Smart City in Developing Countries

www.worldbank.org/eco2

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Finance, Economic and Urban Department, the World Bank
Outline

- Introduction
- Global Urbanization Trend
  - Demographic Change
  - Agglomeration Economy
  - Environmental Costs
  - Social Costs
- Smart Growth as Paradigm Shift
  - Smart City Requires Systematic Integrated Approach
  - Green TOD as Practical Strategy for Smart City
- Conclusion
Demographic Change: World is urbanizing
The World Urbanizes

UN World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision

<table>
<thead>
<tr>
<th></th>
<th>1950</th>
<th>2000</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Population (bil.)</td>
<td>2.54</td>
<td>6.12</td>
<td>9.19</td>
</tr>
<tr>
<td>World Urban Population (bil.)</td>
<td>0.74</td>
<td>2.85</td>
<td>6.4</td>
</tr>
<tr>
<td>Share of Asia (%)</td>
<td>32.1</td>
<td>48.1</td>
<td>54.5</td>
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</tbody>
</table>
Million-Plus Cities Emerging in Asia & Small and Mid-Size Cities Also Grow
Agglomeration Economy: Cities as Engine of Economic Growth
Economic Growth & Urbanization
Density—why it pays to be close to Cities

Vis-à-vis other regions, South Asia Africa's’ economic mountains are small hills.
Middle Class and City Based Economy
Spending by the Global Middle Class, 2009 to 2030
(millions of 2005 PPP dollars)

<table>
<thead>
<tr>
<th>Region</th>
<th>2009</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>5602</td>
<td>5863</td>
<td>5837</td>
</tr>
<tr>
<td>Europe</td>
<td>8138</td>
<td>10301</td>
<td>11337</td>
</tr>
<tr>
<td>Central &amp; South America</td>
<td>1534</td>
<td>2315</td>
<td>3117</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>4952</td>
<td>14798</td>
<td>32596</td>
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<tr>
<td>SSA</td>
<td>256</td>
<td>448</td>
<td>827</td>
</tr>
<tr>
<td>M-East &amp; N-Africa</td>
<td>796</td>
<td>1321</td>
<td>1966</td>
</tr>
<tr>
<td>World</td>
<td>21278</td>
<td>35045</td>
<td>55680</td>
</tr>
</tbody>
</table>

Infrastructure: Key for Cities’ Growth
$40 trillion needed between 2010-2030
Environmental Costs: 
*Unsustainable Urban Growth*

The World Bank, AECOM
Unsustainable Growth

- Projected new urban built up area in developing countries alone is 400,000 km² (2000 – 2030)
- This equals the total urban built up area of the ‘entire world’ as of the year 2001 – we are building a ‘whole new world!’
- 4 Earths (Ecological Footprint) required if developing country cities urbanize following the models of developed country cities
Automobile Dependent Urbanization
Energy Consumption -> GHG -> Climate Change
Happening now, not future
GHG Emissions are Unequally Distributed Within and Across Countries

Sources: EIA International Energy Annual 2006 and World Development Indicators 2008
The climate factor multiplies existing resource stress

If mismanaged, driving up inflation and curbing growth
Social Costs: Poverty Is Urbanizing
Inequality is increasing
But urbanization can lift poverty, if well managed.
Smart Growth As Paradigm Shift: *Smart City as Solution*

[Image of Eco² Cities book]

[Image of tram in a green environment]

[Website link: www.worldbank.org/eco2]
Eco or Eco or Eco2?
Example of Simultaneous Economic and Environmental Improvement.

Since 1990 Swedish CO2 emissions have been reduced by 9% while its economy has been growing at a stable rate.

Source: Symbiocity
The low-carbon energy market will triple by 2020e

- Energy efficiency becomes the largest market segment
- Renewable electricity offers the largest growth on the supply side

Low-carbon energy production

<table>
<thead>
<tr>
<th>Category</th>
<th>2009</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable elec</td>
<td>203</td>
<td>544</td>
</tr>
<tr>
<td>Nuclear</td>
<td>192</td>
<td>368</td>
</tr>
<tr>
<td>CCS</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Renewable heating</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>Biofuels</td>
<td>18</td>
<td>93</td>
</tr>
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Energy efficiency and management

<table>
<thead>
<tr>
<th>Category</th>
<th>2009</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport eff</td>
<td>113</td>
<td>677</td>
</tr>
<tr>
<td>Building eff</td>
<td>245</td>
<td>87</td>
</tr>
<tr>
<td>Industrial eff</td>
<td>93</td>
<td>183</td>
</tr>
<tr>
<td>Energy storage</td>
<td>14</td>
<td>66</td>
</tr>
<tr>
<td>Smart Grids</td>
<td>10</td>
<td>23</td>
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</tbody>
</table>
Smart City Requires Systematic Integrated Approach
Sustainable Urban Development & Triple Bottom Line
Eco\textsuperscript{2} Integrated Approach

