Sustainable urban mobility within the framework of land-use and transport integration

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No single policy instrument will be sufficient alone.

There will be barriers to the implementation of most policy instruments.
I. Visioning level

Visioning: a big picture of objectives
- Enhancing QoL and sustainability
- Location-efficient urban structure
- Quality mobility for social Inclusion

II. Strategic level

Strategy: a combination of instruments
- Land use and transport integration
- Restriction of car ownership and use
- Competitive public transport systems

III. Implementation level

- Timing of investment for mass transit systems
- Maximum utilisation of existing infrastructures
- Opening / promoting market for value capture
Urbanisation

Suburbanisation

Disurbanisation

Reurbanisation

Urban concentration
Development of rail transport

Urban expansion with sprawl
Rapid motorisation
Long distance and fast travel

Decentralisation and decline
Continued motorisation
Collapse of public transport

Regeneration of urban cores
Emergence of new mobility
Neighborhood and slow travel

Changing roles of urban transport
From urban sprawl to reurbanisation

Cycle Revolution
Scenario building towards a revolution

- Jump in fuel prices (2002)
- Road pricing schemes (2003)
- Bombing in tube and bus (2005)
- Kyoto protocol for GHG
- Unprecedented super-aging
- Great East Japan earthquake

Cycle revolution in London, etc.

- Needs for spontaneous and self-supported mobility
- Driving time of special and irreplaceable value
- Relatively low cost of private car purchase and use

- Road space with a high priority to private car use
- Urban space that ensures door-to-door trips
- Dispersed city discouraging public transport use

- Relatively low fuel price that enables daily car use
- Unawareness of externalities of private car use
- Inattentiveness to a super-aging society

Mobility Guarantee
Management of urban mobility systems has to start with the location of activities, where the need for mobility is generated. Complex urban systems are often discussed fragmentally. Even in the transport sector, public transport planners do not want to talk about bicycles and new mobility measures. The linkage between a wide-spectrum of transport, land use and infrastructures are often neglected, and lack of their coordination undermines the sustainability of urban mobility systems, esp. PT.
Environment
Transformation of urban structures and spaces

High priority to private car use

Absence of alternatives

Land use
Compact - eco city

Transport
Public Transport
TOD · corridor
Dynamic links
ICT/smart community
Social inclusion
Community

Infrastructure
Personal Mobility
EV infra
Road space diet

Safety
Speed and priority management in road space

Society/vibrancy
Social platforms focusing more on the elderly needs

Mobility manage’t to use right modes in the right places

Loss of social ties

Risk in travel

Process of Revolution
Cross-assessment in the strategic level

Strategic objectives (prioritised targets/values)

- Priority of efficiency (profit max)
- Priority of environment (CO₂ min)
- Priority of equity (distrib. of user benefit)

Operator profits → CO₂ emissions → User Benefits

Synergy or trade-off effects among objectives

Urban area
Non-urban area
A technique for evoking strategies

Most often used methods for evoking ideas

- Analogy
- Forced association
  - Reverse
  - Replace
  - Extremise

What happens if we extremely or thoroughly pursue some strategic objective among efficiency, equity and environment.
Land use scenarios: up to 2030

- 269 urban areas which are divided into 1 km² grid cells

Present

2030 (compact)

2030 (trend)

Population

- 7,000 - 11,000
- 3,900 - 7,000
- 2,400 - 3,900
- 1,500 - 2,400
- 900 - 1,500
- 500 - 900
- 300 - 500
- 200 - 300
- 100 - 200
- 0 - 100
Analytical framework

Population (Age, density) $D_i$

$C_{ijk}$

Trip generation and distribution by age Modal choice: $P_{ijk}$

$\sum_{i,j} Q_{ij} (C_{ij}^o - C_{ij}^w)$

Traffic (OD) $Q_{ij} \cdot P_{ijk}$

Traffic (Grid) $q_{mk}$

User's benefit

CO2 emissions

Operator's profit

LU model

Urban land use Transport Strategies

Grid-LOS $t_{mk}, l_{mk}/(v_{mk} n_{mk})$

Vehicle speed: $v_{mk}$ Route length: $l_{mk}$

Public transport operation ($n$)
Emissions reduction: 2010-30

- BAU: 4.8 MT-CO₂/yr
- NBM: 4.7 MT-CO₂/yr
- PM: 5.2 MT-CO₂/yr
- CO₂: 6.1 MT-CO₂/yr

Financial balance in 2030

- 2010: -924 bil. yen/yr
- BAU: -1024 bil. yen/yr
- NBM: -944 bil. yen/yr
- PM: -174 bil. yen/yr
- CO₂: -275 bil. yen/yr

NBM: Net user benefit maximisation
PM: Profit maximisation of public transport operator
CO₂: CO₂ emissions minimisation

