halted.

As indicated in previous assessments (Hidalgo and Carrigan, 2011; Muñoz and Hidalgo, 2013; Lindau et al., 2014; Finn and Muñoz, 2014; Currie and Hidalgo, 2018), problems with BRT implementation and operation seem to be more a result of institutional and financial constraints rather than the technical characteristics of bus systems. BRT has been able to deliver high-capacity and fast and reliable services, complementing rail systems in most cities. But as with any system, infrastructure and operations require permanent management and investment. Like the metro systems in Washington DC (Esteban and Muskeens, 2016), New York City (Fedak, 2017), or Mexico City (Badillo, 2021), lack of investment and maintenance resulted in operational issues and reduced quality of service. Management is not intrinsic to the technology; nevertheless, issues with BRT are often referred to the use of buses and busways, rather than governance and financial constraints. It is intriguing that these cities failed to follow demand increments by increasing transport capacity at the same pace. Instead, authorities allowed their previously successful systems to suffer from overcrowding and its implications: discomfort, speed and frequency drops, and security issues.

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After 20 years of fast growth in the number of cities implementing BRT and bus corridors, there is a reduction in the number of cities implementing new systems or expanding existing networks. There is still a large potential, and eventual need, for new implementations and growth of existing systems. Very importantly, BRT corridors should be considered part of multimodal integrated mass transit networks, not isolated systems by themselves (Munoz and Paget-Seekins, 2016). Political debates between transit alternatives have affected new implementation and expansion of transit services, with negative impacts on cities.

Innovation and technology will play a significant role in the next generations of bus systems (Munoz and Paget-Seekins, 2016). One critical concern is the use of diesel buses, which despite advances in emission control technologies, are not considered green. Most developing countries lack ultra-low sulfur diesel (less than 15 parts per million), reducing the opportunity to comply with Euro 6 standards. Nevertheless, fast development of batteries is helping the introduction of electric buses, improving not only the environmental performance but user acceptance of buses.

The use of real-time data and technology can also make operations more dependable, using, for example, real-time dynamic control strategies to avoid the frequent problem of bus bunching. For the time being, the premise has been to increase bus speeds, through the reduction of dwell times at stations and by taking the buses out of general traffic congestion with busways. Bus systems need also to consider reliability as a core characteristic (Soza-Parra et al., 2021). Furthermore, it has been argued that vehicle automation, including electronic platooning, should be in BRT corridors before being tried in automobiles (Zhang et al., 2019). BRT corridors are a natural intermediate step between Metro lines and general traffic. Such technology should allow for a more reliable, comfortable, and cost-efficient operation.

In addition, the occupancy standards used in most applications needs to be revised. Early applications in Brazil used a standard of 6–7 passengers standing per square meter. Replication in other parts of the region kept these extremely high occupancy levels. This has proven too high and is one of the sources of growing user discontent with BRT services in several cities. Some studies have estimated the economic cost of crowdedness in Santiago and Bogotá (Batarce et al., 2015), and more recently recomputed these values during the COVID-19 pandemic adding the impact of mask-wearing on traveler perceptions (Basnak et al., 2022). Therefore, BRT and public transport systems should be improved considering adequate occupancy levels. Lower occupancy levels than those observed before the pandemic need to be kept now that the health crisis is over.

Finally, a strong consideration of urban impacts is required as part of the planning process, to make the systems more attractive and acceptable to the community at large. The experiences of Alameda-Providencia in Santiago (Nueva Alameda Providencia, 2016) and Corredor Verde in Bogotá (Pardo, 2020) promise to advance not only the quality of the urban design but also a very open and effective participatory process. Innovative participatory processes using technology may help in bringing broader community perspectives and help in community buy-in (Pardo, 2020).

Winning the heart of the users and citizens is still a pending subject for BRT as systems become more mature. Politics, lack of funding, and inadequate institutional settings have played a key role in this condition. Rather than ending BRT implementation or scaling down BRT networks, cities in low- and middle-income countries can continue benefiting from their positive aspects. BRT is not a panacea, a miracle cure, or a magic wand. But it can certainly be part of high-quality multimodal integrated public transport networks. Data can help in improving planning and operations; there seems to be a large space to take advantage of in terms of big data and real-time data generated by users and mobile applications and fare collection systems.

While this paper focuses on BRT, it is important to recognize that transit ridership revenues and new public transportation projects are declining in several geographies, especially after the pandemic. The effects of this downward trend are not discussed in this paper and are an important subject for further research. BRT has been also a vehicle for transit reform from informal and semiformal services to new formal transit systems. Discussion of issues in these transit reforms is not considered in this paper and is also a key area for further research.

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Figure 3 was created by the authors with data from (Martínez, 2012; Schmucki, 2012; Guarnieri, 2020).
Figure 4 was created by the authors with data from (Global BRT Database, 2023).

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