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Public Transport Improvement and Integration with Non-Motorized Transport

Manfred Breithaupt

Urban Transport Advisor

What are the options for making cities more liveable?

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Paradigm shift

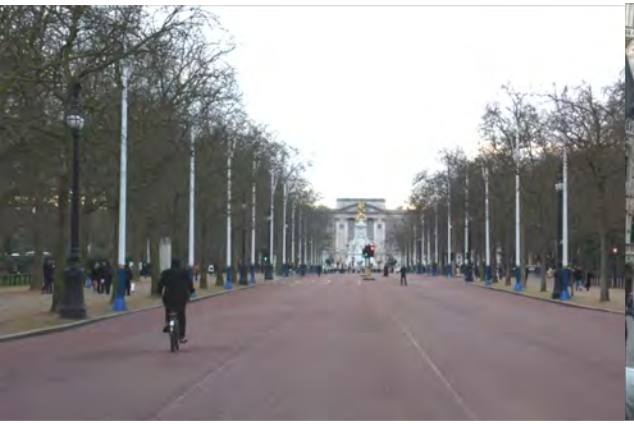
Achieving greater sustainability in transport means...

... investing in schemes and initiatives that **improve accessibility** and developing more liveable cities based on non-motorized transport and public transport (and especially its integration).

Transmilenio, 2005

Why focus on **liveable**, sustainable, resilient, compact and attractive cities?

- A **liveable** city is a city that provides a **high quality of life** for its citizens
- This requires:
  - **Economic strength**
  - **Social balance**
  - **Ecological viability**
- All these elements are interdependent



London

Brussels

Vienna

Livable Cities & Urban Life

What influences Liveability?

Direct transport related factors:

- Infrastructure
- Accessibility
- Quality of architecture
- Urban design
- Public Transportation
- Public places
- ...etc.

Other factors:

- Political and social environment (Safety/Crime)
- Socio-cultural environment
- Medical and health considerations
- Schools and education
- Recreation
- Availability of goods/services
- Economic environment (banking services)
- Housing
- Natural environment

Livable Cities & Urban Life

Rankings of Quality of Living

Mercer Quality of Living Survey 2018 – Top 10 (worldwide):

- Vienna, Austria *(1st)*
- Zurich, Switzerland *(2nd)*
- Auckland, New Zealand *(3rd)*
- Munich, Germany (3*th*)
- Vancouver, Canada *(5th)*
- Düsseldorf, Germany (*6th*)
- Frankfurt, Germany (*7th*)
- Geneva, Switzerland (*8th*)
- Copenhagen, Denmark (*9th*)
- Basel, Switzerland and Sydney, Australia (*10th*)

Vienna

Zurich

Munich

Source: Mercer, 2015.

Livable Cities & Urban Life

Locational factors

Source: European Cities Monitor 2011, Cushman Wakefield

Six key factors for deciding where to locate a business

% of businesses who consider this to be an 'absolutely essential' location factor

..and what is their success story?

Examples: Vienna (#1 Quality of living Index)
Public Transport and NMT

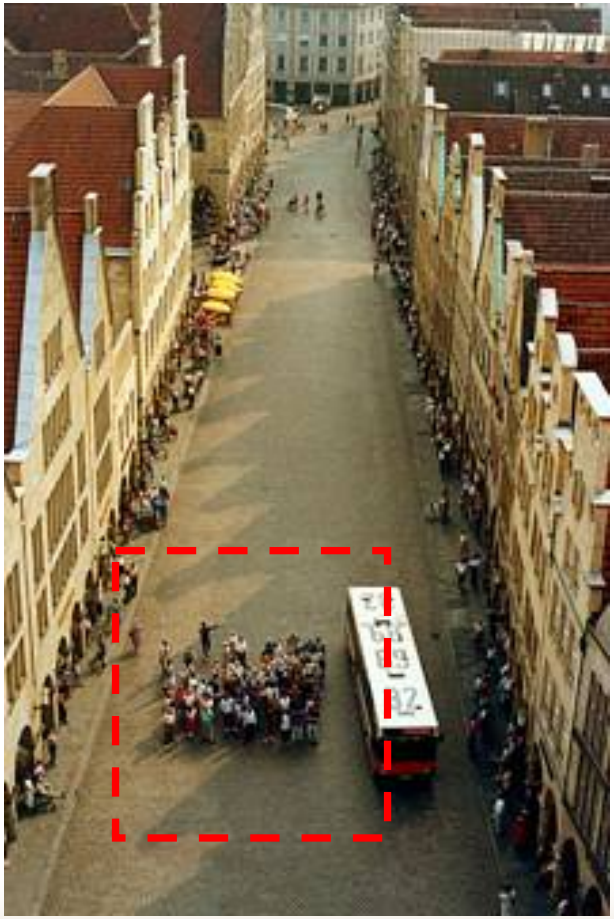
(PT and NMT not for poorer cities, but smart solutions, promoting growth and attractiveness. Proven to be a success factor for high income and successful cities)

- Integrated Transport Policy: PT, NMT and IMT
- Modal Share of PT 36%
- **More than 2/3 of journeys are done by PT and NMT (which is the case for all so called livable cities such as Zurich, Munich, Berlin, London…….). Which is Sustainable Urban Transport or Active Transport.**
- Vienna top ranked in quality of living surveys conducted by the British consultancy firm Mercer

Source: M. Breithaupt, 2009, http://www.wien.gv.at.

Tackling the Problem

Traditional focus was given to road design: More infrastructure for cars, more space for motorized vehicles, unsustainable focus: Question is, how to use the always limited road space best



Source: City of MünsterMu

We are not exactly talking about this ……

Picture: Paul Starkey

Different PT sytems in Berlin

PT in developing cities means often

•Dirty, overcrowded buses- "poor man's mode"
• Mix of modes
• often>50% trips; <5% vehicle share
• Ad hoc planning
• No priority on roads

• Often high tax burden (much more than cars)
• No quality monitoring

All traffic concentrates on few arterial roads..

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Dhaka current situation

Unattractive public transport systems

- Insufficient cooperation between public transport operators
- Each change of mode normally requires the purchase of another ticket
- No uniform service level standards among modes and operators

The reality in most cities:

- Public transport is underdeveloped, not attractive enough for customers (often 2-4 tickets are required to get to work per direction)
- There often exist stand alone systems (Bangkok, Manila, Kuala Lumpur….) without proper physical, time table- and fare-integration
- Fares are collected at vehicles (causing slower services)
- Urban transport responsibilities are often fragmented between various ministries, provincial and municipal level

Looking ahead:

Public transport integration iscontinues to be the challenge during coming years to considerably increase attractiveness of PT!

What do citizens want?

- ✓ Convenience
- ✓ Easy Access
- ✓ Comfort
- ✓ Frequent Service
- ✓ Rapid journey
- ✓ Safety & Security
- ✓ Customer Service
- ✓ Affordability
- ✓ Have a network

Public Transport should be designed around the customer and not around a technology

Conventional Public Transport Planning Approach

Step 1. Choose technology

Technology chosen due to manufacturer lobbying efforts

Design chosen to please existing operators

Technology chosen to help property developer

Step 2. Fit city to the technology

Reduce size of network due to financing limitations

Charge higher fares in attempt to pay for expensive system

Operate infrequent services to reduce operating losses

Require large subsidies for lifetime of system's operation

Step 3. Force customer to adapt to technology

Extensive marketing campaign to convince customers that system is in their interest

The innovative and successful approach

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Step 1. Design a system from customer's perspective

Rapid travel time

Few transfers

Frequent service

Short walk to station from home / office

Full network of destinations

Low fare cost

Safe vehicle operation

Secure environment

Comfortable and clean system

Friendly and helpful staff

Step 2. Evaluate customer-driven options from municipality perspective

Low infrastructure costs

Traffic reduction benefits

Environmental benefits

Economic / employment benefits

Social equity benefits

City image

Step 3. Decision

Technology decision based on customer needs and municipality requirements

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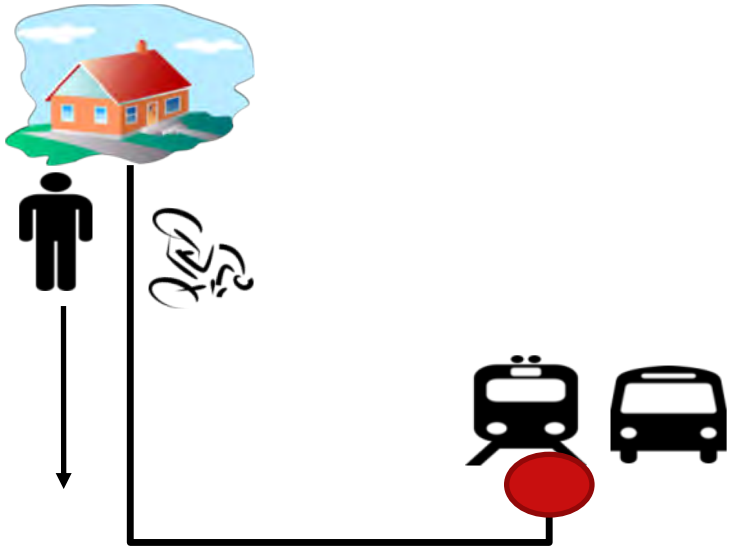
Checklist for efficient public transport planning

Accessibility- Options



- How to reach the PT station?
  - Walk, bike or drive
  - How good is the path?

Station Design

- Passenger friendly designs?
  - Clear signage, disabled friendly
  - Better interchanges
  - Public amenities

Vehicle and infrastructure design

- Comfortable
- Capacity
- Attractive

Source: Carlos F. Pardo

Which one to select?

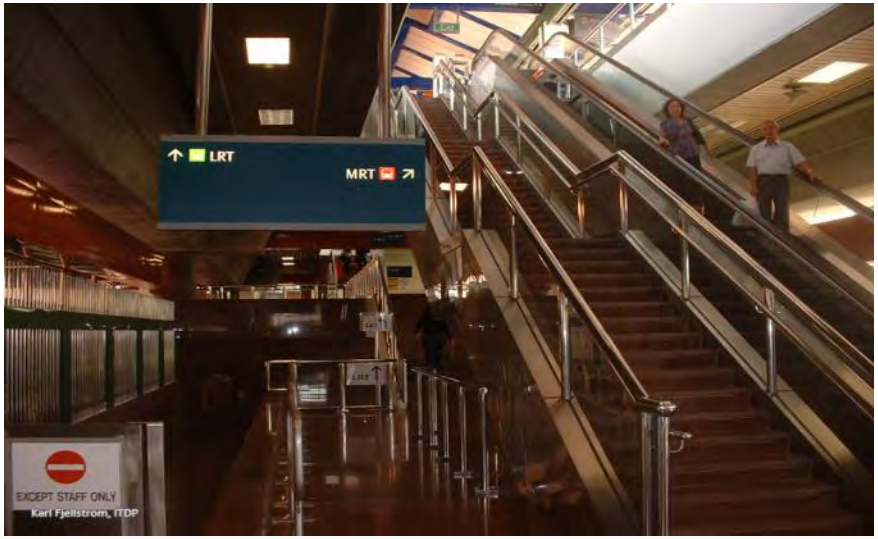
Source: Carlos F. Pardo

Public Transport priority

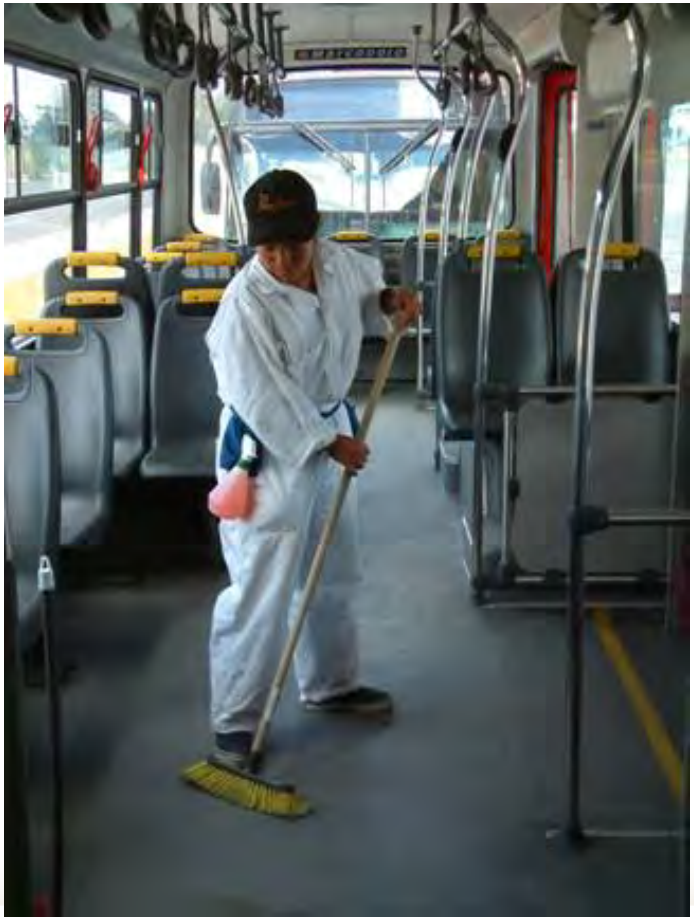
- Is PT prioritized over other modes?

