Sustainable Transport Development and Integrated Transport Planning in Asian Context

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Contents

- Concept of sustainable transport and international patterns → any lessons for Asian countries?

- Context of Asian countries and policy implications → imperative of and opportunities for integrated transport

- Elements of integrated transport planning and examples

- Conclusion
### Sustainable Transport

**Evolving scope and indicators**

- Economically efficient
- Environmentally sound
  - Local environment (pollution)
  - Global environment (GHGs)
- Socially acceptable (safe, inclusive)

<table>
<thead>
<tr>
<th>Economic indicators</th>
<th>Environmental Indicators</th>
<th>Social indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of accessibility</td>
<td>Local emissions</td>
<td>Accessibility</td>
</tr>
<tr>
<td>Transport costs</td>
<td>CO2 emissions</td>
<td>Inclusiveness</td>
</tr>
<tr>
<td>Productivity</td>
<td>Car ownership rate</td>
<td>Affordability</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Pass-km per capita</td>
<td>Barrier free transport</td>
</tr>
<tr>
<td>Costs to economy</td>
<td>Fuel consumption</td>
<td>Safety/security</td>
</tr>
<tr>
<td>Profitability</td>
<td>Emission standards</td>
<td>Fitness/health</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>Fuel quality</td>
<td>Livability</td>
</tr>
<tr>
<td>Public subsidy</td>
<td>Ecological damage</td>
<td>Equity</td>
</tr>
<tr>
<td>Load factor</td>
<td>Soil/water pollution</td>
<td></td>
</tr>
<tr>
<td>Modal split</td>
<td>Noise and waste</td>
<td></td>
</tr>
</tbody>
</table>
Transport emission per person: Contributing factors & strategies

\[
\frac{\text{Trns.CO}_2}{\text{Person}} = \frac{\text{CO}_2}{\text{Unit.Energy}} \cdot \frac{\text{Unit.Energy}}{\text{V.Km}} \cdot \frac{\text{V.Km}}{\text{Seat.Km}} \cdot \frac{\text{Seat.Km}}{\text{Pass.Km}} \cdot \frac{\text{Pass.Km}}{\text{Person}}
\]

Minimize \(\text{CO}_2\) intensity of transport energy: use of low carbon fuel/energy

Vehicle Capacity

Minimize \(\text{km/}\text{person}\) (travel demand): land-use, transport pricing

Maximize the vehicle occupancy rate: higher density, incentives for mode choice

Move people in higher capacity vehicle: Provision of public transport

Improve energy efficiency of vehicles: fuel economy etc

different policy options to be implemented in a coordinated ways!

Source: Morichi and Acharya (2013)
Sustainability of passenger transport

In general, rail/bus have lower emission intensity, but it may vary by countries due to:
- Load-factor
- Source of energy

Public transport (Passenger, Rail/bus):
- Minimize travel needs through transit oriented development
- Lower energy and emissions per passenger-km
- Possibility of using low-carbon energy
- Economically efficient (lower energy, labor per pass-km)
- Safer than other modes
- Inclusive, equitable and affordable

CO2 emission by modes (Japan, 2010):

- Rail: 18 g/pass-km
- Bus: 49 g/pass-km
- Air: 102 g/pass-km
- Car: 169 g/pass-km
Sustainability of freight transport

**CO2 emission by modes, India**

- Water: 15 g/ton-km
- Rail: 28 g/ton-km
- Road: 64 g/ton-km

**Average cost of freight transport, Thailand**

- Water: 2.1 US cents/ton-km
- Rail: 3.1 US cents/ton-km
- Road: 5.7 US cents/ton-km

Data source: McKinsey & Company

Data source: OTP, Thailand

- Water and rail modes have lower CO2 emission and cost per ton-km
- Current modal split is dominated by road - not sustainable
Travel volume per person per year by countries and travel modes

` Different patterns of per capita travel volume & mode share → different degree of sustainability → lessons for Asian countries?`
Road safety crisis: an emerging challenge

World’s total (death) 2007: 661,319
- Rest of the world: 45%
- ESCAP region: 55%

World’s total (death) 2010: 637,584
- Rest of the world: 42%
- ESCAP region: 58%

..what is the most effective policy response?
Traffic accident fatality rates, 2008 (US and Japan)

Why?

