Congestion in Latin American Cities

Innovative Approaches for a Critical Issue

Discussion Paper

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Roundtable

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ITF Discussion Papers

Cite this work as: Bocarejo, JP (2020), "Congestion in Latin American Cities: Innovative Approaches for a Critical Issue", *International Transport Forum Discussion Papers*, No. 2020/28, OECD Publishing, Paris.

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Introduction

Latin America has experienced considerable urban growth over the past 40 years, rising from an urban population of 62% of the national total in 1980 to almost 85% in 2019. Cities such as Sao Paulo, Mexico City, Lima, Buenos Aires, Bogotá, and Santiago have doubled in size in that period, consolidating strong economic development and concentrating much of the opportunities of their respective countries. Latin America's megacities are extraordinary generators of wealth and social development, despite the inequitable growth of their population and territory.

Mobility is frantic and supports social development, generating access to opportunities in the vast territories that make up these cities and regions. This has created strong pressure on the public sector in the search for mobility solutions. Investments in road infrastructure, mass transit, technologies and, more recently, non-motorised modes have been a priority for the governments of Latin American countries and cities.

Still, mobility remains one of the biggest concerns of the inhabitants of large cities in Latin America. Congestion is a major challenge for local governments and for the habitants of Latin American cities. Several of these capital cities feature among the most congested in the international rankings.

With limited resources and needs across multiple sectors, the cities have adopted very different solutions and established very different investment priorities to implement them. In developing policy, transport plans and investments, they face a constant discussion around the relative merits of providing more infrastructure for the private vehicle versus discouraging private vehicle use and giving priority to more sustainable modes.

This paper analyses the demand management strategies that have been developed in the region, focusing on the experience of the city of Bogotá. Recommendations are made for the development of such measures in developing cities, based on the lessons learned.

Congestion trends in Latin American cities

Mobility in Latin American cities has grown considerably in recent decades. High population growth rates, vast urban expansion, commuting from neighbouring municipalities, rapid growth in the mode share of individual transport modes vis-à-vis public transport and, more recently, the success of vehicle on-demand apps, have all contributed to major increases in daily vehicle kilometres (vkm) travelled in Latin American cities.

City growth and density

The recent history of the capital cities of Latin America is one of an explosion in their size and economic dynamism. In the period from 2000 to 2018, the populations of the main capitals of Latin America, especially Mexico City, Lima and Bogotá, showed annual growth rates above 1.5%. However, changes in urban density have differed in extent and direction. While cities like Santiago (-8%) and Mexico City (-13%) have experienced a reduction in average population density, other cities such as Sao Paulo (+ 5%) and Bogotá (+10%) have seen increasing density, especially around their axes of mass transportation (Bocarejo, Portilla & Perez, 2013).

Bogotá's density stands out, at close to 25 000 inhabitants per km^2, ranking it as one of the densest cities in the Western world, surpassed only by a few cities in Asia and India.

Table 1. Population and urban density in Latin American cities

City	Population (2000-2018) Millions	% Population growth	Built-up density (2000-2018) p/Km^2	% change in density
Bogotá	6.2 – 8.2	25%	22 200 – 24 500	+10%
Buenos Aires (*)	11.3 – 13.9	19%	9 900 – 9 400	-6%
Lima	7.9 – 10.4	24%	12 000 – 11 064	-8%
México City (*)	15.0 – 21.8	32%	12 600 – 11 000	-13%
Santiago	5.6 – 4.8	15%	11 400 – 10 500	-8%
Sao Paulo (*)	17.0 – 21.8	19%	10 800 – 11 400	+5%

(*) Urban agglomeration information

Sources:
1. Population: United Nations (2018, 2000) Demographic Year Book.
2. Density: United Nations (2016), Atlas of Urban Expansion, author’s projections to 2018.
3. Density Lima: Demographia (2018, 2010), World Urban Areas.

Urban density has had a significant influence on the way activities have been organised, and thus on transport systems.

While in Bogotá a monocentric structure has been consolidated, with an expanded centre that attracts a significant number of trips to work and study, (Bocarejo, Portilla and Perez, 2013) Santiago has diversified its attraction centres, increasing travel distances (Figueroa and Rodrigues, 2013). In Mexico City, urbanisation is still growing at rates over 4% in the periphery (Hernandez et al., 2017).

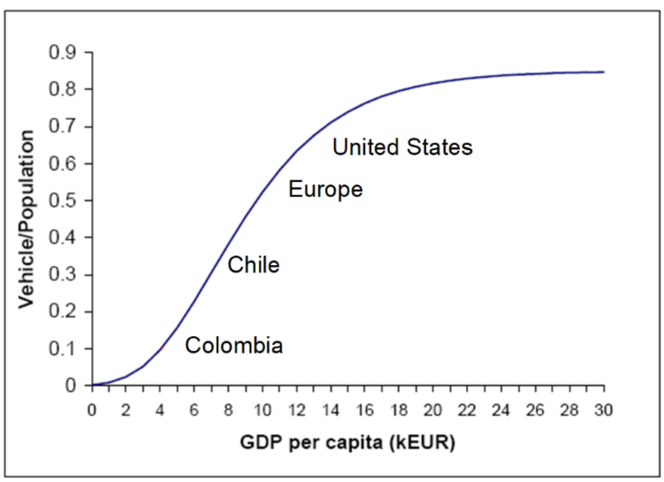
Density patterns and land uses vary within the same city. All the capital cities presented in Table 1 have seen a substantial displacement of residential uses from the traditional centre to the periphery, especially for the lower-income sectors of the population. Analysis of the variation in land uses and activities for each city is beyond the scope of this paper. However, it should be emphasised that differing urban growth dynamics have generated different mobility needs and uses of available infrastructure, with varying results on congestion, confirming the findings of Newman and Kenworthy (1989) on how some cities favour the use of public transport and others the use of the automobile.