Modal Integration

- Can an individual take his/her bicycle? Is it easy to walk? Should he/she can drive to the station?



Professionalism

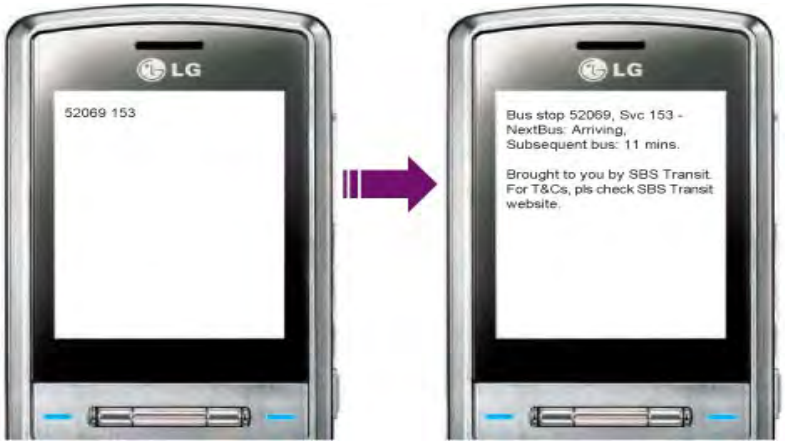


- Are the stations and the fleet clean?
- Do the drivers have good road etiquettes?
- Continuous quality control

Network coverage

- Can I reach the CBD, shopping district, my home?

Frequency, Reliability



- How soon can I get at the next train, bus, tram?

Fare Integration

How not to do...

- How many times one should buy a ticket?
- Where one should buy the ticket?
- Who are the operators?

an example

Approx 35 km

Pavlovsk

St. Petersburg

Metro: 17 Rubles

Train: 43 Rubles

Minibus: 13 Rubles

= 73 Rubles

Fare Integration…(contd)

How to do...an example

Approx 40 km

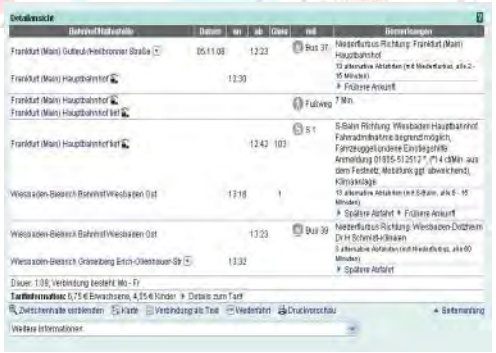
Frankfurt

Wiesbaden

1 fare / 1 ticket

6.75 Euro

+



Integrated timetable

Before heading for a new MRT System, the existing bus system, which will also in future be the backbone of any PT System, needs to be improved through…

-bus route planning and optimization (at present often many overlapping routes, outdated routes,…..
-appropriate regulatory framework
-improvement of bus operations
-monitoring and quality insurance system

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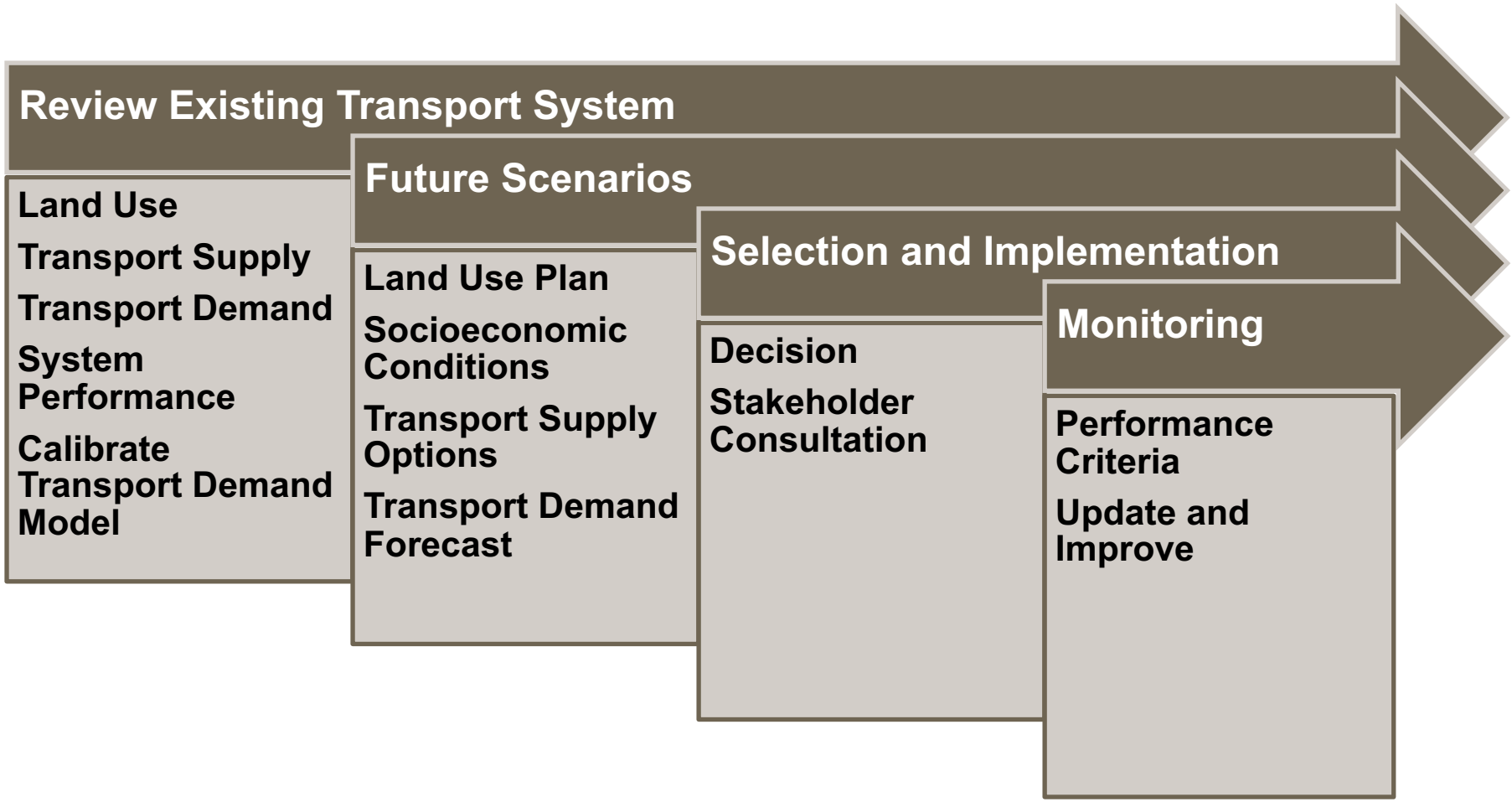
Available options in Mass Transit

Comprehensive Mobility Plan



Dont forget this...Common deviation between planning and implementation

	Actual/ Estimated (Average)
Cost	**1.91**
Passenger Demand	**0.52**

Bent Flyvbjerg,"Cost Overruns and Demand Shortfalls in Urban Rail and Other Infrastructure," Transportation Planning and Technology, vol. 30, no. 1, February 2007, pp. 9-30.
DOI: 10.1080/03081060701207938
Link to published article: http://www.tandfonline.com/doi/full/10.1080/03081060701207938
12 urban rail transit projects with information before and after

Different Mass Rapid Transit Modes available

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Heavy urban rail

Monorail

Underground metro

Light rail, tram

BRT

Personal rapid transit

182 Cities with Metro

10,435 km, 112 million passengers per day

220 BRT AND BUS CORRIDOR SYSTEMS

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PRODUCIDO POR EMBARQ BUS RAPID TRANSIT EN ASOCIACIÓN CON SIBRT iea ADMINISTRADO POR WRI BRASIL

400 Light rail transit and tram systems

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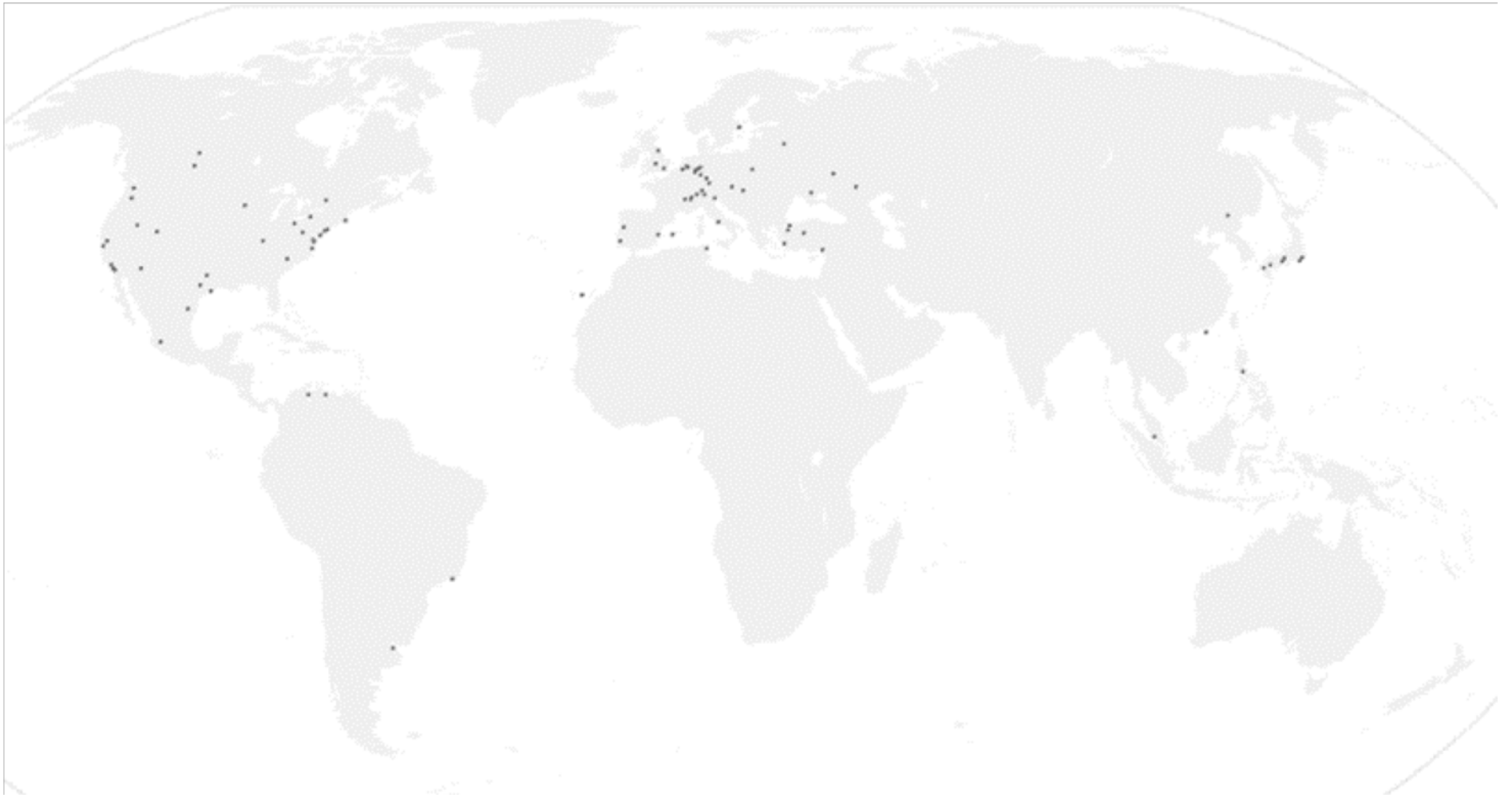

Selection Criteria for MRTs

- Construction, maintenance and operating costs
- Right-of-way availability
- Environmental impact
- Journey time
- Safety
- Comfort
- Flexibility
- Reliability
- Fare
- Technical sophistication
- Implementation complexities
- Image

- Before going into more details on MRT planning and selection let me ask how many of you are involved in such questions?

