Network Planning Principles

OUTLINE
1. Objectives and purpose of network planning
2. The role of Economics in Network Planning
3. Principles of planning
4. Issues in planning

OBJECTIVES AND PURPOSES

1. OBJECTIVES AND PURPOSE OF PLANNING

- Defining the nature and scope of network planning tasks and measuring its success
- Impacts on urban structure – transport and land use
- Institutional issues and their impact on 'success'
- Network success factors

CONTEXT

DEFINE SCOPE OF NETWORK PLANNING

- Partly defined by the institutional set-up
- Partly determined by mode
- BUT VERY important
- Define the area of study
- Define the aspirations for level of service
- Understand how existing resources contribute to different goals
- Recognise that planning in the short, medium and long-term have different issues

DEFINING THE NETWORK PLANNING TASKS

- Specify goals and objectives
  - Allow public transport operators to provide services that customers are willing to pay for
  - Support social policy
  - Provide efficient transport
  - Contribute to a sustainable city
Network Planning: Principles

DEFINE THE INDICATORS OF SUCCESS

› Monitoring change necessary for good decision making and management
› Key indicators needed at the planning stage so that evaluation is targeted

IMPACT ON URBAN STRUCTURE

› Public transport networks do influence land use structure and vice versa
  - eg proposed metro and the building up of densities around proposed stations
  - Developments can drive the need for new public transport links
› These need to be positively considered so that land use and public transport strategy reinforce each other

IMPACT ON URBAN STRUCTURE

Network Planning Principles

INSTITUTIONAL ISSUES

› Public transport framework does make a difference in terms of its regulatory features
› Choice of institutional framework does have an impact on costs
› Network planning is most important in the public service approach
› The co-ordination of the bodies involved will determine the success of the planning outcome

MARKET COMPETITION

Market competition is not a goal in itself but a means to achieve some other benefits

Advantages

Disadvantages

- Is likely to result in large differences in service levels between areas and corridors. A concentration of services to strong, well established markets around the city centre, where competition from the car is weakest, due to congestion, few and restricted parking spaces e.g. Weak coverage by public transport in large areas with heavy car use.

- Many operators in the same market often lead to complex and almost incomprehensible network of lines and services. Excess capacity and overproduction as a result of several parallel services, without taking advantage of economies of scale, with low profitability as a consequence.

- May lead to proprietary information and ticketing systems and strongly segmented marketing and branding, even to the extent that users pay more for the service than they have to.

- More focus on the development of new products and services. The flexibility and market adjustments lead to a less stable service that weakens the basis for the development of heavy infrastructure.

Source: Public Transport – planning the networks. Hitrans Best Practice Guide 2
**COORDINATED PLANNING**

**Advantages**
- It is possible to develop an integrated network as a full attractive and understandable travel alternative to car use.
- May exploit economies of scale when designing an integrated network, in the scheduling of routes and in the choice between different means of public transport.
- Can form the basis for long-term planning of infrastructure and land use.

**Disadvantages**
- There is a risk of developing an inefficient monopoly of planning with weak market orientation and too little focus on efficient operations and service product development. There is also the possibility of ignoring the transfer penalty perceived by passengers.
- May create a system with inherent cross subsidy so that it is difficult to identify which routes are viable in their own right.
- Can form the basis for long-term planning of infrastructure and land use.

**INSTITUTIONAL ISSUES**

**SUCCESS FACTORS**
- Regional organisation
- Funding
- Complementary policies which reinforce the underlying transport policies in their achievement of modal shift.
- Successful co-ordination between land-use policies and transport policies in recognition of their conjoint spatial attributes.

**INSTITUTIONAL ISSUES – FUNDING**

<table>
<thead>
<tr>
<th>City</th>
<th>Population (000)</th>
<th>Subsidy per head of population (£)</th>
<th>Public Transport Investment per head of population (£)</th>
<th>Single Fare (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madrid</td>
<td>5600</td>
<td>54</td>
<td>5</td>
<td>0.65</td>
</tr>
<tr>
<td>Barcelona</td>
<td>4228</td>
<td>17</td>
<td>1</td>
<td>0.65</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>1800</td>
<td>111</td>
<td>5</td>
<td>1.00</td>
</tr>
<tr>
<td>Helsinki</td>
<td>1200</td>
<td>71</td>
<td>40</td>
<td>1.50</td>
</tr>
<tr>
<td>Stockholm</td>
<td>1500</td>
<td>141</td>
<td>100</td>
<td>1.20</td>
</tr>
<tr>
<td>London</td>
<td>7000</td>
<td>29</td>
<td>43</td>
<td>2.00</td>
</tr>
<tr>
<td>Munich</td>
<td>2500</td>
<td>72</td>
<td>200</td>
<td>1.20</td>
</tr>
<tr>
<td>Zurich</td>
<td>1200</td>
<td>125</td>
<td>17</td>
<td>1.50</td>
</tr>
<tr>
<td>Edinburgh/Lothians</td>
<td>700</td>
<td>59</td>
<td>21</td>
<td>1.30</td>
</tr>
</tbody>
</table>

