Future scenarios of urban mobility and their sustainability

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outline

1 The relevance of future urban mobility
2 The future is rooted in the past. Some ongoing trends
3 The drivers of change
4 Some scenarios for the next decades
1. The relevance of future urban mobility

The role of mobility in future cities can hardly be overestimated.

- Most of the population lives in cities:
  - Urbanized population passed the "symbolic threshold" of 50% in 2007 and going to exceed 60% in 2030.

1. The relevance of future urban mobility

The (sometimes implied) roles of mobility:

- Connect residences to workplaces/schools/shops, etc. (economic/territorial)
- Connect people (social)
- Allow urban metabolism
  - Input of goods (logistics)
  - Output of waste (waste management and reverse logistics)
1. The relevance of future urban mobility

The costs of mobility

- Consumption of space
- Consumption of people’s time
- Consumption of energy
- Externalities on welfare (accident)
- Externalities on environment

![Consumption of energy by sector](chart1)

![CO2 emissions by sector](chart2)

1. The relevance of future urban mobility

The quality of the urban environment is increasingly seen as a major competitive factor of cities.

The ease and “environmental footprint” of their mobility systems is one of the key factors contributing to its quality.

In the urban environment and in cities, the quality of life is measured by means of numerous social indicators.

<table>
<thead>
<tr>
<th>Index</th>
<th>weight for each index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport and Mobility</td>
<td>22%</td>
</tr>
<tr>
<td>Air</td>
<td>19%</td>
</tr>
<tr>
<td>Urban Environment and Waste</td>
<td>14%</td>
</tr>
<tr>
<td>Water and Energy</td>
<td>12%</td>
</tr>
<tr>
<td>Management</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: ECOSISTEMA URBANO DI LEGAMBIENTE

![Future Scenarios of Urban Mobility and their sustainability](chart3)

Turin, October 28-30, 2013
1. The relevance of future urban mobility

Cities are what their transportation systems allow them to be

<table>
<thead>
<tr>
<th>Pre Industrial (Concentric)</th>
<th>Streetcar (Sector)</th>
<th>Bicycle (Concentric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking, Horsecar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Automobile (Concentric)</th>
<th>Highway (Concentric and Nodal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centers</td>
</tr>
<tr>
<td></td>
<td>Railways</td>
</tr>
<tr>
<td></td>
<td>Suburb Towns</td>
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<tr>
<td></td>
<td>Roads</td>
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<tr>
<td></td>
<td>Main roads</td>
</tr>
<tr>
<td></td>
<td>Highways</td>
</tr>
<tr>
<td></td>
<td>Suburb</td>
</tr>
<tr>
<td></td>
<td>New suburb</td>
</tr>
</tbody>
</table>

Source: Adapted from Taaffe E.J., Gauthier H.L. and O'Kelly M.E. (1996) Geography of Transportation (second edition)

Outline:

1. The relevance of future urban mobility
2. The future is rooted in the past. Some ongoing trends
3. The drivers of change
4. Some scenarios for the next decades
2. the future is rooted in the past

- Future of urban mobility depends on how urban transportation systems, and more generally cities, are today.
- Cities around the world have different dimensions and structure, and have reached solutions to their mobility needs that are very diverse.

<table>
<thead>
<tr>
<th>City</th>
<th>Public Transport</th>
<th>Bike, Walking, other</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles</td>
<td>10%</td>
<td>33%</td>
<td>57%</td>
</tr>
<tr>
<td>San Paolo</td>
<td>33%</td>
<td>33%</td>
<td>34%</td>
</tr>
<tr>
<td>Napoli</td>
<td>36%</td>
<td>17%</td>
<td>47%</td>
</tr>
<tr>
<td>Milano</td>
<td>40%</td>
<td>18%</td>
<td>42%</td>
</tr>
<tr>
<td>Londra</td>
<td>45%</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>New York City</td>
<td>50%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Tokyo</td>
<td>73%</td>
<td>0%</td>
<td>27%</td>
</tr>
</tbody>
</table>

LOS ANGELES

- 4 MLN INHAB. – 3000 INHAB./KM²
- 10% PT – 80% CAR – 10% OTHER
- METRO: 114 KM – 2.85 CM/INHAB.
2. the future is rooted in the past

The future is rooted in the past, but we cannot predict it judging from the past as we cannot know the exact shape of a tree only by observing its roots.