Component	Metro	LRT	BRT
Infrastructure	Rail Tracks	Rail Tracks	Roadway
Type of Right of Way	Underground/ Elevated/ At-grade	Usually At-grade – some applications Elevated or Underground (tunnel)	Usually At-grade – some applications Elevated or Underground (tunnel)
Segregation From the Rest of the Traffic	Total Segregation (no interference)	Usually Longitudinal Segregation (at grade intersections) – some applications with full segregation	Usually Longitudinal Segregation (at grade intersections) – some applications with full segregation
Type of Vehicles	Trains (multi-car)	Trains (two-three cars) or single cars	Buses

Component	Metro	LRT	BRT
Stations	Level boarding	Level boarding or stairs	Level boarding (few with stairs)
Payment Collection	Off-board	Usually off-board	Off-board
Information Technology Systems	Signalling, control, user information, advanced ticketing (magnetic/electronic cards)		
Service Plan	Simple; trains stopping at every station; few applications with express services or short loops	Simple; trains stopping at every station between terminals	From simple to very complex; combined services to multiple lines; express, local – some combined with direct services outside the corridor
User Information	Very clear signage, static maps and		dynamic systems
Image	Modern and	attractive	Advanced as compared with standard buses

Sources: UNHabitat (2013) from Fouracre, et al. (2003), Vuchic (2007), Diaz and Hinnebaugh (2007)

Mass Transit Project Plan

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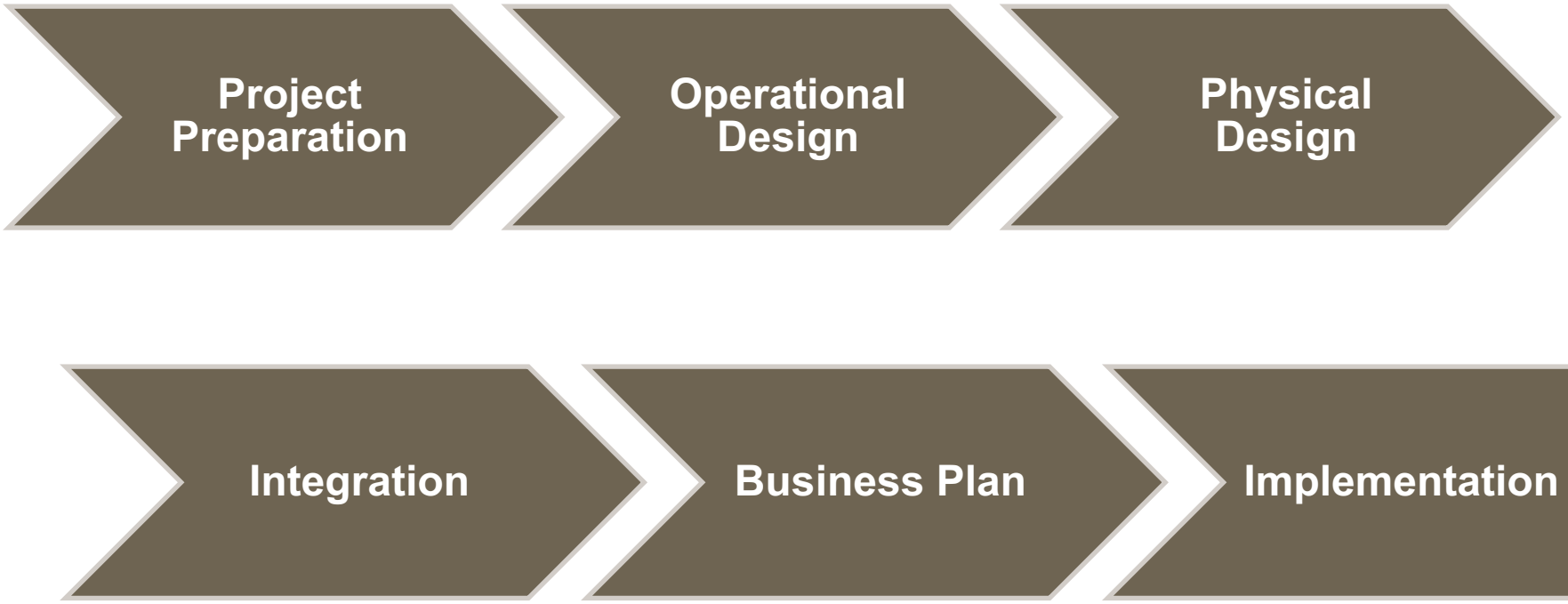

http://www.itdp.org/microsites/bus-rapid-transit-planning-guide/

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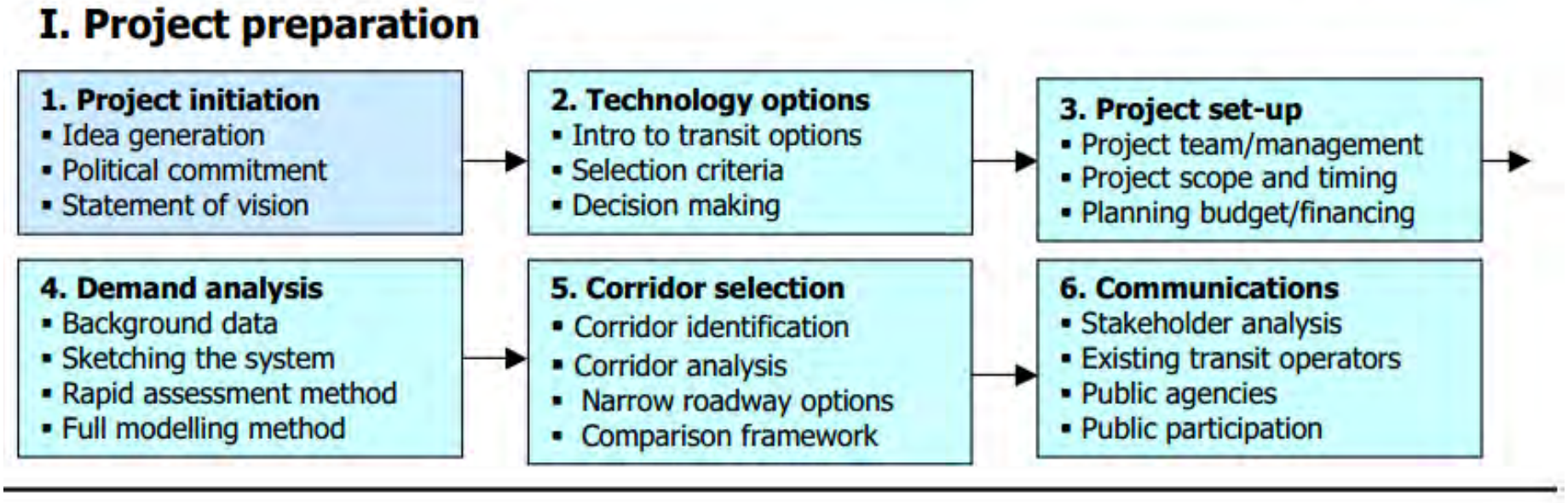

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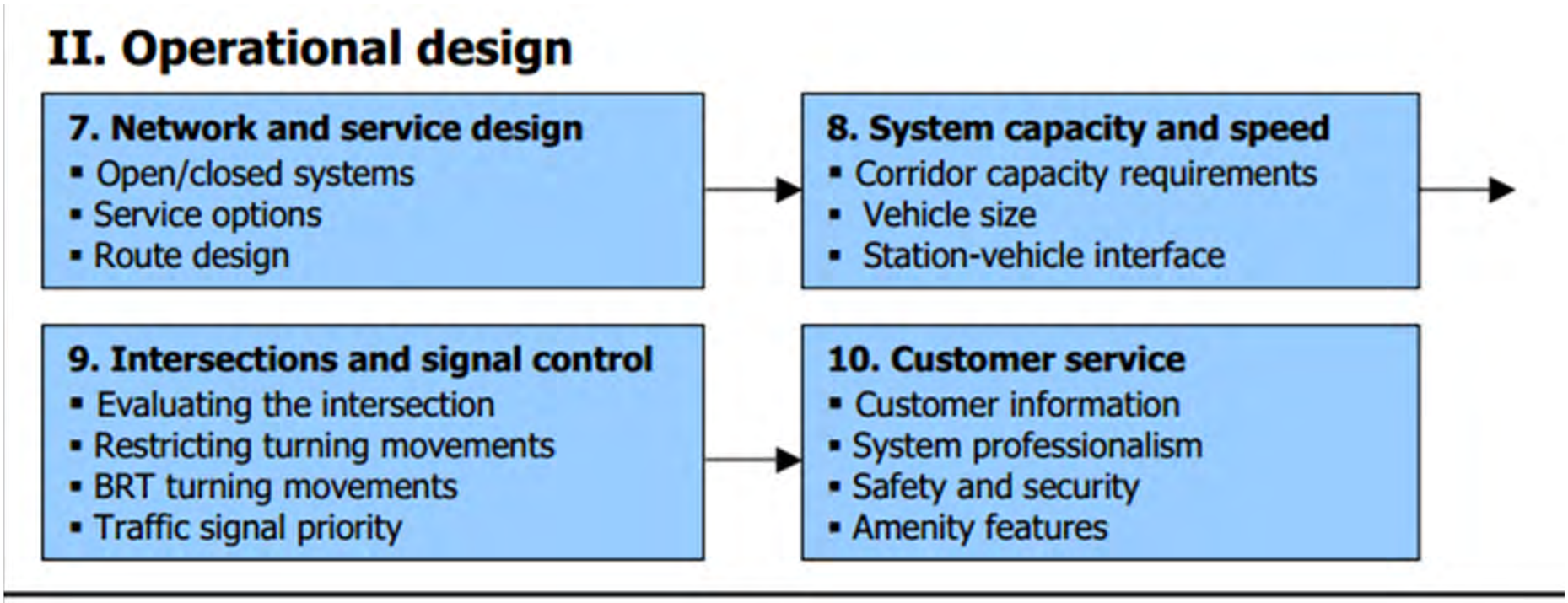

