UNCRD workshop (13/5/30)

*Designing Sustainable Low-Carbon Transport Systems integrated with Regional Development in Asia*

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Risk of rapid growth in CO$_2$ emissions in developing countries in Asia

Developed Countries

Developing Countries

Per Capita GHG Emission

Leap-frog

Backcasting

Low Carbon Society

Energy-consuming development
Framework of Backcasting Approach to Developing Low-Carbon Transport Systems

**Economic Growth**
- Employment
- Education
- Safety
- Health
- Environment

**Ageing**

**Innovation in ICT**

**Socio-Economic Systems**

**Elements**
- Travel Demand (Habits)
  - Necessity to Travel
  - Local Travel
  - Diverse Destination
  - Mode Preferences
- Life Style
  - Information Dependence
  - Community
  - Leisure
  - Sharing

**Indicators**
- GDP
- QOL
- CO₂

**Other Systems**

**Land-use Transport System**
- Travel Distance
- Modal Share
- Emission Factor by mode

**Other Policies**

**Land-use Transport Policies**

**Financial & Institutional Coordination**
(Domestic & International)
Socio-Economic Trends in Asia

Economic Growth in Japan

Population Growth in Japan

Economic Growth in Asia (Forecast)

Population Growth in Asia (Forecast)

Population growth ratio from 2010

Source: UN World Population Prospects: The 2010 Revision
Visioning Future Transport Systems with Key Indicators

What are necessary policies to realize it?

Avoid Unnecessary Travel
Shift to Low-Carbon Mode

AVOID
SFHIT

Ageing
Transport Emission intensity

BAU
Leap-Frog

CO2

Walk
16%
Bus
41%
Car
43%
Rail
4%

Walk
2%
Car
56%

1989 2005 2050

Bangkok

London

Reference
Tokyo

(2008)

(2007)

Car
56% 25%
Bus
17% 19%
Walk
6% 25%
Rail
13% 25%

What are necessary policies to realize it?
## Policy/technology options (CUTE Matrix)

<table>
<thead>
<tr>
<th>Strategies</th>
<th>AVOID</th>
<th>SHIFT</th>
<th>IMPROVE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Means</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Technologies</td>
<td>• Transport oriented development (TOD)</td>
<td>• Railways and BRT development</td>
<td>• Development of electric vehicles</td>
</tr>
<tr>
<td></td>
<td>• Poly-centric development</td>
<td>• Interchange improvement among railway, BRT, bus and para-transit modes</td>
<td>• Development of biomass fuel</td>
</tr>
<tr>
<td></td>
<td>• Efficient freight distribution</td>
<td>• Facilities for personal mobility and pedestrians</td>
<td>• &quot;Smart grid“ development</td>
</tr>
<tr>
<td>Regulations</td>
<td>• Land-use control</td>
<td>• Separation of bus/para-transit trunk and feeder routes</td>
<td>• Emissions standards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Local circulating service</td>
<td>• “Top-runner“ approach</td>
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<tr>
<td></td>
<td></td>
<td>• Control on driving and parking</td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>• Telecommuting</td>
<td>• ITS public transport operation</td>
<td>• &quot;Eco-driving&quot;</td>
</tr>
<tr>
<td></td>
<td>• Online shopping</td>
<td></td>
<td>• ITS traffic-flow management</td>
</tr>
<tr>
<td></td>
<td>• Lifestyle change</td>
<td></td>
<td>• Vehicle performance labeling</td>
</tr>
<tr>
<td>Economy</td>
<td>• Subsidies and taxation to location</td>
<td>• Park &amp; ride</td>
<td>• Fuel tax/carbon tax</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cooperative fare systems among modes</td>
<td>• Subsidies and taxation to low-emissions vehicles</td>
</tr>
</tbody>
</table>
Dynamic Tracking of Transport Related Emission Mechanism

**Mitigation**
- CO₂ emission
  - GDP

**AVOID**
- Travel Demand (Travel Distance)
  - GDP

- Car Dependency (Modal Split)
  - GDP

- Technology (CO₂ Emission Factor)
  - GDP

**SHIFT**
- Urban Compactness
- Built-up Area
- Trip Frequency
- Public Transport Network
- Car Ownership
- Fossil Fuel Share
- Traffic Speed

**IMPROVE**
- GDP

**CUTEPolicyMatrix**
- Technology
- TOD
- PT Development
- Road Development
- Development Control
- Regulation
- Information
- Economy
- Road Pricing
- Fuel Tax
Feasibility of Policy Implementation

Thailand

Increasing public investment in economic growth

Japan

Increasing limitation to transport investment due to ageing and population decline

What are necessary frameworks to implement policies to realize the future vision?
Steps of the Backcasting Approach