- Traffic fatality rates per population: significantly different in Japan and US
- However, fatality per vehicle-km is almost same

• Minimize vehicle ownership
• Minimize VKm per capita

• Maximize the use of public transport!
## Asian context and policy implications

### Context
- Higher economic growth
- Rapid urbanization
- Megacities development
- Economic restructuring in process
- Evolving spatial form
- Higher population density
- Land scarcity
- Large scale travel demand
- Rapid motorization
- Higher use of motorcycles
- Public transport captive users
- Inadequate infrastructure
- Widening income disparity

### Policy implications
- Need of multimodal transport system (diverse services)
- Better opportunities for transport and land-use coordination
- Commercial viability of public transport
- Importance of “space efficient” technology
- Some degree of road congestion inevitable!
- “modal keep” : as important as “modal shift”?
- Importance of both hardware and software options

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**Integrated transport!**
## Road Space in Selected Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Area (Km²)</th>
<th>Pop. Density Per/ha</th>
<th>Road Area Km²</th>
<th>% (city area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Paris</td>
<td>105</td>
<td>202</td>
<td>27</td>
<td>25.8</td>
</tr>
<tr>
<td>New York City</td>
<td>837</td>
<td>112</td>
<td>210</td>
<td>25.2</td>
</tr>
<tr>
<td>Inner London (12 boroughs)</td>
<td>589</td>
<td>72</td>
<td>96</td>
<td>16.4</td>
</tr>
<tr>
<td>Inner Tokyo (8 wards)</td>
<td>110</td>
<td>121</td>
<td>24</td>
<td>21.7</td>
</tr>
<tr>
<td>Tokyo 23wards</td>
<td>621</td>
<td>131</td>
<td>114</td>
<td>18.1</td>
</tr>
<tr>
<td>Seoul City</td>
<td>605</td>
<td>168</td>
<td>80</td>
<td>13.3</td>
</tr>
<tr>
<td>Taipei City Inner Core</td>
<td>134</td>
<td>197</td>
<td>20</td>
<td>14.9</td>
</tr>
<tr>
<td>Shanghai City Inner Core</td>
<td>108</td>
<td>378</td>
<td>13</td>
<td>12.0</td>
</tr>
<tr>
<td>Bangkok City Core</td>
<td>225</td>
<td>96</td>
<td>16</td>
<td>7.2</td>
</tr>
<tr>
<td>Jakarta City</td>
<td>656</td>
<td>133</td>
<td>48</td>
<td>7.3</td>
</tr>
</tbody>
</table>

Data source: STREAM Study compilation

### Asian cities
- Inadequate road
- Inefficient road hierarchy
Integrated transport: Key elements and examples

1. Best use of different transport modes to serve their respective competitive niches- investment for infrastructure and service provision.

Diverse transport modes serving different demand segments in Asian countries
Competitive travel distance for intercity transport modes

Mode shares for different intercity modes along Toakaido-Sanyo (Tokyo-Osaka-Fukuoka) corridor in Japan

- **Car**: < 270 km
- **Rail (HSR)**: 270-960 km
- **Air**: > 960 km

- Wider market niche for HSR, but many Asian countries yet to introduce the technology
- HSR project under planning, such as in India, Thailand, Malaysia, Viet Nam, HSR

Data source: MLIT, Japan
Competitive niche for freight transport for different modes, India

- Over 2/3 of freight volume in India is suitable for water and rail transport!
- Scope for modal shift

Freight modal split India, 2007

- Road: 58%
- Rail: 36%
- Water: 6%

Source: McKinsey & Company

Freight by transport distance India

- 100% = 850 billion ton-km
- Bulk
  - >700 km: 55%
  - 400-700 km: 26%
  - 0-400 km: 19%

- 100% = 475 billion ton-km
- Non-bulk
  - 0-400 km: 21%
  - 400-700 km: 60%
  - >700 km: 19%
Integrated transport: Key elements...contd

2. Coordination between private and public transport modes
   
   – No single mode can serve the large travel demand
   
   – Externalities and operating cost dynamics require support for public transport (level-playing field) and/or rational pricing for private modes

   • Higher cost for the use of private modes partly explains higher mode share of public transport in Japan.
   