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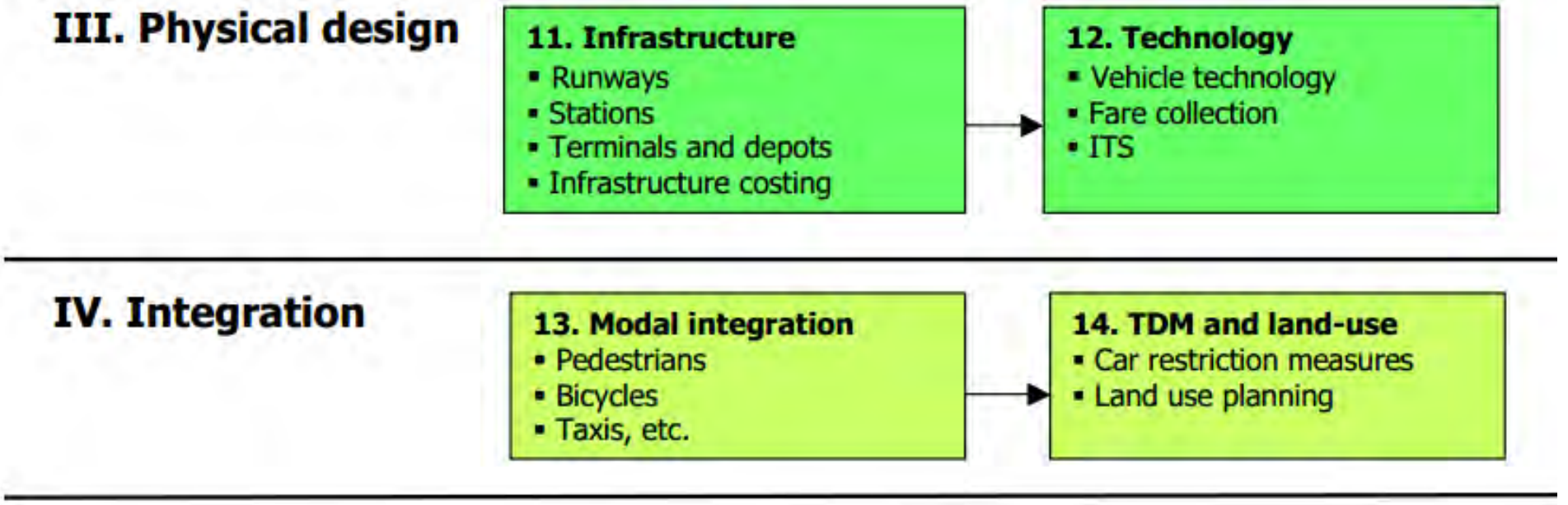

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Mass Transit Project Plan

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V. Business plan

15. Business structure
- Business model
- Transforming structures
- Institutional set-up

→

16. Operational costs
- Operational cost items
- Revenue distribution
- Tariffs

→

17. Financing
- Financing options
- Public financing
- Private financing

→

18. Marketing
- System name
- Logo and slogan
- Campaign strategies

VI. Implementation

19. Evaluation
- Traffic impacts
- Economic, environmental, social, urban form

→

20. Implementation plan
- Construction plan
- Contracting plan

http://www.itdp.org/microsites/bus-rapid-transit-planning-guide/

Commuter Rail Systems

- Heavy rail system, sometimes called suburban rail
- Serve lower-density areas, typically by connecting suburbs to the city centre
- High average speeds
- Often only serving one station in each village and town
- Operation at a lower frequency than Metros
- Scheduled services (i.e. trains run at specific times rather than at specific intervals)
- More seating and less standing room
- Often sharing track or right-of-way with intercity or freight trains.

Metro Systems

Manila, Philippines


Singapore

Photo © Thomas Schunk

- As well: subway or heavy rail transit
- Serves high density urban areas
- High frequencies
- High carrying capacities
- Grade-separated
- Also commonly applied to elevated heavy rail systems.
- Distinction between heavy and light Metro

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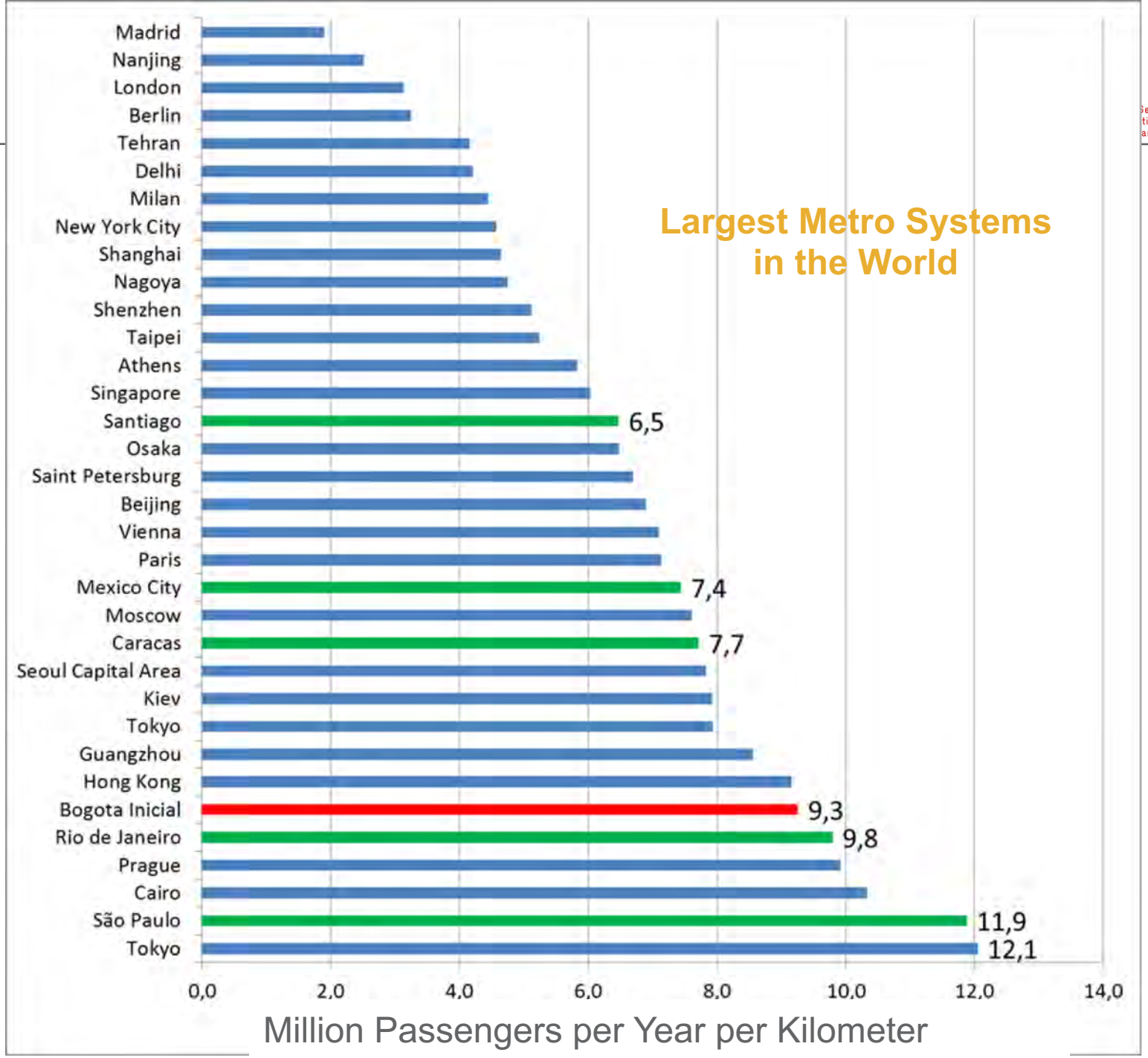
Largest Metro Systems in the World
Madrid
Nanjing
London
Berlin
Tehran
Delhi
Milan
New York City
Shanghai
Nagoya
Shenzhen
Taipei
Athens
Singapore
Santiago
6,5
Osaka
Saint Petersburg
Beijing
Vienna
Paris
Mexico City
7,4
Moscow
Caracas
7,7
Seoul Capital Area
Kiev
Tokyo
Guangzhou
Hong Kong
Bogota Inicial
9,3
Rio de Janeiro
9,8
Prague
Cairo
São Paulo
11,9
Tokyo
12,1
0,0
2,0
4,0
6,0
8,0
10,0
12,0
14,0
Million Passengers per Year per Kilometer

Light Rail Transit (LRT)

Toronto, Canada


Cairo, Egypt

- Metropolitan electric railway system
- Variable frequencies, capacities and speed
- Operates in mixed traffic as well as grade separated
- At ground level, aerial structures, in subways, or in streets
- Board and discharge passengers at track or car floor level.

Tramways

- **Serve urban high density areas**
- **Often operate without an exclusive right-of-way, in mixed traffic.**
- Lower capacities
- High frequencies

Tramway in Frankfurt

Photo by Carlosfelipe Pardo

BRT combines infrastructure, equipment and operation to improve service quality

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Characteristics of a “full” BRT

- ✓ Segregated, median bus ways + stations
- ✓ Pre-board fare collection and verification
- ✓ Restricted operator access
- ✓ Free transfers between corridors
- ✓ Modal and fare integration, user oriented
- ✓ Competitively bid concessions
- ✓ High frequency service and low station dwell times
- ✓ Level boarding and alighting
- ✓ Emissions reductions through newer fuel technologies

When comparing alternatives, there is no technological option that will outperform the others in every aspect…it will be a trade off

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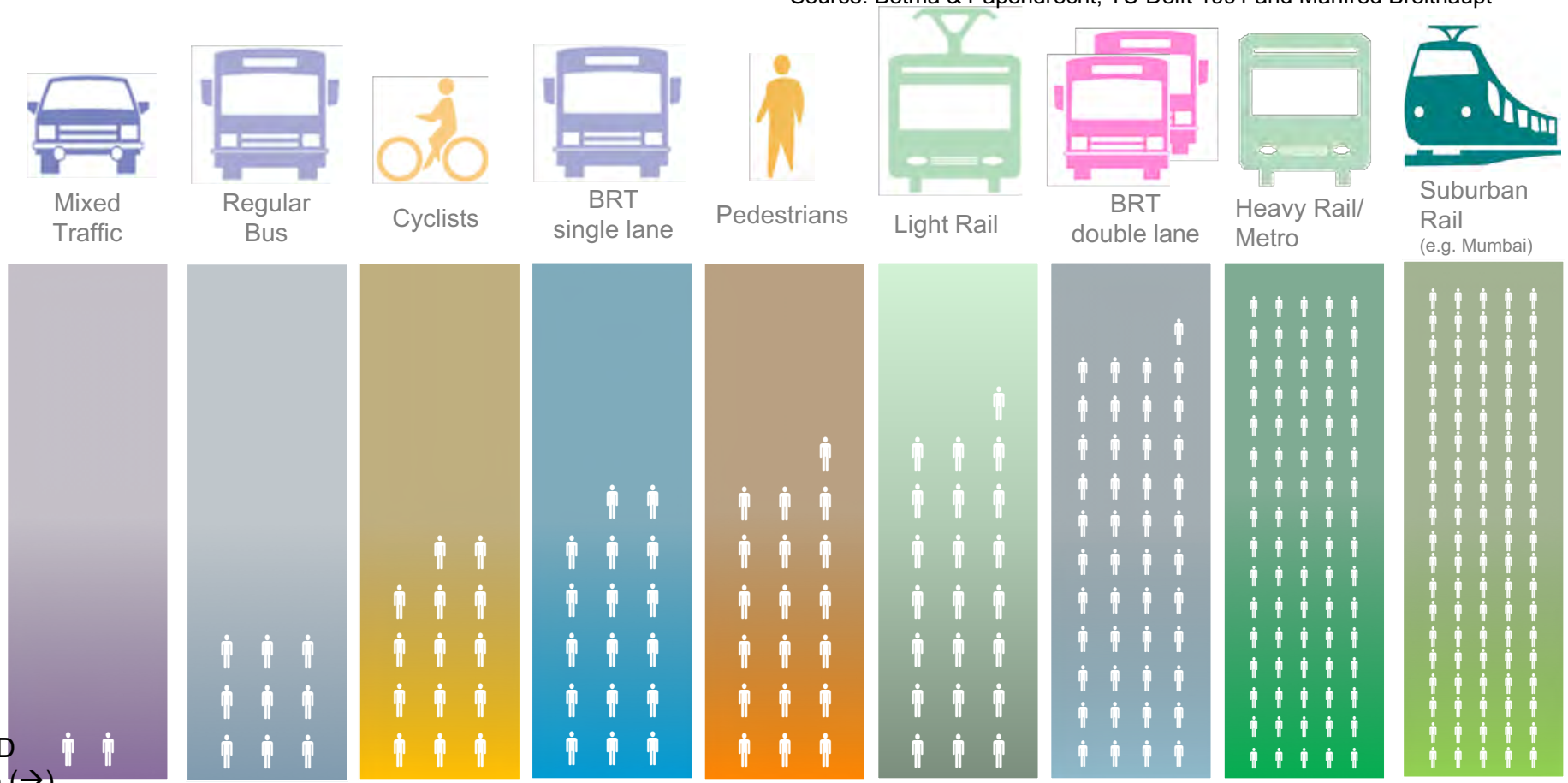
Characteristic	Priority lanes / only bus	Light rail/ street car	Heavy rail/ Metro	Bus Rapid Transit BRT
Required space	2-4 lanes existing roads	2-3 lanes existing roads	New road underground or elevated	2-4 lanes existing roads
Flexibility	High	Limited	Low	High
Impacts on traffic	Variable	Variable	Congestion reduction (?)	Variable
Integration with feeders	Easy	Difficult	Difficult	Easy
Level of service (frequency and occupancy)	Regular	Good	Very Good (dense corridor)	Good
Safety	Regular	Good	Very Good	Good
Emissions	High	Low	Low	High Medium
Reliability	Low	Low (bunching)	Good	Media
walk/transfers	Low	Medium	High	Medium

