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CAPACITY BUILDING FOR SUSTAINABLE URBAN MOBILITY PLANS

COLLECTIVE PASSENGER TRANSPORT

23-24 September 2024

Source: Sebastiano Piazzi, Unsplash

TRT DTV CONSULTANTS Goudappel stratec TIS TREDIT S.A.

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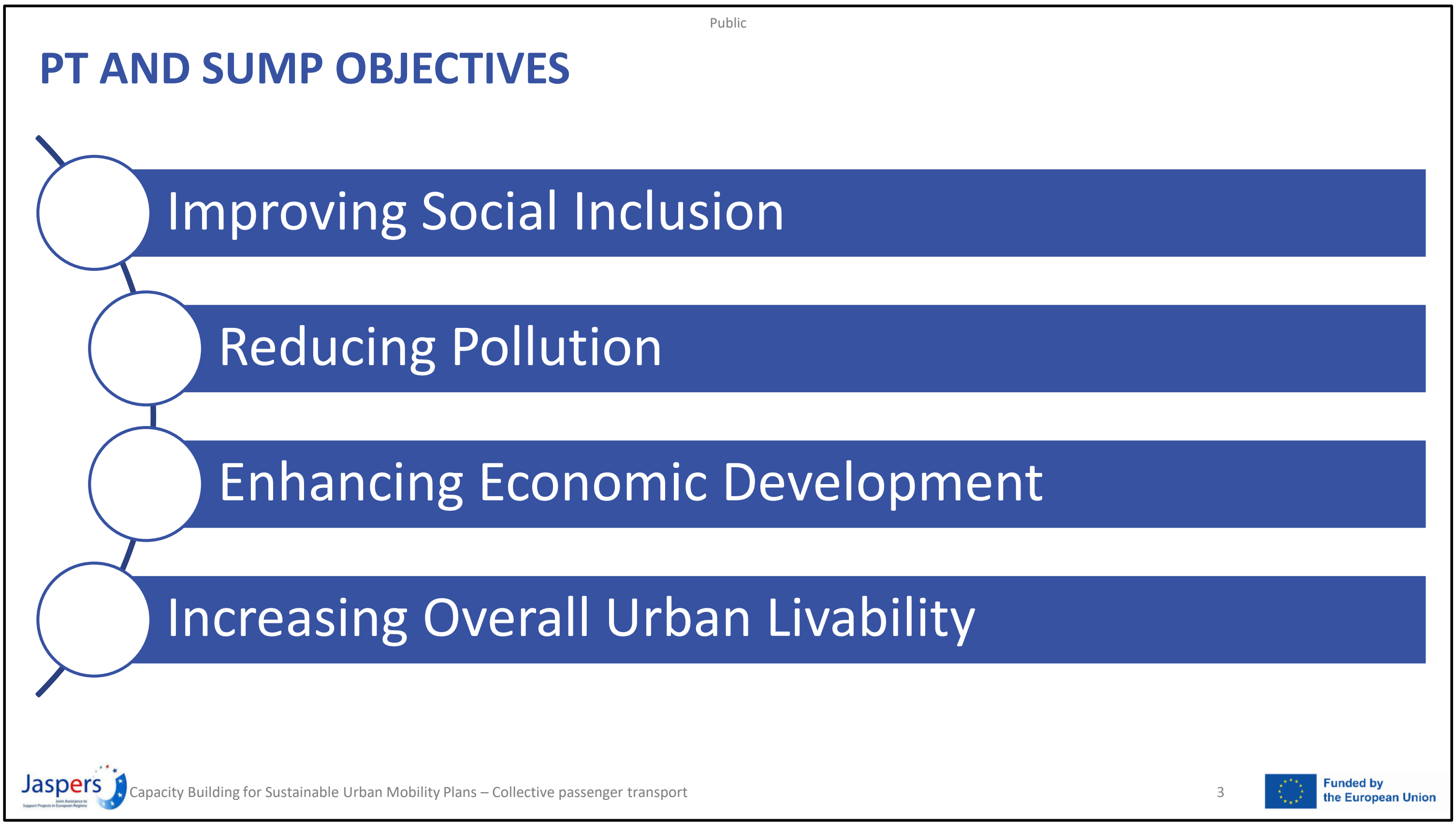
- Benefits, impacts and limitations of Collective Transport
- PT and SUMP Objectives
- Relevance of PT to Cities of Different Sizes
- PT Investments, Measures & Policies
- Appraisal Methods within the context of SUMPs
- Effective PT Institutional Arrangements and Governance
- Systematic Approach to PT Development
- Integrating PT with Other Measures



To achieve the strategic and operational objectives of a SUMP, various PT measures can be implemented. These measures contribute to improvements in social inclusion, pollution reduction, economic development, and overall urban livability.

PT Measures for SUMP Objectives

1.Improving Social Inclusion:

1. **Affordable Fare Structures:** Implementing subsidized or reduced fare options for low-income residents, students, and the elderly to ensure that PT is accessible to all socioeconomic groups.
2. **Comprehensive Coverage:** Expanding PT networks to underserved and peripheral areas to ensure equitable access to employment, education, healthcare, and other essential services.
3. **Universal Design:** Ensuring that all PT infrastructure and vehicles are accessible to people with disabilities, the elderly, and parents with strollers by incorporating features like low-floor buses, ramps, and tactile paving.

2.Reducing Pollution:

1. **Clean Energy Fleets:** Transitioning to electric, hybrid, or hydrogen-powered buses to lower emissions and reduce the city's carbon footprint.
2. **High-Frequency Services:** Increasing the frequency of PT services to make them a more convenient and attractive alternative to private car use, thus reducing overall vehicular emissions.

3. **Park and Ride Facilities:** Establishing park-and-ride lots on the outskirts of the city to encourage commuters to use PT instead of driving into the city center, thus cutting down on congestion and pollution.

3. Enhancing Economic Development:

1. **Transit-Oriented Development (TOD):** Promoting mixed-use development around PT hubs to stimulate local businesses and housing markets, creating vibrant and economically productive neighborhoods.
2. **Integrated Ticketing Systems:** Developing integrated and seamless ticketing solutions that allow for easy transfers between different modes of transport (buses, trams, trains), making PT more user-friendly and efficient.
3. **Job Access Programs:** Coordinating PT routes and schedules with major employment centers and industrial areas to ensure reliable access for workers, boosting employment rates and productivity.

4. Increasing Overall Urban Livability:

1. **Real-Time Information Systems:** Installing digital information systems at PT stops and via mobile apps to provide real-time updates on schedules and delays, enhancing user experience and reliability.
2. **Dedicated Bus Lanes:** Creating dedicated lanes for buses to improve service speed and reliability, reducing travel time for PT users.
3. **Bicycle Integration:** Providing bike racks on buses and secure bicycle parking at PT stations to encourage multi-modal commutes and promote cycling as a complement to PT.

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PT's CONTRIBUTION TO SUMP OBJECTIVES - EXAMPLES

- **Improving Social Inclusion**:
  - Make PT accessible to all with low fares
  - Provide access for those without cars
  - Independent mobility for PRM – accessible vehicles, stops, stations
- **Reducing Pollution**:
  - clean energy fleets
  - Mode shift to PT to reduce car use
- **Enhancing Economic Development**:
  - Improved accessibility
  - Development opportunities at PT hubs
  - PT as major employer

Source: *https://www.nationalgeographic.com/expeditions/destinations/europe/journeys/budapest-prague-vienna-berlin-central-europe-tour/*

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CASES OF PT AND SUMP OBJECTIVES

Vienna, Austria: Social Inclusion

- €365 annual ticket for unlimited use of PT introduced 2017
- Over 800,000 annual tickets sold by 202
- Increased PT usage by 7%

Source: Stadt Wien

Berlin, Germany: Economic development

- €28 billion expansion and modernization of the PT network 2020 – 2030
- Predicted impacts:
  - Increase of over 500,000 jobs within a 30-minute by PT
  - Enhanced connectivity to 25 higher education institutions
  - Improved access to over 10,000 businesses
  - Decrease travel times by an average of 10% for commuters

Source: Berlin.de

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Example: Vienna, Austria

•**Measure**: Instituting an annual €365 ticket offering unlimited access to public transportation.

•**Impact**: With over 800,000 annual tickets sold by 2020, the initiative markedly improved affordability and accessibility, notably benefiting low-income residents and students.

•**Result**: The implementation saw a considerable 7% surge in public transport utilization, thereby bolstering social inclusion by ensuring mobility for all strata of society.

Example: Berlin, Germany

•**Measure**: Expansion and modernization of the public transport network, including the U-Bahn (subway) and S-Bahn (urban rail) systems.

•**Investment**: €28 billion allocated for public transport projects from 2020 to 2030, including the expansion of U-Bahn lines and the procurement of new S-Bahn trains.

•**Impact**: Improved connectivity and accessibility, particularly in underserved neighborhoods and outer districts.

•**Result**:

- **Job Access**: Increased accessibility to over 500,000 jobs within a 30-minute public transport commute.
- **Educational Access**: Enhanced connectivity to 25 universities and higher education institutions.

- **Commercial Access**: Improved access to over 10,000 commercial establishments, stimulating economic activity.
- **Travel Time Reduction**: Decreased travel times by an average of 10% for commuters using the upgraded public transport system.

•**Outcome**: Strengthened economic vitality and competitiveness, with public transport serving as a catalyst for sustainable growth and urban development in Berlin.

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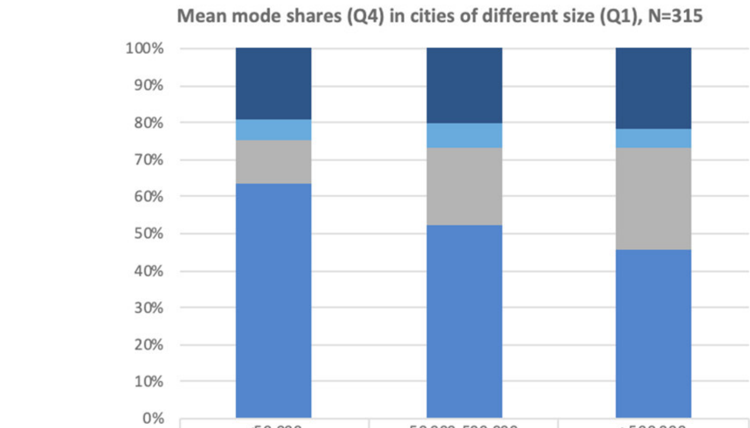
PT IN CITIES OF DIFFERENT SIZES

- PT relatively more important in larger cities
- As share of trips, walking as important as PT in smaller and medium sized cities
- PT though has ability to compete with car over medium distances
- Few cities have PT mode share > 30% of trips



	<50,000	50,000-500,000	>500,000
Walk	19%	20%	22%
Bike	6%	7%	5%
Public transport	12%	21%	28%
Private motor vehicle	63%	52%	45%

Source: SUMP-PLUS - City Typology, for context-sensitive framework and tools development

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PT is a cornerstone of urban development, offering significant benefits to cities of all sizes. From reducing traffic congestion and pollution to fostering economic growth and social inclusivity, the importance of PT cannot be overstated. Here's a comprehensive look at why PT is crucial for small, medium, and large cities:

Small Cities

1.Accessibility and Connectivity:

1. **Vital Links**: PT systems in small cities provide essential connections between residential areas, business districts, and service centers, ensuring that all parts of the city are accessible.
2. **Rural Integration**: For small cities surrounded by rural areas, PT facilitates the movement of people and goods, enhancing regional integration and economic activity.

2.Economic Development:

1. **Local Business Support**: Efficient PT helps local businesses by making it easier for customers to access shops, restaurants, and services, stimulating the local economy.
2. **Employment Opportunities**: Reliable PT enables residents to access a broader range of job opportunities, contributing to lower unemployment rates and higher overall productivity.

3.Environmental Benefits:

1. **Reduced Emissions**: PT systems, especially those powered by clean energy,

help reduce the carbon footprint of small cities, preserving local natural resources and improving air quality.

Medium-Sized Cities

1.Traffic Congestion Mitigation:

1. **Efficient Commutes**: Medium-sized cities often face increasing traffic congestion. PT offers a viable alternative to private car use, reducing traffic jams and improving commute times.
2. **Space Optimization**: By reducing the need for extensive parking spaces and road expansions, PT helps in better land use and urban planning.

2.Social Inclusivity:

1. **Equitable Access**: PT ensures that all residents, including those without access to private vehicles, can reach essential services like healthcare, education, and employment.
2. **Community Building**: Shared transportation modes promote social interactions and community cohesion, fostering a sense of belonging among residents.

3.Economic Efficiency:

1. **Cost Savings**: PT systems can be more cost-effective than maintaining extensive road networks. Investment in PT infrastructure often yields high returns in terms of economic development and reduced transportation costs for residents.

Large Cities

1.Mass Mobility Solutions:

1. **High-Capacity Transport**: Large cities require PT systems capable of moving vast numbers of people efficiently. Subways, trams, and extensive bus networks are crucial for handling the high demand.
2. **24/7 Operations**: In metropolitan areas, PT often operates around the clock, supporting the dynamic lifestyle and diverse working hours of urban populations.

2.Sustainable Urban Development:

1. **Environmental Impact**: PT significantly reduces greenhouse gas emissions by decreasing reliance on private cars, which is vital for combating climate change in densely populated areas.
2. **Reduced Urban Sprawl**: Efficient PT can discourage urban sprawl by promoting higher-density development along transit corridors, leading to more sustainable and livable urban environments.

3.Economic and Social Vibrancy:

1. **Global Competitiveness**: Cities with robust PT systems are more attractive to businesses, tourists, and residents, enhancing their global competitiveness.
2. **Quality of Life**: PT contributes to a higher quality of life by reducing commute times, lowering transportation costs, and providing reliable access to cultural, recreational, and social activities.

A clear relationship between city size and the mean mode shares for private vehicle use and public transport use. On average, larger cities demonstrate a lower mode share for private vehicles and a higher mode share for public transport. This trend is expected, reflecting the superior quality and quantity of public transport available in larger European cities, as well as greater restrictions on car use, such as parking controls.

However, it is important to note that many cities with smaller populations are actually municipalities situated within broader city-regions or near large cities, rather than being small rural municipalities. This proximity to larger urban centers likely weakens the correlation between mode share and population size, as public transport services are often provided at a regional level. Thus, the presence of regional public transport networks can lead to higher public transport use even in smaller municipalities, complicating the direct relationship between city size and transport mode share.

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MODE SHIFT TO PT IN CITIES OF DIFFERENT SIZES

Small Cities
(Population < 100,000)

- Current Mode Share for PT: Typically low (5-15%)
- Expected Mode Shift:
  - With modest improvements: 5-10% increase
  - With significant improvements: 10-20% increase

Medium-Sized Cities (Population 100,000 - 1,000,000)

- Current Mode Share for PT: Moderate (15-30%)
- Expected Mode Shift:
  - With modest improvements: 10-15% increase in
  - With significant improvements: 15-25% increase

Large Cities
(Population > 1,000,000)

- Current Mode Share for PT: Moderate (30-50%)
- Expected Mode Shift:
  - With modest improvements: 5-10% increase
  - With significant improvements: 10-20% increase

Small Cities (Population < 100,000)

Current Mode Share for PT: Typically low (5-15%)

Expected Mode Shift:

•**With modest improvements** (e.g., better bus services, minor infrastructure upgrades): 5-10% increase in PT mode share.

•**With significant improvements** (e.g., new tram lines, integrated ticketing, enhanced frequency): 10-20% increase in PT mode share.

Example:

•**City**: Marburg, Germany

•**Current PT Share**: ~10%

•**After Improvements**: Increased to ~20% with the introduction of more frequent bus services and improved connectivity.

