

## A model for Transit Oriented Development

In the mid-1960s, to keep pace with Curitiba's surge in population, traffic congestion, and uncontrolled urban sprawl, the City shifted its urban planning strategy from a radial growth pattern to a linear model with Transit Oriented Development at its core. Through coupling land-use and transport planning, the City has substantially reduced its carbon footprint, while boosting the quality of urban life.

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### Summary

In the 1960s, the City of Curitiba turned the challenges of increased urbanization and private vehicle use into opportunities for integrated land-use and transport planning.

By adopting a Transit Oriented Development (TOD) approach, the City, in cooperation with the Institute of Urban Planning and Research of Curitiba (IPPUC), created vibrant, high-density, mixed-use communities along mass public transport corridors through a series of strategic incremental steps.

As a result, TOD enabled the city to reduce downtown traffic congestion and urban sprawl. The City's forward-thinking efforts have made Curitiba a global model in low-carbon urban development practices. TOD has improved quality of life and access to public space for the city's residents, and has helped make the streets of Curitiba pedestrian friendly.

This people-oriented method of urban and transport planning is highly applicable for cities that are increasing in population and have limited financial capital to implement the necessary infrastructure reforms.

### The importance of Transit Oriented Development

The transport sector accounts for roughly 25 percent of all global energy-related CO<sub>2</sub> emissions, a figure which is projected to grow to 33 percent by 2050. The majority of these emissions, approximately 75 percent, stem from private vehicle and truck usage. Dependency on these modes of transport is heavily influenced by the availability of public transportation and its proximity to the built urban environment.

Only 75 percent of local governments worldwide have direct control over their transit system, and only 80 percent have control over road infrastructure. Municipal mandates typically include urban planning and the enforcement of urban development policies at the community-scale, and this presents local governments with the opportunity to plan for strategic growth through an integrated approach that considers transport and the built urban environment.

Despite this, the majority of cities continue to pursue urban and transport planning in isolation, and typically favor automobile centered development. As a result of these trends, urban sprawl, segregated land-use, and uncoordinated urban development arise. Automobile reliant environments that lack access to public transport threaten the environment, and directly impact social equity, economic growth and quality of life.



### Facts & Figures

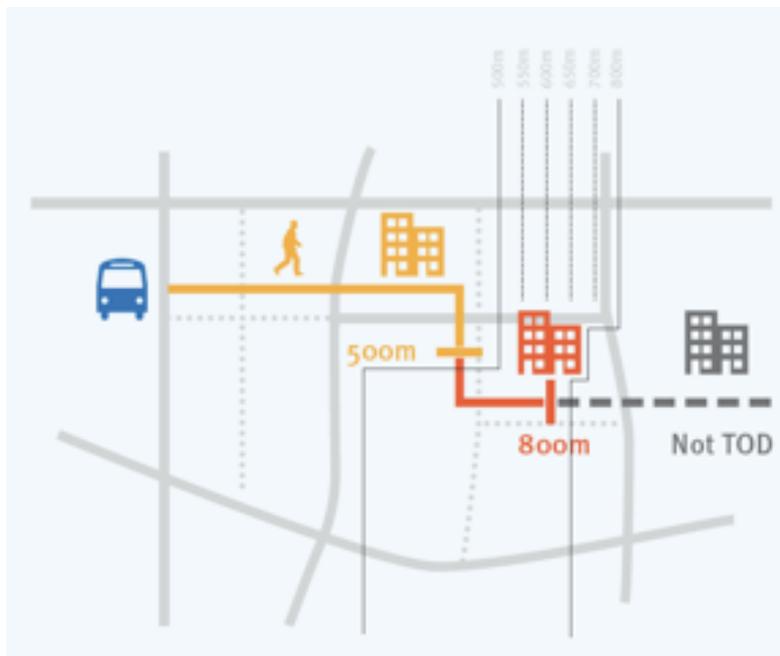
**Population / Land area**  
1,750 million / 435 km<sup>2</sup> (2010)

**Municipal budget**  
USD 2.300 million (2015)

**Greenhouse gas inventory**  
Yes (2008 and 2013)

Transit Oriented Development (TOD) is an urban development approach that emphasizes reliable public transport and prioritizes the maintenance of a closely knit urban fabric through high-density, mixed-use and human-scale design that ensures residents are within walking distance from transit stations. TOD approaches have been known to decrease CO<sub>2</sub> emissions by up to 43 percent, and can reduce private vehicle use by 50 percent.

