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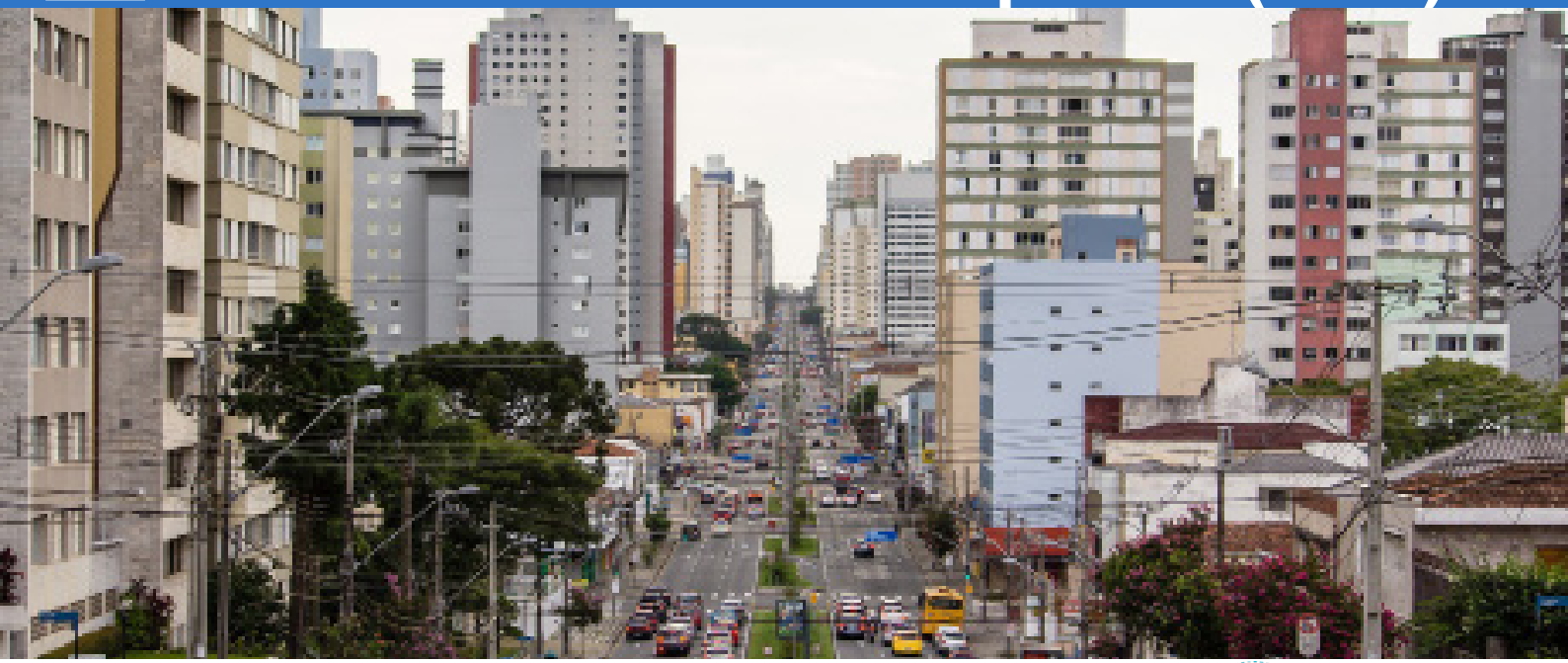
Factsheet

Transit-Oriented Development (TOD)



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Urban Electric Mobility Initiative (UEMI) was initiated by UN-Habitat and the SOLUTIONS project and launched at the UN Climate Summit in September 2014 in New York.
UEMI aims to help phasing out conventionally fueled vehicles and increase the share of electric vehicles (2-,3- and 4-wheelers) in the total volume of individual motorized transport in cities to at least 30% by 2030. The UEMI is an active partnership that aims to track international action in the area of electric mobility and initiates local actions. The UEMI delivers tools and guidelines, generates synergies between e-mobility programmes and supports local implementation actions in Africa, Asia, Europe and Latin America.

Solutions

SOLUTIONS aims to support the exchange on innovative and green urban mobility solutions between cities from Europe, Africa, Asia and Latin America. The network builds on the SOLUTIONS project and brings together a wealth of experience and technical knowledge from international organisations, consultants, cities, and experts involved in transport issues and solutions.

