Modos de Transporte Público

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Modos de Transporte Público

- **Definições**
- **Classificação**
- **Comparações entre modos de transporte**

Modos de Transporte Público

➢ Definições

Componentes Físicos

- Veículos
- Vias
- Estações/Pontos de parada
- Garagens/Pátios
- Sistemas de Controle
- Fonte de energia
- Linhas/Serviços

Desempenho do Sistema

- Frequência
- Velocidade
- Confiabilidade
- Segurança
- Capacidade
- Produtividade
- Utilização

Nível de Serviço

- Qualidade para o usuário
- Impactos
- Custos

Modos de Transporte Público

- **Classificação por tipo de uso**

Table 2.1 Classification of urban passenger transportation by type of usage

Usage type / *Characteristic*	*Private*	*For-hire*	*Public or Common Carrier*
Common designation	Private transportation	Paratransit	Transit
Service availability	Owner	Individuals, groups	Public
Service supplier	User	Carrier	Carrier
Route determination	User (flexible)	User (carrier)	Carrier (fixed)
Time-schedule determination	User (flexible)	User (carrier)	Carrier (fixed)
Cost-price	User absorbs	Fixed rate	Fixed fare

Modos de Transporte Público

- **O que diferencia um modo de transporte?**
  - **Uso do espaço viário (Right-of-Way, ROW)**
  - **Tecnologia**
  - **Operação**

Modos de Transporte Público

➢ Classificação

- Uso do espaço viário (Right-of-Way, ROW)

Categoria C

Tráfego misto

Categoria B

Tráfego segregado
Cruzamentos em nível

Categoria A

Tráfego segregado
Vias exclusivas

Modos de Transporte Público

➢ Classificação

- Uso do espaço viário (Right-of-Way, ROW)

Table 10.1 Characteristics of transit systems with different ROW categories

Characteristics \ *ROW Category*	*C*	*B*	*A*
System performance: capacity, speed, reliability, safety	Moderate	High	Very high
Investment cost	Low	High	Very high
Level of service	Moderate	High	Very high
Image/identification	Moderate	Good	Very strong
Passenger attraction	Moderate	High	Very high
Potential impact on urban form	Weak	Strong	Very strong
Full automation possibility	None	None	Full

Modos de Transporte Público

➢ Classificação

- Tecnologia: características dos veículos e interface com a via

Suporte ⇨ Contato vertical entre o veículo e a via
- Apoiado (ônibus, trens)
- “Abraçado” (monotrilho)
- Suspenso (monotrilho)

Orientação ⇨ Orientação lateral do veículo
- Dirigido (ônibus)
- Guiado (monotrilho, trens)

Modos de Transporte Público

➢ Classificação

- Tecnologia: características dos veículos e interface com a via

Propulsão
- Tipo de unidade propulsora (combustão interna, motor elétrico)
- Transferência da tração (aderência, cabo, força magnética)

Controle ⇨ Espaçamento entre veículos (horários, visual, sinalização, automática)

Modos de Transporte Público

- **Classificação**

Table 2.2 Classification of urban public transportation modes by ROW category and technology[a]

ROW \ Technology	Highway Driver-Steered	Rubber-Tired Guided, Partially Guided	Rail	Specialized
C	*Paratransit* *Shuttle bus* *Regular bus (on street)*	*Trolleybus*	*Streetcar / tramway* Cable car	*Ferryboat* *Hydrofoil*
B	*Bus rapid transit (BRT)*	*Guided bus*	*Light rail transit (LRT)*	(Cog railway)
A	Bus on busway only[b]	*Rubber-tired metro* *Rubber-tired monorail* *Automated guided transit (AGT)* PRT[b]*	*Light rail rapid transit* *Rail rapid transit / metro* *Regional / commuter rail* *Monorail Schwebebahn*	Cog railway *Funicular* Aerial tramway

[a] Modes extensively used are shown in italic type.
[b] Modes that are not in operation.
*Personal Rapid Transit

Modos de Transporte Público

➢ Classificação

- Tipo de serviço

Rotas
- Curtas distâncias e baixas velocidades (aeroportos, campus)
- Urbanas (ROW categorias A, B e C)
- Longas distâncias e alta velocidade (metropolitanas, ônibus expressos)