Change in complex systems are of two types:

- Incremental changes
- Revolutions
2. the future is rooted in the past

- Incremental changes

Changes that derive from modifications, either technological and/or organizational, of elements and their arrangements already existing.

The changes of urban transportation systems over the last 30-40 years are of this type.

**In the ‘70s and ‘80s:**
- cars and transit systems
- metro and street cars
- parking arrangements and traffic lights
- traffic and congestion management schemes
- radio and tv information on traffic

**Modification and Applied Tech:**
- car engines and dimensions
- Intelligent Transportation Systems
- information connected to personal computing first and to smartphones
- “Station Renaissance”
- new regulations and congestion reduction policies

2. the future is rooted in the past

- Incremental changes

In some cases things have even gone “backward”.

E.g. metro and surface mass transit systems **trams** the comeback of the **bike**, either electrically powered or not.

Milano 1925  
Firenze 2013
2. the future is rooted in the past

Los Angeles (1984)

Los Angeles (2013)
2. the future is rooted in the past

➢ Revolutions

Significant and fast changes induced either by innovations in technology and/or organization

From Gilbert and Perl “Transport Revolutions”

“...a substantial change in a society's transportation activity that occurs in less than 25 years”, where substantial change is intended as “either something that was happening before increases or decreases dramatically, say by 50 percent, or a new means of transport becomes prevalent to the extent that it becomes a part of the lives of ten percent or more of the society's population”

Two examples from the past

✔ Urban transportation in a few decades during the second half of the XIX century as railways spread and the dimension and shape of cities changed accordingly

✔ Urban transportation in North American cities in the first three decades of the last century with the widespread of individual cars, and similar delayed revolution in most European and non European countries following the World War II
3. the drivers of change

Several factors will likely play a role in this process across several cities in the world

- Socio-economic factors
- Mobility markets
- Energy and Power Sources
- New emergent modes
- Technological innovation in existing transport modes
- Innovation in ICT and ITS
- City logistics and freight distribution
3. the drivers of change

Socio-economic factors

- Demographics (including migration)
- Activity participation, lifestyles and consumption models
- Income levels and distribution
- «Peak Car» and Ownership vs. Use of individual modes

Financial Crisis and Traffic-GDP decoupling

2012 data show a crisis in the transport sector greater than that in 2009

Highway Traffic (LDV+HDV) [10 Mln veh-km]

Fuel consumption [10 thousand tons]

Gross National Product (Mil €)
3. the drivers of change

Socio-economic factors

Increasing environmental consciousness
3. the drivers of change

Socio-economic factors
Substitution / Complementarity of mobility with virtual interactions

Internet Penetration, 2011

Source: Internet World Stats - www.internetworldstats.com
World Internet Penetration Rates by Geographic Regions - 2011

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Turin, October 28-30, 2013

3. the drivers of change

Mobility markets
Increasing role of private operators

Project Financing projects

Private investors in High Speed railway services

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Car sharing

iPhone Unit Sales (millions)
2.3  4.4  8.7  16.2  37  52.3

Source: Internet World Stats - www.internetworldstats.com
iPhone Unit Sales are based on a world population of 6,380,000,000 and 1,991,000,000 estimated internet users on March 31, 2011
Copyright © 2011, Nielsen Media Research Group
3. the drivers of change

Technological innovation in existing transport modes

- Cars
- Trains and metros
- Trams and medium capacity surface mass transit
- Motorcycles and mopeds
- Bikes and e-Bikes
- Buses

Future Scenarios of Urban Mobility and their sustainability

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3. the drivers of change

New emergent modes
Autonomous driving vehicles

Individual/Collective mixed modes

Worldwide & Regional Fleets (2006-2012)