Sources: Adapted from D. Hidalgo , 2000, L. Wright and K. Fjellstrom, 2003, y V. Vuchic, 1992

Choosing modes – Carrying Capacity

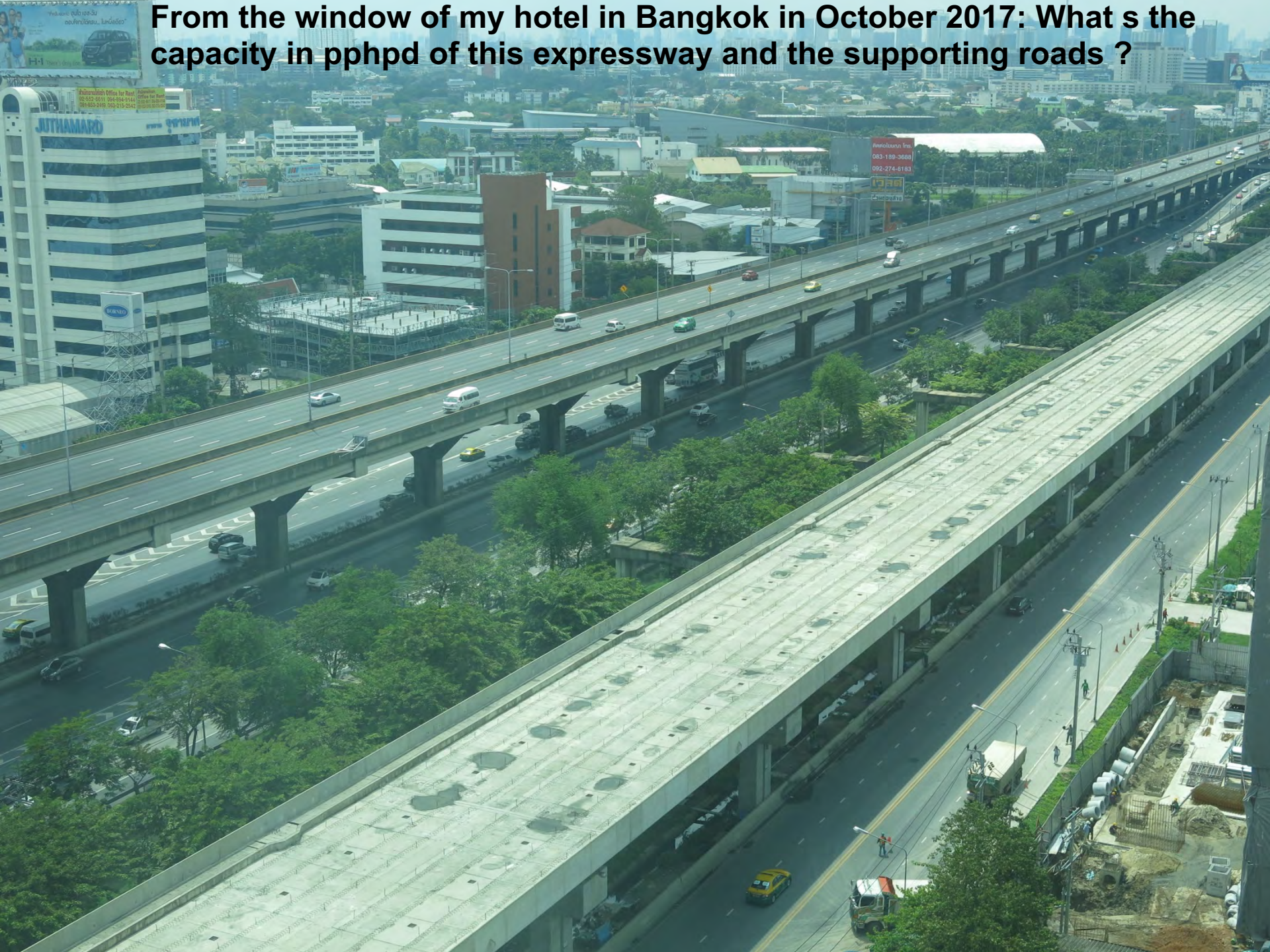
(people per hour on 3.5 m wide lane in the city – PPHPD [PAX/hour/direction])

Source: Botma & Papendrecht, TU Delft 1991 and Manfred Breithaupt



	Mixed Traffic	Regular Bus	Cyclists	BRT single lane	Pedestrians	Light Rail	BRT double lane	Heavy Rail/ Metro	Suburban Rail (e.g. Mumbai)
PPHPD Range (→)	1500-2000	5000	14000	9000	15000	18000 – 20000	??	40000 – 60000	60000 – 90000
Maximum PPHPD achieved & where (→)	2000	8000	14000	15000, Curitiba	19000	20000	43000, Bogotá	80000, HKK	>100000, Mumbai

Equivalency road width: In order to carry 20,000 automobile commuters PHPD, a highway must be at least 18 lanes wide. (assumption 1.2 passengers per automobile)



From the window of my hotel in Bangkok in October 2017: What s the capacity in pphpd of this expressway and the supporting roads ?

Time for construction

Bus Rapid Transit
< 18 months possible
i.e. within the term of a Mayor s period

Metros
> 5 years

Comparing the costs

Tram
US$ 10 – 25 millon / km

Light Rail Transit (LRT)
US$ 15 – 40 millon / km

Urban commuter rail
US$ 25 – 60 millon / km

Elevated rail
US$ 50 - 125 millon / km

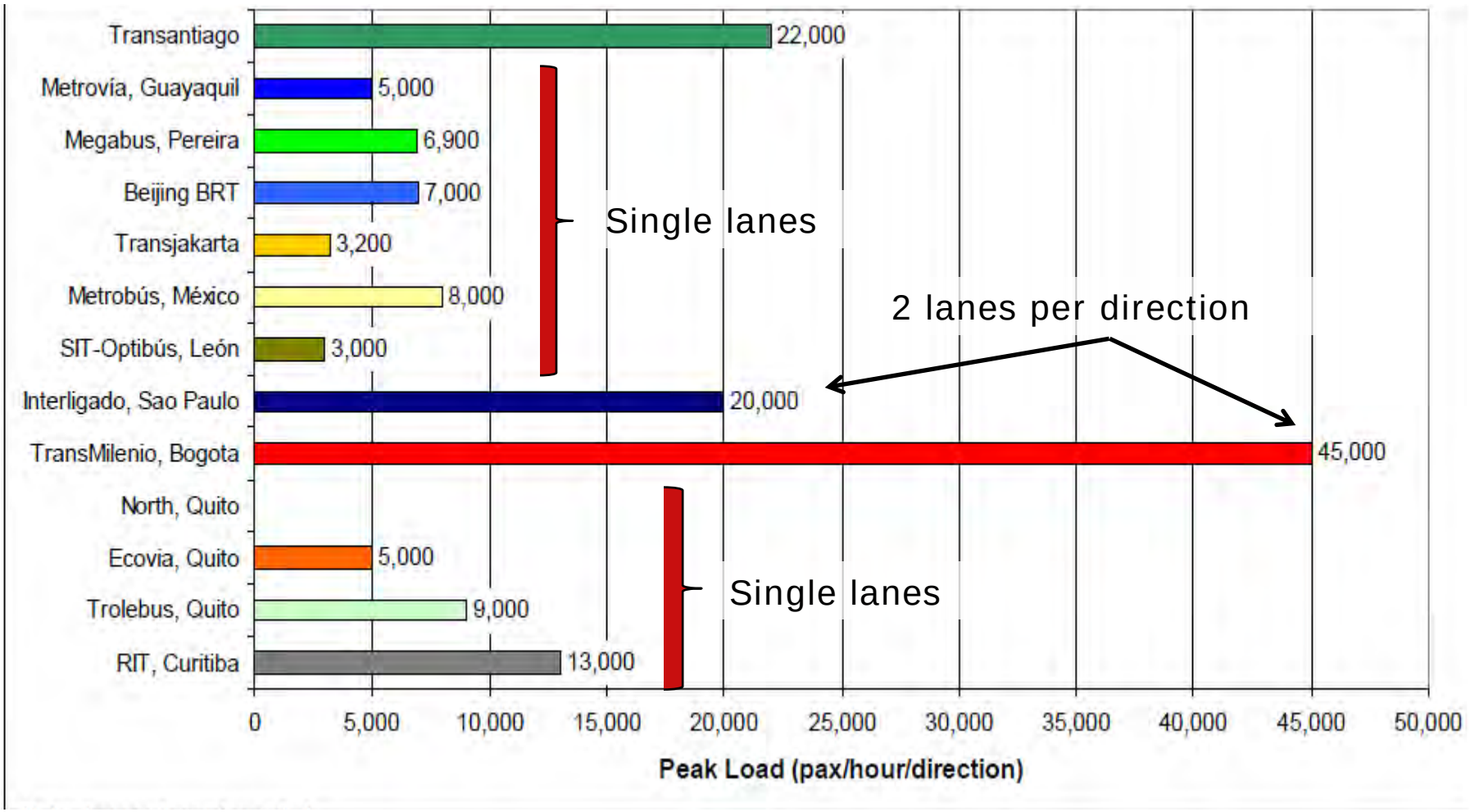
Metro
US$ 50 millon – 300 millon / km; at grade less (up to 50 milllion)