Medium-Sized Cities (Population 100,000 - 1,000,000)

Current Mode Share for PT: Moderate (15-30%) **Expected Mode Shift**:

•**With modest improvements**: 10-15% increase in PT mode share.

•**With significant improvements**: 15-25% increase in PT mode share.

Example:

•**City**: Freiburg, Germany

•**Current PT Share**: ~34% (combination of tram, bus, and cycling)

•**After Improvements**: Could increase to ~50% with more frequent services, better cycling infrastructure, and expanded tram lines.

Large Cities (Population > 1,000,000)

Current Mode Share for PT: High (30-50%) **Expected Mode Shift**:

•**With modest improvements**: 5-10% increase in PT mode share.

•**With significant improvements**: 10-20% increase in PT mode share.

Example:

•**City**: Vienna, Austria

•**Current PT Share**: ~39%

•**After Improvements**: Increased to ~48% after the introduction of the €365 annual ticket, expanded tram lines, and enhanced bus services.

Modest Improvements

Modest improvements in PT typically include enhancements that are less extensive and more cost-effective. Examples of modest improvements are:

•**Increased Bus Frequency**: More frequent bus services to reduce wait times and improve reliability.

•**Minor Infrastructure Upgrades**: Adding bus lanes, improving bus stops, and minor route extensions.

•**Better Service Coverage**: Expanding service hours and coverage areas to reach more neighbourhoods.

•**Integration of Services**: Improved coordination between existing modes (e.g., buses timed to connect with trains).

Significant Improvements

Significant improvements involve more substantial changes and investments in the PT infrastructure. Examples include:

•**New Tram or Light Rail Lines**: Building new tram or light rail lines to provide faster and more reliable services.

•**Integrated Ticketing Systems**: Implementing a single ticketing system that covers all modes of PT, making it easier for passengers to switch between modes.

•**Enhanced Service Frequency and Coverage**: Dramatically increasing the frequency of services and extending coverage to underserved areas.

•**Infrastructure Overhauls**: Major upgrades to stations, adding dedicated bus lanes, and improving accessibility features.

While these improvements can significantly boost PT usage, the absence of demand management for private transport (such as congestion charges, limited parking, or car-free zones) can limit the potential for a substantial mode shift. Here's why:

1.**Convenience of Private Cars**: Without measures to make car usage less convenient, many people may still prefer the perceived flexibility and comfort of private cars, especially in areas with low congestion and ample parking.

2.**Cost Comparison**: If the cost of owning and operating a private vehicle remains low, even well-designed PT systems may struggle to attract a significant number of car users.

3. **Behavioural Change**: Long-term habits and cultural attitudes favouring car usage can be hard to break without some form of regulatory push.

Factors Influencing Mode Shift:

1.Quality of Service: Frequency, reliability, and coverage of PT services.

2.Integration: Seamless integration between different modes (e.g., bus, tram, metro, bike-sharing).

3.Accessibility: Proximity to PT stops and stations.

4.Affordability: Cost of PT compared to private vehicle use.

5.Urban Density: Higher density often supports higher PT usage.

6.Policy Measures: Restrictions on car use, parking policies, and incentives for using PT.

7.Cultural Factors: Public attitudes towards PT and car usage.

The actual mode shift will depend on the specific context and effectiveness of the improvements made.

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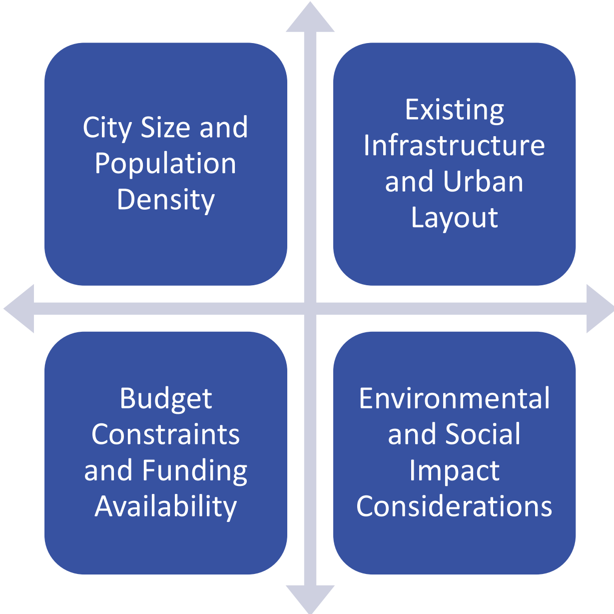
IMPORTANCE OF SELECTING APPROPRIATE PT MEASURES WITHIN SUMP FRAMEWORK

- PT – huge menu of possible measures to select
- Key: select those that contribute most to SUMP objectives
- Existing PT system, and factors on right, influence choice
- Big investments (e.g. new metro, new tram) may not have most effect



•The choice of PT measures is crucial for achieving the goals set out in the SUMP. These measures must be tailored to the specific needs and conditions of the city.

•Appropriate PT measures can significantly impact the city's traffic congestion, air quality, energy consumption, and overall quality of life.

•Selecting the right PT measures helps in maximizing resource efficiency, ensuring cost-effectiveness, and achieving long-term sustainability goals.

•It is essential to align PT measures with broader urban planning and policy objectives to create a cohesive and integrated transport network.

Objectives of the Section: To Understand PT Measures, Their Costs, and Suitability for Different City Sizes

•**Understanding PT Measures:** Gain insights into various public transport options such as buses, trams, metros, bike-sharing systems, and how they function.

•**Assessing Costs:** Learn about the financial aspects, including capital and operational costs associated with different PT measures.

•**Evaluating Suitability:** Analyze which PT measures are best suited for different city sizes and contexts, considering factors like population density, existing infrastructure, and budget constraints.

•**Integration with SUMP:** Explore how these PT measures can be effectively integrated within the SUMP to achieve sustainable urban mobility goals.

INTERACTIVE EXERCISE

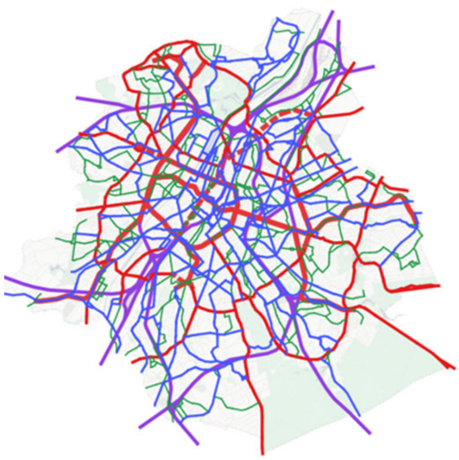
Most benefits of PT in SUMP only happen if people transfer from car to PT.

This exercise is about the measures (changes in PT) that will do this. Work in groups of 3, for 10 minutes. Be prepared to report back on your brief thoughts on the following questions:

1) What are the four main key characteristics of local and regional public transport that determine whether or not it is an attractive alternative to car (e.g. price)?
2) For each characteristic, think of **two** possible measures that could be used to improve an existing **bus service** in terms of that characteristic.
3) How could other parts of the transport system – **but not public transport itself, directly** - be changed to improve the **relative** attractiveness of public transport?

PLANNING PT TO GET INCREASED RIDERSHIP AND MODE SHIFT

Brussels' Public Transport



- PLUS
- CONFORT
- QUARTIER (= District)
- PLUS (Railway)

Source: Good Move Plan, Brussels - https://mobilite-mobiliteit.brussels/en/good-move

- PT provides network – even in small towns
- To increase ridership and get mode shift from car, network must offer:
  - Speed
  - Frequency
  - Reliability
  - Service to main destinations
  - Attractive fares
  - Legible, easy to use
- How then to decide how and where to improve this offer?

Need to break this down into the characteristics that really influence PT ridership, and then to decide about where to focus investment (and increased operational and/or fares subsidy) to improve these characteristics. Key point: these improvements can always be brought about to an extent with a bus network; BRT and rail may only be required only when demand goes beyond a level that can be served reliably by bus running on conventional roads, and in cities under a certain size, metro and tram are unlikely to be cost-effective.

The Brussels map shows the hierarchical way in which its network has been planned: plus routes link key destinations at high frequencies and as they carry the most passengers are often the routes where (a) improvements bring the most benefits and (b) where investment to improve segregation and speed (so BRT and/or conversion to rail-based modes, with priority) are most likely to be justified. (Source of graphic: https://mobilite-mobiliteit.brussels/en/good-move).

How to identify and plan the network:

1) Work out where key trip generators are e.g. hospitals, shopping and employment centres, high density residential areas, city centre and district centres, airports, main rail stations. They need to be linked by direct high capacity routes (but direct may include interchange – see later slides).
2) Consider on which corridors PT demand is already high – where are the highest frequencies at present? But also, which corridors that maybe have little PT service at present have very high demand for car travel? If there are major concentrated trip generators on those corridors (as opposed to llots of dispersed trip generators feeding demand onto one major road) it may be viable to offer public transport on

this corridor.

3) Focus improvements on improved capacity (frequency, speed and pax/hour) on these key corridors.

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Building or improving a network – key policy choice – coverage or ridership (often controversial)

Source: Walker (2012) Human transit

Ridership diagram – higher frequencies on core routes. Coverage diagram – low frequencies on lots of routes

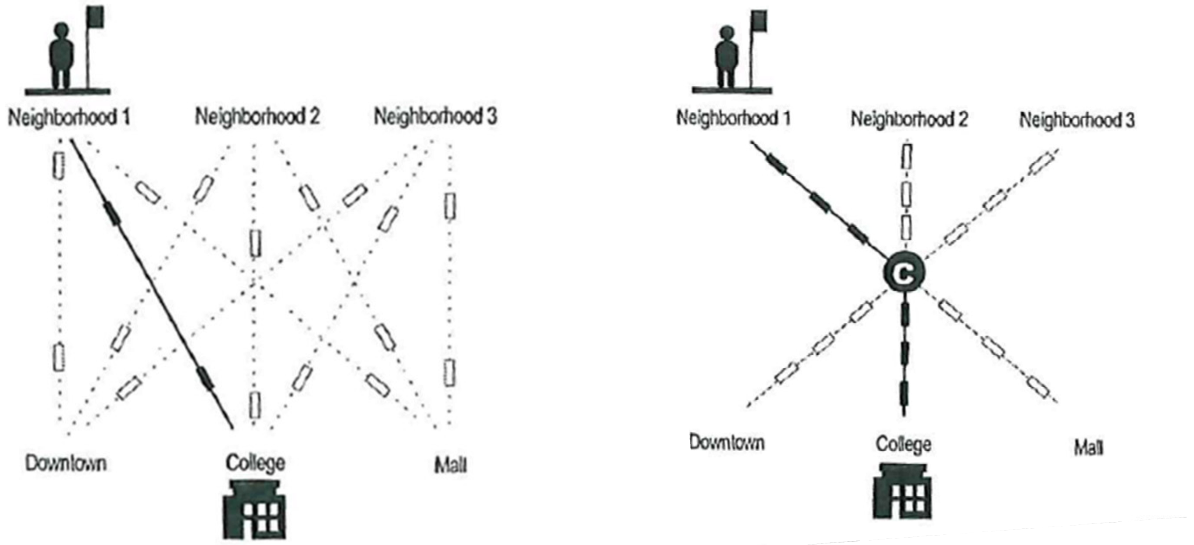
Ridership result of fares +travel time costs + waiting time costs + feeder time costs (e.g. walking to stop)

This slide shows a key network design consideration: should the network seek to maximise coverage in terms of the maximum number of people (or destinations) having some sort of PT service nearby; or should it maximise coverage by ensuring that the majority of people have an attractive (fast, high frequency) service, but that some people are left with little or no service? With a given resource (in this case, 12 buses per hour), the two diagrams show the two alternatives – a few high frequency routes going through the areas where most people live and work; or many low frequency routes, trying to make sure that everyone is served.

Can ask participants – on which network are *fares +travel time costs + waiting time costs + feeder time costs (e.g. walking to stop)* lower and why? Answer – on coverage network, because waiting times and travel times for majority of people will be longer.

Key point: networks that have achieved ridership growth and mode shift have focused on the first option, particularly for their core networks – and this means that some destinations and areas of the city do not have a core high frequency service. Low frequency and demand responsive services can be used to fill in the gaps. Clear identification of core routes also allows clearer view of where to invest in bus priority, higher frequencies, BRT and rail-based solutions also – on some of these routes.

BUILDING OR IMPROVING A NETWORK – DIRECT OR CONNECTING SERVICES?



Source: Good Move Plan, Brussels - https://mobilite-mobiliteit.brussels/en/good-move

In the lefthand example, a bus is offered between each of the 3 neighbourhoods (at top) and each destination (at bottom); but in the second, only between a neighbourhood and one destination. To reach another destination, it's necessary to change at C. However, with a given level of resources (buses and drivers), someone in Neighbourhood 1 will have a more frequent service to all destinations in the righthand case than in the lefthand case, although they will have to change services at C to get to 2 of the 3 destinations. This case also makes it easier to get to other neighbourhoods. In smaller cities "C" is often the city centre. This arrangement also makes it easier to identify and then focus improvements on routes that need more capacity and speed. Through ticketing is essential in this situation.