1. Capturing Key Causal Relationship of CO₂ Emissions from Transport
2. Visioning Low Carbon Transport Systems
3. Selecting Effective Policy Packages to Realize the Vision
4. Examining the Feasibility of Policy Implementation

Visioning Low Carbon Transport Systems

Selecting Effective Policy Packages to Realize the Vision

Examining the Feasibility of Policy Implementation

Capturing Key Causal Relationship of CO₂ Emissions from Transport
Steps of the Backcasting Approach

Vision

System

Transport Policy

Incentive to Implement

1. Capturing Key Causal Relationship of CO₂ Emissions from Transport
Causal Relationship of Transport-related CO$_2$ Emissions in Asia: Vicious Circles between Motorization and Urban Sprawl

- Income growth → Higher car ownership → More car use
- Excessive car-park provision
- Poor access to public transport
- More car use → Longer travel distance → Traffic congestion
- Road-oriented development → Larger built-up area
- Urbanization → Station-area development → Railway/BRT development

- Car plate auction → Motorization (SHIFT)
- Car plate restriction
- Freight traffic restriction zone
- Economic Damage
- More energy consumption
- Disadvantages (IMPROVE)
- Emission standards
- Environmental Problems

Urban Sprawl (AVOID)
The Trend of Car Ownership Growth

Car ownership rate
[cars/ 1000 inhabitants]

Per capita GDP [Constant 2003 USD]
The Trend of Traffic Congestion

![Graph showing the trend of traffic congestion with data points for different cities over the years, including speed (min/km), road length per car (m/car), and car ownership (car/1,000 inhabitants).]
The Trend of Road Development

Tokyo

Beijing

Bangkok

Shanghai
Megacities in Asian developing countries have started MRT development since the early 2000s.
**Changes in Urban Forms**

**Shanghai** (6,400km²)

- 2000
- 2005
- 2010

**Bangkok** (7,650km²)

- 2000
- 2005
- 2010

Population [person]
- ~5,000
- ~10,000
- ~30,000
- ~50,000
- ~100,000
Steps of the Backcasting Approach

1. Visioning Low Carbon Transport Systems
2. System
3. Transport Policy
4. Incentive to Implement

Visioning

System

Transport Policy

Incentive to Implement
Vision 2050: Urban Transport

Hierarchically Connected Compact City

- AVOID: Self-contained compact city connected with each other
- IMPROVE: Low-carbon vehicles and traffic operation system
- SHIFT: Seamless & hierarchical transport system

railway, bus rapid transit, conventional bus, para-transit, personal mobility

small vehicle, renewable energy + biomass fuel
Key Options of the Vision (Urban Transport)

A: Transit-Oriented Polycentric Systems
B: Quality MRT Systems
C: Multi-Purpose Transport Systems

- Safe Transport to Secure Communal Education
- Reliable Transport to Support Economic Growth
- Diverse Transport to Contribute to Healthy Life

To form habits not to use cars
Policy Package of Transit-Oriented Polycentric Development for Early-stage Developing Cities with Land-use Control

Transit-Oriented Sub Center Development
- Provision of local employment & education
- Value Capture

MRT development
- Integrated fare system among modes
- Comfortable bus stops

Curitiba BRT

Development axes
Policy Package of Quality MRT Development for Early-stage Developing Cities without Land-use Control

MRT Infrastructure/ Management Improvement

- Express lines, Large capacity carriers
- ICT-based operation
- Traffic control

Bogota BRT
2. Policy Package of Multi-Purpose Transport Development for Developing Mega-cities

**Suburban Urban-Village Development**
- Neighborhood design connected to transit services
- Multi-socioeconomic neighborhood development

**Feeder Transport Improvement**
- Provision of feeder circular routes
- Street improvement for personal mobility & pedestrians

**Singapore LRT**

**Punggol LRT**
- Orbital local network
- 10km, 15 stations
- Connection to MRT
- Automatic operation

(Sun, G., LTA)
Steps of the Backcasting Approach

1. Vision
2. System
3. Transport Policy
4. Incentive to Implement

Selecting Effective Policy Packages to Realize the Vision
Testing Development Scenarios of Megacities; Bangkok, Thailand

SHIFT (Rail Network)

AVOID (Spatial Distribution of Population)

2005

2050 Road-oriented Development Scenario

2050 Rail-oriented Development Scenario

Is Rail development more effective than Road development?
Estimated Time Saving from Road and Rail Development (Bangkok)

*1 In the Do-Nothing case, no investment in transport development would be made from 2005 to 2010.
Estimated CO₂ Mitigation in Bangkok

