Mix of Transport Modes for Different Tasks

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Travel patterns in cities are complex, varying with space, time and travel purpose. But all travel uses energy, utilises space and time (often in short supply in cities) and creates environmental and other externalities such as pollution, noise, accidents and congestion.

- **Categorised under:**

- Feasability, Planning, Design,
- Access and Transport,
- State Government, Local Government,

Introduction

All cities have access to the same basic transport technologies, including automobiles; trains, trams, buses and other forms of mass transit; commercial vehicles; and bicycles and other forms of personal mobility. Most of these technologies have existed for a century or more, but the reliance by different cities on different modes varies dramatically. At one extreme are cities like Hong Kong and Tokyo, which are heavily reliant on rail and other mass transit; at the other are most Australian cities which are heavily car-oriented.

This sheet discusses how to select the most appropriate mode or modes for different transport tasks, taking into account urban density, geography, cost and other factors. The first section covers key issues which need to be considered by those planning urban and transport development, the second discusses choosing between modes, the third covers longer term impacts.

Nature of the travel task

When considering which mode(s) are appropriate for specific situations, the nature of the travel task needs to be clearly understood. This includes such aspects as the volume of trips to be undertaken, the length of the trips involved, the typical purposes underlying the travel, and variability over time. For example, the travel task might be to connect a newly developing residential area to a major centre; in this case there will be trips for work, shopping, entertainment and other purposes, and there will typically be daily peak and off-peak periods with heavier flows in the peak direction. Major sporting facilities often generate trips from many directions, but concentrated into specific time periods. Major shopping centres generate high volumes of travel, with the busiest times often being on Saturday mornings.

Nature of the urban environment

Urban environments also vary dramatically, and are affected by geography, urban density, street layouts etc. For example, cities surrounded by mountains can be more susceptible to high levels of ambient air pollution than those which are well ventilated; cities with heritage buildings may place a high value on visual amenity; while cities with difficult topography may require extensive tunnelling for major transport infrastructure. All of these factors can influence the suitability of different modes for a given city or region.

Characteristics of the transport modes

Different modes have very different characteristics, which make them more or less suitable for specific travel tasks:

- Heavy rail systems (suburban rail, metro rail etc) have high capacity and relatively high average speeds, with full grade separation from roads and pedestrians, but have high capital costs per kilometre and usually have stations separated by at least one kilometre
- Light rail systems can be operated in their own rights of way or in a mixed environment with other vehicles and pedestrians. The capacity, average speed, cost and stop spacing can vary substantially depending on local circumstances. Being electrically powered, light rail produces no local pollution and is therefore suitable for environments with high pedestrian concentrations.
- Busways and guided busways are essentially rubber tired versions of light rail, which allow greater route flexibility but with less reliable operating performance and greater impacts on the local environment.
- Buses in mixed traffic environments are the commonest form of mass transit, have low capital costs, and provide good local accessibility, but generally have slow average speeds (20kph including stops is typical in many cities), and high operating costs per passenger-km. Their capacity is also limited both by vehicle size and traffic conflicts.
- Demand-responsive options include taxis, shuttle and other flexible-route bus services, and â€œmaxitaxisâ€• and other low capacity, shared-ride services. These provide flexibility in both route and travel time, and high levels of physical accessibility (including door-door service) but at the highest cost per passenger-km of mass transit modes.
- Specialized systems include monorails, personal rapid transit (PRT) systems, group rapid transit and other newly emerging systems. These tend to have been applied in specialized â€œnicheâ€• applications with particular physical or other characteristics, such as airport terminals, theme parks, universities or recreational facilities.
- Automobiles are highly flexible in time and space, and can provide door-door convenience. However they have high space requirements for both roads and parking, are highly energy intensive, generate air pollution and

noise, and have relatively high accident costs. They also reduce amenity and livability if used in large numbers, and tend to generate significant road congestion not just for other motorists but for other road users (commercial vehicles, buses, cyclists).