- South America
- Australia
- Asia
- Europe
- North America
- Worldwide

0 5000 10000 15000 20000 25000 30000 35000 40000 45000 50000

<table>
<thead>
<tr>
<th>Year</th>
<th>South America</th>
<th>Australia</th>
<th>Asia</th>
<th>Europe</th>
<th>North America</th>
<th>Worldwide</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>7,455</td>
<td>12,300</td>
<td>22,556</td>
<td>7,010</td>
<td>4,238</td>
<td>43,136</td>
</tr>
<tr>
<td>2008</td>
<td>11,200</td>
<td>15,500</td>
<td>28,403</td>
<td>16,709</td>
<td>6,444</td>
<td>41,554</td>
</tr>
<tr>
<td>2012</td>
<td>18,920</td>
<td>23,916</td>
<td>31,767</td>
<td>20,444</td>
<td>6,393</td>
<td></td>
</tr>
</tbody>
</table>

Source: Transportation Sustainability research center

3. the drivers of change

Innovation in ICT and ITS
- Personal information
- System-wide monitoring and control
- Individual mobility pricing/crediting

Electronic Road Pricing in Singapore
3. the drivers of change

Energy and Power sources

➢ Availability and prices of oil and traditional power sources (including bio fuels)
➢ Renewable energy sources, availability and prices

4 outline

1 The relevance of future urban mobility

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3 The drivers of change

4 Some scenarios for the next decades
4. Some scenarios for the next decades

- **Strong correlations** among some of the factors
  
  E.g. **increase in fuel prices**
  
  - **reduce** the demand for less energy efficient modes (**cars**),
  - **increase** the use and **promote** technological innovation of other modes
  - **reduce** available income
  - **reduce** travel demand on the whole
  - **promote** denser land use patterns

- Several **internally consistent scenarios** can be figured out based on consistent sets of assumptions on the key drivers and related changes in other factors

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**Future Scenarios of Urban Mobility and their sustainability**

**Random Town:** business as expected (**Incremental Scenario I**)  
**Vision:**
Trends-as-they-are evolution of divergent urban mobility systems

- **cars and individual modes** would evolve technologically
- **urban mobility solutions for most cities in the world** with increasing overall market (where developing countries motorization rates will approach those of developed ones)

  - ITS and car technology would help in providing extra capacity without major network extensions, for developed Countries
  - **major highway constructions**, for countries in the developing (especially BRICS)

- some cities would evolve their mobility systems trying to **optimize the use of individually owned cars**
- in other countries will steer towards less car dependent systems based on livability as a competitive factor
4. Some scenarios for the next decades

**Sharedville: modal equilibration (Incremental Scenario II)**

**Vision:**
No significant technological breakthroughs, but the joined effects of increased energy prices and/or environmental concerns and/or space and life quality reclamation will push many cities towards policies aimed at modifying modal shares at least for certain trip types

- Implementation of demand management policies, possibly based on widespread use of pricing and mobility credits, investing in better transit (and mostly mass transit systems), urban densification policies (Transit Oriented Development), the opening of transit and mobility services markets (e.g. car and bike sharing systems on larger scales)

- ITS will be part of the process with an emphasis on trip planning, system monitoring and automatic toll/credits collection

- In several cities walking and biking will increase their share of urban mobility

**Low-battery City: energy crisis (Revolution Scenario I)**

**Vision:**
Scarcity of traditional fuels and delays in new low cost energy sources and then prices increases

+ possibly limitations in the availability of fuels for individual modes

the car is no longer the basic option for urban mobility

- Overall reduced availability, inducing a lower modal share of cars and a promotion of a number of changes in cities
- Real estate markets would show major changes: peripheral areas will be less and less attractive, traditional and new mobility services (e.g. trip planning, vehicles sharing, collective taxis) will develop with the help of ITS technologies
- Urban mobility would be a major factor of competitiveness among cities, with those cities with well-developed transit systems taking the edge
4. scenarios and possible evolution paths

Connect City: high-tech revolution (*Revolution Scenario II*)

**Vision:**
Prompted by technological innovation, ITS, connectivity and individual vehicles

- Cars, or their substitutes, would increasingly be able to run in dual mode: drivers control and system control, with significant increases of system capacity and energetic efficiency

- Vehicles would either be individually owned and operated or operated by mobility service providers responding with autonomous driving vehicles to the needs of travelers on whole trips or at least for some trip sections (e.g. access to terminals, main roads, repositioning, etc.)

- ITS developments would accordingly support the diffusion of autonomous driving, individual trip planning and system optimization, with crediting/pricing systems

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**basic references**


Thank you for your attention!