   • Lower fuel tax (or even subsidy) and lower toll rate in most developing Asian countries → not helpful for sustainable transport!
Integrated transport: Key elements...contd

3. Coordination among different public transport modes: hierarchical system of public transport

**Urban rail hierarchy in Tokyo**

<table>
<thead>
<tr>
<th>Railway Type</th>
<th>St. Spacing</th>
<th>Operating Speed *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shinkansen Railway (Bullet Train)</td>
<td>30 – 50 km</td>
<td>120 -130 km / hr</td>
</tr>
<tr>
<td>Inter-city Train (Japan Railways)</td>
<td>5 – 6 km</td>
<td>50 - 60 km / hr</td>
</tr>
<tr>
<td>Express Train (Private Railways)</td>
<td></td>
<td>40 - 45 km / hr</td>
</tr>
<tr>
<td>Ordinary Train (Private Railways)</td>
<td>1 – 2 km</td>
<td>40 - 45 km / hr</td>
</tr>
<tr>
<td>Subway</td>
<td>0.5 – 1 km</td>
<td>30 - 35 km / hr</td>
</tr>
<tr>
<td>Monorail / AGT</td>
<td>0.5 – 1 km</td>
<td>20 - 30 km / hr</td>
</tr>
</tbody>
</table>
Integrated transport: Key elements...contd

4. Coordination between transport and other related system (land-use and users' behavior)

Successful transit oriented development in developed East Asian cities!

Transport performance depends on the interaction among different systems!
GRP per capita Vs car ownership rate:
Selected metropolitan areas (2002–04)

Data source: STREAM Study compilation from various sources

Different regions:
- Path of US cities?
- Path of EU cities?
- Path of developed Asian cities?
- Alternative paths for Asian Dev’ping cities?

Selected metropolitan areas (2002–04):
- Tokyo
- New York
- Atlanta
- Rome
- Singapore
- Hong Kong
- Taipei
- Seoul
- Athens
- Paris
- London
- Frankfurt
- Shanghai
- MNL
- BJG
- BKK
- JKT

GRP per capita Vs car ownership rate:

Path of US cities?
Path of EU cities?
Path of developed Asian cities?
Alternative paths for Asian Dev’ping cities?
GRP per capita Vs urbanized density

\[ y = -177.06 \ln(x) + 1111.2 \]

\[ R^2 = 0.7643 \]

- Urbanized density: key factor for car ownership rate!
- Higher density: result of deliberate policies?

Data source: STREAM Study compilation from various sources
### Operating indicators for selected metro (subway etc) system