NETWORK DESIGN AND SPATIAL PLANNING

- Straight direct routes are faster and more competitive with car

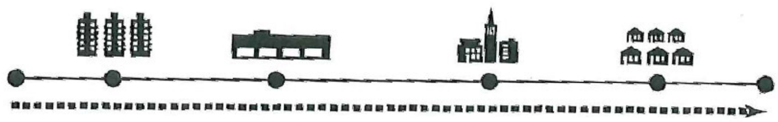


Figure 14-1a Ideal geometry for transit. *Credit:* Alfred Twu

- Straight direct routes only possible if spatial planning supports PT

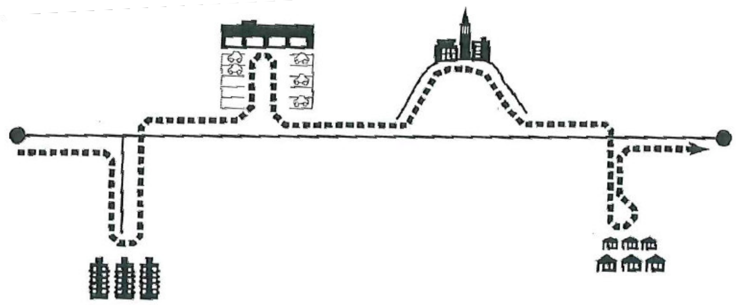


Figure 14-1b Terrible geometry for transit. *Credit:* Alfred Twu

Source: Walker (2012) Human transit

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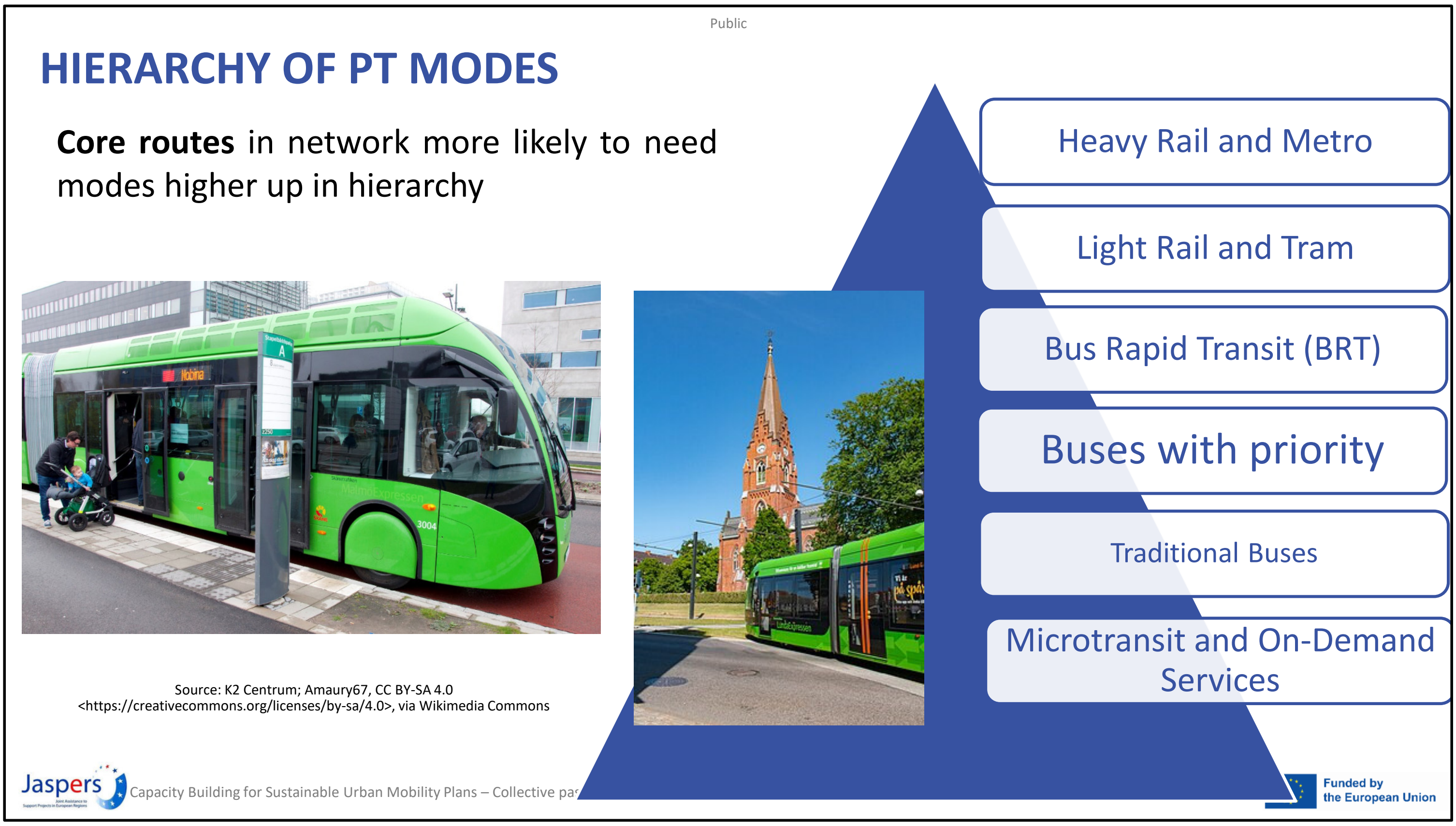

Developing a systematic approach to PT systems involves understanding the hierarchy of PT modes and planning them as a cohesive network and system. This approach ensures efficient, accessible, and integrated PT solutions that meet the diverse needs of urban populations.

Hierarchy of PT Modes

1.Heavy Rail and Metro:

1. **Characteristics:** High capacity, high speed, and extensive coverage, suitable for long-distance travel and high-density urban areas.
2. **Role:** Backbone of the PT system, serving major corridors and connecting key urban centers and suburbs.
3. **Planning Considerations:** Requires significant infrastructure investment, long planning and construction times, and high operational costs.

2.Light Rail and Tram:

1. **Characteristics:** Medium capacity, medium speed, and moderate coverage, suitable for medium-distance travel and medium-density areas.
2. **Role:** Serves as an intermediate mode, connecting with heavy rail and metro at transfer points and providing coverage in areas not served by high-capacity modes.
3. **Planning Considerations:** Lower cost and shorter construction times than heavy rail, flexibility in routing, and integration with urban streetscapes.

3. **Bus Rapid Transit (BRT):**
    1. **Characteristics:** High capacity, high speed, and flexible coverage, suitable for medium to long-distance travel in urban and suburban areas.
    2. **Role:** Provides rapid transit service on dedicated lanes, bridging the gap between traditional bus services and rail-based systems.
    3. **Planning Considerations:** Moderate infrastructure investment, relatively quick implementation, and adaptable to existing road networks.

4.Traditional Buses:

1. **Characteristics:** Low to medium capacity, variable speed, and extensive coverage, suitable for short to medium-distance travel and lower-density areas.
2. **Role:** Forms the backbone of local transit, providing feeder services to higher-capacity modes and extensive coverage within neighborhoods.
3. **Planning Considerations:** Low infrastructure cost, high operational flexibility, and ease of route adjustment based on demand.

5.Microtransit and On-Demand Services:

1. **Characteristics:** Low capacity, flexible routing, and extensive coverage, suitable for last-mile connections and low-density areas.
2. **Role:** Complements fixed-route services by providing first-mile/last-mile connectivity and serving areas with low demand.
3. **Planning Considerations:** Requires integration with existing PT systems, demand-responsive technology, and coordination with other modes.

Here's how to approach it:

1.Network Design: Design the public transport network as a cohesive system that serves various origins and destinations within the urban area. This includes planning for multiple modes of transport such as buses, trams, metro/subway, ferries, and commuter rail, and ensuring they complement each other to provide seamless connectivity.

2.Integration: Ensure integration between different modes of transport to facilitate convenient transfers for passengers. This may involve designing interchanges and transfer points that are well-connected and easy to navigate, as well as implementing integrated ticketing systems to simplify fare payment across modes.

3.Coverage: Aim for comprehensive coverage of the urban area by the public transport network, ensuring that all neighborhoods, employment centers, educational institutions, healthcare facilities, and recreational areas are adequately served. Consider factors such as population density, land use patterns, and travel demand when determining service coverage.

4.Frequency and Connectivity: Plan for frequent and reliable service frequencies to minimize waiting times and provide passengers with convenient travel options. Ensure that routes are designed to provide connectivity between different parts of the city, allowing passengers to reach their destinations efficiently with minimal transfers.

5.Accessibility: Prioritize accessibility for all passengers, including those with disabilities, seniors, and individuals with limited mobility. Design stations, stops, and vehicles with features such as ramps, elevators, priority seating, and tactile paving to ensure that public transport is accessible to everyone.

6. **Demand-Responsive Services**: Consider implementing demand-responsive services such as flexible routing, on-demand shuttles, or microtransit to complement fixed-route services and provide coverage in areas with low demand or limited accessibility.

7.Environmental Sustainability: Integrate principles of environmental sustainability into public transport planning by prioritizing modes of transport that are energy-efficient, low-emission, and environmentally friendly. This may include promoting walking, cycling, and electric-powered vehicles, as well as investing in infrastructure that supports sustainable transport modes.

8.Data and Technology: Utilize data analytics, modeling tools, and emerging technologies to inform network planning, optimize route design, and improve service efficiency. Collect data on travel patterns, passenger demand, and performance metrics to identify areas for improvement and make informed decisions about network optimization.

By adopting a whole-network approach to public transport planning, cities can create integrated, efficient, and sustainable transportation systems that meet the diverse needs of their residents and contribute to the overall livability and accessibility of the urban environment.

A hierarchical PT network structure ensures efficient service delivery by categorizing routes based on demand and connectivity needs. This approach helps cities optimize the overall PT system within the SUMP framework.

High-Demand Corridors

Metro Systems:

•**Function**: Serve the most heavily-used corridors with high-capacity metro lines, providing rapid and frequent service.

•**Example**: **London, UK**

- **Details**: The London Underground efficiently serves the busiest corridors across the city, offering high-frequency services that reduce congestion and travel times.
- **Impact**: As a backbone of London's PT network, the Underground supports millions of daily journeys and connects key areas of the city.

Secondary High-Demand Corridors

Frequent Buses:

•**Function**: Use high-frequency bus services on secondary, yet high-demand routes to ensure reliable and convenient travel options.

•**Example**: **Dublin, Ireland**

- **Details**: Dublin's frequent bus network complements its light rail (Luas) and commuter rail (DART) services, efficiently covering secondary corridors.
- **Impact**: This integration provides comprehensive coverage and supports high ridership on busy routes.

Low-Frequency and Demand-Responsive Transport (DRT)

Flexible Services:

•**Function**: Implement low-frequency buses and DRT services in less populated or lower-demand areas to ensure adequate coverage.

•**Example**: **Helsinki, Finland**

- **Details**: Helsinki offers DRT services in suburban areas, providing flexible routing and on-demand shuttles to complement fixed-route services.
- **Impact**: These services enhance coverage and accessibility, especially in areas where regular bus services are not viable.

Identifying High-Demand Corridors and Trip Generators

Data Collection:

•**Methods**: Use travel surveys, ticketing data, and GPS tracking to gather comprehensive data on travel patterns and passenger volumes.

•**Tools**: Advanced data analytics platforms and transport modeling tools.

Analysis:

•**Evaluation**: Assess travel patterns, peak travel times, and passenger volumes to identify high-demand corridors and major trip generators.

•**Outcome**: Determine where PT services are most needed and plan routes accordingly.

Taking a whole-network approach to PT planning involves considering the entire transportation system as an interconnected network rather than focusing solely on individual routes or modes. In the context of a SUMP, network planning typically builds on existing infrastructure, aiming to enhance Level of Service (LoS) and network coverage through specific improvements based on a thorough evaluation process.

Key Components of a Whole-Network Approach

Network Design:

•**Objective**: Design the PT network as a cohesive system serving various origins and destinations within the urban area. This includes planning for multiple modes of transport such as buses, trams, metro/subway, ferries, and commuter rail, ensuring they complement each other for seamless connectivity.

•**Example**: **Berlin, Germany**: Integrates metro (U-Bahn), suburban trains (S-Bahn), trams, buses, and ferries to provide extensive coverage and seamless transfers.

Integration:

•**Objective**: Ensure integration between different modes of transport to facilitate convenient transfers for passengers. This includes designing well-connected interchanges and implementing integrated ticketing systems to simplify fare payment across modes.

•**Example**: **Paris, France**: The RATP and SNCF networks offer integrated ticketing and coordinated schedules between metro, RER trains, trams, and buses.

Coverage:

•**Objective**: Achieve comprehensive coverage of the urban area, ensuring that all neighborhoods, employment centers, educational institutions, healthcare facilities, and recreational areas are served. Consider factors like population density, land use patterns, and travel demand.

•**Example**: **Vienna, Austria**: Provides extensive coverage through a well-connected network of U-Bahn, trams, and buses, reaching all parts of the city.

Frequency and Connectivity:

•**Objective**: Plan for frequent and reliable service frequencies to minimize waiting times and offer convenient travel options. Ensure routes are designed to provide connectivity between different parts of the city with minimal transfers.

•**Example**: **Zurich, Switzerland**: Known for high-frequency services across trams, buses, and trains, ensuring minimal waiting times and efficient connectivity.

Accessibility:

•**Objective**: Prioritize accessibility for all passengers, including those with disabilities, seniors, and individuals with limited mobility. Design stations, stops, and vehicles with features like ramps, elevators, priority seating, and tactile paving.

•**Example**: **Stockholm, Sweden**: Incorporates accessible design features across its metro, bus, and tram systems to ensure inclusivity.

Demand-Responsive Services:

•**Objective**: Implement demand-responsive services such as flexible routing, on-demand shuttles, or microtransit to complement fixed-route services, especially in areas with low demand or limited accessibility.

•**Example**: **Barcelona, Spain**: Offers on-demand shuttles and flexible bus routes in less densely populated areas, enhancing coverage.

Environmental Sustainability:

•**Objective**: Integrate principles of environmental sustainability by prioritizing energy-efficient, low-emission transport modes and promoting walking, cycling, and electric-powered vehicles.

•**Example**: **Copenhagen, Denmark**: Invests in electric buses and infrastructure supporting cycling and walking to reduce emissions and improve air quality.

Data and Technology:

•**Objective**: Utilize data analytics, modeling tools, and emerging technologies for network planning, route optimization, and service efficiency improvements.

•**Example**: **Helsinki, Finland**: Uses the HELMI system with GPS and AVL data to optimize bus and tram routes, enhancing service reliability.

Balancing Directness of Route and Coverage

Directness of Route:

•**Advantages**:

- **Reduced Travel Time**: Minimizes travel time by reducing stops and transfers.
    - **Example**: **London Underground**: High-capacity metro lines offer rapid and frequent services, significantly reducing travel times.
- **Increased Attractiveness**: Direct routes are more likely to be chosen by

passengers for their convenience and speed.

    - **Example**: **Paris RER**: Provides direct connections between suburbs and central Paris, making it a preferred option for commuters.

- **Higher Frequency**: Supports higher service frequencies, enhancing reliability and reducing waiting times.

    - **Example**: **Dublin's Frequent Bus Network**: High-frequency services on direct routes improve reliability and convenience.

•**Disadvantages**:

- **Limited Coverage**: Direct routes may not serve all areas, leaving some neighborhoods underserved.

    - **Example**: Direct metro lines might not reach outlying suburbs, necessitating additional transport modes for complete coverage.

- **Underutilization of Resources**: Over-focus on direct routes can lead to overcrowding on some lines and underused services elsewhere.

Coverage:

•**Advantages**:

- **Comprehensive Accessibility**: Ensures all neighborhoods, including those with lower population density, have access to PT.

    - **Example**: **Vienna's Public Transport Network**: Ensures comprehensive coverage, including suburban and less densely populated areas.

- **Equity and Social Inclusion**: A broad network makes essential services accessible to everyone.

    - **Example**: **Stockholm's Public Transport**: Prioritizes equitable access, ensuring all areas are well-served.

•**Disadvantages**:

- **Increased Travel Time**: Extensive coverage can lead to longer travel times due to more stops and transfers.

    - **Example**: Bus routes covering many neighborhoods may take longer to reach their final destination compared to direct routes.

- **Operational Challenges**: Maintaining a wide network can be more costly and operationally challenging, especially in less populated areas.

    - **Example**: Low-demand routes might require subsidies or demand-responsive transport solutions to remain viable.

Interchange-Based Systems vs. Direct Route Systems

Interchange-Based Systems:

•**Definition**: Relies on transfer points where passengers switch between different routes or modes, emphasizing connectivity and network coverage.

•**Characteristics**:

- **Multiple Modes**: Combines buses, trams, metros, and trains for smooth transitions.

    - **Example**: **Zurich, Switzerland**: Features numerous interchanges for easy transfers between trams, buses, and trains.

- **Extensive Reach**: Ensures comprehensive coverage by connecting remote areas to central hubs.
    - **Example**: **Berlin, Germany**: S-Bahn and U-Bahn systems provide extensive coverage through interchanges.
- **Flexibility**: Adapts to changing travel patterns and demands.
    - **Example**: **Paris, France**: RER and metro systems with numerous interchanges allow flexible routing options.
- **Passenger Experience**: May require inconvenient transfers if facilities are not well-designed.
    - **Example**: **London, UK**: Transfers at busy interchanges like King's Cross can cause delays and overcrowding.
- **Operational Efficiency**: More cost-effective by spreading demand across the network.
    - **Example**: **Helsinki, Finland**: Distributes passenger load through well-placed interchanges.

Direct Route Systems:

•**Definition**: Focuses on uninterrupted, point-to-point services, minimizing the need for transfers.