Energy Efficiency & Renewable Energy:
- Green Buildings
- District Heating/Cooling
- Smart Grid
- Solar, Geo, Wind, Hydro

Water Management

Risk Resiliency

Finance Viability

Waste Management

Social Equity

Optimal Urban Form
- Land Use and Management

Transportation
- Green Transport Mode
- Clean Energy Efficient Vehicle/Fuel
- Transport Planning

Regulation, Incentives, Awareness Technology and Investments

Governance and Leadership
Cross –Sector Integrated Approach
Stockholm, Sweden

Integrated Utility Management & Resource Management
Brown Filed Redevelopment of Hammarby Sjöstad

Source: Stockholm City Planning Administration
City’s System Integration-Key Elements

- Integrated spatial development/Urban Transport & Land Mgt
- Policy/Regulation
- Integrated Utility Management
- Resource/Energy Management & Demand Management
- Waste Management
- Financing
- Investment
- Technology

<table>
<thead>
<tr>
<th>Sector Integration</th>
<th>System Integration</th>
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</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Policy/Regulation/Planning</td>
</tr>
<tr>
<td>Transport</td>
<td>Institutional/operational integration</td>
</tr>
<tr>
<td>Water</td>
<td>Resource management</td>
</tr>
<tr>
<td>Solid waste</td>
<td>Investment/Financing</td>
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</table>

Policy/Regulation/Planning
Institutional/operational integration
Resource/energy management
Stakeholder Collaboration is critical

1. Formal collaboration on three tiers
2. A shared planning framework
3. Integrated Design Process
Concerted Efforts of All the Stakeholders In Reducing Waste, Yokohama, Japan

- **Solid Waste Reduction**
  - Implementation of 3R (Reduce, Reuse, Recycle) with citizen's collaboration
  - Achieved 38.7% reduction in six years (2001-2007) and US$1.1 Billion Savings.

![Waste Reduction in Yokohama](image)

The graph illustrates the waste reduction in Yokohama from FY2001 to FY2007, with the reduction in waste from business activities, household waste, and recyclables.
Investment Framework that Values Sustainability Based on Life Cycle Cost Benefit Analysis


Financial Accounting
- Capital
- O & M Costs
- Disposal Costs

Environmental Load Profile
- Construction
- Materials (Steel, Concrete, etc)
- Energy, Water
- Waste/Recycle

* Authorities
* Capital providers
* Property developers
* Architects
* Engineers

* Contractors
* Materials and equipment suppliers
* Logistics
* Waste management operators

* Buyer/Owner
* Property manager
* Energy suppliers
* Water suppliers
* Waste management operators
* Users

R&D Design
Planning and programming, Design and engineering
Spatial Dimension of Smart City: *Transit & Land-Use Integration*
Urban Spatial Form Determines City Energy Efficiency

Decisions today are limited by past decisions

Study Objectives

- Identify barriers to and opportunities for effective integration of the transit and land use in cities in developing countries.

- Recommend a set of policies and implementation measures for overcoming these barriers and exploiting these opportunities.

www.worldbank.org/urban
Land Use as an end

Transport as a means

Land Use/Transport Integration

➢ Land

➢ Transport

Copenhagen’s Finger Plan

Smart Growth

Source: Robert Cervero
TOD “empowered” by TDM

Singapore: The Constellation Plan

Source: Robert Cervero
Singapore: Transport Demand Management

**Implemented 1975**
Area Licensing Scheme (ALS)

**Since 1998**
Electronic Road Pricing (ERP)

source: Singapore Government
Ahmedabad Janmarg – India’s First BRT

- Development plan surfaced in 2005
- System built in 2 years (October 2007-Dec 2009)
- Janmarg BRT, 217 km planned in total of 4 phases

- Phase 1 complete
  - improved city’s mobility
    - Ridership: 135,000/day
    - Speed: 25km/ hour
    - 95% on-time departure
  - Customer satisfaction is very high
Development Pattern (2006-2011)

- New development is apparent in city’s periphery
- More development concentration along the road
  - current and future BRT corridors

Brownfield development: redevelopment of closed textile mill parcels
Bogota: Beyond TransMilenio

- Development plan surfaced March 1998
- Construct 388km in 5 phases (1998-2016)
- Phase I and II are done
- Phase I built in 36 months
  - Quickly built
- System’s service quality is recently deteriorating
  - Overcrowded
  - Lowering average speed
  - Long waiting
Development pattern (2004-2010)

- Changes in built environment (2004 - 2010)
  - Building density increased across the city, but not necessarily along the BRT corridors.
  - More densification in spaces around end stations closer to city’s periphery,
  - Overall, did not cause strategic densification and mixed-land use

- Bogota’s building density by FAR continues to be low, excluding some areas.
Key Barriers for Integration