The overall objective is to make a substantial contribution to the uptake of innovative and green urban mobility solutions across the world by facilitating dialogue and exchange, promoting successful policy, providing guidance and tailored advice to city officials, fostering future cooperation on research, development and innovation.

Aims

SOLUTIONS_UEMI supports urban mobility implementation actions that contribute to the Paris Agreement and the New Urban Agenda.
Sustainable energy and mobility can make positive contributions to a number of policy objectives, nationally and locally. In particular in cities there is a great potential to create synergies between for example safety, air quality, productivity, access and climate change mitigation. A UEMI resource centre will provide opportunities for direct collaboration on projects focusing on sustainable urban mobility and the role e-mobility can play in it. The UEMI will pool expertise, facilitate exchange and initiate implementation oriented actions.
UN-Habitat, the Wuppertal Institute & Climate Action Implementation Facility jointly host the resource centre for the Urban Electric Mobility Initiative, aiming to bridge the gap between urban energy and transport and boosting sustainable transport and urban e-mobility.

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In brief

The high levels of congestion and air pollution, triggered by car-oriented planning and high urbanisation rates, has significantly increased the priority of mobility issues in the agendas of local governments. Thus, the provision of adequate transportation systems has become as important as the provision of sewage and safe water in cities. In the past decades, the need to integrate transportation systems with land use has attracted not only the interest of local governments in developed and developing countries but also the interest of international organisations aiming to achieve sustainability goals. These concerns have driven attention to the concept of Transit Oriented Development (TOD), a concept developed in the USA in the 1990's to counteract the impacts of the urban sprawl generated by the mass motorization that started in the1950's. TOD is defined as a dense, mixed-use type of development around mass transit stations with well-designed public space that promotes walkability (Bishop, 2015; Cervero, Murphy, Ferrell, Goguts, & Tsai, 2004). "TOD is not simply an assembly of buildings around transit nodes. It is also about community and neighbourhoods" (Cervero et al., 2004, p. 8) . The characteristics of TOD were applied in the late 19 th Century around most streetcar and interurban rail lines. This practice continued until today in most European cities, but in the US it only lasted until the construction of roads and highways gained importance.

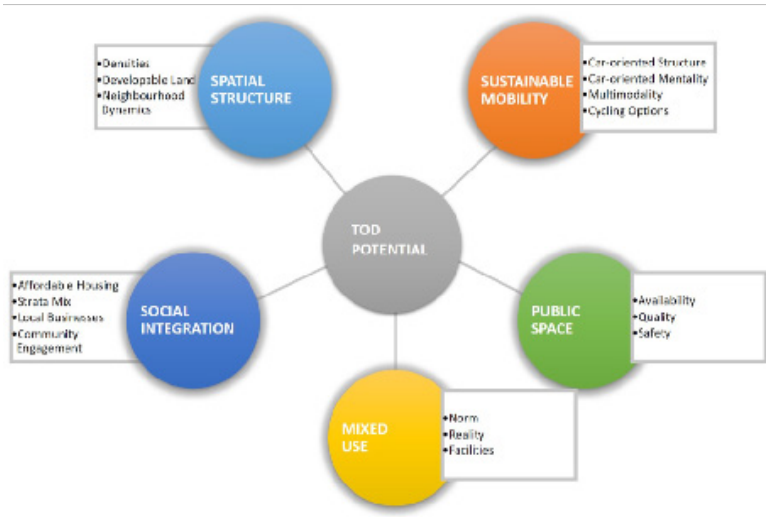
TOD, a planning tool of smart growth that integrates land use and transport in a regional context, has been implemented in cities around the globe looking forward to counteracting main urbanisation issues (Galelo, Ribeiro, & Martinez, 2014) . At present, more than 100 TOD projects have been implemented in the United States (Cervero et al., 2004), and some efforts on TOD have been made along BRT corridors in Latin America, showing good practices as well as lessons learnt. Despite its undeniable benefits, the implementation of a TOD Strategy is complex, as it must integrate several aspects and sectors, which has posed several challenges on the executing agencies. Accordingly, this paper focuses not only on the definition and measures, but also on the lessons learnt and the gaps in the TOD interventions carried out so far with the aim to implement it successfully in future.