Figure 1: The TOD concept  
 Source: The Institute for Transportation and Development Policy (ITDP)



## Curitiba in Context

The City of Curitiba, the capital of the Brazilian state of Paraná, has a population of 1.8 million inhabitants living within an area of 430 km<sup>2</sup>. The City is home to strong industry, commerce and service sectors, and boasts a higher per capita GDP and lower rates of unemployment than the majority of other Brazilian cities.

Curitiba is also known as Brazil's "ecological capital"; a title it earned following decades of prudent urban planning practices which were supported by strong political will.

Yet every environmental triumph is born out of a challenge, and the challenges which produced Curitiba's successes were complex. Between 1955 and 1975, the city grew from 350,000 to 940,000 inhabitants (IBGE, 2010). The continuous influx of inhabitants forced the city to prioritize a strategy for long-term, sustainable growth.

## Planning for integrated land-use and transportation

### Trial and error: learning from the failure of the 1943 Agache Plan

Curitiba's urban planning began in 1943 with the Agache Plan, a strategy devised by the French architect, Alfred Agache. However, the city's population, which had doubled by the 1950s, outpaced the City's ability to fund the majority of the Plan and, as it had been developed with a considerably smaller population in mind, rendered it unsuitable.

In 1964, the City of Curitiba launched a planning competition, "Curitiba de Amanhã" (Curitiba of Tomorrow), and placed the integration of transportation and land-use, along with the reduction of private vehicle use, as its foremost priorities. The



Coordination body (COMEC) came into force, therein linking transport within Curitiba's 13 municipalities.

## TOD implementation: long-term policies and infrastructure for guided growth

Curitiba's TOD is anchored in a phase-based approach to low-carbon urban development, emphasizing structured urban development and sound transport policy in order to guarantee compact, livable communities, and to develop the infrastructure needed to support the growth of the system over time.

**Axis marks the spot:** The cornerstone of Curitiba's planning reformation in 1972 was predicated upon promoting density with the axes of the City (marked primarily in red, purple and orange, right). These corridors serve as the city's main transport arteries. To realize this transformation, the City implemented zoning and land-use regulations to foster the creation of high density mixed-use neighborhoods along the main public transport corridors.

**Zoning for mixed-use, walkable neighborhoods:** the Plan zoned and set a requirement that a minimum of 50 percent of ground and second floors along transit corridors be devoted to shops, restaurants and commercial services in order to create lively, socially equitable and prosperous neighborhoods.

Additionally, the City mandated inclusive zoning for Special Social Interest Housing Sectors for low-income residents (Law No. 901, 1980) and a Jobs Route Zone (Linha do Emprego, Law 9,800/2000) in order to boost economic activity. As a means of increasing walkability, the city zoned specific car-free areas of the city, such as downtown Curitiba, for pedestrian use.

**Densifying density:** designating high-density residential and commercial zones along the North-South and Northeast-West axes (Law No. 4199, 1972) set a course for future development. In 1975, (Law 5,234) limited density in the peripheral residential zone led the City to promote residency along structural corridors. To optimize land use, the City mandated specific floor area ratios (FARs) for four out of its five corridors at 6:1 (later modified to 5:1), and 4:1 for medium-to-high density areas surrounding the axis in close proximity to transit routes. Development also incentivized via density bonuses and transfer development rights (1993, Decree 380) which enabled building owners in areas with lower densities, such as historic zones (preserved under Historical Sector Decree 1,160/1971), to sell or transfer development rights to those in high-density zones.