<table>
<thead>
<tr>
<th>System/Agency</th>
<th>Route-Km</th>
<th>Average daily metro rail passengers per route-km</th>
<th>Average rail car occupancy (persons per rail car)²</th>
<th>Total operating revenue (million US $)³</th>
<th>Ratio of operating revenue and operating expenses⁴</th>
<th>Fare box ratio⁵</th>
<th>Depreciation and amortization (% of total operating expense)</th>
<th>Average fare revenue per passenger (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York Subway⁶</td>
<td>337</td>
<td>12,844</td>
<td>28</td>
<td>2,246</td>
<td>0.58</td>
<td>0.58</td>
<td>15.1</td>
<td>1.42</td>
</tr>
<tr>
<td>London Underground</td>
<td>402</td>
<td>7,544</td>
<td>36</td>
<td>2,999</td>
<td>0.95</td>
<td>0.86</td>
<td>12.2</td>
<td>2.45</td>
</tr>
<tr>
<td>Paris Metro (RATP)⁷</td>
<td>214</td>
<td>18,935</td>
<td>36</td>
<td>3,117</td>
<td>0.60</td>
<td>0.52</td>
<td>14.1</td>
<td>1.03</td>
</tr>
<tr>
<td>Tokyo Metro (Tokyo)</td>
<td>195</td>
<td>32,346</td>
<td>66</td>
<td>3,736</td>
<td>1.29</td>
<td>1.15</td>
<td>28.3</td>
<td>1.45</td>
</tr>
<tr>
<td>Toei Subway (Tokyo)</td>
<td>109</td>
<td>21,331</td>
<td>36</td>
<td>1,484</td>
<td>1.15</td>
<td>1.08</td>
<td>37.6</td>
<td>1.63</td>
</tr>
<tr>
<td>Seoul Metro (Seoul)</td>
<td>135</td>
<td>29,963</td>
<td></td>
<td>793</td>
<td>0.81</td>
<td>0.69</td>
<td>15.4</td>
<td>0.46</td>
</tr>
<tr>
<td>SMRT Corp (Seoul)</td>
<td>152</td>
<td>11,007</td>
<td></td>
<td>455</td>
<td>0.71</td>
<td>0.62</td>
<td>25.5</td>
<td>0.65</td>
</tr>
<tr>
<td>MTR Corp. (Hong Kong)⁸</td>
<td>218</td>
<td>16,321</td>
<td>60</td>
<td>2,082</td>
<td>1.80</td>
<td>1.39</td>
<td>14.4</td>
<td>1.23</td>
</tr>
<tr>
<td>SMRT Singapore⁹</td>
<td>99</td>
<td>14,910</td>
<td>70</td>
<td>353</td>
<td>1.37</td>
<td>1.37</td>
<td>18.3</td>
<td>0.66</td>
</tr>
<tr>
<td>TRT Corporation (Taipei)</td>
<td>101</td>
<td>13,739</td>
<td></td>
<td>399</td>
<td>1.01</td>
<td>0.88</td>
<td>4.2</td>
<td>0.69</td>
</tr>
<tr>
<td>Sky Train (BTS, Bangkok)</td>
<td>26</td>
<td>15,300</td>
<td></td>
<td>122</td>
<td>1.43</td>
<td>1.29</td>
<td>35.9</td>
<td>0.76</td>
</tr>
<tr>
<td>Bangkok Subway (BMPCL)</td>
<td>20</td>
<td>9,094</td>
<td></td>
<td>55</td>
<td>0.90</td>
<td>0.78</td>
<td>15.5</td>
<td>0.73</td>
</tr>
<tr>
<td>Delhi Metro</td>
<td>161</td>
<td>8,789</td>
<td></td>
<td>220</td>
<td>0.95</td>
<td>0.88</td>
<td>54.0</td>
<td>0.40</td>
</tr>
<tr>
<td>Santiago Metro</td>
<td>103</td>
<td>16,510</td>
<td></td>
<td>419</td>
<td>1.12</td>
<td>0.95</td>
<td>32.2</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Data source: Annual report of respective agencies. Operating expenses includes all operating costs including depreciation.

- Maintaining high ridership is important for sustainable operation of metro system
- In most western cities, metro rail operation requires public subsidies
5. Physical and operational integration of infrastructure and services
   - Feeder and line-haul modes
   - Transfer facilities, station plaza
   - Direct operation between commuter rail and subways (to avoid transfer such as in Tokyo)
   - Fare integration (IC card, distance-based fare: Seoul, Singapore)
   - Facilities for intermodal freight transport (cargo handling, dry ports, logistics centers, last-mile infrastructure)
Conclusion

• Integrated transport is the most effective approach to develop sustainable transport system.

• If transport system is developed by focusing on particular technology/mode at different points of time, narrow scope of integration in future (only at the operational level).

• Special context of Asian countries offers real opportunities for developing fully integrated system → contribute to developing sustainable transport system.

• Asian countries are making efforts to improve public transport and intermodal freight transport to achieve sustainable performance.

• Integrated transport planning can put more efficient physical structure (infrastructure and land-use etc) in place that results in a sustainable operation.
Thank you!