Economic growth and private car ownership

There is a strong relationship between the rate of car ownership and the *per capita* income of the population. In 20th-century Latin American cities, most of the population did not have enough income to purchase a private vehicle. Consequently, most trips were made by public transport, with a large proportion of users having limited modal choice.

However, this situation has changed significantly in recent decades. Various studies show that growth in car ownership follows a Gompertz equation, in the form of an S curve: at low income levels, car ownership will be low; the *per capita* income of the population subsequently increases to a point at which the majority of the population will be able to buy a vehicle, generating strong growth in the motorisation rate. However, after a certain income level is reached, further increases in income lead to limited further growth in car ownership. Research has confirmed that this relationship between motorisation and income has been observed in developing countries (Zegras and Hannah, 2012).

Figure 1. Car ownership rate and income



Source: derived from Dargay and Gately (1999) and Gómez-Gelvez and Obando (2013).

As Table 2 shows, the growth of the fleet of cars and motorbikes in Latin American cities has been significant. Lima, Buenos Aires and Bogotá have almost doubled their car fleet in the last eight years. Mexico City and Sao Paulo already had a considerable vehicle stock by 2010, yet growth in the eight years to 2018 was 22% for Sao Paulo and 30% for Mexico City.

The growth in the number of motorcycles is also substantial. Buenos Aires and Sao Paulo already have more than one million motorcycles each, while cities such as Bogotá, Lima and Mexico City are approaching half a million motorcycles. The growth of motorcycles in Mexico City has been particularly strong. This reflects the fact that environmental measures have significantly increased car ownership costs, making this a less attractive option. In addition, the motorcycle has advantages in congested city traffic. Cities with earlier economic development such as Sao Paulo and Santiago have seen lower fleet growth rates than cities where economic growth in recent years has been highest, such as Lima and Bogotá.

Table 2. Increase of vehicle ownership in Latin America (2010-2018)

City	Cars (2010-2018) Millions	% car growth	Motorbikes (2000-18) Millions	% motorcycle increase
Bogotá	1.0 – 1.8	80%	0.2 – 0.5	150%
Buenos Aires	2.4 – 4.2	75%	0.6 – 1.3	117%
Lima	0.9 – 1.8	100%	0.2 – 0.4	100%
Mexico City	4.0 – 5.2	30%	0.05 – 0.4	700%
Sao Paulo	5.1 – 6.2	22%	0.9 – 1.2	33%
Santiago	0.9 – 1.5	67%	0.06 – 0.1	67%

Sources: Bogotá, Registro Distrital Automotor – RDA; Buenos Aires: Registro de Propiedad Automotor – Dnrpa; Lima: Superintendencia nacional de registros públicos; México City: Instituto Nacional de Estadística y Geografía – INEGI; Sao Paulo: Departamento Estadual de Tránsito de Sao Paulo; Santiago: Instituto Nacional de Estadística – INE.

Box 1 shows the results of the application of prospective motorisation models for the case of Bogotá. In the next ten years, with the economic growth rates expected before Covid-19, cities like Bogotá would see a near doubling in their vehicle fleet, making the congestion problem increasingly critical.

Box 1. Motorisation models applied to Bogotá

Gómez (2010), Gómez and Obando (2013) have used different models to predict motorisation growth in Colombian cities. These models feature a strong relationship between *per capita* income and vehicle ownership, as Dargay and Gately (1999) found for a worldwide analysis on motorisation.

In the case of developing countries, an additional aspect has to be considered: the rate of motorcycle ownership. Models show that the low-income population in developing cities is able to buy a motorcycle before a car. This pattern was also seen through much of Europe post World War Two. Private vehicle ownership expanded first via motorcycle purchase, then increasingly bikes were replaced by cars.

Table 3. Prospective vehicle fleet in Bogotá (millions)

	2010	2020	2030	2040
Car	0.71	1.28	2.19	3.34
Motorcycle	0.2	0.5	0.8	1.4

Source: Acevedo et al. (2010).

Congestion trends in Latin American cities

Over the past decade several technology companies that offer satellite tracking of vehicles such as INRIX and Tom Tom, as well as others that have developed navigation APPS such as Google and Waze, have developed metrics for comparing traffic and congestion trends between different cities worldwide. In these rankings it is usual for Latin American cities to take the top places in terms of congestion.

For example, Tom Tom measures the difference between the speed of circulation at low-demand times, as a proxy for free-flowing circulation, and average circulation speeds throughout the day. Using this metric, Bogotá, Sao Paulo, Mexico City and Lima are among the 20 most congested cities worldwide.

