INTEGRATING BICYCLES AND PUBLIC TRANSPORT IN THE DEVELOPING WORLD: THE CASE OF SANTIAGO, CHILE

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Abstract

The primary purpose of this study is to review the potential for greater bicycle-public transport integration in the developing world, exploring strategies for encouraging multimodal connections in Santiago, Chile. The provision of bicycle transport facilities at major public transport hubs can offer an alternative to walking or driving distances of a kilometre or more. In addition, it can broaden the catchment area of public transport, adding the convenience of door-to-door (last-mile) travel not always available to passengers. A better understanding of opportunities and barriers surrounding bicycle access to public transport is essential in implementing any multimodal plan. However, whilst bicycle-public transport integration has been achieved in many cities of the industrialised world, its application has been limited in developing cities, where the predominance of private operators often makes it difficult to coordinate a systemwide program. In addition, the relative lack of capacity on most systems—particularly during peak periods—makes it virtually impossible to fit bicycles on public transport vehicles. What are the alternatives for facilitating connections between bicycles and the public transport system?

Mumbai, Buenos Aires, São Paulo and Santiago are examples of (middle income) cities where bicycle transport has been promoted and bikeshare systems have been implemented in recent years. However, whilst these systems and simultaneous efforts to extend bicycle infrastructure have further encouraged the use of bicycles, attempts to integrate these systems with public transport have been somewhat limited. For example, bikeshare systems have located facilities at several locations, including near rail stations, but in most cases, have not actively collaborated with planners and public transport operators to design convenient and accessible connections to rail and bus systems. Perhaps, if there were closer collaboration, the catchment areas for public transport systems in these cities could be further extended, yielding important transport benefits (e.g., greater mode choice, time savings and congestion relief to roadways and capacity-constrained bus systems).

This research will identify past efforts to integrate bicycle and public transport uses and obstacles preventing bicycle-public transport integration from further advancing. A mixed-methods approach will employ a literature review of bicycle-public transport integration in the industrialised and developing worlds; and will trace recent progress in Santiago through past reports and articles, as well as interviews with bicycle transport experts there. In addition, findings from a survey of bicycle users accessing public transport in San Francisco will also be explored. Ideally, this study will provide insight into existing institutional barriers; as well as strategies for encouraging greater collaboration between bicycle planners, public transport operators and user groups.

Key words: bikeshare, integration, multimodal, catchment

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1. Introduction

In the 21st Century, transport planners, researchers and authorities have placed increasing importance on the integration of public transport modes, as well as their integration with other modes. These connections offer yet another tool through which to promote sustainable urban planning, effectively extending catchment areas and reducing dependence on the private car. It is increasingly important to link public transport to "last mile" strategies, such as the accommodation of bicycles on public transport (Walker, 2012; Pucher et al., 2009).

The primary purpose of this study is to review the potential for promoting bicycle-public transport integration in cities of the developing world. Santiago, Chile provides a case study for exploring many of the institutional issues related to this form of intermodal integration.

2. Bicycle-Public Transport Integration

This paper is primarily focused on connecting public transport and bicycle transport in developing countries and Santiago, in particular; however, it is important to note that most of the early efforts to connect these modes took place in industrialised cities. For this reason, it is important to briefly review some of these efforts and some of the institutional constraints and opportunities that they have faced in both industrialised and developing countries.

2.1 Industrialised Countries

In many cities of the industrialised world, public transport systems have been adjusted and expanded to accommodate bicycles. In Europe, cycling has long played a significant role in transport provision. Such countries as The Netherlands or Denmark have permitted bicycles on board and have featured bicycle parking facilities, either within or adjacent to rail stations (Reitveld, 2000; Martens, 2007). For example, in cities such as Copenhagen, there are vast spaces reserved for bicycle parking at the street level, often near metro station entrances.

In the U.S., public transport systems have increasingly accepted the bicycle, with on-site bicycle parking facilities, as well as the on-board accommodation of bicycles (Pucher, 2012). Many public transport agencies have recognised the growth in use of the bicycle as an alternative means of transport to the car, introducing policies and practices that permit the cyclist to conveniently combine a bicycle ride with a bus, train of ferry ride.