•**Characteristics**:

- **Single Mode Dominance**: Often relies on a single mode for direct routes.
    - **Example**: **New York City Subway**: Subway lines run from one part of the city to another without requiring transfers.
- **Limited Coverage**: Used in high-demand corridors, potentially leaving some areas underserved.
    - **Example**: **London, UK**: Elizabeth Line (Crossrail) offers direct routes through central London, primarily serving high-demand areas.
- **Speed and Efficiency**: Provides faster travel times by eliminating transfers.
    - **Example**: **Hong Kong MTR**: Direct routes like the Airport Express offer rapid travel without intermediate stops.
- **Passenger Experience**: Highly convenient for passengers traveling along the route.
    - **Example**: **Tokyo Metro**: Direct routes reduce the need for transfers, providing a seamless travel experience.
- **Operational Challenges**: Can lead to overcrowding on direct routes during peak times.
    - **Example**: **Mexico City Metro**: Direct routes often face severe overcrowding, especially during rush hours.

Key Differences and Trade-Offs

1.Connectivity vs. Directness:

1. **Interchange-Based**: Prioritizes connectivity and coverage, making it possible to reach more destinations within the network. However, it may require multiple transfers.
2. **Direct Route**: Focuses on direct travel between major points, reducing travel time but potentially neglecting broader coverage.

2.Passenger Convenience:

1. **Interchange-Based**: Can be less convenient due to the need for transfers, which can be time-consuming and potentially confusing.
2. **Direct Route**: More convenient for passengers traveling along the route, offering a simpler and faster journey without transfers.

3.Infrastructure and Operational Costs:

1. **Interchange-Based**: Generally more cost-effective, as it utilizes existing infrastructure more efficiently and spreads out passenger demand.
2. **Direct Route**: May require significant investment in infrastructure to handle high demand on specific routes and maintain service quality.

4.Flexibility and Scalability:

1. **Interchange-Based**: Highly flexible and scalable, allowing for easy adjustments and expansions to meet changing travel patterns.
2. **Direct Route**: Less flexible, as adding or changing direct routes can be more complex and costly.

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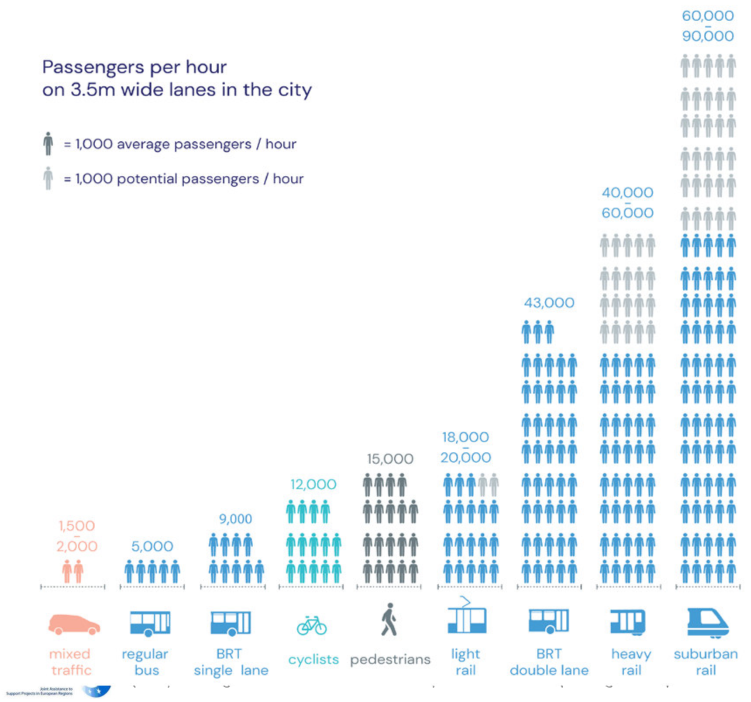
PASSENGER CAPACITY OF DIFFERENT TRANSPORT MODES



- Higher capacity modes – higher investment cost, lower operation cost per passenger
- Modes with segregation offer greater reliability
- Rail does not necessarily mean greater segregation – trams can get stuck in traffic too

Source: TUMI – Transformative mobility

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Funded by the European Union

The infographic compares passenger capacity of different modes of transport in terms of passengers per hour on a 3.5 m wide lane.

1.Metro/Subway/Underground: Metro systems typically have high passenger capacities due to their frequent service and high-capacity trains. Depending on the configuration of the train and the length of the platforms, metro systems can accommodate thousands of passengers per hour per direction (PPHPD). For example, larger metro systems in major cities can handle up to 50,000 PPHPD or more during peak hours.

2.Tram/Light Rail: Trams and light rail systems have moderate to high passenger capacities, depending on factors such as the size of the vehicles, frequency of service, and alignment of the tracks. Trams can typically accommodate hundreds of passengers per vehicle, and systems with high-frequency service can handle several thousand PPHPD.

3.Bus Rapid Transit (BRT): BRT systems have variable passenger capacities depending on factors such as the size of the buses, frequency of service, and dedicated infrastructure (such as bus lanes and stations). BRT systems can typically handle several thousand PPHPD, with larger systems in densely populated cities accommodating tens of thousands of passengers per hour.

4.Commuter/Regional Rail: Commuter and regional rail systems have high passenger capacities, especially on longer-distance routes between urban centers and their suburbs. These systems typically use high-capacity trains and can accommodate tens of thousands of passengers per hour during peak periods.

5.Heavy Rail (e.g., Intercity Trains): Heavy rail systems, such as intercity trains, have very high passenger capacities, especially on high-speed lines between major cities. These trains can accommodate hundreds to thousands of passengers per train, and high-speed lines can handle tens of thousands of passengers per hour.

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PT INVESTMENT COSTS – improve existing system – those in red have most impact on ridership

Operational Efficiency Improvement	Indicative Cost	Example City
Schedule Optimization and Real-Time Monitoring	€100,000 - €500,000	Helsinki, Finland
Energy-Efficient Vehicles and Technologies	€300,000 - €800,000 per vehicle	Copenhagen, Denmark
Fare Collection System Upgrades (speed up boarding)	€200,000 - €1 million	London, UK
Driver Training and Performance Monitoring	€50,000 - €200,000 annually	Berlin, Germany
Route Optimization and Service Planning	€100,000 - €400,000	Zurich, Switzerland
Infrastructure Upgrades for Speed and Efficiency	€1 - €5 million per km	Paris, France
Passenger Information Systems	€100,000 - €500,000	Amsterdam, Netherlands

Jaspers Capacity Building for Sustainable Urban Mobility Plans – Collective passenger transport

Source: Introducing a Novel Framework for the Analysis and Assessment of Transport Projects in City Regions (2024)

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Schedule Optimization and Real-Time Monitoring

•**Cost**: €100,000 - €500,000

•**Description**: Implementing advanced scheduling software to optimize vehicle dispatch and reduce wait times.

•**When and Why:**

- Suitable for all city sizes to improve punctuality and reduce wait times.
- Real-time monitoring allows for dynamic adjustments to schedules, enhancing service reliability.
- Suitable for all city sizes.

•**Examples**:

- Helsinki: Utilizing real-time data to adjust schedules dynamically.
- Barcelona: Automated systems for better alignment with passenger demand.

Energy-Efficient Vehicles and Technologies

•**Cost**: €300,000 - €800,000 per vehicle

•**Description**: Procuring and deploying hybrid/electric buses and other energy-efficient vehicles.

•**When and Why:**

- Ideal for cities aiming to reduce operational costs and environmental impact.
- Implementing energy-efficient vehicles like electric buses can lead to long-

term savings and sustainability.

- Suitable for cities with environmental sustainability goals and available infrastructure for alternative energy sources.

•**Examples**:

- Copenhagen: Introduction of electric buses to reduce emissions.
- Oslo: Hybrid buses with regenerative braking systems.

Fare Collection System Upgrades

•**Cost**: €200,000 - €1,000,000

•**Description**: Upgrading to contactless and mobile payment systems for faster and more convenient fare collection.

•**When and Why:**

- Useful for improving revenue collection efficiency and reducing fare evasion.
- Modern systems like contactless payments enhance user convenience and streamline operations.
- Suitable for all city sizes, particularly those with high ridership and fare evasion issues.

•**Examples**:

- London: Oyster card system and contactless payments.
- Stockholm: Mobile ticketing and NFC-enabled fare gates.

Driver Training and Performance Monitoring

•**Cost**: €50,000 - €200,000 annually

•**Description**: Continuous training programs and performance monitoring systems using telematics.

•**When and Why:**

- Essential for ensuring safety and improving service quality.
- Regular training and monitoring can lead to more efficient driving practices and better customer service.
- Essential for all city sizes.

•**Examples**:

- Berlin: Telematics systems to monitor driving behavior and optimize fuel usage.
- Zurich: Regular training sessions focusing on safety and efficiency.

Route Optimization and Service Planning

•**Cost**: €100,000 - €400,000

•**Description**: Utilizing advanced analytics and planning tools to optimize routes and service frequency.

•**When and Why:**

- Critical for maximizing coverage and minimizing operational costs.
- Data-driven route planning can adapt to changing demand patterns, ensuring efficient use of resources.
- Suitable for all city sizes.

•**Examples**:

- Zurich: Data-driven route planning to improve coverage and reduce travel times.
- Milan: Dynamic routing based on passenger demand patterns.

Infrastructure Upgrades for Speed and Efficiency

•**Cost**: €1,000,000 - €5,000,000 per km

•**Description**: Developing dedicated lanes, signal priority systems, and other infrastructure enhancements.

•**When and Why:**

- Necessary for reducing travel times and enhancing service reliability.
- Upgrades like dedicated bus lanes and priority signaling can significantly improve PT efficiency.
- Particularly beneficial for medium to large cities with congestion issues.

•**Examples**:

- Paris: Bus lanes and signal priority systems for faster transit times.
- Amsterdam: Dedicated tram tracks and upgraded signaling for improved efficiency.

Passenger Information Systems

•**Cost**: €100,000 - €500,000

•**Description**: Implementing real-time digital displays, mobile apps, and backend systems for better passenger information.

•**When and Why:**

- Improves user experience by providing real-time information on schedules, delays, and routes.
- Encourages public transport use by making it easier to navigate the system.
- Suitable for all city sizes, especially those looking to increase ridership.

•**Examples**:

- Amsterdam: Real-time display screens at bus and tram stops.
- Vienna: Mobile app providing real-time updates and journey planning.

•**Schedule Optimization and Real-Time Monitoring**: Costs vary based on the complexity of the system and the size of the network.

•**Energy-Efficient Vehicles and Technologies**: High upfront costs for procurement and potential subsidies.

•**Fare Collection System Upgrades**: Depends on the extent of system overhaul and technology used.

•**Driver Training and Performance Monitoring**: Ongoing costs for continuous improvement and monitoring.

•**Route Optimization and Service Planning**: One-time setup cost with ongoing updates and refinements.

•**Infrastructure Upgrades for Speed and Efficiency**: Significant investment in physical infrastructure.

•**Passenger Information Systems**: Includes both hardware (displays) and software (apps, backend systems).

These costs are indicative and can vary significantly based on local conditions, existing infrastructure, and specific project requirements.

Source: Introducing a Novel Framework for the Analysis and Assessment of Transport Projects in City Regions (2024)

Cost-Benefit Evaluation Tools on the Impacts of Transport Infrastructure Projects on Urban Form and Development

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PT VEHICLE IMPROVEMENT COSTS

Vehicle Improvement	Indicative Cost per Vehicle (€)	Example City
Decarbonisation (Electric Buses)	€300,000 - €800,000	Copenhagen, Denmark
Comfort Improvements	€20,000 - €50,000	Vienna, Austria
Euro Standard Compliance	€15,000 - €100,000	Berlin, Germany

Source: Introducing a Novel Framework for the Analysis and Assessment of Transport Projects in City Regions (2024)

Impact on environmental objectives and compliance; little direct impact on passenger numbers or mode shift

Decarbonisation (Electric Buses)

•**Cost**: €300,000 - €800,000 per bus

•**Description**: Replacing diesel buses with electric buses to reduce emissions and improve air quality.

•**When and Why:**

- Cities aiming to reduce their carbon footprint and improve air quality should consider transitioning to electric buses.
- Electric buses produce zero tailpipe emissions, reducing urban air pollution and greenhouse gas emissions. They also have lower operational and maintenance costs over their lifetime compared to diesel buses.
- Best for cities with environmental sustainability goals and available infrastructure for electric vehicle charging.

•**Examples**:

- **Copenhagen**:
  - **Project**: Introduction of electric buses on routes 2A and 18.
  - **Impact**: Reduced CO_2 emissions by 4,300 tons per year.
  - **Details**: Copenhagen aims to replace all diesel buses with electric buses by 2025 to achieve zero emissions.
- **London**:
  - **Project**: Deployment of electric buses in the central bus fleet.

- **Impact**: Significant reduction in pollution and operational costs.

Comfort Improvements

•**Cost**: €20,000 - €50,000 per vehicle

•**Description**: Upgrading seats, lighting, and interior design to enhance passenger comfort.

•**When and Why:**

- Continuous improvement is essential in cities where public transport usage is high or targeted for growth.
- Enhancing comfort in public transport vehicles can significantly improve user satisfaction and increase ridership. Measures may include ergonomic seating, climate control, noise reduction, and smoother ride quality.
- Relevant for all cities, particularly those looking to attract more riders and improve public perception of public transport.

•**Examples**:

- **Vienna**:
  - **Project**: Upgraded trams with ergonomic seating and improved lighting.
  - **Impact**: Increased passenger satisfaction and ridership.
- **Berlin**:
  - **Project**: Enhanced interior of U-Bahn trains with modern seating and better lighting.
  - **Impact**: Improved travel experience and increased usage.

Euro Standard Compliance

•**Cost**: €15,000 - €100,000 per vehicle

•**Description**: Upgrading engines and exhaust systems to meet Euro emission standards.

•**When and Why:**

- Applicable to European cities or regions adopting stringent emission standards. Typically implemented during vehicle procurement or retrofitting phases.
- Compliance with Euro standards (Euro VI, V, etc.) ensures that vehicles meet strict emissions regulations, reducing pollutants such as NOx and particulates, contributing to better air quality.
- Essential for European cities; applicable worldwide where similar standards are adopted.

•**Examples**:

- **Berlin**:
  - **Project**: Retrofitting buses to comply with Euro VI emission standards.

    - **Impact**: Reduction in harmful emissions and improved air quality.
- **Paris**:
    - **Project**: Upgrading the city's bus fleet to meet the latest Euro emission standards.
    - **Impact**: Significant decrease in NOx and particulate matter emissions.

These indicative costs provide a broad overview of the financial implications associated with each type of vehicle improvement, along with specific examples from different European cities.

•**Decarbonisation (Electric Buses)**: The costs include the price of electric buses and the necessary charging infrastructure. These investments lead to long-term savings and environmental benefits.

•**Comfort Improvements**: Enhancements such as ergonomic seating and improved lighting can attract more users and increase customer satisfaction.

•**Euro Standard Compliance**: Costs vary depending on the vehicle's age and the specific requirements to meet Euro emission standards. This involves retrofitting or upgrading vehicle engines and exhaust systems.