Waze uses a driver satisfaction ranking that measures six factors: traffic, pavement quality, road safety, user services, socio-economic characteristics and application usage. For traffic-related factors, variables such as traffic jam length, average peak-hour travel time, the presence of works and road closures are measured. In this comparative ranking, Latin American cities also score badly, with scores on the factors of traffic conditions and infrastructure being particularly poor.

Although the comparability of data between cities can be criticised, these rankings do indicate the critical nature of traffic problems in the region's cities.

Table 4. Congestion in Latin American Cities

City	TomTom Ranking 2019	Waze ranking 2019
Bogotá	3	166
Buenos Aires	66	107
Lima	7	169
Mexico City	13	135
Sao Paulo	24	129
Santiago	26	128

Source: TomTom, Waze (2019).

While in European cities, vehicle flow and road capacity are the main explanatory factors for congestion, in Latin American cities, driving patterns may have an important impact on road capacity. For example, there are more than 500 crashes every day in the city of Bogotá (SDM, 2020), which take on average more than two hours to be cleared. Poor parking practices and poorly designed bus stops in the main corridors also contribute to congestion. The guide "Congestion Charges in Colombian Cities" developed by University College London and the University of Los Andes (UCL and Universidad de Los Andes, 2014) identifies these additional factors:

1. Inadequate road infrastructure design
2. Poor road maintenance
3. Inappropriate road signs

4. Inappropriate behaviour of drivers and pedestrians
5. Poor vehicle maintenance
6. Obsolete traffic light system

The demand management approach

The governments of large Latin American cities have sought to address congestion using different policies to change the travel decisions of citizens. These interventions have focused on economic instruments, seeking to make the ownership and use of vehicles more expensive. Taxes, especially on fuel, surcharges on off-street parking and charging for on-street space are the main actions undertaken. Cities like Santiago are also beginning to adopt low emissions zones. Moves toward implementing congestion charging have been modest in scope, with the exception of more robust initiatives in Bogotá and Santiago.

Santiago and Mexico City have imposed various restrictions on the movement of vehicles, mainly for environmental reasons, while Bogotá has done so to reduce congestion.

The promotion of high occupancy vehicles has also been considered. Some cities have encouraged companies to develop travel plans including carpooling, virtual work and cycling, and to change work schedules.

Increasing cost of car use

National and local governments in Latin America have imposed taxes on private vehicles primarily to generate resources for public investment, rather than to discourage the use of the car. According to the IEA (2020), the tax component of retail fuel prices is about 24% in OECD Latin American countries (Mexico and Chile) while for European countries the tax burden is equal to about 60% of the price.

Colombian car users pay a 25% surcharge tax on fuel, with the revenue being earmarked for projects in the transport sector at the local level. There are also annual taxes on car ownership, a revenue source for the local governments. Taxes associated with vehicle use accounted for 13% of total tax revenue in 2019 in Bogotá. (SDH, 2020)

In Mexico, revenue from the gasoline surcharge is allocated to states and municipalities, with an additional charge payable in respect of the most polluting fuels.

In addition to these taxes, some cities have made significant progress in charging for on-street parking. Buenos Aires, Sao Paulo, Mexico City and Santiago have granted on-street parking concessions and have regulated the use of off-road parking. A variable percentage of the revenue goes to the city.

In Colombia, the national government has issued a series of laws that enable cities to generate new revenue from vehicle taxation. Cities can establish congestion and pollution charges and impose surcharges on off-street parking. However, these initiatives are subject to approval by municipal councils and their political unpopularity means they have not been approved to date. In the three years to 2019, the government of Bogotá unsuccessfully requested city council approval of a surcharge on off-road parking on three occasions.

Table 5. Increasing costs of car use

City	Taxes on fuel	Parking
Bogotá	- 25% tax on fuel - Charged to consumer - Destination: 50% mass transit, 20% pavement maintenance, 30% Access to poor neighbourhoods.	- Off-street surcharge denied three times by city council - Fare regulation to off-street parking - On-street parking project (2019)
Mexico City	- Local Surcharge through special tax on production (IEPS) - two national taxes - Tax for polluting fuels	- On-street parking scheme "ecopark", since 2012
Santiago	- Consumer tax aimed at financing infrastructure maintenance	- Concession of on-street parking in city centre 2013

Source: Bocarejo, Lopez Ghio and Blanco (2018).

Car use restriction

At the end of the 20th century, Santiago and Mexico City implemented measures to restrict the use of private vehicles according to the registration plate number. The main reason for this restriction was bad air quality. Currently, vehicle restrictions in these cities apply only to the most polluting vehicles, except when pollution rises to levels that trigger emergency environmental restrictions.

A similar measure was taken by the city of Bogotá in 2000, to address congestion, and has been gradually adopted by a large number of cities in Colombia. The measure in Bogotá has changed through time. Currently, the restriction in Bogotá applies to half of the car fleet at peak times, every weekday.

From an economic perspective, the restriction generates a cost, since citizens cannot use their preferred mode and travel period. However, it yields benefits in terms of congestion reduction and air quality improvements. An assessment of the restriction for the year 2005 showed a negative benefit/cost outcome, with net costs of close to EUR 600 000 per day (Bocarejo, 2008).