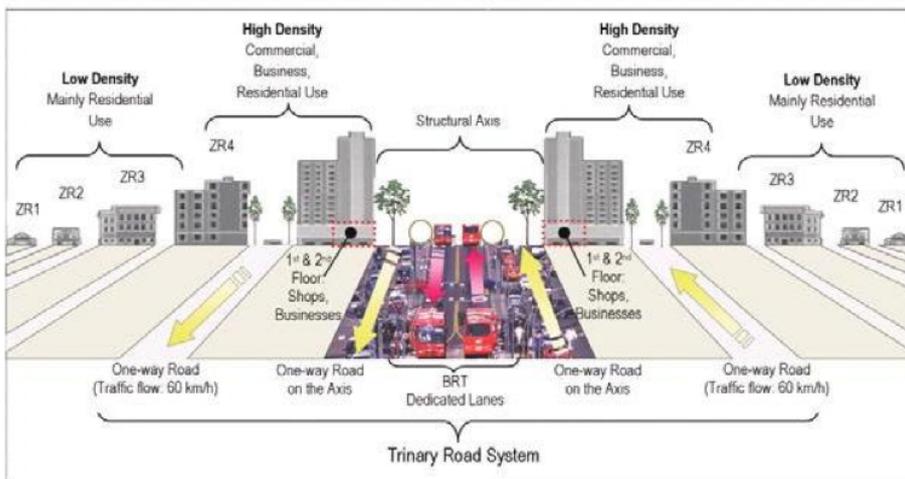


Figure 3: Different densities and traffic directions along Curitiba's structural axes

## Scaling up existing infrastructure for pioneering innovation

At the time of the Master Plan's development, Curitiba had limited financial capacity, and thus scaled up its existing transportation services with an adaptive BRT transit

strategy to compliment the City's new urban development policies. This phased approach allowed for the timely deployment of buses, while allotting time for necessarily gradual development of transit infrastructure.

**Trinary Road System:** The pioneering Trinary Road System (Figure 3) is an example of improving existing infrastructure. The Trinary Road System utilizes three roads designed to minimize traffic. The core of the system is comprised of a two-lane street that is exclusively dedicated to a Bus Rapid Transit (BRT) System, therein guaranteeing accelerated, accessible transit from point A to B. High-density residential and commercial zones line the BRT system, and these zones are neighbored by two smaller one-way streets (one fast and one slow) which guide traffic in opposite directions.

### Creating the Integrated Transit Network (RIT) with Bus Rapid Transit

In 1972 the City introduced a BRT network plan known as the Integrated Transit Network (Rede Integrada de Transporte (RIT)). The RIT began as a north-south integrated transit network, and in 1974 the first two bus corridors were implemented; however, it was not until 1979 that the RIT came into full force.

Curitiba's RIT is managed by a municipal company, Urbanizacao de Curitiba SA (URBS), and operates akin to a metropolitan subway system. The system uses five different types of bus models which serve six corridors, eleven lines, and cover a total of 81.5 km of the city.

The RIT is designates it various types of bus (express, inter-district- or feeder bus) by color (Fig. 4&5) in order to channel effective ridership and compliment land use designations. For example, feeder buses collect riders from less dense neighborhoods, allowing them to transfer to express buses at designated terminals.

In addition, the City coupled the RIT with other measures to manage and regulate traffic, and encourage ridership, including:

- the creation of raised tube docking stations for increased security, weather proofing, and reduced bus boarding and exit times;
- flat service rate pricing, enabling users to utilize multiple types of buses at one fixed price, along with payment tube stations which accept electronic fares; and
- accessibility aid for the elderly and disabled. Over 90 percent of the city's transportation vehicles are wheelchair accessible, have illuminated signs for the hearing impaired, and platelets with braille for the visually impaired.

**Expansion of walking and cycling paths:** The IPPUC and URBS also installed bike paths as an additional transportation alternative. In 2013, in order to expand and scale up the city's cycling infrastructure, the City passed another official plan, the Plano Director Ciclovuario. This plan strategized the addition of 300 km of cycling lanes by 2016. Priority has been placed on the creation of roughly 25 km of cycle friendly routes along BRT routes, as well as the deployment of 50 km of lanes within eight of Curitiba's parks. Cycling infrastructure has been further supported with a planned pilot electrical bike rental system which will feed into bus station stops and along the primary BRT routes in the city and public parks.