BRT
US$ 0.5 – 15 millon / km

Image source: Manfred Breithaupt

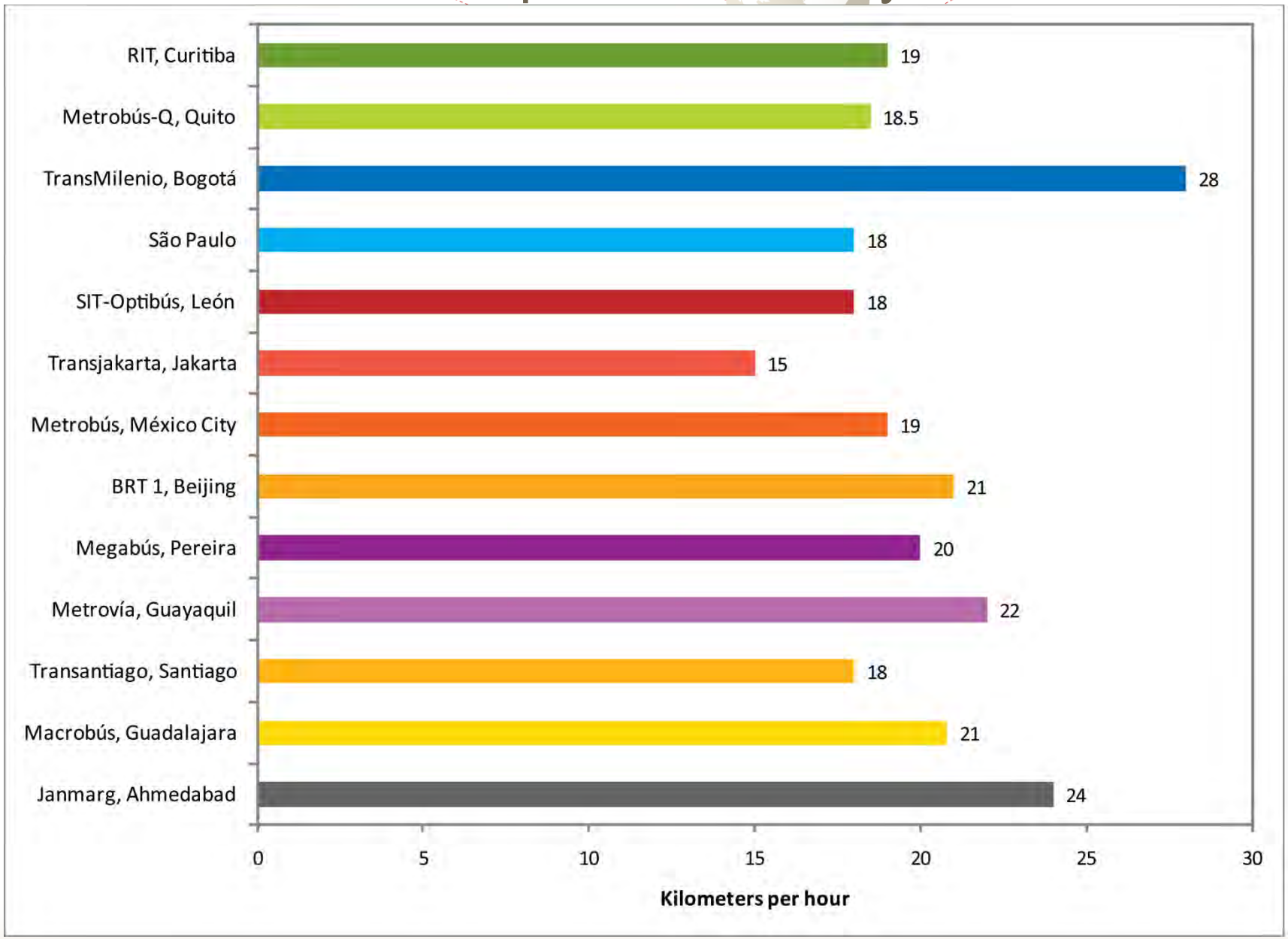
Lloyd Wright

Corridor capacity for BRT systems



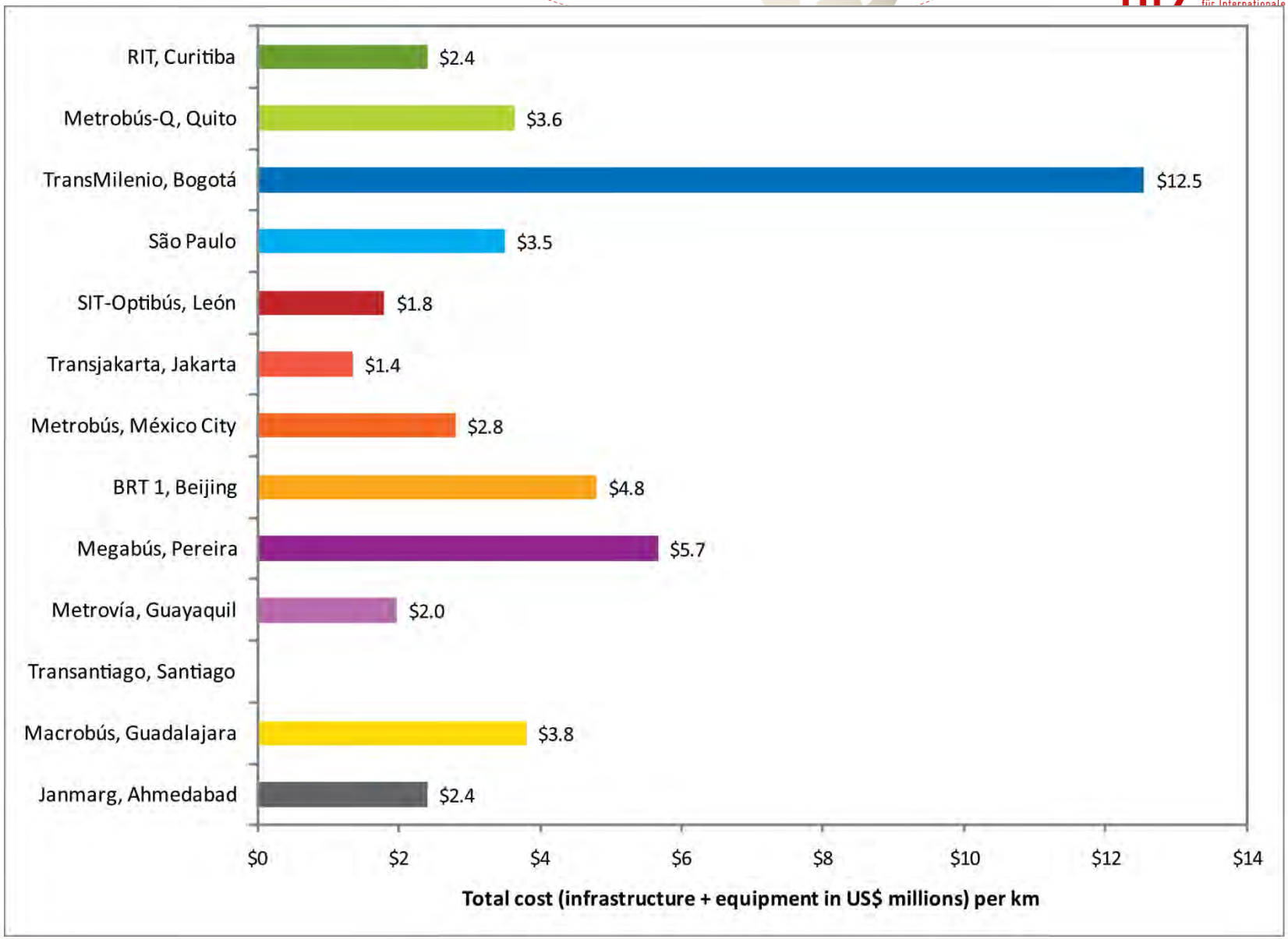
Source: Hidalgo

Commercial speed of BRT systems



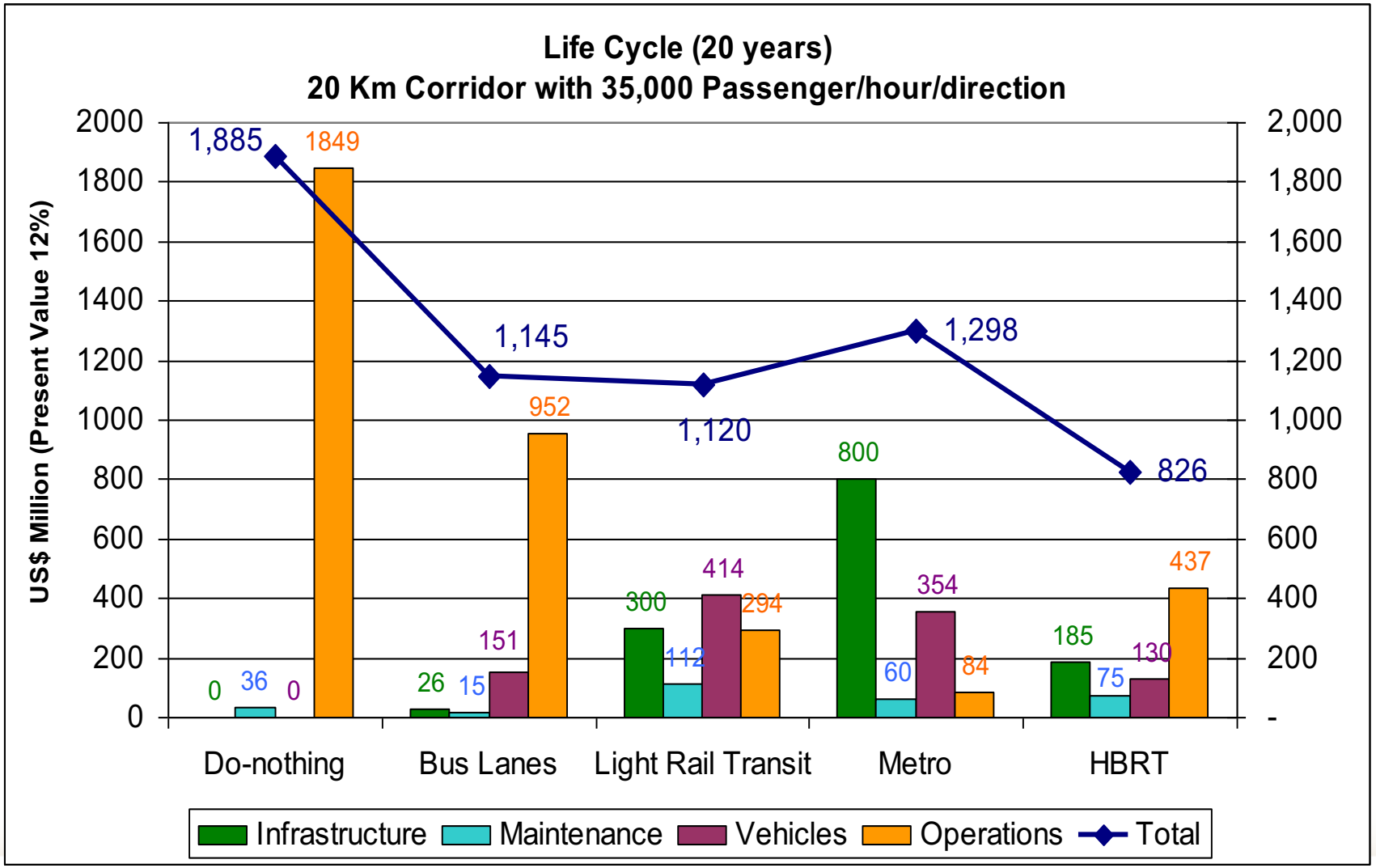
http://www.wri.org/publication/modernizing-public-transportation