Another concern relating to the efficiency of such measures is their medium-term impact. Moncada, Escobar and Jones (2018) show that the measure has stimulated the acquisition of a second car or motorbike, thus reducing the measure's effectiveness in achieving congestion benefits and imposing efficiency costs through increased rates of asset underutilisation.

In 2019, the Mayor's Office of Bogotá created a mechanism by which people could pay to be exempted from the restriction, with the annual fee being set at USD 1 250 and the revenue earmarked for public transport financing. Feasibility studies and willingness to pay surveys (SDM, 2019b) predicted that nearly 60 000 car owners would pay, generating revenues of about USD 75 million per year. At the same time, exemptions to the restriction enabling nearly 20 000 armoured vehicles to move freely were eliminated. The evaluation carried out shows that traffic could increase between 2% to 4% in the peak period, marginally affecting speed. The introduction of the voluntary payment mechanism has, however, been delayed by Covid-19.

Sustainable mobility plans and carpooling

Public and private institutions can be important partners in generating behavioural changes among their employees. Government agencies have encouraged employers to develop and adopt travel plans which provide incentives for their employees to adopt sustainable transport modes. These have been shown to have benefits for employers, by reducing pressure to find additional parking space for employee vehicles, as well as yielding improvements in employee health via increased physical activity. The main initiatives promoted are teleworking, the use of non-motorised transport modes and carpooling (SDM, 2017).

In 2018, the mayor of Bogotá made it mandatory for public companies to implement sustainable mobility plans and established guidelines for private sector companies to adopt them. At the same time, a network of companies was developed to share experiences, seeking clusters that would facilitate the joint implementation of measures. More than 300 organisations joined the network, representing almost 200 000 employees.

The network has requested more road space be allocated to carpooling. However, HOV lanes have not been implemented, as they compete with bus priority lanes for the scarce public space available in the city. All the megacities in Latin America have adopted BRT lanes in at least some main transport corridors. In some of the projects, BRT has been an evolution from priority lanes. It is usual that these projects take part of the space previously allocated to the car. In dense Latin American cities, HOV lanes have not been able to compete with public transport projects, which provide higher passenger capacity and, therefore, a more efficient use of road space.

Congestion charge

Congestion is a negative externality that is generated when an excessive number of vehicles circulate on a road, slowing other vehicles. When driving at a lower speed than allowed, users lose time and use more fuel, while the emission of polluting gases that affect the health of residents also increases, more greenhouse gases are emitted and property values can be affected.

Congestion is a key quality of life issue and local and national governments have adopted a range of different policy responses. These have included engineering, infrastructure and technology-based approaches, as well as economic tools aimed at managing demand, and direct restrictions on movement.

Internalisation of congestion

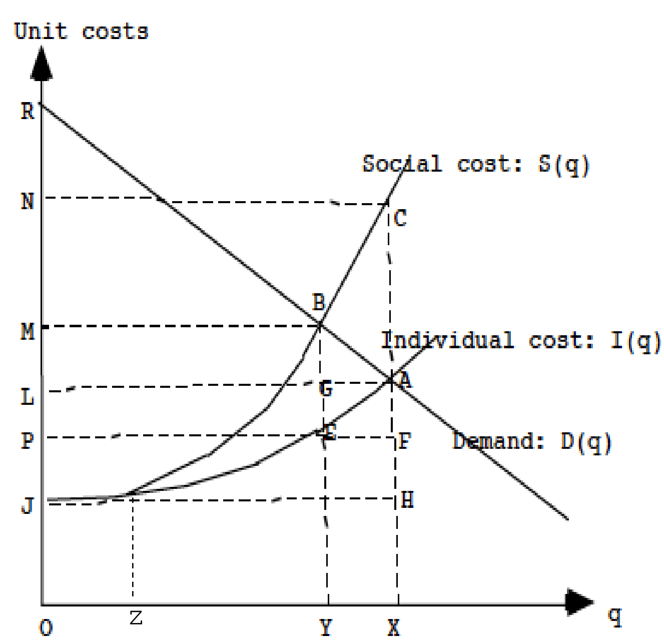
Economic theory has built a strong case for the internalisation of the costs of congestion. It is based on the theory of externalities developed by Pigou (1920) and Vickrey (1969). The Smeed report (1964) discusses its application to the case of road congestion in detail. However, despite its theoretical strength, few cities have managed to implement congestion charging.

Figure 1 summarises the theoretical approach of economics to eliminating this externality (Smeed, 1964). The I(q) curve represents the individual cost to users when travelling on a road, which increases as traffic

(q) on the road increases. The S(q) curve represents the social cost generated. It is equal to the individual cost multiplied by the number of users on the road. The total cost of congestion for X vehicles can be obtained from the difference between the two curves, in this case, the ABC triangle. If the car use cost increases, demand will decrease. A decrease in users could bring the social cost close to zero. For this, a charge on car use should be introduced. With that additional cost, Y vehicles would travel on the road. The social cost would be located at point B, which intersects the demand curve D(q).