Operação
- Paradores
- Paradas intermediárias
- Expressos

Horário
- Regulares
- Pico
- Especiais

Modos de Transporte Público

➢ Classificação

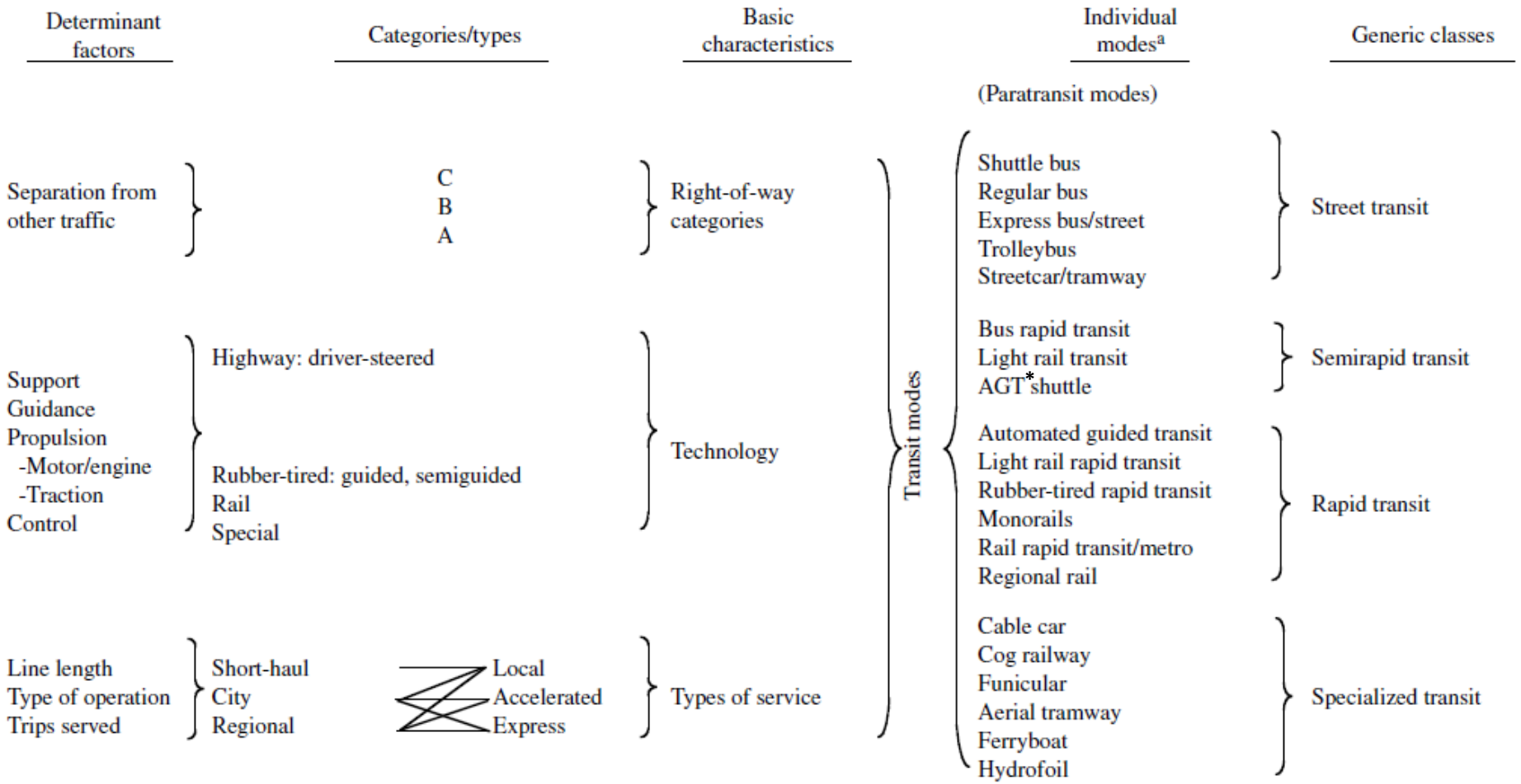

Figure 2.1 An overview of transit mode definition, classification, and characteristics

*Automated Guided Transit

Modos de Transporte Público

- **Comparações entre modos de transporte**

Table 10.2 Technical components of transit modes grouped by ROW categories[a]