Source: Introducing a Novel Framework for the Analysis and Assessment of Transport Projects in City Regions

Cost-Benefit Evaluation Tools on the Impacts of Transport Infrastructure Projects on Urban Form and Development

https://www.just-auto.com/news/denmark-byd-to-provide-e-buses-for-public-transit-in-copenhagen/

https://www.publicpower.org/periodical/article/electric-buses-mass-transit-seen-cost-effective

PT INFRASTRUCTURE COSTS PER KM – New lines

PT Mode	Indicative Infrastructure Cost (€/km)	Example City	Example Cost (€/km)
Metro Systems	€50 - €300 million	Copenhagen, Denmark	€300 million
Light Rail/Tram Systems	€10 - €40 million	Strasbourg, France	€25 million
Bus Rapid Transit (BRT)	€1 - €10 million	Nantes, France	€10 million
Regional/Commuter Rail	€5 - €20 million	Paris, France (RER)	€15 million

Source: Introducing a Novel Framework for the Analysis and Assessment of Transport Projects in City Regions (2024)

Cost justified where demand sufficient. Light rail/tram must be protected from other traffic to realise benefits

Metro Systems

•**City**: Copenhagen, Denmark (Copenhagen Metro)

- **Infrastructure Cost**: Approximately €300 million per km
- **Details**: The Cityringen (Circle Line) project cost around €3 billion for 15.5 km, illustrating the high costs associated with underground metro systems in urban areas
- **When and Why:** Suitable for large cities with very high passenger volumes and severe congestion issues. Offers the highest capacity and frequency, ideal for major urban centers.

Light Rail/Tram Systems

•**City**: Strasbourg, France

- **Infrastructure Cost**: Approximately €25 million per km
- **Details**: Strasbourg's tram network, one of the most extensive in Europe, has seen expansion costs averaging around €25 million per km for new lines.
- **When and Why:** Best for medium to large cities with high passenger demand and existing urban infrastructure. Provides a reliable and comfortable transit option with moderate to high capacity.

Bus Rapid Transit (BRT) Systems

•**City**: Nantes, France

- **Infrastructure Cost**: Approximately €10 million per km

- **Details**: The Busway in Nantes, a BRT system, had infrastructure costs around €10 million per km, including dedicated lanes and modern stations.

Regional/Commuter Rail

•**Example**:

- **City**: Paris, France (RER)
- **Infrastructure Cost**: Approximately €15 million per km
- **When and Why:** Suitable for medium to large cities with significant traffic congestion. Provides high-capacity transit on dedicated lanes, improving travel times and reducing congestion.

Factors Influencing Costs:

1.Local Conditions: Geographic and geological conditions can significantly impact costs, especially for underground metro systems.

2.Land Acquisition: The cost of acquiring land for new routes can be substantial in urban areas.

3.Technology and Standards: Higher technology standards (e.g., automated metro systems) and stringent safety requirements can increase costs.

4.Project Scale: Larger projects may benefit from economies of scale, reducing per kilometer costs.

5.Regulatory Environment: Stringent regulatory and environmental requirements can increase infrastructure costs.

6.Labor Costs: Higher labor costs in developed countries can lead to higher overall project costs.

Source: Comparison of Capital Costs per Route-Kilometre in Urban Rail

https://www.generalecostruzioniferroviarie.com/en/on-the-sites/cityringen-metro-copenaghen

https://www.urban-transport-magazine.com/en/a-tram-extension-in-strasbourg/

https://brtdata.org/location/europe/france/nantes

https://www.railway-technology.com/projects/reseau-express-regional-rer-france/#?cf-view

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IMPROVING A PT NETWORK – WHERE TO START?

- Consider SUMP objectives – what needs to be achieved? Often, mode shift from car; inclusion; cleaner vehicles.
- Analyse existing network: frequency, (relative) speed, reliability, crowdedness of routes, service to major trip generators, legibility, comfort, vehicle technology
- Focus improvements on busiest routes/corridors
- Generate and compare options to improve speed, frequency reliability, and capacity (e.g. tram? BRT? Monorail?)
- Consider routes if major trip generators unserved
- New modes if capacity reached e.g. bus every 3 minutes on single route, all full – need for BRT or tram

Source: civitas.eu

Jaspers Capacity Building for Sustainable Urban Mobility Plans – Collective passenger transport 19 Funded by the European Union

These steps to evaluating possible improvements to a PT system are dealt with in much greater detail in Module 5.

A SUMP should evaluate (as part of diagnosis/analysis work under Phase 1) the suitability and effectiveness of the collective transport offer, including network, operations, organisational set up.

The analysis (informed by proper public and stakeholder feedback) is expected to identify main issues to tackle by the SUMP and this ought to be reflected properly in the diagnosis (e.g. SWOT) and the detailed SUMP objectives.

Collective transport and how to improve its overall role and performance (attractiveness, efficiency) will be key to the SUMP options analysis (scenario building and appraisal).

- The different SUMP alternative scenarios (options) should all aim at improving the public transport network (e.g. catchment, hierarchies, land use integration, etc.) and operations (offer, fleet, depots, energy), based on the findings of the analysis conducted.
- Regarding scenarios and collective (public) transport, aspects related to decarbonisation policies at EU and national level need to be attentively considered.
- The SUMP should investigate the opportunities and threats in relation to this process, evaluate and propose suitable way(s) forward.
- The importance of promoting shift to (attractive and efficient) public transport, rightly mentioned in the presentation, needs to be emphasised, since mere fleet renewal with zero emission

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INTEGRATED PT NETWORKS – EXAMPLE OF ZURICH

Integration of suburban rail, trams, buses, and ferries into seamless PT network

Investment:

- Early plans for metro – scrapped in favour of upgrading tram and rail
- Continuous investment in network (CHF 400 million annually)

Policy:

- Unified ticketing system and synchronized timetables for easy transfers
- Priority for public transport on-road
- Orienting land use to public transport corridors

Outcomes:

- High PT usage (40% of trips) and user satisfaction (90% of residents report satisfaction)

Source: Stadt Zuerich

Source: zuerich.com

Zurich, Switzerland

•**Measure**: Integration of trams, buses, trains, and ferries into a seamless public transport (PT) network.

•**Investment**: Continuous investment in maintaining and expanding the network, with an average annual investment of CHF 400 million.

•**Policy**: Implementation of a unified ticketing system and synchronized timetables to facilitate easy transfers between different modes of transport.

•**Outcomes**:

- **PT Usage**: Over 70% of Zurich's population use public transport regularly.
- **User Satisfaction**: 90% of residents report satisfaction with the reliability and efficiency of the public transport system.
- **Modal Split**: Public transport accounts for 40% of all trips within the city.
- **Reduction in Traffic Congestion**: Public transport usage has contributed to a 20% reduction in traffic congestion in the city center.
- **Economic Impact**: For every CHF 1 invested in public transport, Zurich sees a return of CHF 4 in economic benefits, including reduced healthcare costs and increased productivity.

APPRAISAL OF PT MEASURES

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COST-BENEFIT ANALYSIS (CBA)

Very simply:

- Put money value on benefits of investment
- Compare this value to investment cost
- Predict this for certain number of years in future
- If benefits predicted to > costs, go ahead
- But which costs, which benefits have money value?
- Main benefit is time saved by PT (disbenefit – time increase for cars?)
- Changes in operating and investment costs

Example of bus lane painted on road

- Investment cost €100 000
- Saves 1 minute per bus
- Multiply 1 minute by 500 000 total passengers/year – 8333 hours
- Value of time (Ireland) €6/hour
- Total benefit €50 000 year – exceeds costs after Year 2

Source: Google Maps

Example of Cost-Benefit Analysis (CBA) for a Bus Priority Lane:

1. Define the Framework for the Analysis:

•**Objective:** Evaluate the economic feasibility of implementing a bus priority lane.

•**Scope:** Consider all relevant costs and benefits over a defined time period.

•**Stakeholders:** Include perspectives from local government, transport authorities, commuters, and local businesses.

2. Identify and Classify Costs and Benefits:

•**Costs:**

- **Capital Costs:** Construction of the bus priority lane, including materials, labor, and any necessary infrastructure upgrades.
- **Operating Costs:** Additional bus services, driver salaries, and fuel or electricity.
- **Maintenance Costs:** Regular maintenance to ensure the lane remains in good condition.

•**Benefits:**

- **Travel Time Savings:** Reduced travel time for bus passengers.
- **Emission Reductions:** Decrease in emissions due to reduced congestion and increased bus ridership.
- **Accident Reductions:** Fewer traffic accidents due to improved traffic flow.
- **Economic Productivity Gains:** Increased productivity from time saved and

improved reliability of public transport.

3. Drawing a Timeline for Expected Costs and Revenue:

•**Timeline:** Create a timeline that outlines when costs will be incurred and when benefits are expected to be realized. This timeline helps in understanding the temporal distribution of costs and benefits.

•**Phases:** Divide the project into phases, such as planning, construction, operation, and maintenance.

4. Monetize Costs and Benefits:

•**Assign Monetary Values:** Convert all identified costs and benefits into monetary terms. Use existing data, market values, and standard valuation techniques to assign these values.

•**Units:** Ensure all costs and benefits are expressed in the same monetary units for consistency.

5. Discount Costs and Benefits to Obtain Present Values:

•**Discount Rate:** Apply a discount rate to account for the time value of money. This involves converting future costs and benefits into their present values.

•**Present Value Calculations:** Use standard discounting formulas to calculate the present value of each cost and benefit.

6. Calculate Net Present Values:

•**Net Present Value (NPV):** Subtract the total present value of costs from the total present value of benefits to obtain the NPV.

•**Interpretation:** A positive NPV indicates that the benefits outweigh the costs, making the project economically viable. A negative NPV suggests that the costs exceed the benefits.

•By following these steps, cities can systematically evaluate the financial viability of implementing a bus priority lane. The process ensures that the investment will yield positive net benefits and contribute to the overall improvement of the public transport system.

Public

MULTI-CRITERIA ANALYSIS (MCA)

Qualitative assessment of performance against selected criteria

Criteria	Weight	LRT Score (1-10)	LRT Weighted Score	Electric Bus Score (1-10)	Electric Bus Weighted Score
Performance against SUMP objectives	30%	5	1.5	8	2.4
Cost	20%	8	1.6	7	1.4
Feasibility	20%	6	1.2	9	1.8
Stakeholder Preferences	30%	7	2.1	6	1.8
Total Score	**100%**	**6.4**		**7.4**	

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Appraisal Methods with Limited Data:

•Multi-Criteria Analysis (MCA): MCA allows decision-makers to assess and compare PT measures based on multiple criteria, such as cost-effectiveness, environmental impact, social equity, and accessibility. Even with limited data, MCA can provide valuable insights by considering a range of qualitative and quantitative factors.

•Scenario Analysis: Scenario analysis involves developing and evaluating different scenarios based on varying assumptions and data inputs. This approach can help identify potential outcomes and trade-offs associated with different PT measures, even when data is scarce or uncertain.

•Stakeholder Consultation: Engaging stakeholders, including residents, businesses, and transportation experts, can provide valuable input and insights into the potential impacts and feasibility of PT measures. Stakeholder consultation can help fill gaps in data and ensure that SUMP initiatives align with community needs and priorities.

Example of Multi-Criteria Analysis (MCA):

•**Project:** Selection between two public transport options: Light Rail Transit (LRT) vs. Electric Bus System.

•**Criteria and Weighting:**

- Cost (30%)
- Environmental Impact (20%)
- Feasibility (20%)
- Stakeholder Preferences (30%)

Conclusion:

•**Light Rail Transit (LRT):** Total Weighted Score = 6.4

•**Electric Bus System:** Total Weighted Score = 7.4

•**Decision:** Based on the MCA, the Electric Bus System is the preferred option as it scores higher overall, taking into account cost, environmental impact, feasibility, and stakeholder preferences.

DELIVERABILITY OF A PT MEASURE

- Take 3 minutes on your own to list factors that you think influence the ease or difficulty of delivering a public transport measure – an example could be the number of different organisations involved (more = more difficult)
- Then we will list these on the slide and add any not covered by you
- In an "average" medium-sized city, will it be easier to deliver high quality bus-based improvements to PT (higher frequencies, bus priority/segregated lanes, new vehicles, lower fares) or a metro? Why?

The exercise will be managed by the trainer and will draw on the notes below. The final question will be put to a vote and one person in favour of bus and one in favour of metro asked to explain themselves (if all vote for one option, one person will be asked why they did not vote for the other option).

Factors Influencing Feasibility and Implementability

1.Technical Complexity:

1. Projects with high technical complexity, such as metro systems, require extensive planning and expertise, while simpler measures like real-time information systems are easier to implement.

2.Financial Investment:

1. High-cost projects need secure funding sources and long-term financial commitment, while lower-cost measures can be funded through existing budgets or smaller grants.

3.Political and Public Support:

1. Projects that have strong political backing and public support are more likely to succeed. Engaging stakeholders and conducting public consultations can enhance support.

4. Regulatory Environment:

•Regulatory frameworks should be conducive to the proposed projects. Ensuring compliance with local and national regulations is essential for feasibility.

Supportive Regulatory Frameworks

•**Facilitates Projects**: The Netherlands has a supportive regulatory environment for sustainable transport projects. For example, the RandstadRail light rail project between The Hague and Rotterdam was facilitated by clear and supportive regulations, ensuring smooth implementation and compliance with safety standards.

Restrictive Regulations

•**Impediments**: In Italy, the expansion of the Naples metro system has faced challenges due to stringent archaeological regulations and the requirement for extensive environmental impact assessments, which have delayed the project's progress.

5. Institutional Capacity:

•Strong institutional capacity is crucial for the successful planning, implementation, and management of PT projects. Capacity-building programs and external expertise can help bridge gaps.

Strong Institutional Capacity

•**Effective Implementation**: The Swiss Federal Railways (SBB) exemplifies strong institutional capacity. Switzerland's rail network is one of the most efficient in Europe, benefiting from robust institutional structures, skilled personnel, and effective management practices.

Capacity Gaps

•**Need for Capacity Building**: In some Eastern European countries, such as Romania, efforts to modernize and expand urban transport systems have been hindered by limited institutional capacity. Projects like the modernization of the Bucharest metro have required external expertise and capacity-building programs to address these gaps.

Technical Complexity

High Complexity:

•**Metro Systems**:

- **Example**: **Crossrail (Elizabeth Line) in London, UK**
  - **Details**: Crossrail is one of Europe's most complex infrastructure projects, involving extensive underground tunneling and the integration of new lines with existing ones. This project faced numerous technical challenges, including advanced engineering and construction techniques.
  - **Impact**: Once completed, it will significantly enhance rail capacity and reduce travel times across London.

Low Complexity:

•**Real-Time Information Systems**:

- **Example**: **Real-Time Passenger Information in Helsinki, Finland**
  - **Details**: Helsinki's HELMI system provides real-time updates on bus and tram schedules using GPS technology. The system was implemented with relatively low technical complexity, focusing on

improving service reliability and passenger convenience.

- **Impact**: Improved user experience and increased public transport ridership.

Financial Investment

High Investment:

•**Metro Systems**:

- **Example**: **Grand Paris Express in Paris, France**
  - **Details**: The Grand Paris Express is a large-scale metro expansion project with an estimated cost of over €35 billion. It involves constructing new metro lines and stations to enhance connectivity and reduce congestion.
  - **Impact**: Expected to transform the Greater Paris region by providing improved accessibility and reducing travel times.

Low Investment:

•**Bus Rapid Transit (BRT)**:

- **Example**: **Busway in Nantes, France**
  - **Details**: Nantes implemented a BRT system known as "Busway," which uses dedicated lanes and existing road infrastructure to provide rapid and reliable bus service at a fraction of the cost of rail systems.
  - **Impact**: The system has improved public transport efficiency and accessibility with lower financial investment.

Political and Public Support

Strong Political and Public Support:

•**Electric Bus Transition**:

- **Example**: **Electric Buses in Copenhagen, Denmark**
  - **Details**: Copenhagen has committed to transitioning its entire bus fleet to electric buses by 2025. This initiative has strong political backing and public support due to its potential to reduce emissions and improve air quality.
  - **Impact**: Facilitated funding and successful implementation of electric buses.