From the theoretical point of view, there is a conceptual question as to how to define the term "excessive". There is a long-standing technical discussion about how to measure congestion (Prud'homme and Bocarejo, 2005). Figure 2 clarifies the relevant concept. From an engineering point of view, congestion is generated when vehicles cannot travel at the design speed of a road corridor because excess vehicle numbers prevent them from reaching that speed. In that case, the congestion measurement would be the difference between the time they take in the evaluated situation and the time taken in a reference condition.

Figure 2. Congestion charge theory



Source: Prud´homme and Bocarejo (2005).

However, from an economic point of view, this reference condition is not satisfactory, as roads are not built not to be used. In the economic optimum, the number of users is higher than in the free flow condition and determining this optimal situation is more complex. It corresponds to the situation in which a Pigovian toll is applied to internalise the external costs that the congestion situation generates.

In Figure 2, if the reference condition is free flow, the cost would be JM, with a traffic of Z vkm, while in the optimal economic condition, the desirable flow would be that shown at Y and the cost of congestion would be PM.

Moreover, the congestion charge theory is difficult to apply: Because congestion costs vary depending on the road, the hour and the traffic present, the charge should ideally be set on a dynamic basis. However, the congestion charging schemes adopted in London and Stockholm use a simplified approach that, although they may not be able to move road usage levels to the theoretical optimum, enable the social costs of congestion to be significantly reduced.

Congestion charge in Bogotá

For more than 12 years, the Colombian government has been promoting the implementation of congestion and pollution charges in Colombian cities. In the last three presidential terms, the Ministry of Transport has adopted a regulatory framework that allows cities to implement these charges autonomously.

Congestion charge regulatory framework

The Ministry of Transport promotes the implementation of congestion charging schemes in Colombian cities with over 300 000 inhabitants, through a regulation that establishes a number of requirements for cities to implement them. This includes carrying out of a study to determine the extent of current congestion and pollution, verify that the supply of other modes of transport is sufficient to meet the demand for travel and evaluates other negative impacts. It also includes the development of a detailed plan identifying key aspects of the proposed charging scheme, including the affected streets or zones, proposed operating hours and charges, and identification of baseline data on congestion and emissions of polluting gases. In addition, the Ministry of Transport has issued technological standards that would allow control of congestion and toll collection systems on urban highways.

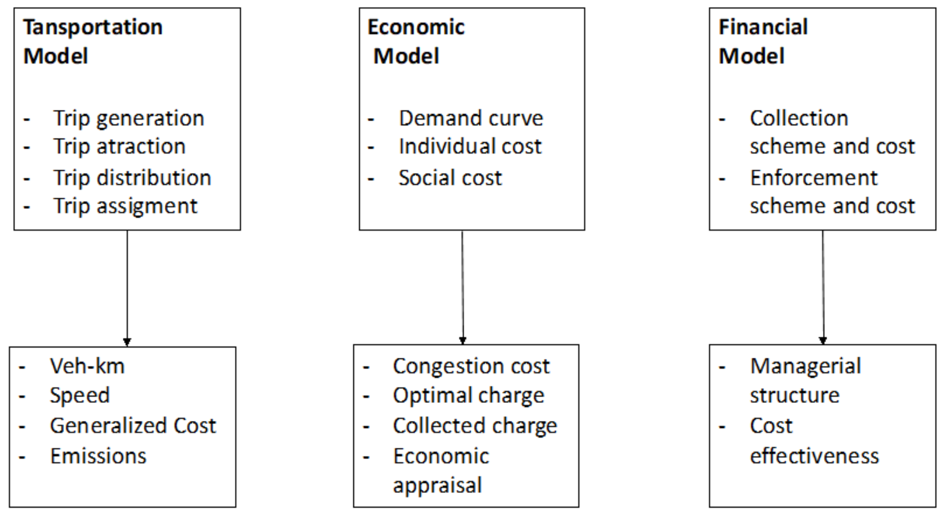
Recognising the difficulties that congestion charging proposals have had in obtaining approval from municipal councils, the national government redefined the nature of the charge in its latest Development Plan, defining it as a "public price" for access to a congestion zone. This means that since 2019, local governments can implement congestion charging without having to ask the permission of city councils.

Congestion charge studies in Bogotá (2012-2015)

In the period 2012 to 2015, the Secretary of Mobility of Bogotá (SDM) worked on the technical, legal and financial structuring of a congestion charge for the city (Unión temporal SDM, PHR and Akiris, 2013). At the same time, the Prosperity Fund in the United Kingdom hired University College London and the University of Los Andes to develop a guide to congestion charge collection in Colombian cities (UCL and Universidad de Los Andes, 2014). This project allowed the construction of a series of complementary models to meet the requirements of the Ministry of Transport and the City Council, as shown in Figure 3.

First, a 4-step rush hour transport model was used, where travel by public and private transport was assigned to road and transit networks. Bogotá has been developing a model since the year 2000 that is used to assess different projects such as new mass transit corridors. It was used in the design of the different congestion charge initiatives. The base information for the model is the household OD survey of Bogotá Region that is updated every four years. This extensive survey has information on almost 100 000 inhabitants. For the congestion charging projects, results from stated preference surveys were fed into the travel choice sub-models.

Figure 3. Congestion charge study structure



Second, an economic model was developed to estimate the cost-related private transport demand curve. This model allows the estimation of the individual private cost, and the social cost of congestion, as well as the amount of an optimal toll and the resources that would be generated by the congestion charge.