Some of the first publications to comprehensively cover the integration of bicycles and public transport were released in the 1980s and 1990s (Replogle, 1987; Doolittle and Porter, 1994). They provided background on the topic (often from a European perspective) and discussed some of the major issues surrounding integration, including its significance within the realm of transport policy. Doolittle and Porter concluded that the two modes complement each other and that integration can be implemented without impacting public transport service.

Recent publications have explored aspects of bicycle-public transport integration in a variety of contexts. Krizek and Stonebraker (2011) assessed strategies for improving integration, while Hagelin (2005) studied its return on investment. Other studies have analysed the impacts of policy on public transport catchment areas (Guerra et al., 2012; Flamm and Rivasplata, 2014), as well as the benefits of bike sharing integration (Shaheen et al., 2012).

In addition, numerous publications on best practices have been released in the U.S. These have identified reasons for improving modal connections: to increase public transport ridership, to reduce congestion, to promote bicycle use, and to provide access to bus and rail systems (BART, 2012; Veryard and Perkins, 2017; APTA, 2018). Some federal agencies have developed websites that provide guidance to public transport operators (FTA, 2019).

2.2 Developing Countries

Whilst bicycle infrastructure has expanded in response to increased demand in the developing world (Suzuki et al., 2018), the coordination of bicycles and public transport has only recently received attention in developing countries. In part, this is due to several factors, including the private management of bus and rail systems and crowding on many systems. In many of these countries, the bicycle is seen as a travel mode of the poor and there is little interest in tailoring public transport to accommodate it (Dias Batista, 2010). In most cases, this has meant that bicycles are effectively prohibited from being taken onboard buses and rail. In other cases, there have not even been efforts to accommodate bicycle parking at public transport stations. However, in the past decade, an increasing number of developing cities in South America and Asia have begun to plan and implement integrated services.

A somewhat limited number of journal and press articles have addressed bicycle-public transport integration in developing world cities in Brazil, Colombia and Southeast Asia (Tobias et al., 2012; Nuñez, 2014; and Travelling Two, 2015). Many cyclists accessing public transport stations in these developing cities are low-income commuters seeking to access opportunities in the city centre (Carvalho de Souza et al., 2017). In general, common barriers to cycling cited in many of these studies include a widespread lack of infrastructure for bicycles, parking facilities, road safety, security and poor road maintenance

In other cities, much of the data has come from agency publications reporting on bus rapid transit (BRT) systems that accommodate bicycles on board. For example, in Bogota, Colombia, where bicycle trips average seven kilometres in length, Transmilenio (BRT system) allows bicycles on board under certain conditions (Nuñez, 2014). Similarly, in Cape Town, South Africa, the MyCiTt system allows for bicycles on the BRT services, if they are stored safely (MyCiTi, 2019). In both cities, BRT serves less that 20 percent of all bus trips and most of the remaining bus services are privately owned/managed and do not accommodate bicycles on board.

3. Case Study: Santiago, Chile

Local planners and researchers in Chile have increasingly sought to improve the access of nonmotorized modes to public transport, as have bicycle advocates. The following paragraphs provide background on Santiago: its geographic setting, its urban expansion, its regional transport network and the implementation of Transantiago, a comprehensive public transport programme.

3.1 Urban Characteristics

Santiago, a city of more than six million inhabitants, is the capital of Chile. It is a primate city, far outdistancing the size and density of the next two largest metropolitan areas: Greater Valparaiso and Greater Concepcion (see Table 1). The downtown is still a centre of commercial activity; however, transport infrastructure investment has supported commercial and residential decentralisation (Rivasplata, 2006). Whilst Greater Santiago has seen spatial expansion, urban densities have also increased in certain areas of the city (INE, 2017).

This growth has continued to perpetuate an established pattern of development in Santiago: higher residential densities in lower-income areas of the south and west, and relatively lower densities in many of the affluent areas of the east (INE, 2017). In addition, motorisation rates have continued to rise, as increased investment in road infrastructure has further promoted car ownership. With more than 1.2 million registered vehicles (INE, 2017), Santiago has seen a significant rise in the levels of congestion and vehicle emissions.

