Public Symposium on
Environmentally Sustainable Transport (EST) in Asia
17 March 2015 @ Nagoya University SusCoDe

Beyond Bangkok 2020 Declaration

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Nagoya University (NU-SusCoDe)
Critical Issues

1. Urban Transport
   1. Low Carbon → Avoid, Shift, Improve strategies + WCTRS-CUTE Matrix
   2. Motorisation – Suburbanisation Nexus
   3. Integrated Transport
   4. Compact city /Smart city /Smart transport?

2. Sustainability Indicators and Standard Analysis Method
   1. CO₂
   2. Pollution (PM2.5, .......)
   3. Well-Being → QOL approach → CO₂/Pollutants Performance for QOL

3. Spatial Scale
   1. Urban Transport → Mega Region Transport → Intercity Transport
   2. Industrial (Re)Location and Transport Provision in mega-regional/ international scale
   3. LCC rapid development vs High Speed Rail

4. Sustainability vs. Resilience?
Urban Transport

1. Low Carbon $\rightarrow$ Avoid, Shift, Improve strategies + WCTRS-CUTE Matrix
2. Motorisation – Suburbanisation Nexus
3. Integrated Transport
4. Compact city /Smart city /Smart transport?
Risk of rapid growth in CO₂ emission in developing countries in Asia

Per Capita GHG Emission

Developed Countries

Developing Countries

Leap-frog

Backcasting

Low Carbon Society

Energy-consuming development

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SusCoDe-UNCRD EST in Asia
School boy waiting for a bus at 4:30 am in Suburb of Bangkok (1993)
Slower than walkers in Sukunvit Rd., Bangkok
8hrs+ Commuters > 10%  (1993)
Neglecting Railways in Bangkok

Photo by Hayashi (1994)

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A Sign for Leapfrog turning to Railways towards Low Carbon Transport in Asia

CO2

1989 2005 2050 2020

Leap-Frog

BAU

Master Plan in 2020

Heavy Congestion

BTS Sky Train 20km

MRT Development 81km

10lines total 464km

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1989

1999

2010
CO2 Emission Caused by Urban Transport (Emission Structure)

**AVOID**

Compact Urban System

**Total Trips [million trips/ day]**

Tokyo

- 2008: 11.3 m pop
- 2010: 12.9 m pop

**Total person-km [million km/ day]**

Bangkok

- 1968: 11.6 m pop
- 2008: 11.3 m pop

**GDP [bil.US$]**

**CO2 from transport [bil.t-CO2/day]**

**Seamless Public Transport**

**Energy Efficient Transport**

**SHIFT**

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**IMPROVE**

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1. Urban Structure
   A. Wide spread
   B. TOD
   C. Centralized
   D. Multipolar

2. Network
   Shape
   a. Grid
   b. Hybrid
   c. Radial

   Mode
   1) Urban Rail
      Bus
   2) Urban rail
      Para-transit
   3) BRT
      Bus
   4) BRT
      Para-transit