Measures

A city needs to consider five fundamental dimensions in the implementation of a TOD Strategy. The first four are Spatial Structure, Sustainable Mobility, Public

Space and Mixed Use, all of them showing a direct link with the definition of TOD, i.e., a dense, mixed-use type of development around mass transit stations with attractive public space that promotes walkability (Cervero et al., 2004). The fifth category goes one step further and aims to include the dimension of Social Integration to avoid TOD's main side effect, gentrification. Figure 1 shows the five dimensions mentioned along with the aspects that each one of them has to take into account.

Figure 1: The five dimensions of TOD



Source: Muñoz B. (2017)

Spatial Structure:
The main aspect of this dimension is by definition density, which can be measured either by population or building density in the area. However, it is not possible to address the issue of density without considering the availability of developable land and the neighbourhood dynamics in terms of spatial growth.

Sustainable mobility:
A shift to sustainable mobility alternatives is also an important factor for TOD. The four main aspects of sustainable mobility are: 1) the car-oriented structure of the neighbourhood (e.g. parking management), 2) the car-oriented mentality of the residents, which aims to reflect in some extent the self-selection bias that may arise from individual choice and preferences, 3) the availability of quality public transportation and 4) cycling options. The main objective of this dimension is to generate the necessary conditions to encourage modal shift.

Public space:
Public space has to be pedestrian friendly in order

to fulfil its function. According to the literature, this element can be assessed through 1) availability (e.g. broad sidewalks), 2) the quality (e.g. good infrastructure and visually pleasant areas that make walking comfortable), and 3) security and road safety (e.g. adequate lighting and the creation of vibrant neighbourhoods).

In order to enhance security in public spaces, the concept of 'eyes on the street' - sometimes referred to as security by design - is key. It is defined as a "web of public respect and trust, and a resource in time of personal or neighbourhood need" (Jacobs, 1961, p. 56). This means that the improvement of public space and promoting occupant security decrease major crimes that usually happen in dark and isolated places.

Mixed use:
Mixed use aims to accommodate different functions in the same place, i.e., housing, commerce and services in an efficient matter so that the daily trips and distances decrease. It depends on: 1) the norm (e.g. the Land Use Plan), 2) the actual development of the area (e.g. diversity of activities), as well as 3) the availability of daily use commerce and services facilities. A study by Cervero (2007, p. 3) highlights the importance of mixed use for an efficient transport system. When mixed-use stations are aligned along linear corridors, they result in trip origins and destinations being evenly spread, producing efficient bi-directional flows.

Social Integration:
Social integration is defined as the availability of affordable housing in a neighbourhood, but also the coexistence and integration of different socioeconomics strata. These two criteria are not only important in terms of equity, but also to maintain ridership in the adequate levels. Additionally, it is important to consider the existence of small and medium local businesses that may also be threatened by gentrification and displacement when mass transit starts running. Finally, for a TOD intervention to be successful, it is important to inform the community and let them participate in the decision-making process.

Benefits

Benefits
TOD, a land use planning and design that foster a sustainable urban form, can reduce the number and distances of trips, generate a modal shift to more sustainable transport modes and decrease the energy consumption (Pettinga et al. 2010). The city receives

direct and indirect benefits from TOD as shown in Table 1. Benefits are categorised by public and private sectors and by primary and secondary positive externalities.

Table 1: Classes and Recipients of TOD Benefits

Type of Benefit	Primary Recipient of Benefit	
	Public Sector	Private Sector
Primary	1. Increase ridership and farebox revenues 2. Provide joint development opportunities 3. Revitalised neighbourhoods 4. Economic development	5. Increase land values, rents, and real-estate performance 6. Increase affordable housing opportunities
Secondary	A. Less traffic congestion and VMT-related costs, like pollution and fuel consumption (1) B. Increased property- and sales- tax (5) C. Reduced sprawl/conservation of open space (1, 3, 6) D. Reduced road expenditures and other infrastructure outlays (1) E. Reduce crime (3, 4) F. Increased social capital and public involvement (3, 4)	G. Increased retail sales (1, 2) H. Increase daccess to labour pools (A, 6) I. Reduced parking costs (C, 2) J. Increased physical activity (C, E, F)

Source: Cervero et al. (2004, p. 120)

Note: Values in parentheses represent primary benefits and/or secondary benefits that are the source(s) of the secondary/collateral benefit listed.

Altogether, TOD is able to generate important social, economic and environmental improvements in a city. Socially it provides health benefits and improves quality of life by reducing the risk of cardiovascular and respiratory diseases due to increased physical activity and deceased air pollution. Economically, it can provide urban renewal in shrinking city centres and increased land value. Lastly, it contributes to the reduction of the GHG emissions as the car trips lower and it helps preserve land from further degradation related to urban purposes.