Capital Costs of BRT s



http://www.wri.org/publication/modernizing-public-transportation

Bus Rapid Transit can result in smaller life cycle costs than rail alternatives

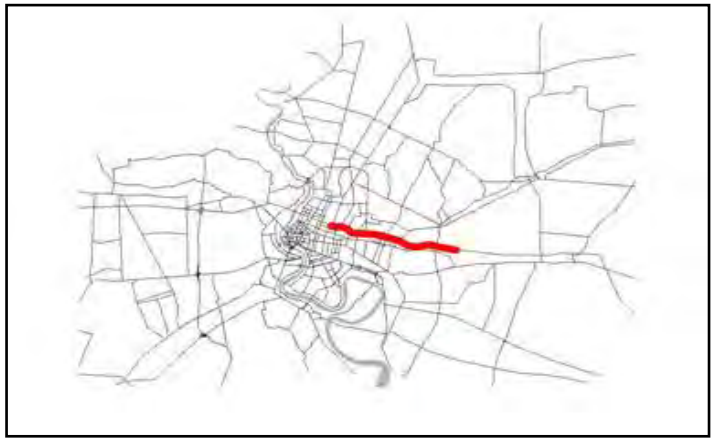


Slides developed originally by Dario Hidalgo

Financial Benefit - What a city can have for 1Bn US$? Make a choice…

400 kilometres of BRT

40 kilometres of LRT



14 kilometres of elevated rail

7 kilometres of subway

*** Source: Actual data from systems built or proposed in Bangkok, Thailand**

Tram/light rail in traffic calmed areas and pedestrian streets

Kassel (Germany)

Zagreb (Croatia)

Source: UITP

Urban integration

Source: UITP

BRT – Intermediate to High Capacity Transit

BRT Guangzhou (Winner of 2011 STA Award)

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Source: Karl Fjellstrom, ITDP China

- 22.5 km of dedicated busway
- Over 800,000 passengers per day on a single corridor
- 27,400 passengers per peak hour per direction

TransMilenio BRT Avenida Caracas

Foto ITDP

Eje Ambiental Avenida Jiménez


BRT can be very productive
Guangzhou, China
35,800 pax/day/km
Source: EMBARQ

Before Metrobus, Itanbul

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Source: IETT

After introducing Metrobus

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Source: IETT

AKYOLBIL – Metrobus Control Center

Source: IETT

Indore, iBus, BRT System, 2013

Photo: EMBARQ

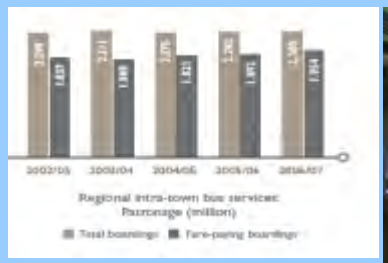
Recommendations regarding a choice on Mass Transit

- Do not choose the technology and then justify it
- For the conditions of any city the key is integration of different services, **taking advantage of the existing systems**
- Avoid any stand alone systems, as we see them often
- Remember the common deviation between planning (forcast) and implementation (discussed above)
- Frquency on a MRT System should not be –let s say- less then 10 minutes. Otherwise it gets unattractive.
- With less then – lt s say- 10 000 -12 000 pass./hour/ direction - any rail system (in this case LRT) will not be competitive in economic terms.

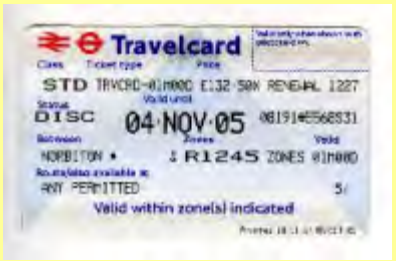
Ways to achieve an increase in PT ridership...

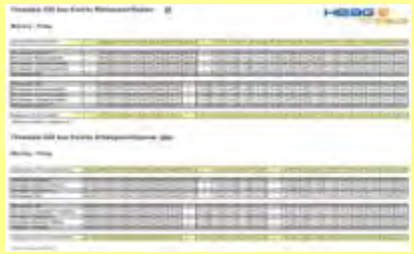
What to do: 2 main issues

Public Transport – Quality Control



Public Transport – Integration (physical, fare, institutions, timetables)





Quality checks and evaluation

- Service kilometer operated/vehicle owned
- Passenger carried/vehicle owned
- Passenger carried /staff member
- Staff/vehicle owned
- Per cent of vehicle fleet operating in peak hours
- Revenue/vehicle owned
- Revenue/vehicle kilometer
- Kilometers operated between breakdowns
- Kilometers/fuel consumed
- Cost/vehicle km
- Fare collection leakage
- Employees' absenteeism
- Number of accidents per 10^5 kilometers

None of these reflect service quality as users would perceive it!

The Oslo Metro Customer Charter

1. We leave on schedule.
2. We will not leave early.
3. You will be informed of an approaching stop.
4. You will always know where we are going.
5. Information will be available before you board.
6. Information will be available on board.
7. We will answer your questions.
8. You will be informed when things go wrong.
9. Carriers will be clean, making your journey pleasant.
10. We will reply when you write to us.
11. We will listen to you.
12. We pay if you arrive late.

Cost coverage in PT- Experience

Some experience from selected cities:

- Hongkong: cost covering PT system as a whole, also on rail system
- Singapore: at least all the operational costs are covered
- Frankfurt: covers operations costs of bus services, after they were completely tendered out. Rail operating costs are nowhere in Europe covered by farebox revenues
- BRT systems, with high occupancy rates can and do cover costs since they achieve higher average speeds, higher daily mileage and hence much greater passenger loads and revenues
- Tendering out of PT services also leads in general to lower requirements for subsidies
- Most bus systems (especially BRT s) in Latin American cities do not reqiure operational subsidies

Farebox recovery ratio of some cities

• Hong Kong	124%	2016
• Tokyo Metro	119%	2016
• Taipei Metro	100%	2015
• Singapore SMRT	101%	2017
• Amsterdam	88%	2018
• Berlin	65%	2010
• London Underground	107%	2016
• Paris STIF	30%	2014
• Madrid	41%	2007
• Rome	36%	2007
• Munich	70%	2010
• Zurich	60%	2014
• Boston	30%	2016
• Dallas	14%	2016
• New York City MTA	47%	2016
• Toronto	70%	2016
• Auckland	44%	2013
• Sydney	27%	2014

Farebox recovery ratio of some cities

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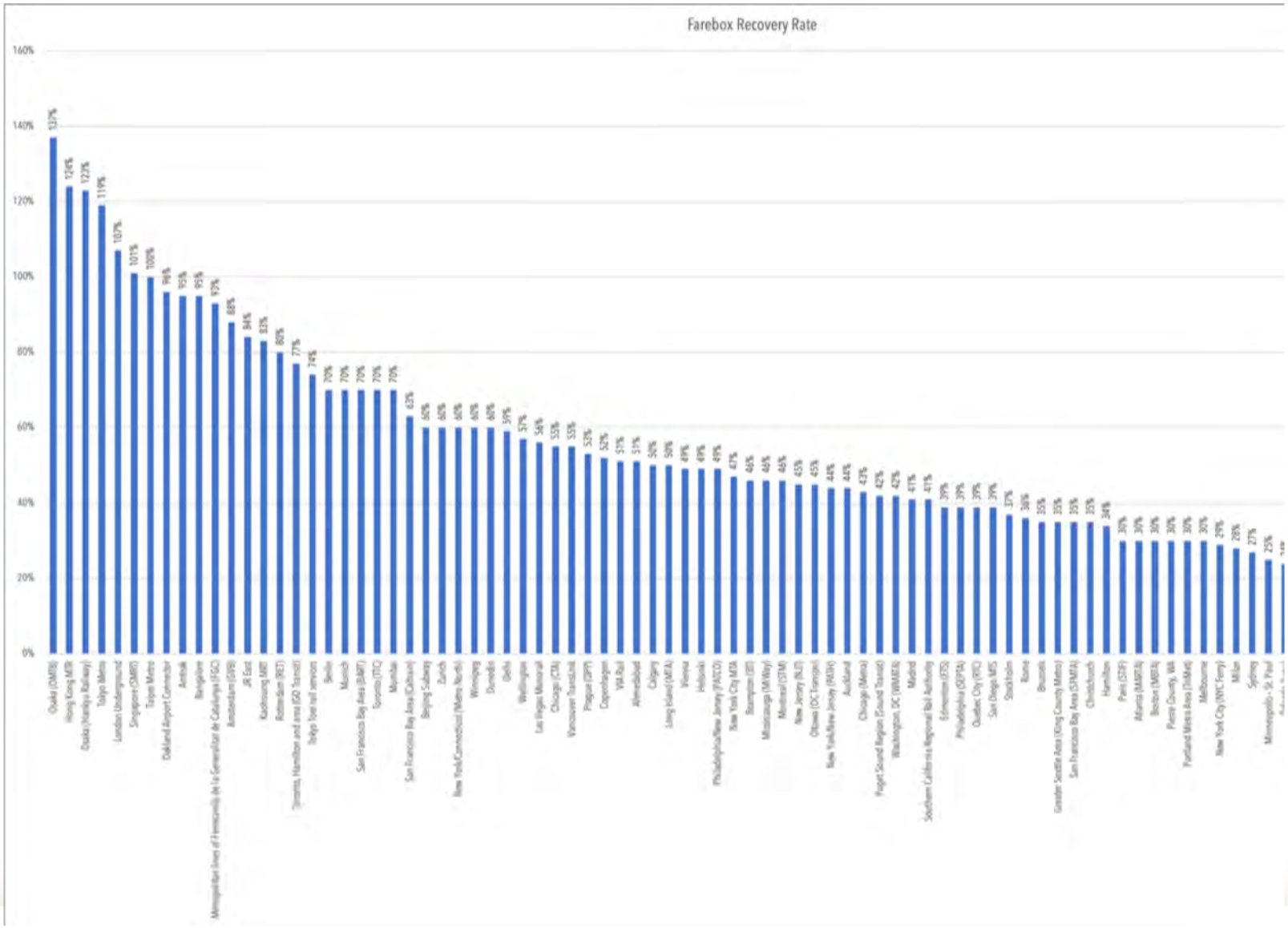

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Access to Public Transport and Integration of Public Transport with NMT

02.10.18

Bogotá's ramped pedestrian bridges work quite well with virtually no non-compliance. Key features..

- 2.5 meters wide
- Aesthetically attractive
- Clean and well-maintained

In many of the developing cities, access trips to PT systems is still a major challenge

Bus Station in Delhi, India

Footpath condition in Bangalore, India

Coherence – consistent, continuous, and adequate amenities

The infrastructure forms a coherent unit and is linked to the origins and the destinations of cyclists

That's why we need:

- Consistent quality

→ Different design

- Continuity

→ Few changes in the design and width

- Complete routes

→ No interruptions

- Adequate signaling

VIKAS MARG
Source: CSE

Can elderly and people with special abilities use such NMT facilities?

Can elderly and people with special abilities use such NMT facilities?

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Achieving modal integration

Without solving this we will not achieve the intended shift from car based travel (PT and NMT complement each other)

What needs to be integrated?

