Decarbonization of Urban Transport in India

Source: Rahul Singh Thakur

Prof. H M Shivanand Swamy | Centre of Excellence in Urban Transport, CEPT University | 10 September, 2020

Urban and Transport Planning Objectives

- Economic progress
- Environmental Sustainability
- Leading to quality of life improvements

Urban and Transport Planning Objectives

- Conflicting?
  - Transport (Mobility) means prosperity
  - Environmental Sustainability means reduction in transport

Urban and Transport Planning Approaches

- Loop sided approach focussed on congestion free cities
- Congestion free cities exists only in utopia
- More mobility need not necessarily bring about prosperity
- Less mobility does not necessarily mean no economic progress
- Externalities – ignored in investment decisions
- Urban and Transportation systems may be planned/designed:
  - To promote economic growth – Promote Accessibility & control congestion
  - To reduce local and global environmental damage
- BUT:
  - Our approaches are not comprehensive
  - Plans are not prepared/revised timely, and
  - Not implemented in spirit & content (laxity)

The Problem

OUR PROBLEM

CEPT UNIVERSITY

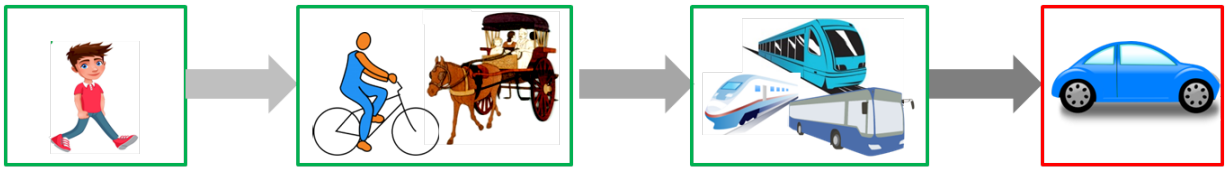
The Problem

The Problem

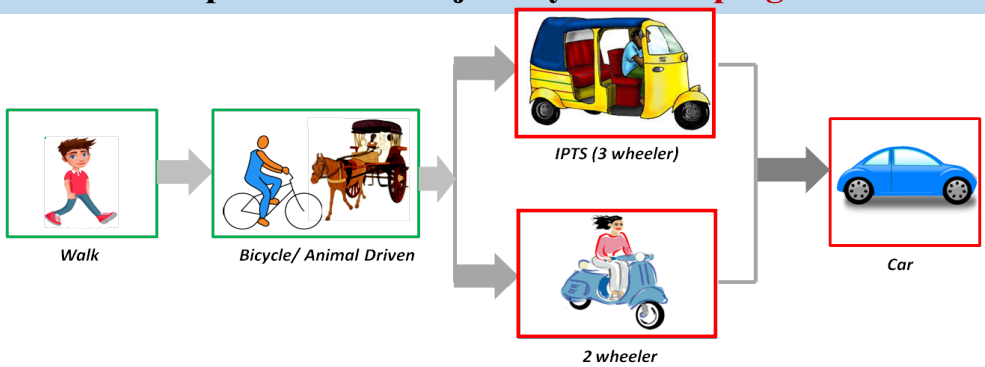
Source: Bangalore TImes

Mode Share (Work Trip) – Top 50 Cites

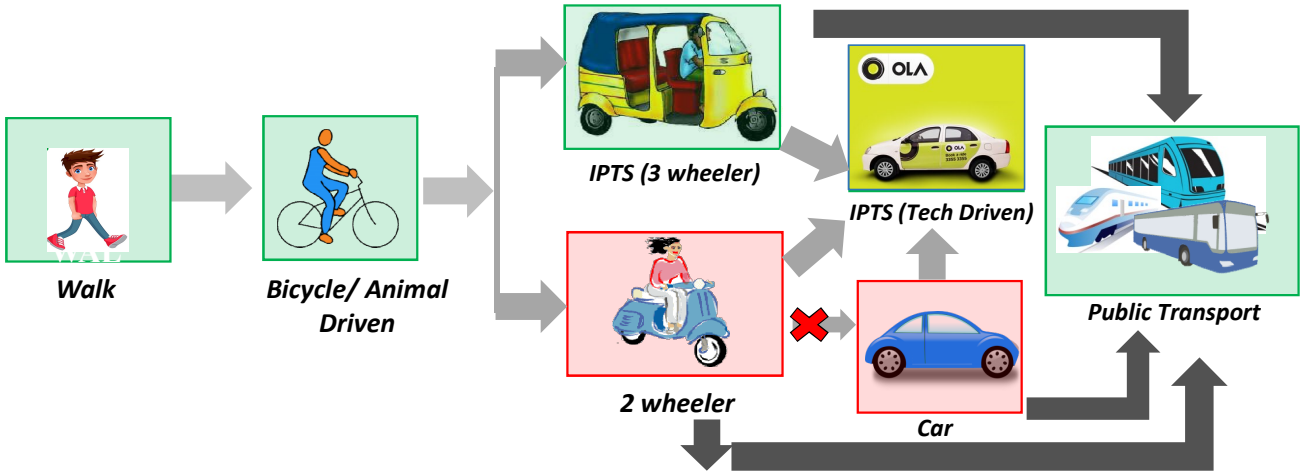
Transport Modes Trajectory – Developed World