**NETWORK SUCCESS FACTORS**
- Networks that perform well are characterised by
  - Stability required for public transport system to influence urban development and create more sustainable transport patterns
  - Robust and simple structure
  - Serving all citizens

**THE ROLE OF ECONOMICS AND ITS IMPACT ON NETWORK PLANNING**

- Economics is fundamentally about allocation of resources
- Individual decisions v Government decisions
- Government responsibilities
- Individual responsibilities

**THE ROLE OF ECONOMICS**

- Economics is fundamentally about allocation of resources
- Individual decisions v Government decisions
- Government responsibilities
- Individual responsibilities
Network Planning: Principles

NETWORKS, SYSTEMS AND ACCESSIBILITY

› Commitment to networks and systems (not ‘projects’ or ‘corridors’)
  - Importance of network effect
› Transport provides accessibility

Source: http://mappery.com/map-of/Melbourne-Australia-Public-Transportation-Map

PUBLIC TRANSPORT OBJECTIVES

› Public transport policy objectives are multidimensional
  - Economic aspects
  - Environmental sustainability
  - Social aspects
› Public transport quantitatively more difficult to provide in rural areas
  - Density
  - Diverse purposes and viability

PUBLIC TRANSPORT USE

› Evidence
  - the ‘forget the timetable’ frequency
  - journey times
  - parking


WHAT SORT OF PUBLIC TRANSPORT?

COVERAGE VERSUS FREQUENCY TRADE-OFF

Coverage

Frequency

… but when it’s presented this way, they see why it’s a tradeoff.
Source: Dr Jarrett Walker

ANALYSIS OF NETWORKS

› Analysis of key corridors giving constraints to the network is imperative
› Understanding how key corridors add to the network
› Improving corridors which contribute to the network effect

Source: Draft NSW Long Term Transport Master Plan 2012, p.84
PRINCIPLES OF NETWORK PLANNING

OUTLINE
- Good Characteristics
- Why Network Planning focuses on buses
- Corridors
- Frequency
- Simplicity
- Responding to demand
- Network effects
- Interchange
- Low density – Flexible Transport Services
- Success and failure

GOOD CHARACTERISTICS
- Stability required for public transport system to influence urban development and create more sustainable transport patterns
- Robust and simple structure
- Serving all citizens

NATURE OF THE NETWORK
- Different modes
- Different lines
Need to be integrated into
- Single, user-friendly travel network giving
  - a stable and simple network of lines with fixed-scheduled services and frequencies
  - a flexible, demand-responsive service catering for all other public transport services

THE NETWORK FACTOR
- Relationship between
  - Lines
  - Waiting time
  - Transfers

SQUARESVILLE – THE IDEAL CASE
Adapted from Mees' (2000)
THE CITY DOES NOT NEED TO BE ‘SQUARE’

WHY NETWORK PLANNING FOCUSES ON BUSES

TWO APPROACHES TO NETWORK PLANNING

CORRIDORS
**Simplicity**

- One section-one line

**Simplicity**

- Minimise the number of routes

**Simplicity saves money**

- Who would understand this?

**Frequency**

- Three classes of frequency (TRRL 2004)
  - Forget the timetable
  - Fixed minute timetable
  - Service on demand only
- Not a lot of evidence as to what the frequency boundaries are …
  - Between 1 and 2: 6-12 departures/hr (London)
  - Between 2 and 3: hourly (Norway)

**Network planning and frequency**

- Forget the timetable – important to have equal intervals
- Fixed minute – challenge is to keep to timetable
- Service level 3 – more flexible approach needed (to discuss later)
› Is there an optimum frequency?
- Empirically 6-12 departures/hour in peak for medium size cities
- Diminishing returns from more than this
- If average wait time = ½ interval between departures, headways > 5-10 minutes gives long wait & transfer times check timetable before departure
- Shorter headways cost more to run but no significant reduction in waiting times