Table 1. Chile: Characteristics of the Principal Metropolitan Areas, 2017

Indicator	Greater Santiago	Greater Valparaiso	Greater Concepcion
Population	6,160,000	901,500	722,900
Land Area (hectares)	81,200	25,700	17,900
Density (persons/hectare)	76	35	40
Daily Trips	18,460,000	2,295,000	Not available

Sources: INE, 2017; City Population, 2019; SECTRA, 2017

3.2 Transport Network

The Santiago transport network is chiefly comprised of many of the same modes found in other cities: private transport; public transport; cycling and walking. Historically, public transport played a predominant role in transport provision, however growth in disposable income and greater access to credit led to explosive growth in car use beginning in the 1980s. In the past few years, there has also been an influx of a few other alternative modes that have seen growth in the industrialised world, including scooters.

The public transport system in Santiago consists of buses, shared taxis, a heavy rail metro system and a regional rail line (Rivasplata, 2006). The road-based public transport modes are privately-operated and regulated by the government, whereas the rail-based modes are publicly operated. The entire public transport network has been branded as one multimodal network, Transantiago. Collectively, public transport carries over five million daily passengers: 80 percent by bus, six percent by shared taxi and 14 percent by rail (see Table 2).

Table 2. Santiago Daily Travel Characteristics, 2012

Indicator	Greater Santiago
Trips: All Modes (thousands)	18,460
Mode Split (percent)*	
Private Transport, including taxi	27.4
Public Transport	31.7
Metro	*5.0*
Bus	*17.1*
Multimodal (Metro and Bus)	*6.7*
Other (including Shared Taxi)	*2.9*
Walk	34.5
Bicycle	4.0
Other (including Motorcycle)	2.4
Public Transport Trips (thousands)	5,940

*Mode Split for all trips

Sources: Subsecretaria de Transporte 2012, SECTRA 2017

3.2.1 Bicycle Transport

In the past decade, there has been a meteoric rise in bicycle use, with Santiago now boasting one of the most extensive bicycle networks in South America. More than 1.2 million bicycle trips are taken on Santiago streets each day, as the mode split for bicycle now approaches six percent, a significant rise from the four percent mode share reported in 2012 (El Mostrador, 2019). In response to this increased demand, the Santiago local government has invested heavily in bicycle infrastructure: there are now 400 kilometres of bicycle lanes ("ciclovias") in Santiago, up from just over 200 kilometres in 2014 (El Mostrador, 2019; Chandler, 2014).

3.2.2 Transantiago

Structurally, Transantiago features a hierarchical route structure that includes buses, the Metro and shared taxis. It consists of two interconnected components: a system of long-distance trunk routes along major travel corridors of the region; and a system of local and feeder routes that supplement the trunk routes (Malbran et al., 2003). Collectively, these form a tight, well-connected network of routes with good physical integration at key points of transfer, as well as coordinated fare and information systems (Muñoz et al., 2008).

Transantiago's launch in February 2007 was problematic, as design issues and operator service changes (including the restructuring of routes and reductions in the number of vehicles available) resulted in inadequate service (Muñoz et al., 2008). However, in the past decade, Transantiago has regained the confidence of system users, as planners have established new fare and route standards, service frequencies and improved interchange (Muñoz et al., 2014).

Under Transantiago, service planners have achieved a higher level of coordination amongst public transport modes. However, whilst ground-breaking in its approach, Transantiago has largely been limited to public transport delivery and the challenge has been to improve last-mile bicycle access to bus or metro.

3.3 Transantiago and Bicycles

Transantiago was not initially designed to widely accommodate bicycles on board nor at bicycle parking facilities at points of interchange. Some early efforts to connect bicycle and public transport trips in Santiago took place before the implementation of Transantiago and were initiated through advocate-based efforts, coordinating with bus operators, the Metro and the suburban train operator (Sagaris, 2006). Some of these efforts have advanced to the proposal stage (El Mercurio, 2018).

Even though local government has recently secured a significant level of investment in bicycle infrastructure in Santiago, much of the initial bicycle route planning did not fully consider connections to public transport facilities (e.g., bus and rail stops and routes). Bicycle infrastructure has significantly expanded in the last decade, as advocacy groups and transport experts have generated increased interest in filling historic voids.