Feeder services

Other mass transit systems

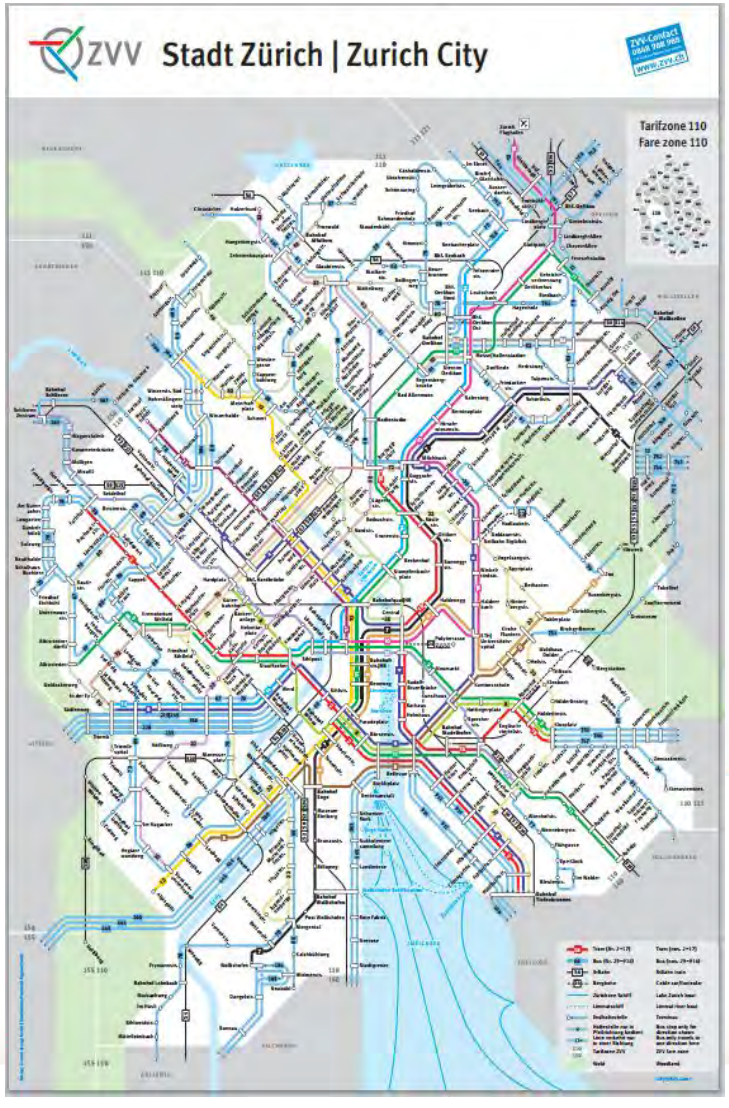
Pedestrians

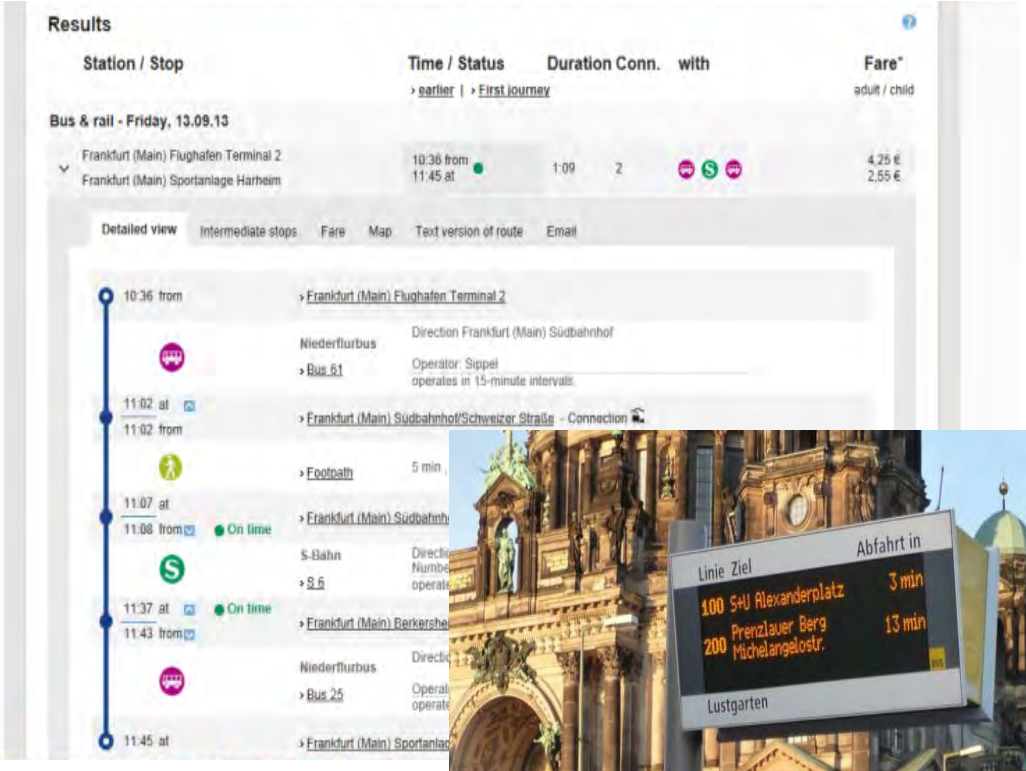
Bicycles

Taxis, shared transport, bicycle- and motorbike taxis

Integration: With PT…. Integrated Transfer Stations

Integrated Information & Timetable planning



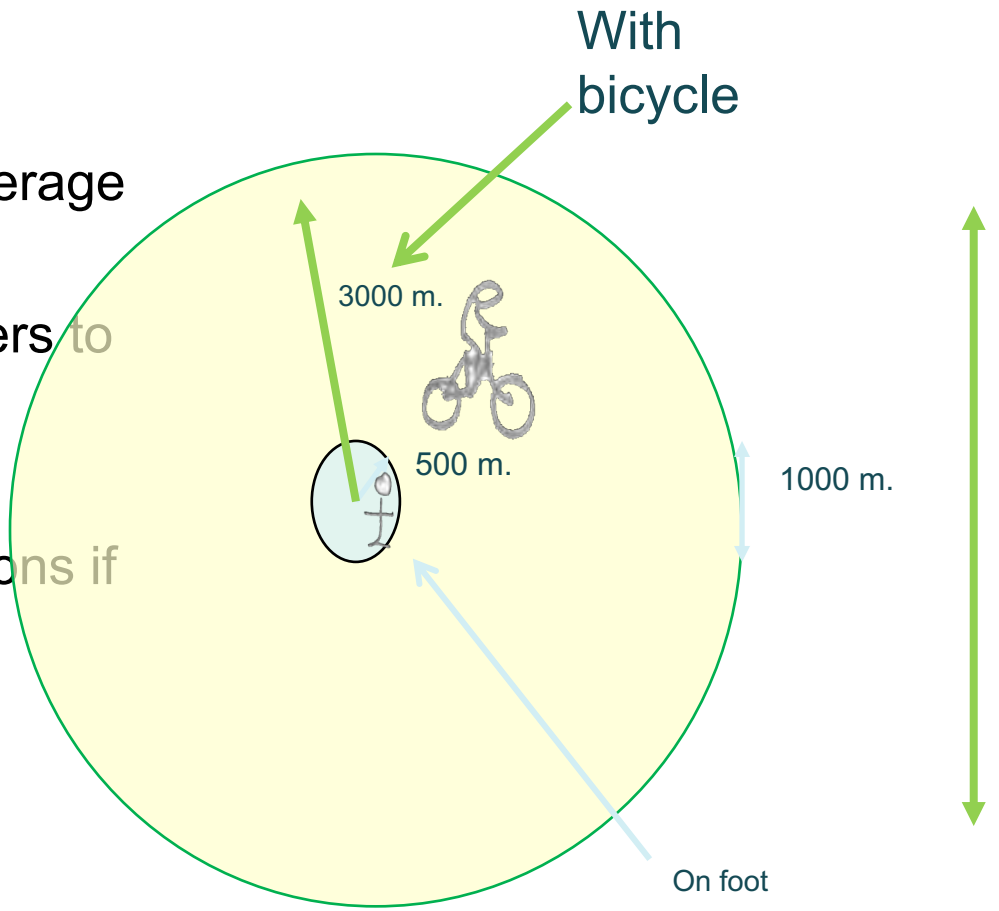


Achieve modal integration between bicycles trips with MRT and Bus Systems

Muenster, Germany

Why should we focus on integrating bicycle trips with PT stations?

- Provides 6 times more spatial coverage compared to walking
- Reduces costs incurred by the users to reach the stations
- Complements feeder routes
- Can reduce demand in some stations if properly implemented



Integrate bicycle parking with MRT stations

e.g. parking a bike at TransMilenio Américas Terminal

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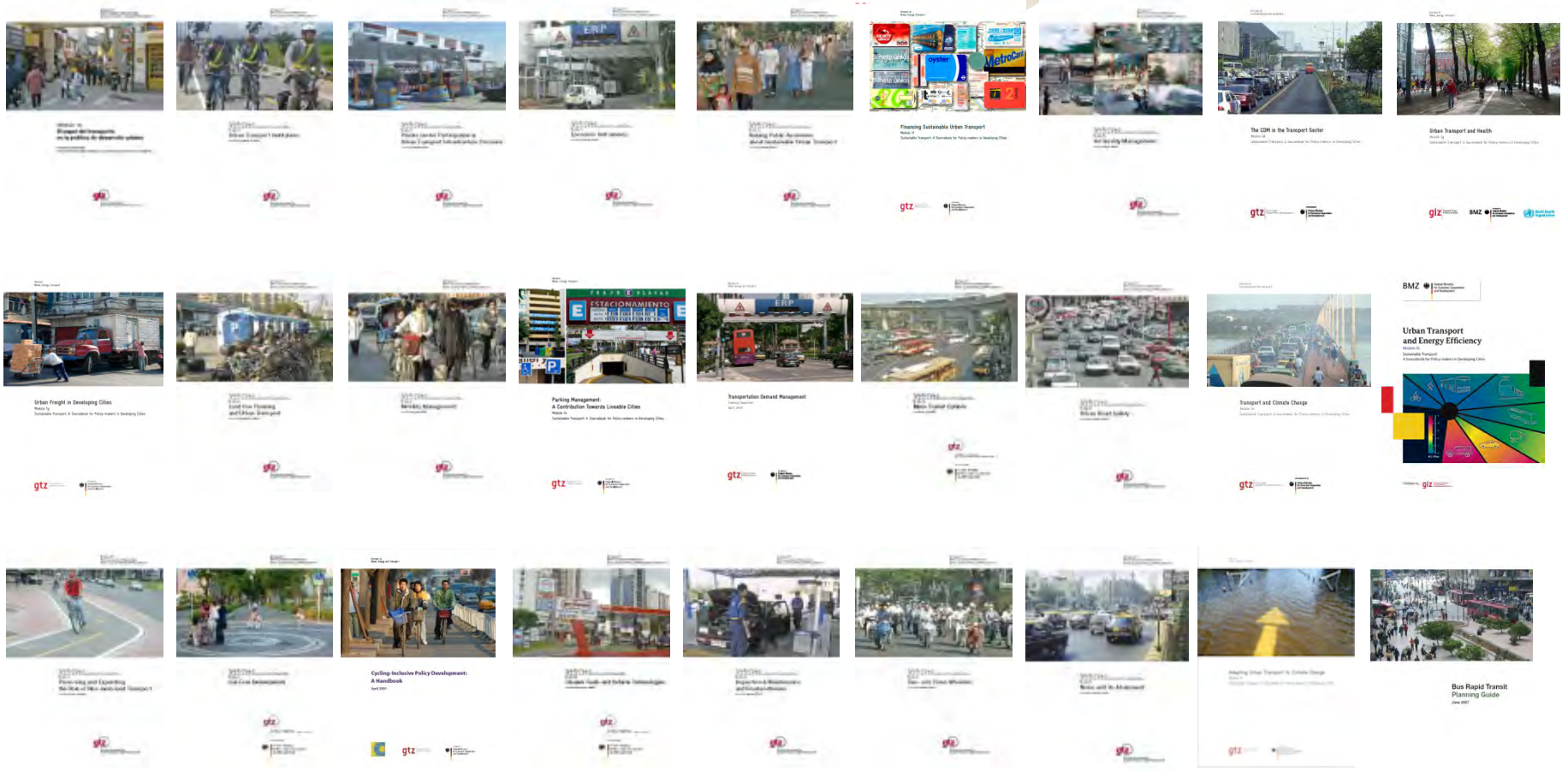
Expand public bike sharing systems in and around MRT stations

Resources



GIZ Sourcebook for Decision-Makers in Developing Cities
http://www.sutp.org/en-sourcebook

Manfred Breithaupt

manfred.breithaupt@gmail.com