Possible side effects

However, some cities experience side effects due to TOD. In some cases, the implementation of mass transit systems has had an impact on the land and property values around stations, causing processes of gentrification and displacement (Jones (2015), Rodríguez et al. (2016), ITF-OECD (2016). In the case of Los Angeles, California, for example, there has been a strong displacement in the downtown area where transit investments have been combined with urban renewal policies (Zuk & Chapple, 2015). To this respect, the International Transport Forum from the OECD (ITF-OECD, 2016) asserts that urban renewal and TOD interventions need to be rethought with the aim to incorporate social inclusion as one of the goals. For TOD projects not to become exclusionary, social inclusion should be one of the objectives starting from

the design phase of the project. Otherwise, gentrification could become unavoidable.

Technical & financial considerations

The implementation of massive public transportation systems such as BRT or subway lines requires a huge investment from local governments. The municipalities in many developing countries acquire long-term loans with development agencies to build the infrastructure. Nonetheless, the extra value added to the land (around 30%) by the implementation of public infrastructure could be captured by the state. This procedure, called land value capture, will allow the local government to pay its debt and also to invest further in public infrastructure and facilities.

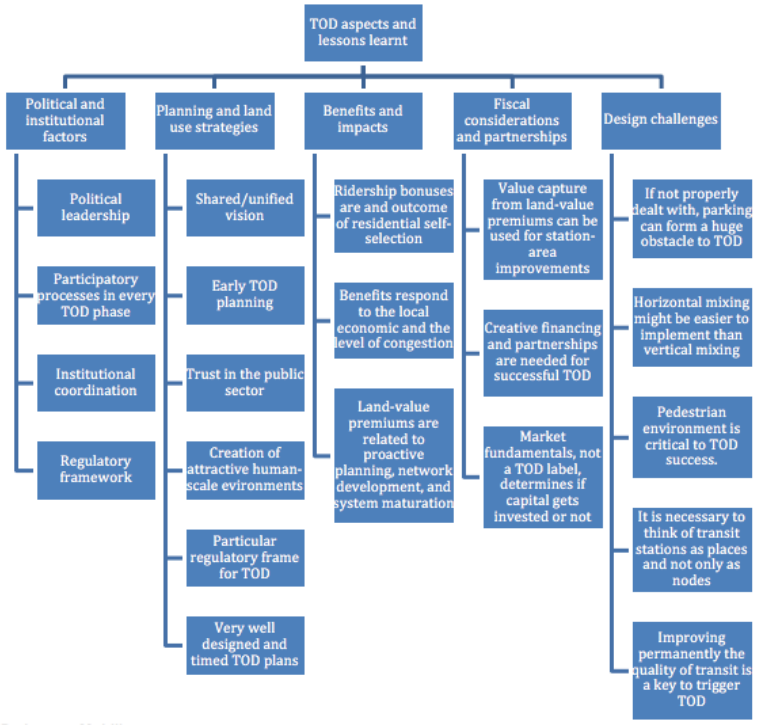
Some of the mechanisms of land value capture that local governments can use for a TOD Strategy include (Suzuki, Murakami, Hong, & Tamayose, 2015):

- Public land sale/lease: sale or leasing of public land that has increased its price due to investments in transit.
- Partnerships between transit agencies and developers: With the partnership, developers supply money or property for the construction of the station facilities, which will attract people to their businesses.
- Air rights sale: sale of additional development rights to investors interested in building additional floors to the ones allowed by the norm.
- Land readjustment: When landowners make their land available for readjustment, it enables the sale of parcels for transit-oriented development-related investments.
- Land consolidation and urban redevelopment: landowners associate with private developers to consolidate their land and build multi-purpose projects.

Policy/legislation & institutions

The aspects to be considered and the lessons learnt from 10 cities that implemented TOD in the USA are summarized in Figure 2 (Cervero et al., 2004). The message is clear: political leadership, institutional coordination and an early and well-designed planning, as well as parking management and pedestrian-friendly environments around stations are key elements of a TOD strategy in order to achieve success.