3. Technology by mode
   Technological Innovation
   New system

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SusCoDe-UNCRD EST in Asia
<table>
<thead>
<tr>
<th><strong>CUTE Matrix</strong></th>
<th><strong>Avoid</strong></th>
<th><strong>Shift</strong></th>
<th><strong>Improve</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>Reduce traffic demand</td>
<td>Reduce emissions per unit Transported</td>
<td>Reduce emissions per kilometer</td>
</tr>
<tr>
<td>▪ Pedestrian Ort Dev’t</td>
<td>▪ Integrated Public Transport System (BRT+ParaTransit)</td>
<td>▪ LEV, EV</td>
<td></td>
</tr>
<tr>
<td>▪ Bicycle Ort Dev’t</td>
<td>▪ Highly Competitive Railway</td>
<td>▪ Alternative Energy</td>
<td></td>
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<tr>
<td>▪ Transit Ort Dev’t</td>
<td></td>
<td>▪ Advanced Infra- Tech</td>
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<td><strong>Regulation</strong></td>
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<td>▪ Bus/Tram Priorities</td>
<td>▪ Logistic Efficiency</td>
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<td>▪ TDM</td>
<td>▪ Non-MT</td>
<td>▪ Emission Standard</td>
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<td>▪ Parking Regulation</td>
<td>▪ Smarter Modal Evolution</td>
<td>▪ Top Runner Program</td>
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<tr>
<td>▪ Compact/Mix Land Use</td>
<td></td>
<td>▪ Eco-Drive</td>
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<td><strong>Information</strong></td>
<td>▪ ICT</td>
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<td>▪ Telework</td>
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<td>▪ ITS</td>
<td>▪ Labeling of Vehicle Performance</td>
</tr>
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<td>▪ Smart Choices for Workplace and Schools</td>
<td></td>
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<tr>
<td><strong>Economic</strong></td>
<td>▪ Fuel Tax</td>
<td>▪ Fuel Tax</td>
<td>▪ Fuel Tax</td>
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<tr>
<td>▪ Road Pricing</td>
<td>▪ Road Pricing</td>
<td>▪ LEV Preferential Tax</td>
<td></td>
</tr>
<tr>
<td>▪ Car Charge / Fee</td>
<td>▪ Car Charge / Fee</td>
<td></td>
<td></td>
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<tr>
<td>▪ Location Subsidy</td>
<td></td>
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</tbody>
</table>
Miracle Revolution of Bangkok
# Chronological Summary of MRT Development in Bangkok

<table>
<thead>
<tr>
<th>Year</th>
<th>SRT</th>
<th>ETA (MRTA)</th>
<th>BMA</th>
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<tbody>
<tr>
<td>1970s</td>
<td>Feasibility study</td>
<td></td>
<td></td>
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<tr>
<td>1980s</td>
<td>Feasibility study</td>
<td>Private Involvement (Fail)</td>
<td>Lavalin</td>
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<td></td>
<td>Hopewell</td>
<td>Private Involvement (Fail)</td>
<td></td>
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<tr>
<td>1990s</td>
<td>Private Involvement</td>
<td>JICA BIRD ACCESS report</td>
<td>BTS</td>
</tr>
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<td></td>
<td>Construction (Incomplete)</td>
<td>Private Involvement (Fail)</td>
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<tr>
<td></td>
<td>Blue Line</td>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>2000s</td>
<td>Airport Link</td>
<td>Construction</td>
<td></td>
</tr>
</tbody>
</table>

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Situation of Sukhumvit after the opening of Skytrain (2002)
Newly Added Rail Transit Till Today

Before 1990

Hopewell project 1990
Lavalin project 1992

1999 Opening of BTS (Skytrain)
2004 Opening of MRTA (Blue line)
2010 Opening of SRT (Airport link)

2010 Opening of SRT (Airport link)

Don Mueang Airport

Bang Sue

Makkasan

Hua Lamphong

Siam

Suvarnabhumi Airport

Kilometers

0 5

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BANGKOK

1990s (Before MRT Development)

2000s (After MRT Development)

Photo by Hayashi, 1993

Photo by Hayashi, 2002

Trend of Traffic Congestion

Average speed (km/hr)

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Speed (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>25</td>
</tr>
<tr>
<td>1985</td>
<td>15</td>
</tr>
<tr>
<td>1990</td>
<td>10</td>
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</tbody>
</table>

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Road vs Rail: which is more effective for calming traffic congestion

2050 Road-Oriented Development (Bangkok)
- CO₂ Emissions: -22%

2050 Rail-Oriented Development (Bangkok)
- CO₂ Emissions: -45%

- Travel Time
- Road Development
- Rail Development
- CO₂ Emissions:
  - Road: -22%
  - Rail: -45%

- Construction & Operation Cost
- Urban Policy Roadmap
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- SusCoRD-UNCRD EST in Asia
3 Factors for Drastic Improvement in Road Traffic Congestion

- Outer Ring Road
- Bang Sue
- Hua Lamphong
- Siam
- Don Mueang Airport
- Makkasan
- Suvarnabhumi Airport

Kilometers

Industrial zone

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The Effects of Integrated Transport Systems on Traffic Congestion and CO₂ Mitigation