Mode Category \ Characteristic	ROW Category	Mode	Support and Guidance	Propulsion	TU Control	Cars per TU	TU Capacity (spaces)	Line Capacity (sps/h)
Street transit	C	Bus, Trolleybus	Road/steered	ICE, electric	Driver/visual	1	80–125	3000–6000
	C	Tram	Rail/guided	Electric	Driver/visual	1–3	100–300	10,000-20,000
Semirapid transit, medium performance	B	BRT	Road/steered	ICE	Driver/visual	1	80–180	6,000–24,000
	B	LRT	Rail/guided	Electric	Driver/signal	1–4	100–720	10,000–24,000
	A	AGT/APM	Guided	Electric	ATO	1–6	50–480	6,000–16,000
Rapid transit, high performance	A	LRRT	Rail	Electric	Signal/ATO	1–4	100–600	10,000–28,000
	A	Metro	Rail	Electric	Signal/ATO	4–10	720–2500	40,000–70,000
	A	Regional rail	Rail	Electric, diesel	Signal/ATO	1–10	150–1800	25,000–40,000

[a]Exceptional characteristics, such as guided bus and diesel LRT, and extreme values found in a few cases are not included.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Por categoria (B e C)

Transit modes with ROW category B compared to those with category C have the following advantages (+) and disadvantages (−):

+ Considerably higher performance: speed, reliability, capacity, riding comfort, safety, etc.
+ Ability to operate trains of two to four vehicles (rail systems only).
+ Stronger identity and image, which, combined with higher performance, results in higher passenger attraction.
+ Lower operating costs per passenger.
+ When rail technology is used, these modes are electrified, providing high vehicle performance and no air pollution, so that they can be operated in tunnels.
− They require space for their ROW.
− They involve higher investment.
− They may require special signals or other control and priority measures.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Por categoria (A e B)

Features of transit systems with ROW category A compared to those with category B have the following advantages (+) and disadvantages (−):

+ They are free from any obstacles, systems on ROW category A have the highest performance (speed, reliability, capacity) of all modes.
+ All rapid transit systems utilize electrically propelled guided technologies with very high dynamic performance.
+ The absence of any interaction with other traffic and the use of automatic train protection results in the highest safety among all transit modes.
+ Exclusive ROW allows the operation of long trains with multiple doors at platform level, resulting in rapid passenger exchange and short dwell times.
− They require by far the highest investment costs, due to exclusive facilities along entire line length.
− Rapid transit line alignment is more geometrically rigid, requiring mostly the use of tunnels or aerial structures in central cities.
− Stations are grade-separated, may require land purchase and involve longer access to stations than LRT on ROW B, which can penetrate pedestrian areas.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Por orientação (guiado e dirigido)

Guided transit systems compared with bus (driver-steered) systems have the following features:

+ Ability to use larger vehicles and operate trains, thus greatly increasing line capacity, providing lower operating costs per space, and offering economies of scale with increasing passenger volumes.
+ Electric traction can be used, bringing major benefits (see below).
+ Guided modes have higher overall performance: speed, capacity, reliability, and safety.
+ Automated signalization provides a fail-safe operation, preventing accidents due to driver error.
+ They require narrower ROW.
+ With exact ROW delineation, no air pollution, or noise, guided systems are better suited to operation in pedestrian areas.
+ Operation in tunnels is feasible without excessively wide cross sections.
+ They provide much better riding comfort.
+ When combined with ROW A, guidance makes fully automated driving possible.
− They require separate ROW (B or A) involving much higher investment cost (except for tramway/streetcar mode).
− They require higher investment due to track/guideway and station construction as well as electrification.
− Their networks are much more limited, requiring transfer facilities and involving more transfers.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Por suporte (apoiado em trilhos ou no pavimento)

For guided transit modes, rail systems compared with rubber-tired systems have the following features:

+ Rail systems can utilize ROW categories A, B, or C; rubber-tired systems can use only ROW A.
+ Rail vehicles have two to three times fewer wheels with lower resistance, resulting in lower total resistance, energy consumption, and heat production.
+ Rail tracks have very simple switching and crossing mechanisms, while rubber-tire guideways require more space and grade separations in yards. Rail systems are therefore much more conducive to efficient line branching, network, station, and yard layouts. Monorails and AGT systems operate mostly on single lines.
+ Rail systems can use larger vehicles and operate at higher speeds than rubber-tired systems.
+ Rail vehicles provide considerably better riding comfort.
= Acceleration and braking are similar because they are limited by passenger comfort.
− Rubber-tired systems can negotiate sharper curve radii and higher gradients than rail; this allows them to have more flexible line alignments.
− Rail vehicles produce more noise and vibration in sharp curves.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Por propulsão (elétrica ou motor a combustão interna, ICE)