Table 6. Bogotá congestion charge scheme, 2014

Item	Value
Congestion zone	9 km^2
Optimal Fare	USD 2.6
Traffic reduction congestion zone	20%
Traffic reduction overall city	5%
Change in speed congestion zone	17.5 km/h – 20.9 km/h
Change in speed overall city	20.0 km/h – 20.5 Km/h
Internalised congestion cost per year	USD 14 million
Collected charge per year	USD 44 million
Operational Cost	USD 15 million

Source: Secretary of Mobility (Union Temporal SDG, PHR and Akiris, 2013).

Third, a financial model made it possible to establish whether toll collection costs made the development of the project attractive for a private participation scheme.

After analysing multiple initiatives on charge collection system types, areas and fees, the scheme adopted by SDM was a cordon area scheme. It consisted of an area of 15 km^2 with a fare of USD 2.60 per cordon crossing. The estimated speed improvement was three km/h, while the estimated internalisation of the cost of congestion was USD 14 million per year.

Different governance alternatives were proposed, from an entirely public operation to a concession. The decision was that the operation of the system would be a responsibility of SDM, supported by a contract with a private company. This company would be in charge of the installation of frames for tag detection, enforcement cameras, collection of the fare and the overall enforcement of the scheme.

The resources to be collected from congestion charging would be earmarked entirely for the financing of the operation of public transport, which is in financial deficit in Bogotá, and to its improvement.

This scheme was presented to the City Council on three occasions in the period 2014-2015 and was rejected.

Charge per kilometre in Bogotá (2018)

In 2018, SDM structured a new, more ambitious scheme, based on a charge determined by the number of kilometres travelled. This scheme considered establishing a differential charge for different zones and times of the day. The increasing spread of congestion, both geographically and temporally, had made the area proposed in the previous scheme insufficient, so the proposed scheme established a wider area of 45 km^2, with a technological scheme of gantries and tags similar to that proposed previously. In this scheme, the vehicle entering the area initially pays USD 0.2 and then USD 0.10 per kilometre travelled.

Table 7. Charge by kilometre, 2018

Item	Value
Congestion zone	45 km^2
Optimal fare	USD 0.2 base + USD 0.1 by km
Traffic reduction congestion zone	5%
Change in speed	20 km/h – 23 km/h
Collected charge per year	USD 27 million
Investment cost	USD 105 million
Annual operational cost	USD 15 million

Source: Secretary of Mobility (Union Temporal SDG, PHR and GSD+, 2018).

One of the interesting findings of the project was the limited willingness to pay, with many users preferring to make longer car trips rather than paying the charge or changing to another mode, despite the chosen area including middle- and high-income users, who have low price elasticities. The predicted overall vkm reduction was near zero, as a result.

Car use reduction in the charging zone was estimated at 5%, generating a 15% increase in average speed. This scheme required a higher number of gantries to be able to estimate the journey inside the charged zone.

As noted, under the new regulatory framework, the scheme does not need to be approved by the City Council. This study was submitted to the Ministry of Transport to receive its technical and financial approval at the end of 2019. It has not been implemented yet.

Several differences between the two projects can be underlined.

- First, the cordon charge project was set up for a small area with exacerbated congestion. This area was chosen because it has a high number of origins and destinations for car travel. The population accessing this area has high incomes, and many are willing to pay the congestion charge.
- Second, in the km-charge project, the zone is larger, but the congestion conditions on average are less severe. The charge per vehicle is lower, and part of the journey can be made on roads outside the charging zone. The average driver (with a higher price elasticity of demand) is willing to travel more kilometres and spend more time to avoid the charge.
- Third, in the kilometre charging scheme, the number of gates and controls required on the trips is higher. Consequently, the investment and operation costs are higher.
- Fourth, the kilometre charging scheme would cover a larger number of vehicles, generating a wider culture of payment for externalities.

Congestion Charge in other Latin American cities

Research funded by the Inter-American Development Bank (Bocarejo, Lopez Ghio and Blanco, 2016) evaluated alternative congestion charging schemes in Bogotá, Mexico City and Santiago. A direct demand model was applied to estimate the distance travelled in peak hours using variables such as operational cost, travel distance, household income and car ownership. The base information used was derived from the available OD surveys in each city. The general model structure is shown in Equation (1). For each city, different variables were tested and the most representative were used as independent variables.

$$\text{Log (distancekm)} = \gamma * \text{Log (costkm)} + \Sigma\, Xi*\beta i$$

Where:

Distance_{km}: Daily Vehicle Km

Cost km: Operational cost including fuel, parking, insurance and others

γ : Elasticity cost-demand

X: Household representative variables such as motorisation, income, car trips, commuters

β: Coefficient from representative variables

The criteria for the selection of the congestion area included the review of previous studies of congestion charging (in Santiago and Bogotá), the concentration of economic activities, high traffic volumes and low average speed.

The benefits obtained in each case show significant improvements in terms of reduction of congestion costs and emissions. The estimated vkm reduction was around 25 to 30%, with improvements in the average speed of five km/h. The expected revenues are also significant, amounting to almost USD 500 000 per day in the case of Santiago and over USD 600 000 per day in Mexico City.