Interregional Vision

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Laem Chabang Port
**Current:**

2010yr 84.8km

**Planning:**

2016yr 236km
2019yr 391km
2029yr 509km

(12 lines)

Source:
Master Plan Study to adjust rail mass transit system in Bangkok and its vicinity (2010)
Sustainability Indicators and Life Style

1. CO$_2$
2. Pollution (PM2.5,........)
3. Well-Being $\rightarrow$ QOL approach $\rightarrow$ CO2/Pollutants Performance for QOL
Driving Forces of Society in Asia

1. **Economic growth (vs 2010)**

   - China (5.5~8.9)
   - Thailand (3.7~8.1)

2. **Population change (vs 2010)**

   - Japan: 0.86
   - Thailand: 0.97
   - China: 1.03

3. **Ageing in Thailand (2010-2050)**

   - 2.92 times (2010-2050)

Source: UN World Population Prospects: The 2010 Revision

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Urban Vision

Targeting Low-Carbon Urban Transport Systems

Efficiency Demanding

Tokyo 23 district

Trip Purpose

- Private: 49%
- Commuting: 31%
- Business: 11%
- Education: 9%

Mode share

- Walk: 25%
- Car: 13%
- Bus: 6%
- Rail: 56%

2008

\[ \text{CO}_2 \text{ per Capita from Transport} = 1.6t \ (2004) \]

Inner London

Trip Purpose

- Private: 69%
- Commuting: 17%
- Business: 6%
- Education: 8%

Mode share

- Walk: 39%
- Car: 25%
- Rail: 17%
- Bus: 19%

2010

\[ \text{CO}_2 \text{ per Capita from Transport} = 1.2t \ (2010) \]
Vision of Future Society needed for Low Carbon Transport in Asia

<table>
<thead>
<tr>
<th>Society</th>
<th>Aggressive Growth (Efficiency Demanding)</th>
<th>Moderate Growth (Sufficiency Seeking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economically Developed</td>
<td></td>
<td>Socially Matured</td>
</tr>
<tr>
<td>Production</td>
<td>Mass Production for Mass Consumption</td>
<td>More Local Production for Local Consumption</td>
</tr>
<tr>
<td>Lifestyle</td>
<td>Work Oriented</td>
<td>More Social Activities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Travel Purposes</th>
<th>Working Age</th>
<th>Commuting</th>
<th>Elderly</th>
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</thead>
<tbody>
<tr>
<td>Business</td>
<td>14%</td>
<td>42%</td>
<td>8%</td>
</tr>
<tr>
<td>Private</td>
<td>26%</td>
<td></td>
<td>46%</td>
</tr>
<tr>
<td>Shopping</td>
<td>17%</td>
<td></td>
<td>36%</td>
</tr>
<tr>
<td>Commuting</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Quantity-based Spatial Design

Quality Human-Oriented Spatial Design

TOKYO (2008)

Urban Vision

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**Vision of Urban Transport System:** Hierarchically Connected Compact City

**AVOID**
Well-Connected Hierarchical Urban Cores

**SHIFT**
Hierarchical Public Transport System

**IMPROVE**
Low-Carbon & Efficient Road Transport System

- **CBD**
- **Transit Oriented Development (TOD)**
- **Mass Rapid Transit (MRT)**

**Urban Vision**
- **Car-Oriented Station Front**
- **Feeder-Improved Station Hinterland**
- **Car-Free Station Front**

- Attractive Urban Development
- Frequent Feeder Services
- Quality Openspace

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Comparison in Effectiveness by Road and Rail Improvements

Road-Oriented Development (2050)
- Car: 78%
- Rail: 2.7%
- Bus: 19%

Rail-Oriented Development (2050)
- Car: 38%
- Rail: 39%
- Bus: 23%

Travel from Inner Suburb to City Centre

Road transport:
- Average travel time: -12%

Rail transport:
- Average travel time
Emission Standards in the World

Atmospheric Concentrations of NOx and PM around roads in Japan

The Roadmap for Low-Carbon Urban Transport Development in ASEAN Megacities

CO₂-emission reduction

- **AVOID**: Land-use control (3% less annual expansion of built-up area)
- **SHIFT**: 4,568 km MRT development, (6 cities, Ave.: 760 km/city)
  - 23,337 km BRT development (23 cities, Ave.: 1015 km/city)
- **IMPROVE**: Increasing LEV share (EV76%, HV23%), Improving Fuel Efficiencies (by 28%)
  - Emission intensity of power generation (2005: 1269 g-CO₂/kwh, 2050: 546 g-CO₂/kwh)
Possibility of CO2 Reduction By AVOID/SHIFT/IMPROVE