Electric compared with ICE propulsion of transit systems has the following differences:

+ Produces higher acceleration and higher operating speed.
+ Allows multiple-unit propulsion and operation of trains.
+ Regenerative braking recovers energy, thus reducing its consumption.
+ Produces no noise and vibration, as most diesel engines do.
+ Produces no air pollution, whereas diesel buses do.
+ Absence of pollution and good dynamic performance makes use of tunnels possible.
+ Electricity can be produced from any primary energy source, thus reducing oil dependency.
− Requires additional investment for electrification of lines, construction of substations, etc.
− Power failure stops all vehicles on a section of line.
− Service is limited to electrified lines, requiring more transfers to feeders.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Por controle (automático ou com motorista)

Fully automated train operation compared with driver-driven systems has the following features:

+ Very frequent operation of short trains is feasible even during off-peak periods.
+ Quick adjustment of TU sizes and schedules to changing conditions is possible.
+ Driving regimes can be optimized for all conditions.
− Fully automated operation requires ROW A.
− Investment cost is considerably higher.
− The presence of a crew member is often desirable anyway for security, passenger information, etc.
− Mechanical and control systems are more complex and require more expensive maintenance.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Light Rail Transit e Bus Rapid Transit

LRT, compared to BRT, has the following advantages (+) and disadvantages (−):

+ Because of its rail tracks instead of roadway lanes, separate ROW (B or A) for LRT is easier to design and due to different technology requires no physical protection and police enforcement as do bus lanes and busways.
+ Because of its electric traction, LRT has better vehicle performance than BRT.
+ LRT produces no exhaust along the line and much lower noise than BRT (except that in a few cities, on high-speed LRT lines, trains are required to use horns at grade crossings).
+ LRT is often designed to serve as the central element for access and image of livable pedestrian areas in central cities; a busway with high-frequency bus services is much less compatible with pedestrianized areas.
+ LRT can use tunnels, BRT cannot.
+ LRT vehicles are more spacious and comfortable and have better riding quality than buses.
+ LRT has a stronger image, it is more popular and attracts more riders.
+ LRT has a stronger positive impact on urban development than BRT (Photo 10.3).
− Investment costs for LRT are higher than those for BRT.
− For the first LRT line in a city, introduction of new technology requires more extensive construction of infrastructure as well as new equipment, and it involves longer implementation.
− LRT services are limited to track networks and involve more transfers than buses.

Modos de Transporte Público

➢ Comparações entre modos de transporte

- Rail Rapid Transit e Light Rail Transit

RRT/Metro compared to LRT has the following advantages (+) and disadvantages (−):

+ With ROW A only and full signal control, metro has higher speed, reliability and safety.
+ Due to longer trains and rapid passenger exchange at stations, metro has much higher line capacity.
+ With its high performance and strong image, metro has stronger passenger attraction.
+ The distinct image of its stations and system permanence give metro more powerful positive impacts on urban development than any other transit mode.
− Metro requires a substantially higher investment cost, causes more disruption during construction, and requires longer implementation time than LRT.
− Metro requires more rigid alignment than LRT and cannot penetrate pedestrian areas at grade.
− LRT is more conducive to construction in stages, utilizing different ROW categories, while metro is limited to ROW A only.
− For a given amount of investment, a city can obtain 2–3 times longer lines of LRT than of metro.