CO₂ > PM > BAU > NBM
PM > CO₂ > NBM > BAU
Results of cross-assessment in nation(2)

Change in profits: 2010-30

Change in benefits: 2010-30

PM > CO2 > NBM > BAU

NBM > CO2 > BAU > PM

CO2 reduction has favorable (the 2nd best) effect on economic and social performance.
Emissions reduction by CO\textsubscript{2} minimisation strategy

The CO\textsubscript{2} min strategy can **decrease** emissions in most cities, especially in large cities. The LU compaction will contribute to more reduction in regional urban centres.
User benefit by CO₂ minimisation strategy

The CO₂ min strategy can increase user benefits in large cities, but decrease them in many small cities. The LU compaction will alleviate the benefit loss in small cities.
Spatial distribution of strategy outcomes (3)

Difference: compact scenario - trend scenario

Difference in CO₂ reduction

Emissions (tCO₂/year)
- 20,000 -
- 10,000 - 20,000
- 1,000 - 10,000
- -1,000 - 1,000
- -10,000 - -1,000
- -20,000 - -10,000
- - -20,000

Difference in user benefits

User benefits (bil. yen /year)
- 10 -
- 5 - 10
- 1 - 5
- -1 - 1
- -5 - -1
- -10 - -5
- - -10

Increase in CO₂ emissions due to more congestion by LU compaction

Decease in CO₂ emissions due to reduction in trip length by LUTI

Benefit loss by increased road traffic congestion
Predicted impacts of the LUTI scenarios

Emissions reduction: '10-'30

User benefit: '10-'30

<table>
<thead>
<tr>
<th>BAU</th>
<th>NBM</th>
<th>PM</th>
<th>CO2</th>
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<td>0</td>
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<tr>
<td>120</td>
<td>120</td>
<td>120</td>
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</tbody>
</table>

KT-CO2/year

bil. yen/year
Cross-assessment at the nation level indicates:

- Three value factors of efficiency, equity and the environment do not necessarily conflict with each other.
  1) the CO$_2$ emissions reduction targets can contribute to improved financial balance of public transport and user benefits.
  2) a strategic combination of the CO$_2$ minimisation and the profit maximisation is expected to bring synergetic effects.

- The spatial analysis in 269 urban areas indicates that
  1) the CO$_2$ minimisation strategy is effective for emissions reduction and improving benefits in large cities, but the relationship of these two outcomes are a trade-off in small cities,
  2) urban compaction in small cities can alleviate the trade-off.

Investigation of the impacts of alternative LUTI scenarios

- Corridors: the highest user benefits
- Corridors with multi-centres: the highest CO$_2$ reduction
Development Types

- Compact
  - planned
  - Top-down governance
  - Alternative fuels dominate

- Sprawl
  - Unplanned
  - Bottom-up
  - Fossil fuels dominate

- Grid
  - Communicity

Scenario Development

- Planned
- Bottom-up

Evaluation

- Public transport
  - Walk
  - Mechanised
- Private car
  - safe, collective
- Top-down governance

Urban structure

Mobility needs

Housing & Mix

- Multifamily
- Townhouses
- Single-family
- Mobile Homes

Development Types

Scenario Development

Evaluation
Environment
Transformation of urban structures and spaces

High priority to private car use
Absence of alternatives
Risk in travel
Loss of social ties
Society/vibrancy
Social platforms focusing more on the elderly needs

Land use
Compact city
District continuity program

Infrastructure
Transport
Road space diet

Transport
ICT/smart community
dynamic links

Public Transport
TOD・corridor

Personal Mobility
EV infra

Community
Social inclusion
Community infrastructure management

Safety
Speed and priority management in road space

Economy
Mobility manage’t to use right modes in the right places
Rate of road traffic fatalities during 2008-2010 in 65 cities with a population more than 300 thousand.

<table>
<thead>
<tr>
<th>City</th>
<th>Rate of fatalities</th>
<th>DID ratio of pop</th>
<th>DID pop density</th>
<th>Pop rate of aging</th>
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<tbody>
<tr>
<td>Takamatsu</td>
<td>6.22</td>
<td>0.511</td>
<td>5320</td>
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<td>Kochi</td>
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</table>
Spatial Pattern of Vehicle travel speeds

The highest fatality area in Japan
Spatial Pattern of Vehicle travel speeds

Osaka Metropolitan Area

Honda Inter-navi Floating Car data: Sep 1 to Sep 30, 2011
Layers of Geographical Data for Analysis

Road traffic fatalities and injuries

Road traffic volume

Population distribution

Travel speed distribution
Benefit Factors affected by travel speed

- Benefit of fatality reduction
  \[ C_n = -\Delta n_m \times 2.26 \times 10^8 \]
  \( \Delta n_m \): change in road traffic fatalities
  Economic value of life: 226 million yen