**Urban Policy Roadmap**

- **AVOID**
  - Road-oriented
  - Rail-oriented

- **SHIFT**
  - Rail-oriented (Car-free)

- **IMPROVE**

**Total person-km (million km/day)**

- Tokyo 12.9 m pop
- Bangkok 12.2 m pop

**Total vehicle-km (million km/day)**

**CO2 from transport (bil.t-CO2/day)**

**GDP (bil.US$)**

- 1968
- 2005
- 2008
- 2050

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Indicators of Quality of Life -Bangkok-

Preference for Living Environment

- Rent Cost
- Work Access
- Shop Access
- School Access
- Hospital Access
- House Space
- Streetscape
- Green Area
- Safety
  - Air Pollution
  - Flood
  - Burglar
- Traffic Accident
- Amenity

Preference for Travel Mode

- Travel Time
- Travel Cost
- Privacy
- Crime
- Traffic Accident
- Transfer
- In-Vehicle Space Quality
- Riding Space
- Access to Mode
- Arrival Delay
- Flexible Departure

Quality Station-Front Development

Transit Quality Improvement

Car Attractiveness  ➔ Transit Attractiveness

Low income
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Middle income (Working Age)

Middle income (Over Age 60)

High income

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LRT Integrated with MRT in Singapore

Bukit Panjang LRT
- 8 km, 14 stations
- Opened in 1999

Sengkang LRT
- 11km, 14 stations
- Integrated with Sengkang MRT
- Fully-automated system
- Opened in 2003

Punggol LRT
- 10km, 15 stations
- Integrated with Punggol MRT
- Fully-automated system
- Opened in 2005
Decomposing the Vision (Target) of Urban Transport Systems into Low Carbon Strategies

**Mitigation**

- CO₂ emissions

**AVOID**

- Travel Demand (Travel Distance)

**SHIFT**

- Car Dependency (Modal Split)

**IMPROVE**

- Energy Efficiency (CO₂ Emissions/km)

- Aggressive Growth (Efficiency Demanding)

- Moderate Growth (Ageing / Sufficiency seeking)

**Road-Oriented Development**

- Urban Sprawl
- Motorisation
- Congestion

**Downsizing Transport**

**Seamless Public Transport Mobility**

**Energy Efficient Technology & Supply Chain**

**Transit Oriented Urban Lifestyle**

**Environmentally-Friendly Industrial Complex**

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Changes in MRT Networks and Urban Forms

**Bangkok**  (7,650km²)

- 2000
- 2005
- 2010

**Shanghai**  (6,400km²)

- 2000
- 2005
- 2010

Population [person] ~5,000 ~10,000 ~30,000 ~50,000 ~100,000

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Urban Policy Roadmap

Dynamic Tracking of Transport Related Emission Mechanism

**Mitigation**

\[ \text{CO}_2 \text{ emissions} \]

\[ \text{GDP} \]

**AVOID**

- Travel Demand (Travel Distance)
- Car Dependency (Modal Split)

**SHIFT**

- Energy Efficiency (\(\text{CO}_2\) Emission / km)

**IMPROVE**

- Car Ownership
- Fuel Efficiency
- Traffic Speed

**CUTE Policy Matrix**

**Technology**

**Transit**

**Mass Transit**

**LEV Development**

**Regulation**

**Oriented Development**

**Information**

**Development**

(TOD)

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Spatial Scale

1. Urban $\rightarrow$ Mega Region $\rightarrow$ Intercity
2. Industrial (Re)Location and Transport Provision in mega-regional/ international scale
3. LCC rapid development vs High Speed Rail
Air Pollution in Shijia Zhuong
Lorries transporting consumer goods back to Beijing → Moving emission
China: Japan = 1:4