Need for Increased Engagement:

•**Cycling Infrastructure**:

- **Example**: **Expansion of Bike Lanes in Paris, France**
  - **Details**: Paris has been expanding its cycling infrastructure to promote sustainable transport. This project initially faced resistance but gained support through public consultations and stakeholder engagement.
  - **Impact**: Increased cycling, reduced traffic congestion, and improved

urban mobility.

Public

NEW TECHNOLOGIES IN SUPPORT OF PUBLIC TRANSPORT

- Integrated data is crucial for trip planning and ticketing
- Real-time information helps users plan their journeys with increased confidence
- IT-based solutions facilitate payment stimulating further usage
- City-mapper and Google Maps as examples of widely available, deeply used apps for better mobility
- The revised TEN-T Regulation imposes that urban nodes provide digital mobility services that enable passengers to access information, book, pay, and retrieve their tickets in multiple modes of transportation

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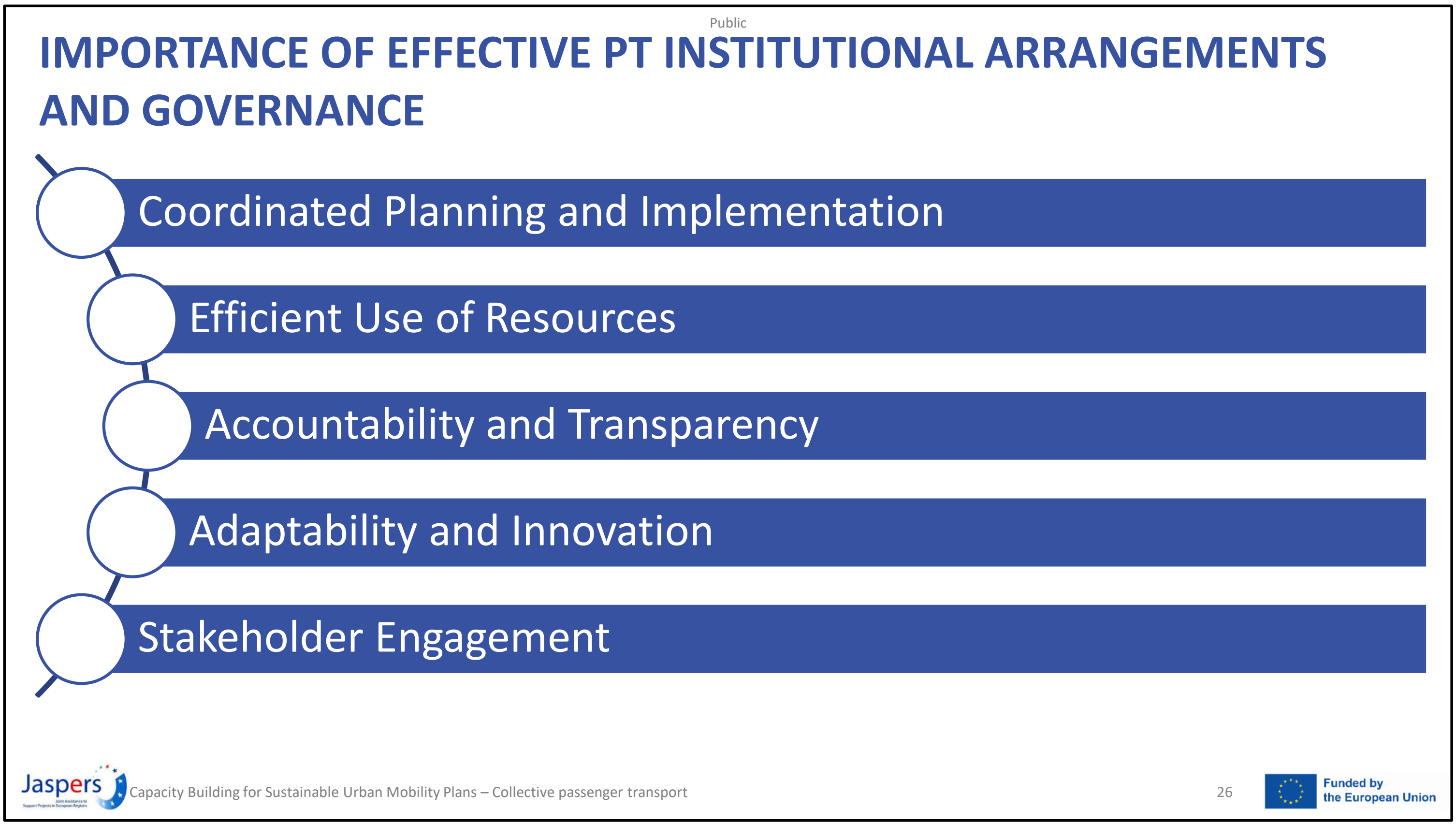
Integrated data on timetables and fares is crucial for trip planning and ticketing, enabling passengers to efficiently plan their journeys and understand the costs involved. Real-time information on transport services further enhances trip planning by providing users with up-to-date information on service schedules and disruptions, increasing their confidence in using public transport. By improving data collection and user perception while reducing operational costs, cities can optimize their public transport systems and enhance the overall passenger experience.

Real-time traffic data plays a vital role in optimizing flexible services, allowing providers to adjust routes dynamically based on current traffic conditions. This flexibility enables service providers to offer Mobility as a Service (MaaS) packages, allowing passengers to seamlessly book and pay for all legs of their journey in one place. IT-based solutions facilitate payment processes, making public transport more accessible to occasional users and stimulating further usage.

Apps like Citymapper and Google Maps have become indispensable tools for urban mobility, providing users with comprehensive information on public transport options, routes, and schedules. These widely available and deeply used apps contribute to better mobility by empowering users to make informed decisions about their travel plans.

The revised Trans-European Transport Network (TEN-T) Regulation mandates that urban nodes provide digital mobility services to passengers, facilitating access to information, booking, payment, and ticket retrieval across multiple modes of transportation. By complying with these regulations and embracing digital mobility solutions, cities can enhance the accessibility, efficiency, and sustainability of their public transport systems, ultimately improving the overall quality of urban mobility.



Effective institutional arrangements and governance are crucial for the development and management of PT systems. They ensure that PT policies and measures are well-planned, efficiently implemented, and aligned with broader urban development goals. Key benefits of effective governance include:

1.Coordinated Planning and Implementation:

1. **Benefit:** Ensures cohesive and integrated transport networks that connect various parts of the city and region seamlessly.
2. **Example:** A central transport authority can synchronize bus, tram, and rail services to offer smooth intermodal transfers and optimized routes.

2.Efficient Use of Resources:

1. **Benefit:** Maximizes the impact of public investments by avoiding duplication and ensuring funds are allocated to priority projects.
2. **Example:** A well-governed transport system can leverage economies of scale in procurement and maintenance, reducing overall costs.

3.Accountability and Transparency:

1. **Benefit:** Builds public trust and ensures that transport policies are fair and effectively address community needs.
2. **Example:** Transparent decision-making processes and regular public reporting enhance accountability and public confidence in transport agencies.

4. Adaptability and Innovation:

1. **Benefit:** Facilitates the adoption of new technologies and innovative practices to improve service quality and operational efficiency.
2. **Example:** Flexible governance structures can quickly implement new mobility solutions, such as on-demand transit or electric buses.

5. Stakeholder Engagement:

1. **Benefit:** Involves citizens, businesses, and other stakeholders in the planning process, ensuring that services meet diverse needs and preferences.
2. **Example:** Regular public consultations and feedback mechanisms help align transport services with user expectations.

Public

GOVERNANCE – STRUCTURAL ISSUES

- Governance arrangements different from one country to another
- EU Reg. 1370/2007 (Public Service Obligations in Transport) → still leaves room for different options at national level
  - Main objectives:
    - "provision of services…more numerous, safer, of a higher quality..at lower cost than those that market forces alone would have allowed"
    - Economic efficiency of PT operations
    - Single European Market, no discrimination among operators
  - It clearly defines roles of authorities (service definition, prices) and operators (provision of service)

Governance arrangements for PT vary from country to country, influenced by factors such as governmental institutions, local preferences, and regulations.

Governmental Institutions and Local Regulations: The structure of governmental institutions, along with local regulations, shapes how PT is governed and operated. This includes the roles and responsibilities of different authorities, regulatory bodies, and stakeholders involved in the planning, provision, and oversight of transportation services.

1.EU Regulation 1370/2007: This regulation sets the framework for Public Service Obligations in Transport within the EU. It aims to ensure the provision of essential services that are safer, of higher quality, and possibly more cost-effective than what purely market-driven forces would deliver. However, it allows for some flexibility at the national level to accommodate local needs and preferences.

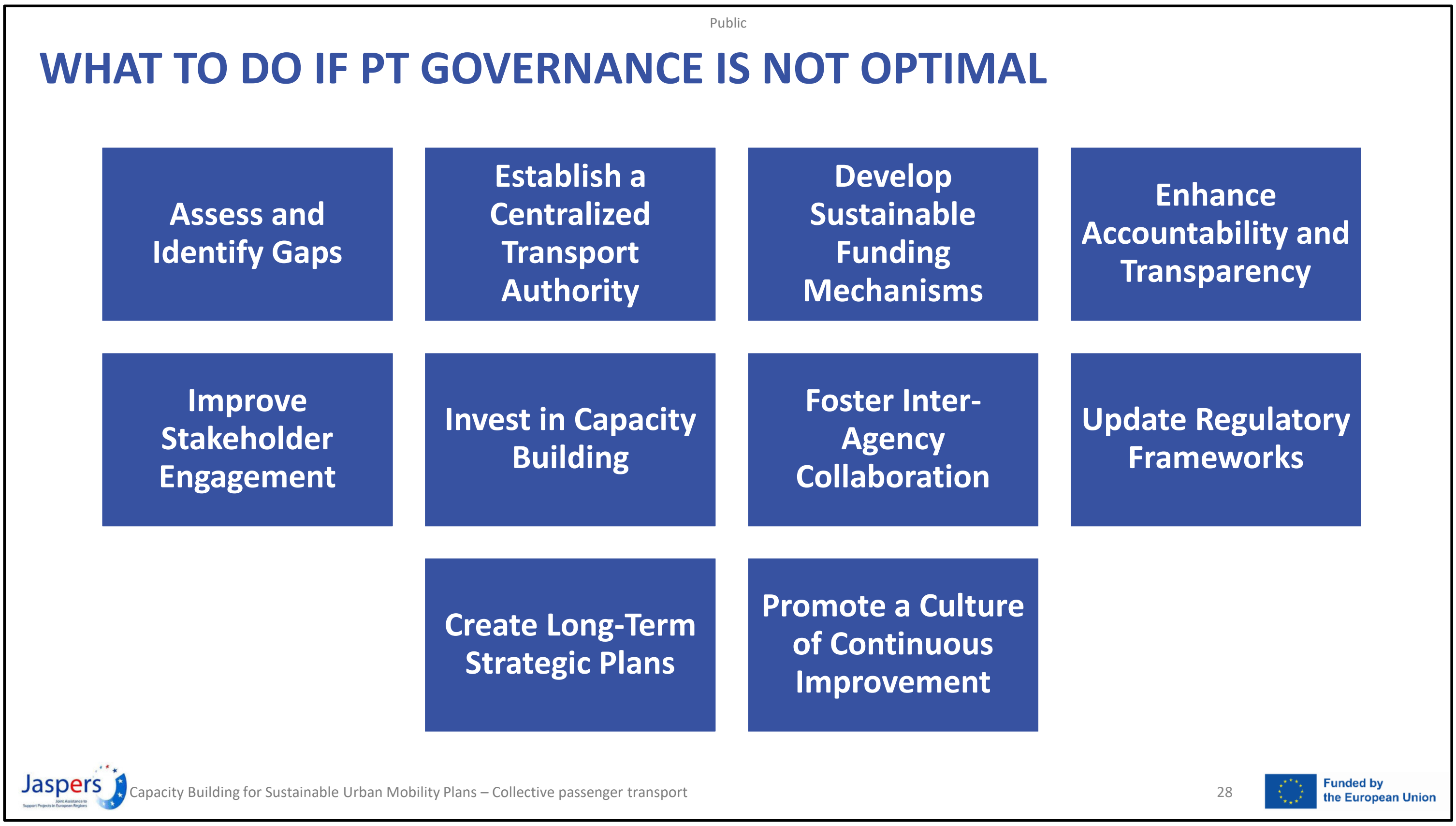
2.Main Objectives of Governance: The primary objectives of PT governance typically revolve around the provision of high-quality, affordable services that meet the needs of citizens while ensuring economic efficiency. This involves striking a balance between serving the public interest and fostering competition and innovation within the transportation sector.

3.Economic Efficiency: Efficiency in PT operations is a key consideration for governance arrangements. This includes optimizing resource allocation, minimizing costs, maximizing service quality, and achieving a balance between financial sustainability and affordability for users.

4.Single European Market and Non-Discrimination: The EU emphasizes the importance of a Single European Market for transport services, which entails ensuring fair competition and non-discrimination among operators, regardless of their national origin. Regulation 1370/2007 defines clear roles for authorities in terms of service definition and pricing, while also outlining the responsibilities of operators in service provision.

5. **Internal and External Operators**: PT services may be provided by both internal (authority-owned or controlled) and external operators, depending on the governance model adopted. Authorities have the discretion to determine the division of revenue risk between themselves and the operators, based on factors such as market conditions, financial considerations, and service objectives.

Overall, effective governance arrangements for PT aim to achieve a balance between meeting societal needs, promoting economic efficiency, ensuring regulatory compliance, and fostering innovation and competition within the transportation sector, all while adhering to EU regulations and principles.



1.Assess and Identify Gaps:

- Conduct a comprehensive review of current governance structures, identifying areas of inefficiency, lack of coordination, and gaps in expertise or resources.

2.Establish a Centralized Transport Authority:

- Create a central body responsible for coordinating all aspects of PT planning, funding, and operations to ensure unified and coherent decision-making.

3.Develop Sustainable Funding Mechanisms:

- Introduce dedicated funding streams such as transport-specific taxes, levies, or public-private partnerships to secure stable and adequate funding for transport projects.

4.Enhance Accountability and Transparency:

- Implement clear accountability frameworks, regular performance audits, and transparent reporting practices to build public trust and ensure effective use of resources.

5.Improve Stakeholder Engagement:

- Develop robust stakeholder engagement processes, including public consultations, participatory planning workshops, and feedback systems to involve the community in decision-making.

6.Invest in Capacity Building:

- Provide training and development programs for transport professionals and hire external experts to fill gaps in knowledge and expertise.

7. Foster Inter-Agency Collaboration:

- Establish joint committees, integrated planning platforms, and shared data systems to improve communication and coordination between different agencies and departments.