Modos de Transporte Público

- **Comparações entre modos de transporte**

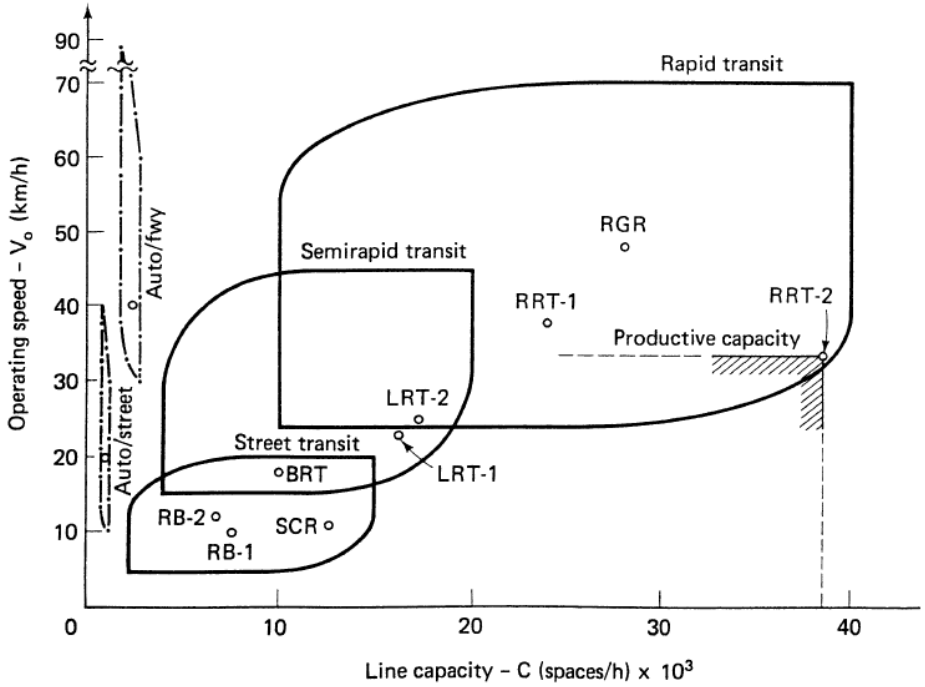

Figure 2.6 Line capacities, operating speeds, and productive capacities of different modes

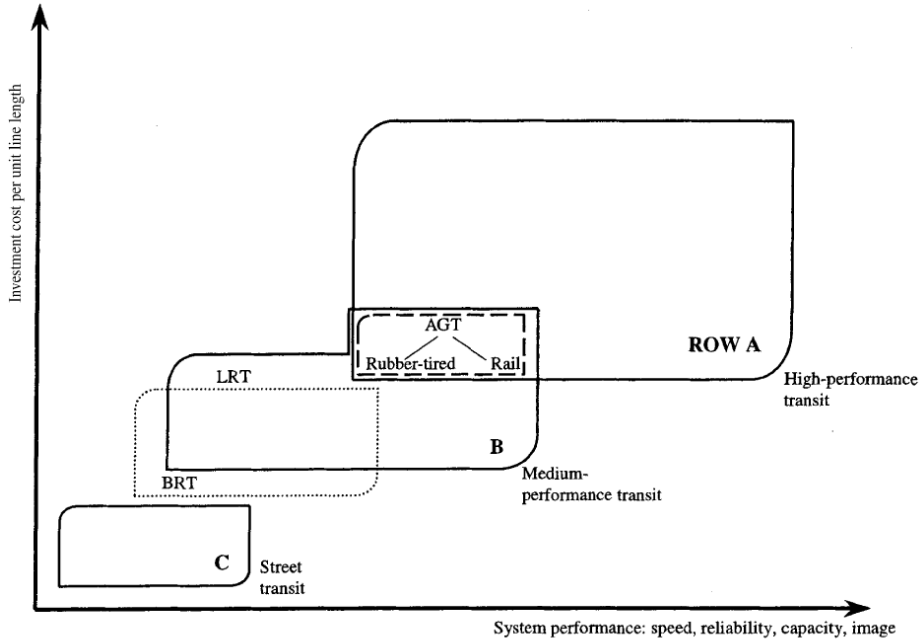

Figure 10.1 Performancecost packages (PCPs) of different generic classes of transit modes

RB - Regular bus SCR - Streetcars or tramways LRT - Light Rail Transit AGT - Automated guided transit

BRT - Bus Rapid Transit RGR - Regional (or commuter) rail RRT - Rail rapid transit

Modos de Transporte Público

➢ Referências

- Vuchic, V. R. (2007). Urban transit systems and technology. John Wiley & Sons.

Chapter 2 – Urban Passenger Transport Modes

Chapter 10 – Characteristics and Comparisons of Transit Modes