4. Methodology

This study explores efforts to link the bicycle with bus and rail, employing a case study approach in the analysis of the opportunities and constraints posed by integrated services. It also includes the results of a survey administered as part of a wider bicycle-public transport integration study conducted in San Francisco. In the case of Santiago, the intent is to identify the costs and opportunities encountered, whilst the San Francisco case identifies issues that are common to many integration efforts.

The case method does not necessarily replicate conditions; however, it can facilitate the study of real-life situations where, under similar circumstances, specific variables are introduced. A case is selected in the context of a theoretical framework for the study (e.g., the establishment of specific forms of integration as a result of history, location and level of competition), within which the case illustrates a specific phenomenon.

This paper employs a mixed-methods approach, including a review of publications and journal articles on bicycle integration worldwide, as well as local government and transport industry documents and media reports in Santiago. This study also included interviews of bicycle experts in Santiago and a survey of cyclist-public transport users in San Francisco.

The primary objective of this study is to provide insight on some of the benefits of promoting bicycle-public transport integration; developments in the area of bicycle integration in Santiago; current institutional barriers preventing further advances there; and suggestions for encouraging greater collaboration between bikeshare planners, government agencies and public transport operators.

In the case of Santiago, several relevant public agency reports, newspaper articles and lecture presentations were consulted. This included the review of documents, articles, blogs and web pages from such sources as the Chilean Ministry of Transport, the Santiago Metro, and the Centre of Sustainable Urban Development (CEDEUS) in Santiago, as well as the El Mercurio and La Tercera newspapers In addition, it included one-on-one discussions with Dr. Juan Carlos Muñoz, Director of CEDEUS and Dr. Lake Sagaris, a bicycle advocate who has been involved in promoting bicycle transport for over 20 years.

The work in San Francisco consisted of administering a cyclist survey at nine major public transport nodes throughout the city, some in the city centre and others in neighbourhood commercial areas (Flamm and Rivasplata, 2014). It included intercept surveys of cyclists entering stations and terminals. In all, 174 surveys were distributed: 20 were administered on site, 134 were handed out to cyclists, and 20 were left on parked bicycles.

5. Findings

This research on integration in Santiago largely relied on secondary sources, such as government documents, industry reports, periodical articles, and conversations with researchers from the Universidad Católica in Santiago. Since few research publications have directly addressed the actual integration process itself, our focus has been on data released by agencies and experts.

For the San Francisco component, the primary source of information was interviews with cyclists accessing public transport, conducted at major points of integration (Flamm and Rivasplata, 2014). In general, these interviews sought to identify constraints and opportunities facing the bicycle-public transport user. In addition, other reliable sources were consulted in the acquisition of background data on each of the case cities.

5.1 Santiago

With the growth of cycling in Chile, several advocacy groups and university researchers have increasingly called for better bicycle access to public transport in Santiago. In the past decade, three separate services connecting these modes have been developed and made available to the general public: BiciMetro, Bike Santiago, and BiciBus. In addition, bicycle advocates and sustainability groups have proposed other alternatives for combining bicycle and public transport use (Muñoz Interview, 2020).

5.1.1 BiciMetro

This Metro-sponsored programme has provided "guarderías" or secure bicycle storage cages at eight Metro stations. The programme forms part of the Metro's sustainable transport policy to reduce impacts on the environment (Metro de Santiago, 2017). Most of these stations are located on the urban periphery, far from the city centre, providing cyclists with the opportunity to leave their bicycles near Metro stations and easily access the Metro (see Figure 1). Guarderías are closely monitored by Metro staff and feature numbered "cages," where the bicycle is protected until the cyclist returns to retrieve it (see Figure 1).

The primary barriers to programme expansion are the lack of space at several stations, and a hesitation on the part of the Metro to create new spaces. The price of this service for the user is not a limiting factor, as it is relatively inexpensive—less than $US1 per day. Participating Metro stations are near commercial nodes on the urban periphery and over time, some infrastructure has been built to improve cycling in the immediate area. However, some corridors leading away from these areas still lack connections to other bicycle routes.