2005

- Car: 59%
- Bus: 29%
- Rail: 2%
- Walk: 10%

2050 Road-Oriented Development

- Car: 97%
- Bus: 3%
- Rail: 0.2%
- Walk: 0.4%

2050 Rail-Oriented Development

- Car: 32%
- Rail: 66%
- Bus: 2%
- Walk: 0.4%

CO₂ Emission (kt-CO₂/year)

- 2005: 50,000
- 2050 Road-Oriented Development: 56,000
- 2050 Rail-Oriented Development: 55,800

Mitigation:
- 8.1% (Road-Oriented Development)
- 55.8% (Train-Oriented Development)
Testing Development Scenarios of Middle-sized Cities; Khon Kean, Thailand

- 450km from Bangkok
- Pop 240,000
- Area 230 km²

- 5 Routes of BRT Planned to operate from 2022
The Future Vision of Khon Kean

With TOD case in 2022

Leverage Advanced Technologies

Hierarchical Compact City

Bio Ethanol Production and Ethanol Bus Introduction

Seamless & Hierarchical Transportation System

Avoid

Shift

Improve
Estimated CO$_2$ Mitigation in Khon Kean

- Shift: 38.5% PV->BRT
- Avoid: 72.6%
- Improve: 29

(Nihon Univ.)
### Policies in previous studies on Vientiane

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Policy</th>
<th>Outline</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid</td>
<td>Compact City</td>
<td>Spawling area put together.</td>
<td>EST</td>
</tr>
<tr>
<td></td>
<td>Transit Oriented Development (TOD)</td>
<td>Land use designed to maximize access to public transport</td>
<td>EST</td>
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<tr>
<td></td>
<td>Information Communications Technologies (ICT)</td>
<td>Cut down commute time by using the Internet.</td>
<td>EST</td>
</tr>
<tr>
<td>Shift</td>
<td>Non-Motorized Transport (NMT)</td>
<td>Accelerate the use of NMT.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Bus Improvement</td>
<td>Introduce of Loop bus or Articulating bus. etc</td>
<td>EST</td>
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<tr>
<td></td>
<td>Bus Rapid Transit (BRT)</td>
<td>Public transportation systems using buses to provide faster, more efficient service than an ordinary bus line.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Light Rail Transit (LRT)</td>
<td>Higher capacity and higher speed than traditional street-running tram systems.</td>
<td>EST</td>
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<td></td>
<td>Road Pricing</td>
<td>An economic concept regarding the various direct charges applied for the use of roads.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Provision with Parking Space</td>
<td>Maintenance appropriate parking.</td>
<td>EST</td>
</tr>
<tr>
<td></td>
<td>Parking Management</td>
<td>Introduce of Park and Ride. etc</td>
<td>EST</td>
</tr>
<tr>
<td>Improve</td>
<td>Road Improvement</td>
<td>Improvement of the intersection and development bypass.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Cleaner Fuels and Technologies</td>
<td>Eco-car to recommend.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Road Traffic Law</td>
<td>Implement the Road Traffic Law.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Intelligent Transportation Systems (ITS)</td>
<td>Improvement of the signal control.</td>
<td>EST</td>
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<tr>
<td></td>
<td>Freight Transport</td>
<td>Efficiency of freight vehicles.</td>
<td>EST</td>
</tr>
</tbody>
</table>

(Nihon Univ.)
3

Development Scenarios of Middle-sized Cities; Vientiane, Laos

Map of Bus lines

Map of proposed BRT lines

(Nihon Univ.)
Low-Carbon Urban Transport Mode by Region in Thailand

Population of a region

Railway (4 cities)
LRT (2 cities)
BRT (16 cities)
Car (7 cities)
Steps of the Backcasting Approach

1. **Vision**
2. **System**
3. **Transport Policy**
4. **Incentive to Implement**

Examining the Feasibility of Policy Implementation
Identifying Necessary Levels of MRT Development to achieve 70% CO₂ mitigation target in Urban Transport

Avoid: land-use control (5%/year less expansion of built-up area)

Improve: Increasing LEV share (EV76%, HV23%),
Improving Energy Efficiencies (by 28%)
Improving power generation efficiencies (17.6 times)
Examining Financial Feasibility of the MRT Development

The Marginal Mitigation Cost decides Effectiveness of Investment depending on Sectors and Regions.

Estimated Marginal Mitigation Cost in Thailand in 2050:

<table>
<thead>
<tr>
<th>Effective Investment in the Transport Sector</th>
<th>Urban Transport ($/t-CO₂)</th>
<th>All-Sector Average ($/t-CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>741</td>
<td>816</td>
</tr>
</tbody>
</table>

Effective Investment in the Transport Sector:

9.2% less
Discussion

• What is the challenges of developing low-carbon transport systems integrated with regional development in Asian developing countries?
• What is the visions of the desirable system?
• How can we realize the vision with measures in a leapfrog manner?
• Is it feasible to implement such measures?