Japan: China = 1:12
Interregional Vision

Decomposing the Vision (Target) of Interregional Transport Systems into Low Carbon Strategies

Mitigation

\[ \text{CO}_2 \text{ emissions} = \text{GDP} \]

Economic Growth

AVOID

\[ \text{Travel Demand (Travel Distance)} = \text{GDP} \]

SHIFT

\[ \text{Air/Truck Dependency (Modal Split)} = \text{GDP} \]

IMPROVE

\[ \text{Energy Efficiency (CO}_2\text{ Emission Factor)} = \text{GDP} \]

Efficient Supply Chain

Low-Carbon Public Transport Mobility

Energy Efficient Technology & Operation

Rail-Oriented Lifestyle

Rail-Oriented Industrial Renovation

Global Industrialisation (Block Economies)

Growth in Low Cost Carriers & Motorisation

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Future Society and Requirements for Transport Systems

Rapid Economic Growth (-2050)

Per capita GDP (1000 US$)

China (5.5~8.9)

Thailand (3.7~8.1)

Abolition of Customs


0~5%

0%

0~5%

0~5%

0%

※some exceptions

Increase in Freight

Interregional Competition

① Bulky Transport System

② Higher Speed

③ Low Carbon

Prepared by Shinya Hanaoka

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Proposing Vision:
Mainstreaming Rail and Water in Interregional Transport

Inland Freight High Speed Rail (HSR) Development between Port Hubs

AVOID

SHIFT

IMPROVE

GMS (Greater Mekong Sub region)

Kyaukpyu Port

Yangon

Bangkok

Phnom Penh

Kunming

Hanoi

Road (Economic Corridor)

High Speed Rail

Local Cities on HSR

Megacities on HSR

Cities on Local Freight Rail

Industrial Rail-Oriented Development (ROD) Corridor

Rail/Water Oriented Intermodal Transport System

Low-carbon Vehicles, Aircrafts, Vessels

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Interregional Vision

Efficient Industrial Supply Chain

Impact analysis to reduce CO₂ emissions by plant location change

**Current Industrial location** (Bangkok)

- Assembly plant
- Supplier locations
- Port
- Export to other countries

**Scenario 1:**
Priority to resilience for disaster

- CO₂ emission
- Present
- Scenario 1

**Scenario 2:**
Priority to low labor cost (Cambodia)

- Need of improving Production process
- +25% CO₂ emission

**Scenario 3:**
Priority to larger economic market (Indian)

- CO₂ emission
- Present
- Scenario 2

Route 1:
- (5,000km)
- From Thailand to India
- Via Singapore
- Cost: $2645 (40 ft container)

Route 2:
- (2,000km)
- From Thailand to India via Myanmar
- Time: 10 days
- Distance: 4352km

Sea only

Integrated transport

Seamless transport using sea and rail or truck

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Targeting Necessary Rail Use for Low-Carbon Interregional Development

Case Study: Bangkok – Hanoi

With railway:
- 30% time saving
- 91.7% Railway

Without railway:
- 14.2% Truck
- 14.2% Maritime

Optimal Modal Splits for reducing 40% CO₂ emission

Bangkok (Thailand) – Hanoi (Vietnam)

Interregional Vision

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The Roadmap for Low-Carbon Interregional Transport Development in ASEAN and China

New GMS-wide HSR network is necessary (km)

AVOID
SHIFT

CO2-emission reduction

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Sustainability vs. Resilience?
Resilience: QOL Transition after Earthquake

- QOL indices are recovered from coast towards inner areas, after roads and facilities were re-open
- Areas of QOL stage 2 are bigger than flooding areas from tsunami at 3/31 and 4/11
14th World Conference on Transport Research
10-15 July 2016 • Tongji University, Shanghai, China

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D. Activity and Transport Demand
E. Transport Economics and Finance
F. Transport, Land-use and Sustainability
G. Transport Planning and Policy
H. Transport in Developing and Emerging Countries

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