8.Update Regulatory Frameworks:

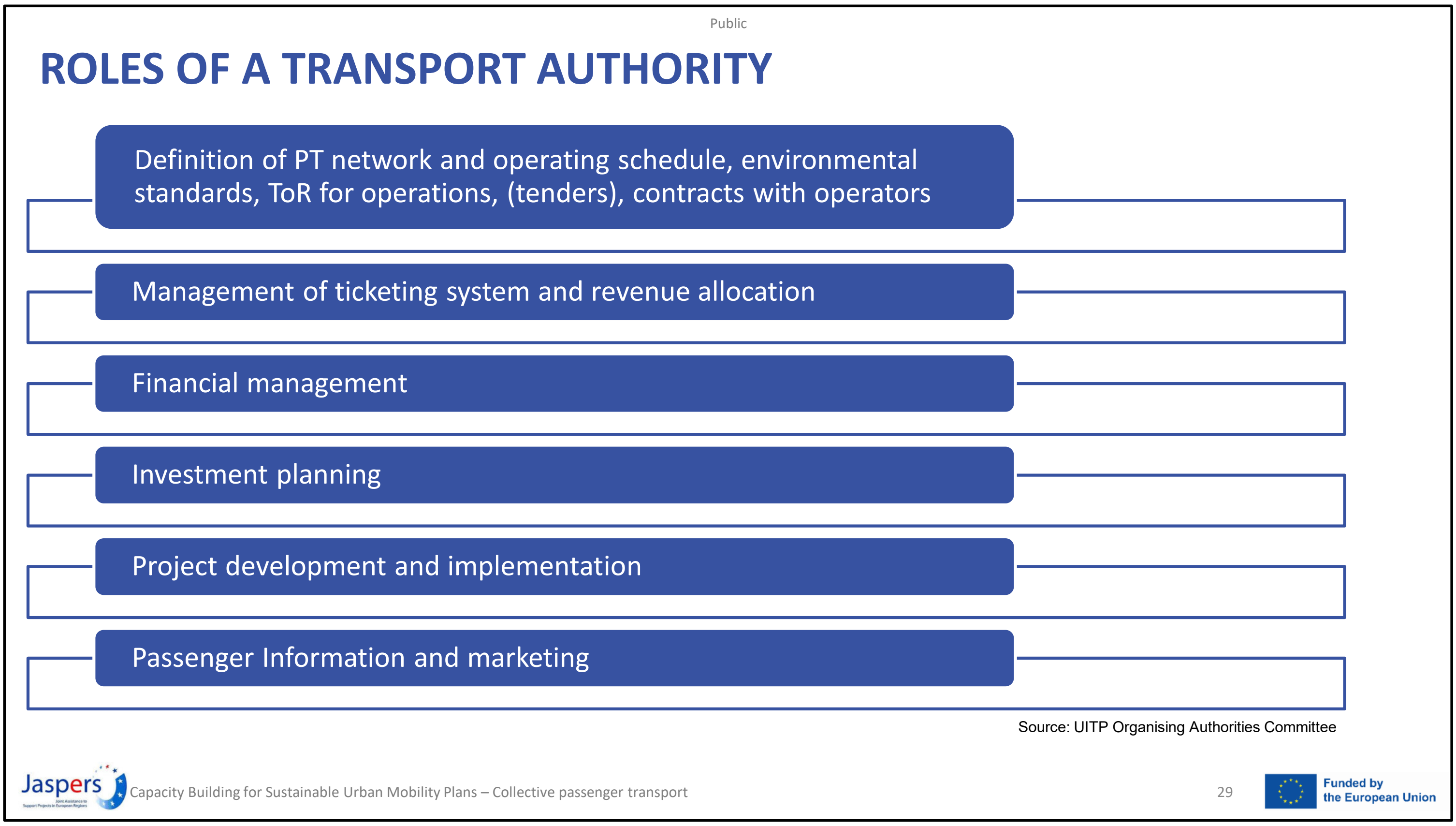
- Regularly review and adapt regulations to accommodate new technologies and practices, ensuring that the regulatory environment supports innovation and modern transport solutions.

9.Create Long-Term Strategic Plans:

- Develop comprehensive, evidence-based transport plans with clear objectives and priorities, insulated from political cycles to focus on long-term sustainability and effectiveness.

10.Promote a Culture of Continuous Improvement:

- Encourage a proactive approach to identifying and implementing best practices, regularly reviewing performance, and making necessary adjustments to policies and operations.



PT authority is set up either by national government mandating it (e.g. Dutch transport regions in Amsterdam and Rotterdam/Den Haag; Swedish regions) or by national government giving municipal authorities the power, if they wish, to group together into PT authorities (Germany).

Roles of a PT Authority:

1.Definition of PT Network and Operating Schedule: PT authorities establish the framework for the PT network, including defining routes, service frequencies, and operating hours. They determine the geographical coverage and service levels to ensure accessibility and meet the needs of the community.

2.Setting Environmental Standards: PT authorities play a crucial role in promoting sustainability by setting environmental standards for PT operations. This includes implementing measures to reduce emissions, promote energy efficiency, and enhance the environmental performance of vehicles and infrastructure.

3.Terms of Reference (ToR) for Operations (Tenders): PT authorities develop Terms of Reference (ToR) for PT operations, outlining service requirements, performance standards, and contractual obligations. These ToRs serve as the basis for tendering processes to select operators and award contracts for service provision.

4.Contracting with Operators: PT authorities enter into contracts with operators to deliver PT services in accordance with established standards and requirements. Contracts outline service specifications, performance targets, fare structures, and revenue-sharing arrangements, ensuring accountability and quality of service provision.

5.Management of Ticketing System and Revenue Allocation: PT authorities oversee the management of ticketing systems, fare collection, and revenue allocation. They ensure the integrity and efficiency of ticketing processes, manage revenue streams, and allocate funds to support PT operations, maintenance, and infrastructure investment.

6. **Financial Management**: PT authorities are responsible for financial management, including budgeting, revenue forecasting, expenditure control, and financial reporting. They develop sustainable funding mechanisms, secure financing sources, and allocate resources effectively to support PT services and infrastructure development.

7.**Investment Planning**: PT authorities develop investment plans to guide the prioritization and allocation of resources for PT infrastructure development and service improvements. They assess needs, identify strategic priorities, and evaluate investment options to enhance the capacity, efficiency, and quality of the PT network.

8.**Project Development and Implementation**: PT authorities lead project development and implementation efforts for PT infrastructure projects, such as new transit lines, stations, and facilities. They coordinate planning, design, procurement, construction, and commissioning activities to deliver projects on time and within budget.

9.**Passenger Information and Marketing**: PT authorities provide passenger information and engage in marketing efforts to promote PT services, attract ridership, and enhance the passenger experience. They disseminate information about routes, schedules, fares, and service updates through various channels, including websites, apps, signage, and outreach events.

By fulfilling these roles, PT authorities play a pivotal role in ensuring the availability, accessibility, and quality of PT services, contributing to sustainable mobility, economic development, and societal well-being.

Public

ESTABLISHING A PT AUTHORITY

Transport for London

Transport for London (TfL)

- Established in 2000, TfL is responsible for the majority of London's transport network, including buses, the Underground, Docklands Light Railway (DLR), Overground, trams, and roads
- Governed by a board appointed by the Mayor of London
- Centralizing various transport services under a single authority enhances coordination and efficiency
- Effective governance ensures better financial management and investment in infrastructure
- A unified structure enables the execution of comprehensive transport policies that improve urban mobility

Example: Transport for London (TfL)

Establishment and Governance: Transport for London (TfL) is a notable example of an effective PT authority. Established in 2000, TfL is responsible for the majority of London's transport network, including buses, the Underground, Docklands Light Railway (DLR), Overground, trams, and roads. It is governed by a board appointed by the Mayor of London, who sets the strategic direction and priorities.

Improvements in Governance: TfL's establishment led to several governance improvements:

•**Integrated Management:** By consolidating various transport services under one umbrella, TfL improved coordination and integration across different modes.

•**Funding and Investment:** A unified governance structure allowed for more coherent investment strategies and better allocation of funds, enhancing service quality and infrastructure.

•**Policy Implementation:** TfL's centralized control facilitated the implementation of city-wide policies, such as the congestion charge, which reduced traffic and pollution.

Cost: The cost of setting up and operating TfL is substantial. Initial funding came from both central and local government sources, supplemented by fare revenues and other income streams. The annual budget for TfL in recent years has been over £10 billion, reflecting the extensive scope and scale of its operations.

Public

CONCLUSIONS

- Key contributions of PT to SUMPs objectives
- Critical role of PT in fostering sustainable and inclusive urban environments
- Need for tailored PT solutions for large, medium-sized, and small cities
- Importance of strong governance and institutional arrangements
- Need for careful appraisal of PT measures for feasibility, impact, and cost
- A systematic approach to PT development
- Importance of integrating PT with cycling infrastructure, land use planning, etc.
- Ongoing innovation and adaptation in PT to meet the evolving needs of urban mobility
- Potential of PT to drive cities toward more sustainable, efficient, and inclusive futures
- PT should be prioritized in urban mobility strategies
- Importance of collaboration and community engagement

PT plays a pivotal role in achieving the objectives outlined in SUMPs, including social inclusion, economic development, environmental sustainability, and traffic congestion relief. PT contributes significantly to fostering sustainable and inclusive urban environments by providing accessible, affordable, and efficient mobility options for all residents, regardless of socioeconomic status or physical abilities.

Tailored PT solutions are essential for addressing the diverse needs and characteristics of large, medium-sized, and small cities. While large cities may require high-capacity metro or BRT systems to accommodate dense populations and alleviate congestion, medium-sized cities may benefit from flexible LRT or tram networks, and small cities may prioritize improving conventional bus services or implementing demand-responsive transport solutions.

Strong governance and institutional arrangements are critical for successful PT implementation, ensuring effective coordination among stakeholders, resource allocation, and policy coherence. A systematic approach to PT development involves comprehensive planning, stakeholder engagement, and performance monitoring to optimize investment decisions and maximize the benefits of PT initiatives.

Integration of PT with cycling infrastructure, land use planning, and supportive policies is essential for creating sustainable and livable urban environments. By promoting seamless multimodal connectivity and encouraging active modes of transportation, such as walking and cycling, cities can reduce reliance on private cars, improve air quality, and enhance public health.

Careful appraisal of PT measures is necessary to assess their feasibility, impact, and cost-effectiveness. This involves utilizing appraisal methods such as Multi-Criteria Analysis

(MCA), Cost-Benefit Analysis (CBA), and Environmental Impact Assessment (EIA) to evaluate PT projects and initiatives comprehensively.

ADDITIONAL MATERIAL (NOT NORMALLY TO BE SHOWN IN PRESENTATION) BUT CAN BE USED IF TRAINER WISHES

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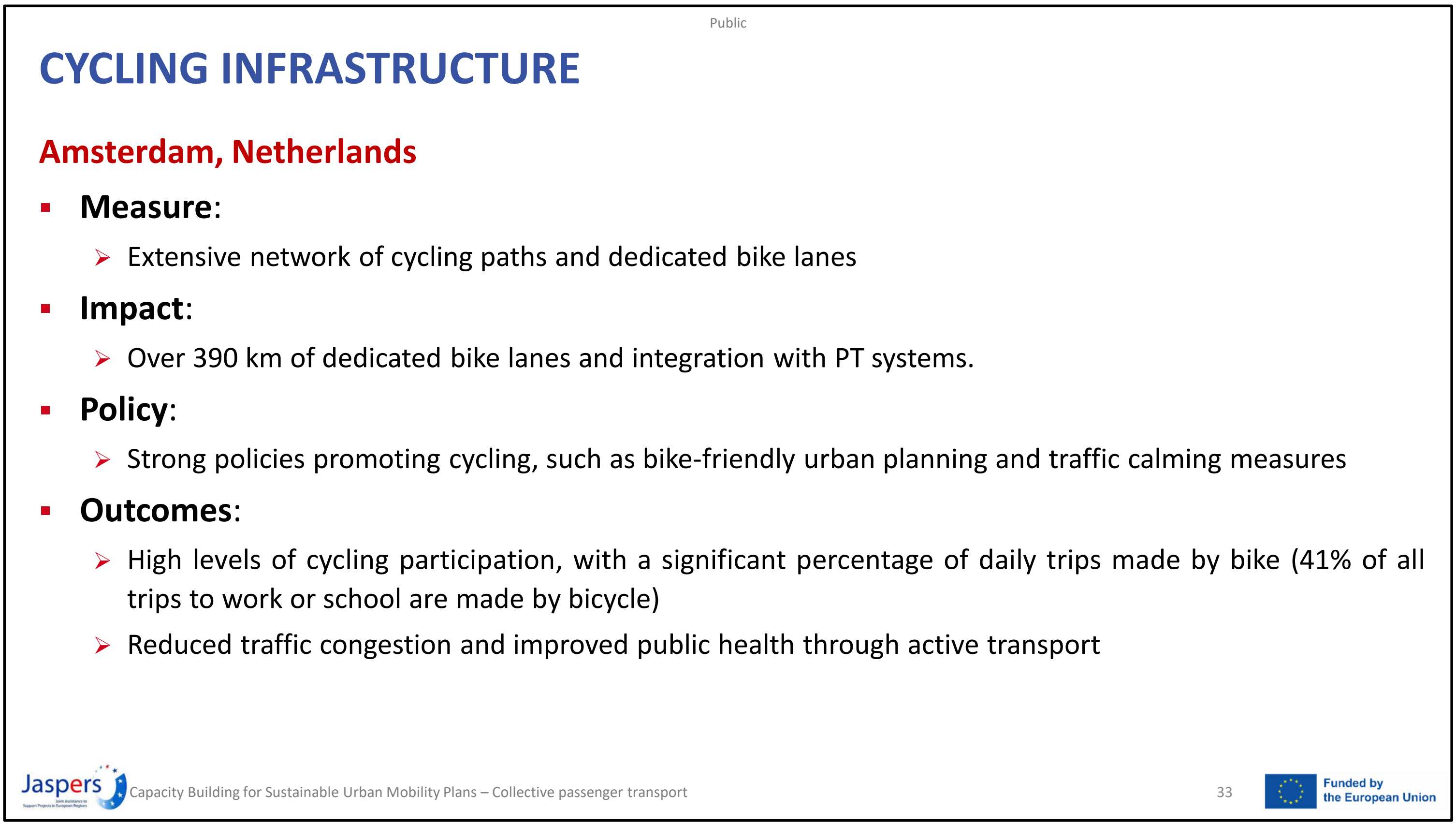
Ongoing innovation and adaptation in PT are essential to meet the evolving needs of urban mobility. By embracing emerging technologies such as electric and autonomous vehicles, implementing flexible route planning and scheduling systems, and integrating real-time passenger information and payment solutions, PT can become more responsive, efficient, and user-friendly.

PT has significant potential to drive cities toward more sustainable, efficient, and inclusive futures. By reducing reliance on private cars, promoting active modes of transportation, and minimizing greenhouse gas emissions, PT contributes to mitigating climate change, improving air quality, and enhancing social equity and accessibility.

Policymakers, planners, and stakeholders must prioritize PT in their urban mobility strategies to realize its full potential. Investing in PT infrastructure, services, and amenities, as well as implementing supportive policies such as congestion pricing, parking management, and transit-oriented development, can help create a conducive environment for PT adoption and usage.

Collaboration and community engagement are crucial in the planning and implementation processes of PT initiatives. By involving stakeholders from diverse backgrounds, including residents, businesses, advocacy groups, and transportation experts, cities can ensure that PT projects are responsive to local needs and preferences, garnering support and buy-in from the community.



Amsterdam, Netherlands

Measure:

Extensive network of cycling paths and dedicated bike lanes

Investment:

Continuous investment in cycling infrastructure, including bike parking facilities

Policy:

Strong policies promoting cycling, such as bike-friendly urban planning and traffic calming measures

Impact: Over 390 km of dedicated bike lanes and integration with public transport systems.

Outcomes:

High levels of cycling participation, with a significant percentage of daily trips made by bike

Reduced traffic congestion and improved public health through active transport

Result: 41% of all trips to work or school are made by bicycle, reducing traffic congestion, improving public health, and enhancing urban livability.