An interesting variable has to do with the price elasticity of car use. In Mexico City and Bogotá, this elasticity is lower than in Santiago. That is, car users are more reluctant to change modes for a given increase in the cost of using the car. This difference appears to relate to different perceptions of the perceived quality of public transport and other alternative modes.

Table 8. Congestion charge alternatives for three Latin American cities

Item	Bogotá	Mexico City	Santiago
Area (km^2)	9	27	16
Daily Fare (USD)	2.00	1.26	0.94
Average speed change (km/h)	17 – 23	11 – 19	21 – 26
Decrease in car use (km 1000)	182 (28%)	592 (29%)	617 (25%)
Internalisation of congestion cost (USD/day)	70 500	400 773	137 560
Reduction in CO_2 emissions (g/km)	60	102	130
Revenue (USD 1 000/day)	154	611	447

Source: Bocarejo, Lopez Ghio & Blanco (2018).

The examples described in this chapter show positive results both in terms of the economic assessment of congestion charging and in terms of the financial viability of the schemes required to implement it. Significant travel time savings and reductions in negative environmental externalities would result, while new revenue would be generated to invest in the most sustainable transportation modes. So why do these initiatives fail at the political level?

Challenges for the future

As described above, there are multiple and powerful variables that will drive the increase in private vkm travelled in the next decade in Latin American cities.

The Covid-19 pandemic may have the effect of further boosting this demand. In the first days after the lockdown, authorities limited load factors in public transport to 35% to 50% of their capacity. Even though some cities have been proactive at promoting bicycle use, there is a high likelihood that this shortage of public transport will produce more car trips. In the medium term, an aversion to public transport may be generated. Although virtual work will reduce commuting at peak hours, trips for reasons other than work or study may increase in the medium term.

Demand management initiatives have been promoted in many cities, especially in developed countries. In most of them, projects have ended in the design phase; a few have been the subject of an open political debate, with a negative outcome in most cases. However, the recent demand management initiatives in Latin America, based on economic tools, may provide useful lessons for future projects. Some key issues are presented below.

The regressive nature of congestion charges

The main argument against congestion charging and other initiatives increasing the cost of car use has been their supposedly regressive nature: higher-income citizens will still be able to use the car, while lower-income citizens will have to change their preferred mode of travel. The most solid counter argument is the allocation of revenue generated towards sustainable mobility projects, especially for improvement of the quality of public transport, which is used by low-income citizens. In the case of the successful London congestion charge, an ambitious plan was funded with the revenues (Prud´homme and Bocarejo, 2005).

Big capital cities in Latin America have been prioritising investment in mass transit in the last two decades.

- Santiago has doubled its metro network and is operating a fleet of more than 200 electric buses
- Bogotá is finally starting the construction of its first metro line, to be integrated with the Transmilenio BRT. New CNG Transmilenio buses meeting EURO VI emission standards have been purchased and this year 485 electric buses will start operation
- Lima is constructing its second and third metro lines via a PPP scheme and operates a BRT line with a CNG-fuelled bus fleet
- Sao Paulo has implemented a driverless subway line, via a PPP scheme, and operates a metro network of more than 370 km.
- Mexico City has developed a BRT system of more than 100 km over a 15-year period.
- Buenos Aires has already implemented 60 km of BRT and has renewed much of its regional train system

Investments in infrastructure for the expansion of the mass transit network, vulnerable user subsidy policies, and rolling stock renewal require significant resources. Cities permanently require fresh resources to be able to finance the enormous cost of having a good public transport system.

Recently, the concept of accessibility has become very popular among transport specialists (Preston and Rajé, 2007). In developing cities, better accessibility depends heavily on having a high-quality, affordable public transport system (Bocarejo and Oviedo, 2012).

The motorist is the State’s cash cow

Most car users in Latin America have middle-class incomes. Although it is common for the richest to have motorisation rates close to those of European countries, and for their journeys to be made mainly by car, in terms of the total number of car trips, the middle class predominates. For example, Bogotá's 2019 mobility survey (SDM, 2019b) shows that 60% of all car trips are taken by the middle class, even though they still travel mostly by public transport. The highest socio-economic stratum uses cars for 48% of their motorised trips. However, these only account for 7% of the total trips.

Car users already pay fuel taxes, high parking fees and vehicle ownership taxes. They consider that this gives them the right to travel on urban roads without having to pay additional charges. They feel that they do not obtain benefits for the extra charges they are paying. Congestion charging is seen as a double payment, without significant benefits (UCL and Universidad de Los Andes, 2014).

A review of vehicle tax policy is recommended to consider which charges are most efficient, if a choice between taxes must be made due to taxpayers' ability to pay. The internalisation of congestion costs has several positive outcomes for cities. Compared to a general tax on fuel, for example, congestion charging has the advantage of generating additional economic benefits related to reductions in travel time and pollution, targeting users at the specific time and place they generate the externalities.

A solid regulatory framework

The application of congestion charges by local authorities requires a legal framework authorising its collection. In the case of the London congestion charge, Transport for London's leadership in its implementation required regulatory support from the national government. In 2000, a Transportation Law was issued, authorising cities to establish such charges (Bocarejo, 2008).