Figure 1. Cyclist leaving his bike at a Metro guardería (Source: Santiago Metro)

5.1.2 Bike Santiago

Inaugurated in 2013, Bike Santiago features more than 150 stations (Bike Santiago, 2019; La Tercera, 2015). Along with Bici Las Condes and a few smaller bikeshare companies, it comprises the city's Integrated System of Public Bicycles (La Tercera, 2014). Bike Santiago is financed by Itau Bank and managed by Tembici, a Brazilian bikeshare company. Most of the bike share stations are either located in Central Santiago, or the affluent areas to the east of the city (e.g., Providencia, Vitacura). Whilst this system features bike share stations at many strategic locations, several factors are considered when choosing a station location and only about a dozen Metro stations are directly served (Bike Santiago, 2019).

There are clear barriers to the use of Bike Santiago by a significant sector of the population and riding public. Whilst some cyclists, particularly tourists and high-income residents, access bikeshare at one or both ends of a Metro trip, for most daily bicycle commuters, this is

an expensive option, given bike share costs are high (e.g., as much as US$9 per day) . In addition, bike share stations have not been established in low-income areas of the urban periphery (e.g., La Pintana), where per capita bicycle use is highest (Advis Jimenez, 2011). In contrast, communities on the affluent east side of the city, have seen significant investment in bicycle infrastructure with Providencia boasting the highest concentration of bicycle routes in Chile. These facilities have made cycling an attractive option for these areas and have attracted the highest number of bike share stations in the city (Chandler, 2014).

Figure 2. A bike station near the Cal y Canto Metro Station (Source: Charles Rivasplata)

5.1.3 BiciBus

This is the most recent effort to integrate bicycles with public transport. Piloted in 2018, it consists of a pilot programme to install bicycle racks at the front of participating buses in Santiago (see Figure 3). The concept was conceived by students and researchers at the Universidad Católica in Santiago, who argued that the installation of bike racks on buses would be relatively cheap and only add an average of eight seconds per person to the overall loading time at stations (El Definido, 2018). In 2015, CEDEUS, a research centre affiliated with the Universidad Católica, studied the feasibility of implementing BiciBus with front-loading bike racks, and presented its findings to the Transport Ministry (Publimetro, 2015).

Subsequently, the Ministry approved the launch of a pilot programme and the Vule bus company, one of several private bus operators regulated by the government, agreed to participate in the programme. With government support, it equipped 10 of its buses (operated along a single route) with bike racks (El Mercurio, 2018). During the pilot period, ten monitors were employed to observe operations.

Since the initial pilot, the project has faced institutional barriers, preventing it from effectively offering intermodal connections to areas of high bicycle-public transport demand. Whilst initial reports indicated that the pilot was moderately successful (El Mercurio, 2018), no further pilot projects have been scheduled in the last few years. Thus, since the initial two-month pilot project ended in March 2018, the Ministry of Transport has not moved forward to provide incentives for other bus companies to equip their vehicles.

Figure 3. A BiciBus vehicle with a front-loading rack (Source: FMDOS)

5.2 San Francisco

The focus of this study is on Santiago, however experiences with bicycle-public transport integration in San Francisco are worth exploring. San Francisco, a city of about 850,000 inhabitants is the historical and cultural centre of the Bay Area, a metropolitan area of more than seven million in Northern California. Given its initial development as an important commercial center prior to the advent of the car (19th Century), this city has the highest population density in the Western U.S., averaging around 72 persons per hectare. Unlike many other cities in the U.S., San Francisco has retained much of its historic public transport infrastructure, providing comprehensive service on a number of its bus and streetcar lines, articularly in the central city.

Since the 1990s, there has been an upsurge in the number of bicycles on the road, rising to approximately four percent of the City's entire travel demand in 2017 (SFMTA, 2017). The San Francisco Bicycle Coalition and other advocate groups have been instrumental in seeing that bicycles are fully considered in all transport plans and development. Bicycle planning came into its own at the beginning of this century, and the 2009 Bicycle Plan has provided solid support for investing in bicycle infrastructure to keep up with growth in demand (SFMTA, 2009).

An increasing number of public transport operators in the Bay Area have provided bicycle-public transport integration at key points of interchange: they have offered bicycle parking facilities at metro stations, bus stops and ferry terminals; and have allowed for bike storage on buses and some trains. Additionally, since 2013, a regional bike share company has operated bike share stations in areas near public transport stations and terminals (BAAQMD, 2015).