- Bicycles provide flexibility and convenience at low costs in terms of the environment and urban space requirements. However unless provided with cycleways or other infrastructure, they can be unsafe, and their speeds and ranges make them most suitable for short distance trips. They can be a good option to use in conjunction with mass transit for longer trips. In addition to bicycles, an increasing range of electric bicycles, scooters and other personal mobility devices are beginning to appear in some cities.

Choosing the best mode or combination of modes

No single mode of transport is ideal for all situations. In general, the longer the trip, the more important travel speed will be; conversely, for short trips, waiting and access time are crucial. The travel demand in a given corridor will depend on such factors as the size of any centres served, and whether it serves multiple routes. The diagram below provides a general concept of how the different characteristics of different modes tend to suit different combinations of travel distance and travel volumes, and the table shows typical peak capacities.

One area of debate regarding the selection of modes concerns busways versus light rail. In general, these have broadly similar costs, capacities and characteristics. Over 100 cities world wide have invested in light rail in the last decade, while cities like Brisbane (Australia), Ottawa (Canada) and Curritiba (Brazil) have invested in busways. Brisbaneâ€™s busway has been successful in attracting patronage, but the large volumes of buses eventually ca se their own form of congestion, as well as impacting on down-town amenity, and the busway has had to be built underground in the city centre, negating the cost advantages compared with light rail. In practice detailed feasibility studies are required to identify the best mode in these situations.

Mode/Facility	**Example**	**Details**	**Average Headway** Seconds)	Passengers per Track/Lane per Hour
Metro	Hong Kong	High capacity	120	50,000
Heavy Rail	Sydney	Double-deck train	180	20,000
Light Rail	Strasbourg	7-section trams	90	10,000
Busway	Brisbane (SE Transitway)	Separate right of way	40	10,000
Buslane	Sydney Harbour Bridge	Many routes coverage	30	12,000
Freeway	Australia	Cars only*	2	2,200*
Arterial	Australia	Cars only*	3	1,500*

** Assuming car occupancy in peak of 1.2 passengers. Capacity assumes cars only (no trucks or buses). Actual capacity will depend on traffic mix*

Longer-term impacts of transport modes

Electrically powered modes (heavy rail, metros, light rail) can be readily converted to operate on green power where this is available, whereas cars and buses currently rely on oil-based fuels, although battery power, hybrids, fuel cells or bio-fuels are appearing. Given the concerns over greenhouse gas emissions and the peaking of oil supplies, this may become a key issue in choosing travel modes in the near future.

Land use patterns in many European cities, as well as the inner suburbs in some Australian and US cities, have been shaped in part by mass transit systems, especially trains and trams. This reinforced strong Central Business Districts, as well as higher density development along tram routes and around stations. But the outer suburbs of our cities and more recently developed cities such as Canberra and Perth have been built around the car, with low densities and few local facilities. This generates long travel distances and makes public transport and walking or cycling unattractive. There are clear relationships between density / land use and transport, with higher density cites, and parts of cities, having higher use of public transport and therefore lower transport energy use and greenhouse gas emissions per capita (Newman and Kenworthy, 1999).

Construction of urban motorways, as has occurred in particular in Sydney and Melbourne in the last two decades, is reinforcing these land use patterns because it encourages the use of cars and undermines other modes. By contrast, Perth has reversed its previous reliance on freeways and is now focusing on transit-oriented development around its new rail system.

Selection of the modes for particular situations thus has longer term impacts both on the corridor or region concerned, and on the wider urban structure. Arguably, this is one of the key criteria underpinning mode selection, yet is typically not accounted for in conventional transport modeling and evaluation. Litman (2007) provides guidance on how to undertake more comprehensive analyses of costs and benefits.

Case Study â€“ Perthâ€™s rail revival

Perth was one of the most car dependent cities in the world in the 1980â€™s and came close to closing its antiquated diesel-powered rail network. But after community opposition, the system was electrified and subsequently substantially expanded. Patronage rose from 8 million passengers in 1990 to 31 million in 2001, and is expected to double again following the recent completion of a major new line to Mandurah and underground link.