Figure 2: TOD aspects and lessons learnt



Source: Author based on Cervero et al., 2004

Transferability

The concept of TOD, as seen in the cities of USA and Latin America, is highly transferable to other cities around the world. It is important to take into account the local context and customise the approach according to the needs of every city. Some specific local conditions that need to be considered are the geographic location, climate, governance and institutional arrangements, social needs, etc.

Case study: Curitiba

Context – TOD attempts in Latin America:
Latin America has had a leading role in terms of urban transportation. Until today, almost 50 cities in the region have implemented BRT, a model that started in Curitiba, Brazil in 1974 and has been replicated across the globe for its benefits (Rodríguez & Vergel, 2013). Its success factors are cost-effectiveness and relative flexibility.

Although the expansion of BRT in Latin American cities has transformed the public transportation system, most of the cities still lack an integration strategy with the urban development, or to be more specific a TOD Strategy. Some efforts are seen to make BRT stations transit oriented, mainly in Curitiba and Bogotá, which together with Quito are the three first cities to have implemented BRT systems. The integration of BRT and

urban development is still at a very initial stage.

A study (Rodríguez & Vergel, 2013) about the transit orientation of 82 BRT stations in seven Latin American cities, including Curitiba, Bogotá, and Quito shows that only 2 of the analysed stations fulfil all the requirements to be categorized as transit oriented. This study concludes that it is not enough to implement mass transit systems. TOD does not happen by itself; it needs planning, strategies, vision and regulations to make it happen. A study by Robert Cervero (1998 in Rodriguez et al., 2016, p. 20) affirms that "a successful urban development vision must precede and guide transportation investments, and that planning is necessary if subcentres around transit stops are to take place". Finally, they conclude that affordable housing and mass transit are difficult to combine if there are not enough policies and regulations from the side of the state.

In this sense, BRT implementation in Latin American cities has focused on the infrastructure, showing a lack of complementary policies to generate TOD such as housing, land use and parking policies. Moreover, in the majority of the cases the BRT lines implemented in Latin America have been constructed along areas with proven demand, meaning that the mobility infrastructure has been adapted to already consolidated areas and therefore, it has not left space for further urban development and densification. Despite all that, it cannot be denied that Curitiba is the most advanced case of the implementation of TOD policies in Latin America and has been used as an example and case study by several authors worldwide.

In action

In Curitiba, the BRT was not only implemented to improve mobility, but to govern the urban development. Accordingly, it is the core feature of a master plan developed in 1966 that has been implemented ever since. This is a very relevant feature, as in most of the cases, "full BRT projects are thought solely as a matter of transportation: planning and operation, infrastructure, cars and services" (Duarte & Ultramari, 2012, p. 2). In this context, the three main goals of the master plan were: i) radial expansion of the city along linear axes concentrating high density along mass public transport; ii) integration of land use and transport; and iii) conservation of the traditional city center.

To follow up the plan, the first bus corridor in Curitiba was implemented already in 1974, which had at that time a population of 600,000 inhabitants. To use

this infrastructure in an optimal way and to achieve the goals of the master plan, high densities were allowed only along the BRT corridors, following a hierarchical road structure which promoted a high concentration of people, retail commerce on the street level and mixed uses in general (Duarte & Ultramari, 2012). In Figure 3 the so-called trinary road system is shown, which is the mixture between transportation through the capacity and uses of the roads, and spatial structure through different density levels.

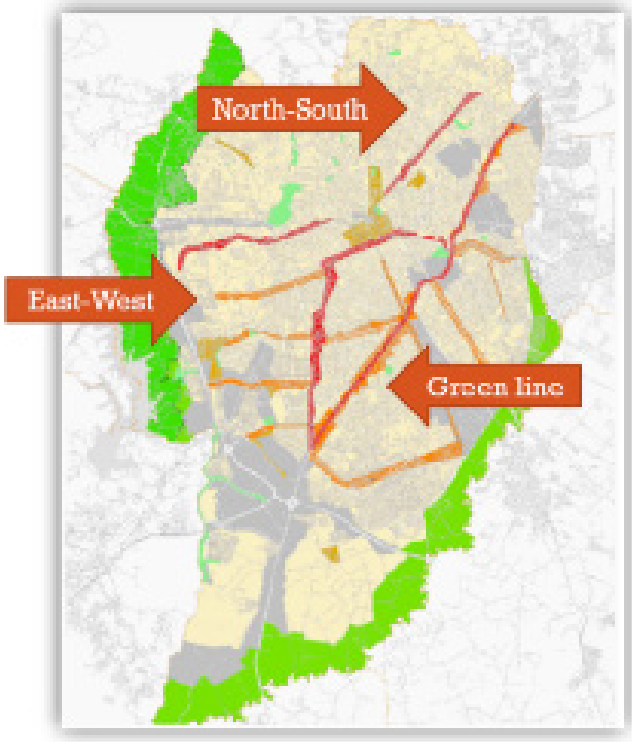
Figure 3: BRT corridor scheme: road hierarchy and verticalisation