During peak and off-peak periods, the survey was administered to bicycle riders directly accessing public transport at important stops and stations in the city of San Francisco. An analysis of the data yielded the following findings:

- Cyclists accessing public transport were largely male, white and well-educated, a profile that reflects the population of cyclists identified in most studies in the U.S. Similar to in Santiago, there was a genuine concern that there is not equal access to bicycle transport, and thus, historically-disadvantaged populations are unable to enjoy some of the benefits that cycling and its integration with public transport can offer (e.g., time savings)

- In general, the users fell into one of two categories: those that only use bicycles as an access mode to public transport; and those who access buses, rail and ferries by bicycle and travel with their bicycles. This is an issue that also impacts cycling in Santiago, as thus far, it is really only the first group that has been served.

- Most survey respondents combined public transport and cycling for work commute trips, but just over one-quarter of the respondents combined public transport and cycling for non-work trip purposes. Again, this distinction between bicycle commuters and other bicycle users is important to highlight. In Santiago, it is not clear that efforts are seeking to benefit both of these groups.

6. Analysis

This section provides a review of the findings for Santiago and lessons learned from the San Francisco study. It provides a look at recent practice concerning the integration of bicycles and public transport.

Prior to the 1990s, bicycle infrastructure was largely non-existent in Santiago, the city was rapidly changing with the proliferation of the car. It was the return to democracy in 1990 that empowered transport planners and engineers to begin to dream of new alternatives, although emphasis was clearly placed on improving the public transport system and enhancing the road and highway networks in and around Santiago. A greater level of attention on quality of life concerns prompted residents to speak out against road projects that endangered their communities (e.g., Costanera Norte).

During the 1990s, bicycle advocates began to support less impactful modes that could mitigate potential impacts, gradually resulting in a strong call for better bicycle infrastructure (Sagaris, 2006). Government eventually capitulated, identifying ways of improving bicycle infrastructure, initially in the middle- to high-income areas of the east side, but later, in other areas of the city. Moreover, despite its initial difficulties with implementation, the Transantiago Plan eventually prompted the need to improve bicycle-public transport integration, i.e., an initiative strongly supported by bicycle advocates (e.g., Ciudad Viva). In the spirit of integration, the next question was how the city's growing use of the bicycle could be further promoted through connections for public transport.

Even though most bicycle advocates were convinced that integration was indispensable and some operators agreed, others questioned the possibility of integrating bicycles into bus and rail systems. Often, it was pointed out that space was an issue, particularly during the peak period when bus and rail vehicles are jam-packed.

But what about the daily commuter? What is Santiago doing to encourage its communities to go green, reduce carbon emissions, reduce road congestion, and improve health? For the

past decade, the answer has been the BiciMetro programme. In a limited number of areas, bicycle paths connect one metro station to the next, with designated areas to park bikes. As mentioned earlier, this service benefits a significant number of bicycle riders from the south and west, effectively allowing these users to access longer trips to commercial areas of the east and centre.

Another important service, especially for the recreational/occasional cyclist is the Bike Santiago bike share programme, which features some bike stations near the Metro. However, it can be costly for daily commuting, especially for low- and middle-income cyclists working in the city centre or areas of the east. In addition, it only serves some of the Metro stations and requires a special subscription (Bike Santiago, 2019).

The BiciBus, promoted by CEDEUS and bicycle advocates, effectively allows for two bicycles to be mounted onto the front of the vehicle (El Mercurio, 2018), but the pilot project did not result in full implementation, perhaps as the result of a change in national government in 2018. There has been hesitation on the part of the Transport Ministry to include bike rack requirements in the recent bus contracts. If implemented in the future, specific bus tendering provisions could prove to be a great way of ensuring that some or all buses offer this integrated service.

According to discussions with the Director of CEDEUS in Santiago, that organisation has even promoted the idea of allowing bicycles on Metro vehicles during off-peak periods (Muñoz Interview, 2020). This would involve allowing cyclists on the end train cars, much as BART did in the Bay Area in the late 1990s. In the latter case, advocates were successful in getting BART to allow bicycles in all train cars.

The findings in San Francisco allow us to draw some general conclusions concerning integration. For example, bicycles and public transport serve as access modes for each other, allowing travellers to access public transport and use bicycles for transport when they might not otherwise be able to. In Santiago, this is especially relevant in peripheral areas, where access to opportunities is often poor.