Curitiba has also developed its Strategic Plan for Sidewalks, the PlanCal. PlanCal contains guidelines to promote sidewalk restoration in the City to further enhance accessibility. It also contains guidelines on how lighting can be used to promote safety and drainage infrastructure to help decreasing flooding caused by heavy rains. PlanCal's state goal is the restoration of 119 km of sidewalks and the construction of 115 km of new sidewalks.



Photos 1 (above), 2 & 3 (below): Images, old and new, of sustainable urban transport in Curitiba



**Addressing private vehicle use/parking management:** regulated street parking and parking controls have been introduced in Curitiba, making it more expensive to park privately owned cars throughout the City. Zoning for car-free areas throughout Curitiba has also been enacted, and the City has employed “push factors” to shift residents towards public transport, including restricting the movement of specific types of vehicles. Curitiba limits the movement of heavy and long vehicles in the central traffic zone. These restrictions have been in place since 1997, while Municipal Decree (973) establishes specific times for loading and unloading according to the load capacity and vehicle length. In 2011, a similar restriction for long and heavy vehicles was implemented at “Linha Verde” to improve traffic safety and flow.

## **Budget and Finances**

Financing Curitiba’s Transit Oriented Development required the allocation of funding for both land-use and transport planning and implementation. The primary source of initial funding for the work outlined in the 1965 Master Plan was provided by the Development Company of Paraná and by the City’s Department of Urban Development. Certain lines, such as the North-South Bi-articulated Bus Line (1995), were financed by the InterAmerican Development Bank, the Municipality and private sector funding.

To guarantee diverse and livable development alongside mass transit corridors, the City purchased parcels of land which lined the corridors in question, and subsequently allowed developers to buy up to two floors of housing by contributing to a low-income building fund for public housing.

The cost of installing bus stations and direct bus lanes amounted to \$200,000 USD per km. This was a far more efficient option than the alternative of installing a light rail system, which would have cost roughly \$20 million USD per km.

Prior to the 1980’s, the City offered licenses to private companies for the provision and operation of RIT buses. Yet by 1986, the state-owned company, URBS, was mandated to control infrastructure, manage and oversee the system and companies. As a result of this mandate, the City of Curitiba presently owns 95 percent of the shares. URBS, in turn, sets fares, manages the bus scheduling and operation, conducts vehicle inspection, and monitors and evaluates overall system performance, maintenance, and public funding.

In 1987, a law instituting grant licenses and reimbursements to companies came into force. This enabled bus companies to earn more based on the amount of kilometers traveled, as opposed to earning being based on number of passengers. This incited competition for more routes, rather than bus companies competing for main routes. Today, the operation of Curitiba’s complex network of buses is financed completely without public subsidies via the City’s sing-fare system. The prices for the public transport system are based on the overall costs of running and maintaining the network.

The Curitiba system encourages ridership and benefits from both municipal and national policy geared toward social equity and inclusivity. For example the RIT system is free under municipal law for roughly 9 percent of total users per month. This is to encourage usability for the elderly (65+) and those who cannot afford it. As a product of national policy, employers subsidize a portion of employee’s transportation costs, when the said transportation costs exceed six percent of their income.

**Table 1. Curitiba TOD Summary**

Policy	Title
Regulation	<ul style="list-style-type: none"> <li>• 1964 launch of the Curitiba Planning Competition</li> <li>• 1965 Decree 1,000 public participation for the new Master Plan</li> <li>• 1966 Curitiba Master Plan changes from radial growth format to linear model</li> <li>• 1972 Planning reformation</li> </ul>
Fiscal	<ul style="list-style-type: none"> <li>• 1963 Mayor creates Curitiba- URBS using FUC Curitiba Development Fund</li> <li>• 1995 ADB financed North-South Bi-articulated bus lane</li> <li>• BRT RIT system is financed via sing-fare system without subsidies</li> <li>• National policy – employers subsidize a portion of employees transportation costs</li> </ul>
Governance	<ul style="list-style-type: none"> <li>• 1965 - IPPUC –is the integrated coordinating body to carry out the Master Plan</li> <li>• 1974: Region Coordination body works together with 14 municipalities to integrate transportation</li> <li>• 1986: URBS controls infrastructure, management and oversees the RIT system</li> </ul>
Stakeholder Engagement	<ul style="list-style-type: none"> <li>• Public participatory planning competition engagement</li> <li>• IPPUC planning committee 14-member multi-departmental board</li> <li>• IPPUC, URBS and COMEC work to integrate the RIT to the regional and national transport systems</li> <li>• Private sector (bus operators)</li> </ul>
Capacity Building	<ul style="list-style-type: none"> <li>• Awareness campaigns</li> </ul>
Technology	<ul style="list-style-type: none"> <li>• 1970s: Bus stop shelters; conventional buses; open terminals; paper/coin ticketing/ truck and feeder system</li> <li>• 1980s: Tube stations; closed terminals; flat fare pricing; inter-district lines, dispatch at terminals</li> <li>• 1990s: Bi-articulated buses; special services; metropolitan services</li> <li>• 2000: electronic ticketing</li> <li>• 2010: B100 biodiesel buses; real time control center</li> <li>• 2015: bike sharing system</li> </ul>