In the case of Colombian cities, it has also been necessary for the national government to create a legal framework. In Bogotá, initiatives for new charges for car users such as the off-road parking surcharge and congestion charge have been rejected by the City Council. The most recent development plan eliminates the need for approval by the Council by changing the formal nature of the different charges on car use.

Another important regulatory element to make congestion charging projects possible has to do with technology. Several countries have set standards to facilitate the development of Intelligent Transport Systems (ITS) and their interconnection. Enforcement systems for future congestion collection schemes should be compatible with automatic road toll collection systems.

A holistic approach to urban mobility

The future of congestion charging schemes depends on the development of a comprehensive sustainable mobility policy. The principle of internalising the external costs of congestion and pollution is fair and promotes sustainability and equity.

However, it is important that the alternatives to car use are real and of good quality. Allocating congestion charge revenues to improve these options eliminates the argument that this, and similar charges on car use, are regressive in nature. Moreover, given that congestion charging would cause a percentage of car users to shift to the transit network, increasing occupation and degrading the level of service offered, there is another strong reason to use congestion charging revenues to expand public transit capacity.

The daily use of the bicycle is also an important challenge for Latin American cities. The increase in segregated bicycle infrastructure and the growth of the number of cyclists has been substantial in recent years. Mexico City, Sao Paulo and Buenos Aires have successful public bikesharing systems, while the number of daily users in Santiago and Bogotá are the highest in Latin America. In the case of Bogotá, more than 1.2 million cycling trips are made daily, accounting for 7% of the total trips in the region (SDM, 2019b).

On-road parking charge schemes should also continue to be consolidated. Buenos Aires, Santiago, Mexico City and Sao Paulo have been expanding their systems, generating new revenues and, if properly implemented, reducing car use.

ITS, better control centres and traffic regulation systems, information for users of all transportation modes and big data analysis are another key element to be developed in this comprehensive approach.

Finally, Latin American cities are also reconsidering the merits of developing and improving urban motorways. This type of project has generated a wide discussion about its sustainability. For decades, the expansion of road infrastructure was seen as positive by society at large. With the exception of some communities that were affected by road expansion projects, the provision of new road space was good news for cities. However, increasing environmental impacts and the sense that congestion in the medium term was not resolved by greater investment in roads has changed the perception of urban road infrastructure projects (Newman and Kenworthy, 1989).

Today the urban highway debate is strong in Latin American cities, although some of them have invested considerable resources in their implementation. One argument against further expansion is induced demand, or triple convergence. Authors such as (Ding and Song, 2011) explain the phenomenon that arises when the supply of road infrastructure increases. Users who decided to shift away from peak hour car use on a congested road, tend to use the new infrastructure, accelerating the demand for the use of the car in the new improved capacity. Providing more road infrastructure is an invitation to increase vkm, whereas allocating these resources to public transport and non-motorised modes would be more sustainable.

This complex discussion will not be treated in this paper. However, regarding tolled urban highways in Latin America, the fare system that has been established on the urban highways of Santiago that changes according to congestion periods is a notable development.

Conclusions

This review of Latin American cities' experiences with congestion policies suggests the following discussion points:

1. Congestion levels, already critical in many Latin American cities, will be exacerbated by the "new order" brought by the Covid-19 pandemic. That is why it remains essential to study and apply theories of congestion charging and other demand management options such as parking strategies.
2. In the capital cities of Latin America, many with populations over 10 million inhabitants, it is not realistic to think that they can turn into neighbourhood cities. The economic dynamism of these cities requires them to have regional influence, and mobility is one of the key assets that make them competitive. The historical predominance of transit trips over car trips in these cities has been shifting in favour of car use. Transport policies must focus on trying to contain this modal change.
3. Taxation on car users is high in some countries in the region. It is advisable to evaluate the most efficient charges and review charging priorities. Congestion charges generate additional benefits that make them more attractive than other automobile taxes and charges.
4. The strong political opposition that has caused several initiatives of charging car use to fail in the city of Bogotá requires actions to build a comprehensive vision. This would reinforce the point that it is fair to charge those who cause pollution and congestion in order to create a kind of cross-subsidy towards the most efficient transportation modes. Car use cannot be seen as independent of other modes and urban decisions. Priority must be given to the most efficient and sustainable modes. Prioritising road space and public resources to these modes is the right policy.

5. In many Latin American cities, it is difficult to think about generating new space for HOVs. Bicycle paths, bus priority lanes, future BRT projects and improved pedestrian space needing traffic calming may have priority.
6. However, urban toll roads in Santiago, Mexico City and Sao Paulo can adopt new strategies to optimise operation, varying charges in relation to demand.

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Congestion in Latin American Cities

Innovative Approaches for a Critical Issue

This paper surveys trends in private vehicle use in Latin American cities and related government policies. It discusses the Colombian government's initiatives to adopt congestion charging in major cities, highlights the political constraints encountered, and discusses policy changes adopted in response. The paper presents modelling results for the impact of different congestion charging proposals and identifies the principal challenges for adopting them.

All resources from the Roundtable on Congestion Control Experiences and Recommendations are available at: https://www.itf-oecd.org/congestion-control-experience-recommendations-roundtable.

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Published: 09/2020 | Photo credit: JW_PNW/Shutterstock