In addition, catchment areas for cyclists accessing public transport are larger than for pedestrian-public transport users, as access trips by bicycle exceed the distance that public transport riders would be willing to walk. Nevertheless, catchment areas are complex, as cyclists travel for many reasons and often do not take the shortest or most direct route to a public transport stop or station (Flamm and Rivasplata, 2014).

Further analysis of the data received from the 2014 survey in San Francisco identified current issues faced by cyclists accessing public transport (Flamm and Rivasplata, 2014). This effort yielded the following results:

- Catchment areas for bicycle riders are significantly larger than for riders who walk to public transport stations and stops.
- The distances that most bicycle users travel would take much longer to travel on foot.
- The value to bicycle users of combining cycling and public transport goes well beyond simple time savings.
- The ability to combine cycling and public transport provides an alternative to costlier modes of travel.
- The ongoing provision of orientation materials is a vital element in the promotion of bicycle-public transport integration.

7. Conclusion and Recommendations

In conclusion, bicycle-public transport integration not only requires a change in societal attitudes, but also depends a great deal on developing and managing infrastructure at points of interchange. In many countries, the bicycle has historically been considered a second-class transport mode, not worthy of the attention paid to motorised transport. Over time, many industrialised countries have responded, providing bicycle infrastructure and linking this mode to public transport at key points. In many developing countries with limited resources, it has been a challenge to coordinate key players and meet potential demand for intermodal connections. In Santiago and other developing country cities, advocates and bicycle planners have worked with government representatives to highlight the benefits of cycling and its contribution to broadening the catchment areas for public transport.

An examination of the available information on bicycle-public transport integration in Santiago revealed that despite past gains, Transantiago does not yet offer a comprehensive programme of options for connecting bicycle and public transport trips. Whilst BiciMetro has provided a cheap opportunity for low and middle-income residents to park a bicycle and access the Metro, it is limited to the amount of space available at each Metro station.

Since the BiciBus pilot project has not yet been fully implemented, cyclists do not currently have the option to bring their bikes with them when they combine modes. It appears that the project has been paralysed since 2018, when there was a change in government—negotiations need to be resumed. Similarly, if the proposal to bring bicycles on the end cars of Metro trains were further piloted and expanded, perhaps it could be shown that there is room to accommodate bicycles on board during specific off-peak hours. Such a programme could shift ridership to the off-peak periods, consistent with the objectives of off-peak pricing.

Interestingly, the San Francisco study yielded two key conclusions supporting the need for integrated services in industrialised and developing countries: (1) public transport catchment areas are much larger for bicycle-public transport users than for public transport users, who access buses and rail on foot; and (2) the concept of a bicycle-public transport catchment area is quite complex and good integration provides a variety of travel opportunities to public transport users. In Santiago, we see that cyclists often take advantage of larger catchment areas to reduce their travel costs.

In San Francisco, bicycles are regularly permitted on BART, the regional heavy rail metro system, during non-peak hours. As part of a feasibility study, perhaps, the Santiago Metro could conduct a survey of bicycle riders to see if they would take advantage of this opportunity and if so, develop a pilot project on a less congested line (during off-peak hours).

It is recommended that the national and local governments take a more proactive role in implementing the BiciBus programme citywide, as well as in studying the feasibility of allowing bicycles on the Metro. Integration can be mutually beneficial: cyclists significantly extend their geographic range, whilst public transport operators expand their catchment areas and provide access to a much wider area (e.g., reducing dependence on the private car).

What is lacking in the Santiago case, is an ongoing commitment on the part of the local and national governments to engage multimodality and expand the scope of integration so that a larger number of system users can combine their bicycle journeys with bus and rail trips, or vice versa. A political champion needs to commit to making sure that government carries through with integration.

Where financially and technically feasible, cities of the developing world should actively promote bicycle-public transport integration in order to provide more equitable access to mainstream activities. The Santiago example offers a few lessons concerning how to proceed. Clearly, there needs to be a comprehensive assessment of each city considered and the establishment of interagency groups to plan, design and implement services that account for settlement patterns and available transport modes. In addition to bicycle-metro and bicycle-bus integration, there needs to be public outreach to educate and provide residents with the tools that they need to fully participate in future planning.

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