Source: Duarte & Ultramari (2012)

Results

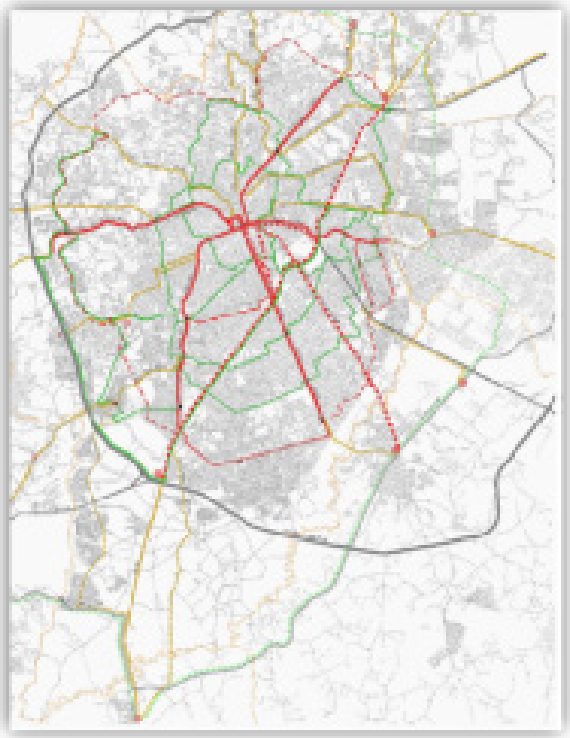
At present, there are four main corridors with 72 km of exclusive lanes mobilising 2 million people daily. This accounts for 70% of the commuters in Curitiba, pointing to the success of this measure when compared to the 7% of Public Transport users in 1970. Figure 4 clearly shows the BRT corridors and its relationship with the density scheme.

Figure 4: Land use plan



Source: IPPUC (2016)

Figure 5: Integrated transport network



Source: IPPUC (2016)

The Land Use Plan (Figure 4) displays an overall low-density city with some concentration of population density on the BRT axes (yellow and orange represent higher densities) and the transport network showed in Figure 5 reflects the concentric structure of the city. After 40 years since the implementation of the first BRT corridor, the result of this strategic plan in the urban structure of Curitiba is shown in Figure 6.

Figure 6: Urban Landscape of Curitiba

Source: Urban Networks (2012)

The facts presented above confirm "the idea that BRT in Curitiba is not only a transport proposal, but part of a more comprehensive urban vision" (Duarte & Ultramari, 2012, p. 3). Some of the concrete actions to support active mobility in the surroundings of the BRT

stations implemented by Curitiba were (Eltis, 2014):

- The creation of major car-free areas in the city centre, which feeds the BRT system by enabling walkability around stations;
- Large sidewalks were built along major roads, providing a safe environment for pedestrians;
- Bicycles are integrated into the bus system with 150km of bike lanes, as well as bicycle parking distributed along the corridors.

However, it is important to mention that one of the success factors is a particular institutional situation, where Jaime Lerner, a visionary urban planner, elected mayor 3 times and governor twice, contributed to the creation of the Instituto de Pesquisa e Planejamento Urbano de Curitiba (IPPUC by its Portuguese acronym). The IPPUC is an institution with an important level of autonomy from the municipal authority, created to develop, supervise, monitor, and continually update the Master Plan.

Despite the fact that Curitiba is an emblem of the implementation of BRT in the world, as in many other Latin American cities, this system has already reached its limits as the demand for public transport grows. However, the development of a strategic urban structure makes the possible introduction of a subway line easier, as the population is already concentrated on the mass transit corridors (Duarte & Ultramari, 2012). It is also worth noting that according to the analysis of some authors (Ghidini, 2009; Rodriguez et al., 2016), Curitiba could still improve the mixed-use, parking management and also improve the pedestrian orientation in the surrounding areas of most BRT stations in order to generate a higher transit orientation of the corridors.

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