THE EFFECT OF FREQUENCY…

> Use timetables to advantage…

ADJUSTING FREQUENCY

ADJUSTING FREQUENCY FOR DEMAND VARIATIONS

RESPONDING TO DEMAND

> When capacity constraints from constant headway, should you increase frequency or change network?
- Headways of 2 mins in many big cities at peak giving vehicle on vehicle congestion
- Often used strategy is to spread out stops but this makes
  - System more complicated
  - Interchange more of a penalty
- Should consider new routes that release pressure and provide alternative travel destinations – but must not forget the network effect
**Network Planning: Principles**

**NETWORK EFFECTS**

Join nodes to extend coverage

- Suburbs
- Inner city
- City centre

Source: Public Transport – planning the networks. Hitrans Best Practice Guide 2

**THE NETWORK EFFECT**

- Low-frequency network
- Network with some high-frequency lines or sections
- High-frequency network: Networks affect

Little chance of attracting car users
Some car users are attracted on radial journeys
Public transport can become a realistic alternative for many car users, even with low complementary measures such as parking restrictions

Source: Public Transport – planning the networks. Hitrans Best Practice Guide 2

**NETWORK EFFECTS ARE IMPORTANT**

- If the frequency is high, walking further will not have an big impact on combined walk and wait time
- Having good frequency only on a small part of the network does not get people out of cars
- Having links radially and cross city with good frequency and interchange can speed up journeys

**WALKING, WAITING AND FREQUENCY**

Walking time

<table>
<thead>
<tr>
<th>Walking and waiting time</th>
<th>Departures per hour</th>
</tr>
</thead>
</table>

Source: G.Neilson, TOI, Oslo

**INTERCHANGES**

- Accept interchanges are needed
- Simple networks will need interchanges between
  - Lines operated by the same mode
  - Lines operated by different modes
- Accepting interchange means that services do not need to concentrate on direct journeys for all – allows greater coverage.
  The planning skill is to maximise the number of direct journeys by knowing what passengers want
- Interchange allows the best of the mode to be exploited and transfer to another mode when better

**INTERCHANGE CAN RELEASE RESOURCES**

Source: Public Transport – planning the networks. Hitrans Best Practice Guide 2
**INTERCHANGE CAN RELEASE RESOURCES**

- Minimise the cost of interchange
- Ensure timetable coordination
- Present route information accessibly
- Remove fare penalties
- Create short and easily understood interchanges

**Empirical evidence**
- Higher levels of transfer associated with higher public transport modal shares – the benefit of the network effect eg Arlanda, Sweden

---

**AREAS OF LOW DENSITY AND DEMAND**

- Alternative strategies are needed
  - Use the ‘hub and spoke’ approach of airlines to co-ordinate arrival and departure times
  - Use flexible transport when demand will not support use of bigger vehicles

**FAILURES AND SUCCESS**

- Use the ‘hub and spoke’ approach of airlines to co-ordinate arrival and departure times

**ISSUES IN NETWORK PLANNING**

**Very easy to do!**

Source: G. Neilson, TOL Oslo

Source: Public Transport – planning the networks. Hitrans Best Practice Guide 2

Source: Public Transport – planning the networks. Hitrans Best Practice Guide 2
ISSUES IN NETWORK PLANNING

OUTLINE

› Timeframes
› Understanding demand

TIMEFRAMES

<table>
<thead>
<tr>
<th>Short term</th>
<th>Medium term</th>
<th>Long term</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 year</td>
<td>2-3 years</td>
<td>6-25 years</td>
</tr>
</tbody>
</table>

- General: Budget planning, Audit and monitoring, Urban and regional structural planning
- Detailed: Fare policy, Mode choice decisions, Transport studies, Investment planning

OUTLINE

› Network Planning Principles 61

Understanding demand

› Clarify the user requirements and preferences. The travelling public want good service
  - Good information
  - Good access
  - Good reliability
  - Good security
  - Low price
  - Short journey time

› Network design and its presentation to the travelling public does have impacts on patronage and on system effectiveness – this is a growing area of research

› Take account of urban structure in locating demand – density, existing infrastructure and networks. Need to recognise that it works ‘both ways’

› Recognise the role of transfers and interchange points and connections to wider networks

› Remember that different topography can cause constraints

› The institutional arrangements – the history, the politics, also act as constraints as to what can be done.

OPERATIONAL SHORT-TERM PLANNING

OPERATIONAL LONG-TERM PLANNING

In vehicle

Start → Travel to stop → Wait → Board vehicle → In vehicle travel → Alight → Finish journey

Remember that the journey on vehicle is a small part of public transport travel and the traveller is concerned with the whole