Ahmedabad

- Restrictive National Regulations (LC Act, Rent Control Act, Stamp Duties)
- Lack of Articulated Density – Uniformly Low FAR
- Small parcels and old low story buildings
- Missing Transport Design No-Feeder System Non integrated Bike Trail
- Missing Micro and Street Designs No TOD Guidelines – Absence of pedestrian friendly design

Bogota

- Inconsistency between City Level Master Plan POD and District Plan
- Lack of Regional Coordination Sector Silo
- Lack of Articulated Density – Uniformly Low FAR
- Small parcels and old low story buildings
- Missing Micro and Street Designs (pedestrian bridge, empty wall, station rotary) and No TOD Guidelines.
Cities in Developing Countries have high average population densities

Source: Alain Bertaud
Articulated Density Matters; Not Average Density

Uniform Average Population Density can have totally different height and spatial form. What matters most for transit and land-use integration is not average population density, but articulated density.

Source: OECD Compact City Policies / Laruelle, N
Curitiba, Brazil: Integrating Transport, Land Use (TOD) by Creating Articulated Densities
LA is one of the cities with highest population densities in US but without articulated densities.

Source: Wulf Daseking
Bogota: Low (<2) FAR Control Does Not Help Create Articulated Densities

Source: The World Bank Bogota Case Study
Ahmedabad’s Uniform Low Density (FAR 1.8-2.25) Creates Dispersed Travel Patterns Not Compatible with Transit

Source: World Bank Ahmedabad Case Study
Missing Micro-Designs
Urban & Street Design Matters

Source: Alejandro Rodriguez
Guangzhou: Proposal for greening of Gangding BRT station
Street without Footpath in Ahmedabad

Source: ITDP India
How to Break Sector-Silo?  
A “Charrette” (Collaborative Design & Planning Workshop) Made It Happen!
Green Transit Corridor Concept
Mass Transit Integration
How to Finance Massive Transit Investments?
Explore Possible Land Value Capture Financing

Hong Kong MTR’s Maritime Square Residential-Retail Development
Source: Hong Kong MTR
Hong Kong’s Model: “R+P” (Rail + Property)

Revenue Sources
- Railway (Fares)
- Property Development
- Property Investment & Management
- Non-fare

*2001-2005 Average

Hong Kong MRT
Tokyo Station City
Land Adjustment for TOD
Hakusan City: Japan
Green TOD: *Practical Strategy for Smart City*
Stockholm: Necklace of Pearls

Source: Robert Cervero
Stockholm’s City Plan for 2020 Science City (Greenfield) & Urban Regeneration (Brownfield)

Inner-Ring Interconnected by Fast Trams

Kista Science City

Hammarby Sjöstad

Source: Robert Cervero
# Green TOD

## A Marriage of TOD & Green Urbanism

<table>
<thead>
<tr>
<th>TOD Mobile Sources</th>
<th>Green Urbanism Stationary Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Design</td>
<td>• Energy self-sufficient</td>
</tr>
<tr>
<td>World-class transit</td>
<td>(renewably powered – solar, wind turbines)</td>
</tr>
<tr>
<td>(trunk &amp; distribution)</td>
<td>• Zero-waste (recycle; re-use; methane digesters; rainwater collection for irrigation &amp; gray-water use)</td>
</tr>
<tr>
<td>Station as hub)</td>
<td>• Community gardens</td>
</tr>
<tr>
<td>• Non-motorized access</td>
<td>(compost, canopies, food security)</td>
</tr>
<tr>
<td>(bikepaths, ped-ways)</td>
<td>• Buildings: Green Roofs, Orientation (optimal temperatures), Materials (recycled; low impact)</td>
</tr>
<tr>
<td>• Bikesharing/ Carsharing</td>
<td></td>
</tr>
<tr>
<td>• Minimal Parking</td>
<td></td>
</tr>
<tr>
<td>(reduced land consumption, building massing &amp; impervious surfaces)</td>
<td></td>
</tr>
</tbody>
</table>

### Overall Carbon Reduction/Energy Savings:

25% to 33% of conventional development

Source: Robert Cervero
Transport Program

- Tramway
- Skinny Streets/Traffic Calming
- Bike-ped Bridge
- Congestion Pricing
- Hammarby Sjöstad: Just outside Congestion Pricing Cordon

Source: Robert Cervero
Smaller Carbon Footprint
Hammarby Sjöstad

Source:
Conclusion

EDO (Tokyo) 1 Million City in 18th Century

Source: Azby Brown *Just Enough: Lessons in Green Living from Traditional Japan.*
Compact Mixed Land Use

Source: Azby Brown *Just Enough: Lessons in Green Living from Traditional Japan*. 
Source: Azby Brown Just Enough: Lessons in Green Living from Traditional Japan.
Thanks

For Further Information

- www.worldbank.org/urban
- www.worldbank.org/eco2

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