## Results

The result of Curitiba's approach to TOD is one of the most sophisticated low-cost, high-capacity public transit networks to date.

- TOD improved Curitiba's low-emission, sustainable mobility. Curitiba's TOD has reduced travel times and private vehicle use.
- The BRT is used by 85 percent of Curitiba's population. This is only possible because the BRT has a very high capacity, a necessary element given the size and expansion of the city. In one BRT lane, 10,000-20,000 passengers can be carried at one time, with a capacity of 40,000 passengers on busy roads (figures from 2011). Between 1970 – 2016, 342 BRT stations were rolled out.
- Since 2007, URBS has provided publically available data on the number of users transported in RIT per day. The RIT offers service via 6 corridors, 11 lines – covering a total of 81.5 km of the city per day.
- Curitiba's approach to integrated planning through TOD has increased residents' quality of life. Between 1970 and 2000, the Human Development Index (HDI) for the city has risen from 0.7 to 0.8, placing it above the HDI levels of the state (both of which stood at 0.4 in 1970 and rose to 0.7 in 2000).
- TOD supported resource-efficient and long-term investments in urban infrastructure. In the 1970's Curitiba's investment of federal funding into both corridors and transport infrastructure enabled longer-term growth, as opposed to Brazilian cities in similar positions, who invested solely in bus systems.
- URBS currently supplies a fleet of 1,368 buses, carrying 1,746,224 passengers per day. Newly deployed buses can carry up to 250 passengers per trip. 34 buses currently run on biodiesel, 10 are hybrid (electric + biodiesel).

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## Lessons Learned

- **Find the right balance between density, building design and development:** in 1990 the City decreased the maximum density along Curitiba's primary arterial roads, as a result of "excessively high occupation", which impacted the environmental integrity of the areas. High-rise and high-density development can result in an urban heat island affect (Decreto No. 579/90, 1995).
- **The creation of the IPPUC as the central coordinating body enabled Urban-NEXUS TOD development** through the engagement of a wide range of relevant multi-sectoral stakeholders.
- **Setting realistic priorities for long-term change:** the phased BRT approach enabled the City to enact rapid change for high-quality and low cost.
- **Everything can be improved upon.** Curitiba is currently conducting research to find out precisely how the citizens of Curitiba and Metropolitan Region use the various means of transport. The results from this research will be the basis for new policies to be adopted to improve the transport infrastructure in Curitiba and in the metropolitan area.

## Replication

In the coming years, urban growth is projected to alter the spatial form of cities across the globe, especially those of medium size (less than 500,000 inhabitants) with limited fiscal capital (UN Habitat, 2011). Through employing a TOD strategy, the City of Curitiba offers valuable lessons as a city having responded to a surge in growth with a long-term, cost-effective and innovative plan.

Curitiba may have pioneered TOD, yet countless other cities – such as Guangzhou, China; Hamburg, Germany; Bogota, Colombia; and Vancouver, Canada – and many more have followed in Curitiba's footsteps. In employing a TOD approach, Curitiba set the stage, providing other cities with a blueprint for how to create a low-carbon, integrated, innovate and socially conscious city.

## Further Reading

<http://urbanleds.iclei.org/index.php?id=182>



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