Perth is now adopting transit-oriented development principles around its rail stations as a key plank in changing its urban form from low density car-oriented suburbia to a modern â€œnetwork cityâ€•.

Key Issues

Risks

New technologies (such as guided buses or PRT) may carry technology risk as they are based on proprietary systems. All modes have patronage or traffic risk, but this can be a particular problem for toll roads (because of price elasticity) and some rail systems (because of the need for change of behaviour or because land use changes take time to occur). Financial risk can result from patronage risk as well as construction cost risk, which has been shown to occur with most major transport projects (Flyvberg, Bruzelius and Rothengatter, 2003). In addition to these conventional risks, the likelihood that oil supplies will peak in the near future, and that major reductions in CO2 emissions will be required in the transport system, provide additional risks to the viability of development if it is based too heavily on cars.

Costs

A major issue in mode selection is the different ways in which mass transit and cars are paid for. In almost all cities public transport requires capital subsidies, and in most cases operating subsidies, given that fares are kept low for political reasons and that car users have access to hidden subsidies, such as free parking (Shoup, 2005). In addition, many of the external costs such as air pollution, congestion, and health effects are not faced by the motorist and not factored into the choice of mode when making a trip. Consequently â€œrationalâ€• choices by indivi duals do not necessarily add up to a rational choice for a city.

Barriers

In many cities, there can be initial barriers to the introduction of new systems or modes, because of opposition from existing operators or the power of key agencies. This can be reduced where a single organisation is responsible for integrated transport provision across all modes.

Development phase actions

Feasibility

When undertaking major urban development, the implications for the transport system need to be considered at the beginning.

At the feasibility stage, broad assessments of the likely travel demand created by the development need to be made, and compared with the capacity and suitability of the various modes, together with the potential to enhance the sustainability of the transport system through suitable investment. This will involve identifying key trip attractors both within the development and outside it, analysis of trip distances and potential volumes along key corridors, and consideration of how land use design modifications (such as transit oriented design principles) can reduce the potential transport impacts. Major developments may require extensions of existing networks, which can have longer term benefits as well as short term costs, which need to be carefully considered in a metropolitan-wide context.

Timing is also important. Ideally, public transport and other sustainable transport infrastructure should be provided very early on in the development, as travel behaviour and car ownership patterns will be based on availability of alternatives. However where there is no guarantee that appropriate modes and capacities will be provided to meet expected demand in a reasonable timeframe, consideration should be given to the impact on project feasibility.

Planning

The planning stage should include detailed proposals for transport infrastructure and services, ensuring that there is safe provision for walking, cycling and small personal mobility devices, as well as mass transit of appropriate types and with appropriate frequency, capacity and quality to attract ridership. Priority should be provided for the more sustainable modes; for example the development should be well-connected to surrounding land uses and developments especially for pedestrians, cyclists and public transport users, with travel distances no longer than for car users. Land uses, densities and street layouts should be arranged to support sustainable modes â€“ with higher act ivity generating uses located adjacent to areas with higher public transport accessibility, such as major stops or interchanges.

Design

Consideration of sustainable transport systems should encompass detailed design, including aspects such as

- design speeds for roads (which greatly affect pedestrian safety and amenity)
- location of bus or other transit stops in relation to the street layout
- grouping of mixed land uses to enable shared use of parking
- provision of separate cycleways on major roads, ideally segregated from heavy or faster moving traffic by parked cars
- provision of park and ride facilities at transit stops, including secure lock-up facilities for bicycles and other small mobility devices.

Links

- International Association of Public Transport
- Victoria Transport Policy Institute (Canada)
- Mobility Management:design for active transport factsheet

References

Flyvberg, B, Bruzelius, N, and Rothengatter, W 2003 *Megaprojects and Risk: An Anatomy of Ambition* . Cambridge Press.

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