- Benefit of time saving
  \[ C_t = -\Delta t_m \times 5.76 \times 10^4 \]
  \( \Delta t_m \): change in travel time
  Economic value of time: 40 yen per minute

- Benefit of environmental improvement
  \[ C_{CO_2} = -\Delta CO_2_m \times 3.46 \times 10^4 \]
  \( \Delta CO_2_m \): change in CO2 emissions
  Reduction cost: 34,560 yen/c-tom
Benefit Distribution of speed management

Benefit in road fatality reduction by 1 km² grid
Benefit Distribution of speed management

Total benefit by 1km² grid

(10 thousand yen)
-4000 -500
-499.9 -100
-99.9 -10
-9.9 -0.1
0
0.1 - 200
200.1 - 2000
2000.1 - 50000

negative benefit

positive benefit

school

DID
• The outcome-based evaluation through cross-assessment will help clarify the direction of strategic objectives and the significance of land use and transport integration.

• It is required to step up the concepts and visions of urban transport with the common understanding on the socio-economic benefits of speed and priority management.

• It is expected to create flexible mobility systems that meet the situation of a city for the long term co-evolution of land use, transport, infrastructure and community.
Thank you for your attention!
The end of car culture

Young People Aren’t Buying Cars Because They’re Buying Smart Phones Instead

Youth culture was once car culture. Teens cruised their Thunderbirds to the local drive-in, Springsteen fantasized about racing down Thunder Road, and Ferris Bueller staged a jailbreak from the 'burbs in a red Ferrari. Cars were Friday night. Cars were Hollywood. Yet these days, they can't even compete with an iPhone - or so car makers, and the people who analyze them for a living, seem to fear. As Bloomberg reported this morning, many in the auto industry "are concerned that financially pressed young people who connect online instead of in person could hold down peak demand by 2 million units each year." In other words, Generation Y may be happy to give up their wheels as long as they have the web. And in the long term, that could mean Americans will buy just 15 million cars and trucks each year, instead of around 17 million.
Challenges of sustainable urban mobility

Less preferences and choices, more constraints
Less forecasting, more backcasting
Less details, more essentials

Consensus-led
Management of urban mobility systems

Vision-led
Systems innovation to achieve social needs

Safe and Secure Society
Ageing society
Low-carbon society

Management-oriented
Innovation-oriented
Examining the sustainability of urban mobility systems through a cross-assessment model to support the decision making in the visioning and strategic level.
Change in values of daily mobility with aging

\[ V.I. = \frac{W_{SS} \times W_{HE}}{(W_{TC})^2} \]
Mode-gram

- Individual travel
  - Auto mobile
  - full motorisation
  - mechanical locomotion
  - with limited power/range
  - animal power
  - human power

- Collective travel
  - minibus; demand-responsive transport
  - dog-sled for 2

- Mechanised
  - cars and taxis with several passengers

- Unassisted
  - horse-drawn bus, tram, etc.
  - horse-drawn rickshaw
  - tandem
  - stage-coach
  - sleigh
  - skis, skates
  - wheelchair
  - sedan chair
  - wheelchair
  - pedestrian
Emerging micro EV in Japan

Land use
- Compact eco city

Infrastructure
- Transportation
  - Public transport
  - Personal mobility
- TOD/Corridors
- New social infra

Complement

Community
- Road diet for all users
New mobility measures for reurbanisation

Regeneration of urban cores
Emergence of new mobility
Neighborhood and slow travel
Mobility measures promoting commobility

Paradigm shift of car-town relationships

Unchanged car-town relationships since the era of horse-drawn carriage (D-to-D)

Micro EV as a mobility suit sensibly designed for the elderly explorer and with indigenous identities

EVE: EV Explorer
Priority in road space as a meta rule

1. Wheelchair/Baby carriage
2. Pedestrian
3. Bicycle (Eco/Health)
4. Bus (Public transport)
5. Taxi (Public transport)
6. Truck (goods transport)
7. Private car
Outbreak situation of traffic fatal accident

<table>
<thead>
<tr>
<th></th>
<th>Private car</th>
<th>Motorcycle</th>
<th>Bicycle</th>
<th>Walk</th>
<th>Others</th>
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<tbody>
<tr>
<td>Japan (2009)</td>
<td>20.6</td>
<td>17.9</td>
<td>16.2</td>
<td>34.9</td>
<td>10.5</td>
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<tr>
<td>Germany (2008)</td>
<td>52.9</td>
<td>17.1</td>
<td>10.2</td>
<td>14.6</td>
<td>5.2</td>
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<tr>
<td>France (2008)</td>
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<td>3.5</td>
<td>12.8</td>
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<td>4.4</td>
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<td>US (2008)</td>
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<td>1.9</td>
<td>11.7</td>
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</tr>
</tbody>
</table>

Countries: Japan, UK, US, France, Germany