Public

COLLECTIVE (PUBLIC) TRANSPORT IN URBAN MOBILITY: INDIVIDUAL BENEFITS

- PT is an essential instrument to provide access to many urban functions for those who cannot / will not drive a car
  - Access to jobs, health, education, leisure and culture, social interaction
  - Equitable access is a key dimension of social inclusion
  - This is pointed out in the European Pillar of Social Rights

- Good access includes the efficient physical connection, affordable price, information about available services, reliable / predictable service

- PT is also important for connecting urban to peri-urban and rural areas
  - The Functional Urban Area (FUA) as defined in the new TEN-T Regulation should be always considered in PT planning

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It is difficult to design and operate a collective transport system that could serve a majority of urban displacements, because of its own limitations:

- Modes of higher capacity and speed require density of demand and cannot serve every neighbourhood,
- End-to-end travel times are severely affected by frequent stops, but long distances between stops force people to long walks,
- Frequent services are very convenient, especially when transfers are necessary, but production costs must be covered, and funding constraints may impose a limit on that frequency.

Public

COLLECTIVE (PUBLIC) TRANSPORT IN URBAN MOBILITY: SOCIAL BENEFITS (I)

- Direct positive social impacts:
  - It reduces congestion and consumption of urban space for transport
    - Improving quality of life in heavily trafficked urban areas
  - It reduces emissions of pollutants, noise and greenhouse gases
  - It favours compact urban development
    - Enhancing walking in general and access on foot
  - Social inclusion is also a social benefit as a factor of justice and harmony
- Public budget subsidies justified by social benefits
- To achieve these impacts, collective transport must also be attractive for those who could drive a car → low transaction costs (info & payment) for infrequent users

Direct Positive Social Impacts of Transportation Improvement:

1.**Reduced Congestion and Urban Space Consumption**: By promoting efficient transportation modes, such as public transit and active transportation, we alleviate traffic congestion and utilize urban space more effectively.

2.**Enhanced Quality of Life in Urban Areas**: Mitigating traffic congestion not only improves the flow of movement but also fosters a more pleasant and livable environment in densely populated urban regions.

3.**Decreased Emissions**: By encouraging the use of eco-friendly modes of transportation, such as electric vehicles and public transit, we reduce the emission of pollutants, noise, and greenhouse gases, contributing to cleaner air and a healthier environment.

4.**Promotion of Compact Urban Development**: Favoring collective transport facilitates compact urban development, encouraging sustainable land use patterns and minimizing sprawl, which in turn promotes efficient resource utilization and community connectivity.

5.**Improved Walkability and Accessibility**: Emphasizing pedestrian-friendly infrastructure enhances walking as a viable mode of transportation, fostering healthier lifestyles and facilitating easier access to amenities and services within urban areas.

6.**Enhanced Social Inclusion**: Ensuring equitable access to transportation options promotes social inclusion by reducing barriers to mobility, thus fostering a sense of community and belonging among diverse population groups.

7.**Justification for Public Budget Subsidies**: Recognizing the broad societal benefits of efficient transportation systems, public budget subsidies can be justified as investments in social well-being, economic prosperity, and environmental sustainability.

8. **Low Transaction Costs for Users**: To make collective transport attractive, it's essential to minimize transaction costs, such as information gathering and payment processes, particularly for infrequent users. Streamlining these processes enhances convenience and encourages broader adoption of public transit options.

By addressing these key factors, transportation improvements can not only alleviate immediate challenges but also pave the way for more sustainable and inclusive urban environments, fostering greater well-being and harmony within communities.

COLLECTIVE (PUBLIC) TRANSPORT IN URBAN MOBILITY: SOCIAL BENEFITS (II)

- PT empowers both the local and regional economic development and is vital for the recovery of the European economy
  - Connecting people, creating local jobs
  - Doubling PT modal share will double the employment positions in the PT service market

- PT sector is amongst the largest employers at local level, employing 2 million people in the EU

Source: UITP

Absolutely, PT plays a pivotal role in driving both local and regional economic development, particularly in the context of the European economy. Here's how:

1.Catalyst for Economic Recovery: PT serves as a critical infrastructure element that connects people and businesses, facilitating the flow of goods, services, and labor. Especially in the wake of economic downturns or crises, investing in PT projects can stimulate economic activity by creating jobs, boosting consumer spending, and attracting investment.

2.Job Creation: The expansion and improvement of PT networks directly contribute to job creation, both locally and regionally. By investing in infrastructure projects, such as building new transit lines, upgrading existing facilities, and expanding service coverage, governments generate employment opportunities in construction, engineering, maintenance, operations, and other related sectors.

3.Local Employment Opportunities: PT systems, including buses, trams, trains, and associated infrastructure, require a diverse workforce to operate efficiently. From drivers and maintenance personnel to administrative staff and customer service representatives, the PT sector offers a wide range of job opportunities, many of which are localized and accessible to residents within the communities served by these systems.

4.Multiplier Effect: Increasing the modal share of PT has a multiplier effect on job creation. As more people choose to use public transit instead of private vehicles, demand for transit services increases, necessitating the expansion of fleet sizes, the hiring of additional staff, and the development of ancillary services, such as retail and hospitality establishments near transit hubs.

5. **Support for Sustainable Development**: PT not only provides essential mobility options but also aligns with broader goals of sustainable development. By reducing reliance on private cars, public transit helps mitigate traffic congestion, decrease carbon emissions, conserve energy, and promote equitable access to transportation services, all of which are crucial for fostering long-term economic prosperity and resilience.

In summary, PT serves as a cornerstone of economic development in Europe, offering both immediate benefits in terms of job creation and long-term advantages related to sustainable growth and prosperity. Investing in robust PT systems is essential for building resilient economies and enhancing the quality of life for citizens across the continent.

RELEVANCE OF PT TO CITIES OF DIFFERENT SIZES

Freiburg, Germany

- **Integration**:
  - A comprehensive tram network combined with buses and a strong emphasis on cycling
  - Focus on sustainable urban development through land-use planning
  - Promotion of walking and cycling as primary modes for short trips
- **Effects**:
  - High PT and bicycle usage, with over 70% of trips made by environmentally friendly modes
  - Significant reductions in car traffic, congestion, and emissions
  - Increased quality of life, with accessible and green urban spaces

Integration Example: Freiburg, Germany

Measure:

•**Comprehensive Tram Network**: Freiburg has a well-developed tram network complemented by an extensive bus system and a strong emphasis on cycling infrastructure.

•**Sustainable Urban Development**: The city prioritizes sustainable urban development through thoughtful land-use planning.

•**Promotion of Walking and Cycling**: Freiburg promotes walking and cycling as primary modes for short trips, supported by extensive pedestrian and cycling paths.

Effects:

1.High Public Transport and Bicycle Usage:

1. **Environmentally Friendly Modes**: Over 70% of trips in Freiburg are made using environmentally friendly modes of transport, including public transport, cycling, and walking. Specifically, cycling accounts for about 34% of all trips, public transport for 18%, and walking for 23%.

2.Significant Reductions in Car Traffic, Congestion, and Emissions:

1. **Car Traffic**: The focus on sustainable transport has led to a significant reduction in car traffic, with car trips accounting for only 25% of all trips in the city, down from 38% over the past two decades.
2. **Congestion**: Reduced car traffic has also resulted in decreased congestion, with traffic delays in the city center reduced by approximately 30%.

3. **Emissions**: Freiburg has achieved a 25% reduction in CO_2 emissions per capita over the last 15 years, contributing to improved air quality and lower pollution levels.

1.Increased Quality of Life:

1. **Accessible Urban Spaces**: The city has developed numerous accessible and green urban spaces, with over 50% of the urban area dedicated to parks, green belts, and recreational spaces.
2. **Cycling and Walking Infrastructure**: Investments in cycling and walking infrastructure have led to a 20% increase in the total length of dedicated cycling paths and pedestrian zones, enhancing mobility and safety for non-motorized users.
3. **Public Satisfaction**: Surveys indicate high public satisfaction with urban transport and quality of life, with 85% of residents expressing contentment with the city's public transport and cycling infrastructure.

Source: https://sustainablemobility.iclei.org/ecomobility-alliance/freiburg-germany/

https://world-habitat.org/world-habitat-awards/winners-and-finalists/30-years-of-planning-continuity-in-freiburg-germany/

https://www.vaia.com/en-us/explanations/geography/sustainable-urban-development/freiburg-case-study/

https://www.ebrdgreencities.com/policy-tool/incentives-to-use-public-and-active-transport-freiburg-germany-2/

Public

RELEVANCE OF PT TO CITIES OF DIFFERENT SIZES

Gothenburg, Sweden

- **Integration**:
  - A well-developed tram system complemented by buses and ferries
  - Integrated ticketing system and synchronized schedules
  - Investments in cycling infrastructure and pedestrian zones
- **Effects**:
  - Increased PT usage and reduced car traffic in the city center
  - Lower emissions and improved air quality
  - Enhanced connectivity and mobility, supporting economic activities and reducing social disparities

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Effects:

1.Increased Public Transport Usage and Reduced Car Traffic:

1. **Public Transport Usage**: Gothenburg has seen an increase in public transport usage, with around 60% of trips within the city and 28% of total trips now made by public transport.
2. **Reduced Car Traffic**: Car usage in the city center has decreased by approximately 20% over the past decade due to the integration of transport modes and improved accessibility.

2.Lower Emissions and Improved Air Quality:

1. **CO2 Emissions**: Gothenburg has achieved a 12% reduction in CO2 emissions since the implementation of its integrated transport system and environmental policies.
2. **Air Quality**: The city has experienced a significant improvement in air quality, with nitrogen dioxide (NO2) levels decreasing by 25% in the city center.

3.Enhanced Connectivity and Mobility:

1. **Economic Activity**: Enhanced connectivity has positively impacted local businesses, contributing to a 7% annual growth in the city's retail and service sectors.
2. **Social Disparities**: Improved access to public transport has helped reduce social disparities, with over 95% of the population living within a 500-meter

radius of a public transport stop.

3. **Cycling and Walking**: Investments in cycling and pedestrian infrastructure have led to a 35% increase in cycling trips and a 20% increase in walking trips over the past five years.

Source: https://www.sei.org/perspectives/swedens-transport-climate-action/

https://earth.org/sustainable-cities-gothenburg/

https://news.cision.com/business-region-goteborg/r/unique--mobility-hotel--to-accelerate-green-transport-in-gothenburg-s-inner-city,c3994247

https://www.sciencedirect.com/science/article/abs/pii/S2213624X1730367X

Public

RELEVANCE OF PT TO CITIES OF DIFFERENT SIZES

Paris, France

- **Integration**:
  - The Paris Métro, one of the densest metro systems in the world, integrates seamlessly with RER (Regional Express Network) trains, buses, and trams
  - Extensive bike-sharing system (Vélib’) and pedestrian-friendly infrastructure complement PT
- **Effects**:
  - High PT usage reduces car dependency and traffic congestion
  - Significant reductions in urban air pollution and greenhouse gas emissions
  - Improved mobility and accessibility across the city, contributing to economic growth and social inclusion

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Effects:

1.High Public Transport Usage Reduces Car Dependency and Traffic Congestion:

1. **Public Transport Usage**: Over 5 million trips are made daily on the Paris Métro. Combined with RER, buses, and trams, the total daily ridership exceeds 10 million.
2. **Car Dependency**: Car usage has declined significantly, with only about 30% of trips within Paris made by car, compared to over 40% a decade ago.
3. **Traffic Congestion**: Traffic congestion has reduced by approximately 20% in the city center due to increased public transport usage and alternative mobility options.

2.Significant Reductions in Urban Air Pollution and Greenhouse Gas Emissions:

1. **Air Pollution**: Paris has seen a 15% reduction in nitrogen dioxide (NO2) levels and a 20% decrease in particulate matter (PM10) concentrations over the past five years.
2. **Greenhouse Gas Emissions**: Efforts to enhance public transport and promote cycling have contributed to a 25% reduction in CO2 emissions from urban transportation over the last decade.

3.Improved Mobility and Accessibility Across the City, Contributing to Economic Growth and Social Inclusion:

1. **Mobility and Accessibility**: Improved integration of various transport modes has led to over 90% of residents living within a 500-meter radius of a public

transport stop.

2. **Economic Growth**: Enhanced mobility has stimulated economic activities, contributing to a 3% annual growth in local businesses and retail sectors.
3. **Social Inclusion**: Increased access to affordable transport options like the Vélib’ bike-sharing system, which has over 400,000 annual subscribers, has improved social inclusion, ensuring mobility for low-income residents and promoting equitable access to jobs and services.

INTEGRATING PT WITH OTHER ENVIRONMENTALLY FRIENDLY TRANSPORT MODES

- Existing infrastructure may not support the integration of different transport modes
  - ➢ Upgrade and expand infrastructure to include dedicated lanes for cycling and walking
- Different transport modes are often managed by separate agencies or operators, leading to coordination issues in service planning and operations
  - ➢ Establish integrated transport authorities
- Lack of integrated fare systems
  - ➢ Implement a unified fare system that allows seamless payments across all modes
- Users may find it inconvenient or unsafe to switch between different modes
  - ➢ Design transfer points with user convenience and safety in mind

Integrating PT with other environmentally friendly transport modes, such as walking, cycling, and shared mobility services, can significantly enhance urban mobility, reduce emissions, and improve public health. However, achieving seamless integration presents various challenges. Here are some of these challenges along with potential solutions.

Challenges

1.Infrastructure Compatibility:

1. **Description:** Existing infrastructure may not support the integration of different transport modes. For example, many urban areas lack dedicated bike lanes or pedestrian pathways that connect seamlessly to PT stations.
2. **Solution:** Upgrade and expand infrastructure to include dedicated lanes for cycling and walking, ensure safe and convenient access to PT stations, and create multimodal hubs.

2.Coordination Between Agencies:

1. **Description:** Different transport modes are often managed by separate agencies or operators, leading to coordination issues in service planning and operations.
2. **Solution:** Establish integrated transport authorities or coordination committees to ensure unified planning and management of all transport modes.

3.Fare Integration:

1. **Description:** Lack of integrated fare systems can deter users from switching

between different transport modes due to inconvenience and higher costs.

2. **Solution:** Implement a unified fare system that allows seamless payments across all modes, such as smart cards or mobile apps that can be used for PT, bike-sharing, and ride-sharing services.

1.User Convenience and Safety:

1. **Description:** Users may find it inconvenient or unsafe to switch between different modes, particularly at transfer points that are not well-designed or maintained.
2. **Solution:** Design transfer points with user convenience and safety in mind, including features such as covered walkways, secure bike parking, real-time information displays, and adequate lighting.

INTEGRATING PT WITH OTHER ENVIRONMENTALLY FRIENDLY TRANSPORT MODES

- People may be resistant to changing their travel habits
  - ➢ Launch public awareness campaigns to educate people about the benefits of multimodal transport
- Different modes may use different technologies for scheduling, ticketing, and information systems, making integration challenging
  - ➢ Develop and adopt interoperable technologies and standards for scheduling, ticketing, and information systems
- Integrating multiple transport modes requires significant investment, and funding may be limited
  - ➢ Explore diverse funding sources, including PPPs, grants, and sustainable finance mechanisms

5. Cultural and Behavioural Barriers:

•**Description:** People may be resistant to changing their travel habits or may not be aware of the benefits of using environmentally friendly transport modes.

•**Solution:** Launch public awareness campaigns to educate people about the benefits of multimodal transport, and implement incentive programs to encourage the use of sustainable transport options.

6. Technology Integration:

•**Description:** Different modes may use different technologies for scheduling, ticketing, and information systems, making integration challenging.

•**Solution:** Develop and adopt interoperable technologies and standards for scheduling, ticketing, and information systems to ensure seamless user experiences.

7. Funding and Investment:

•**Description:** Integrating multiple transport modes requires significant investment, and funding may be limited.

•**Solution:** Explore diverse funding sources, including public-private partnerships, grants, and sustainable finance mechanisms to support multimodal integration projects.