Transport Modes Trajectory – Developing World



Transport Modes Trajectory – Developing World - Goal



Urban & Transport Planning

- More mobility often leads to:
  - Excessive travel – travel budget
  - Travel Costs - family budget
  - Air & Noise pollution
  - Accidents, injuries and fatalities
  - Heat island effects and lack of green space
  - Lack of physical activity
- Leading to increase in morbidity and premature mortality

- Accessibility
  - Mobility
  - Proximity
  - Connectivity
- Objectives
  - Economic Growth
  - Health
  - Liveability
    - Child friendly
    - Differently abled & senior
    - Gender & Security

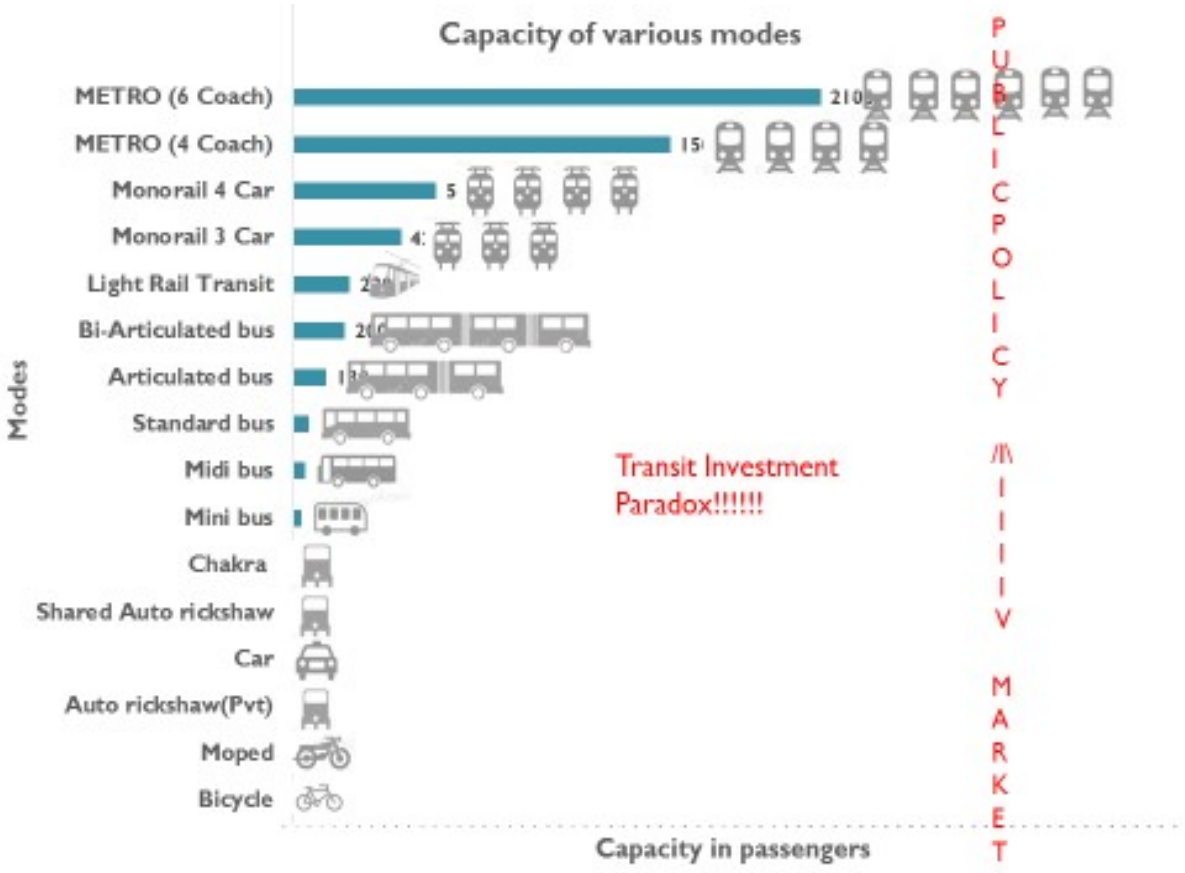
Congestion and Motor Vehicle Emissions

- Buses, taxis, auto rickshaws, cars and motorcycles account for almost all motorized trips in most cities in developing countries.
- **Congestion** and **motor vehicle emissions** are a function of **vehicle-kilometrs travelled** (VKT) and **Fuel used**.
- Congestion is a function of the **capacity of the roadway system** (CAP) relative to the **number of VKT**: **Congestion = f (VKT/CAP)**.
- **Motor vehicle emissions** are the product of VKT and emissions per VKT (E/VKT): **Emissions = VKT * E/VKT**.
- VKT in turn is the product of the number of passenger kilometres travelled (PKT) and the vehicle kilometres needed to carry a passenger kilometre (VKT/PKT): VKT = **PKT * VKT/PKT**.
- PKT is a product of passenger trips (PT) and trip length (TL): **PKT=PT*TL**

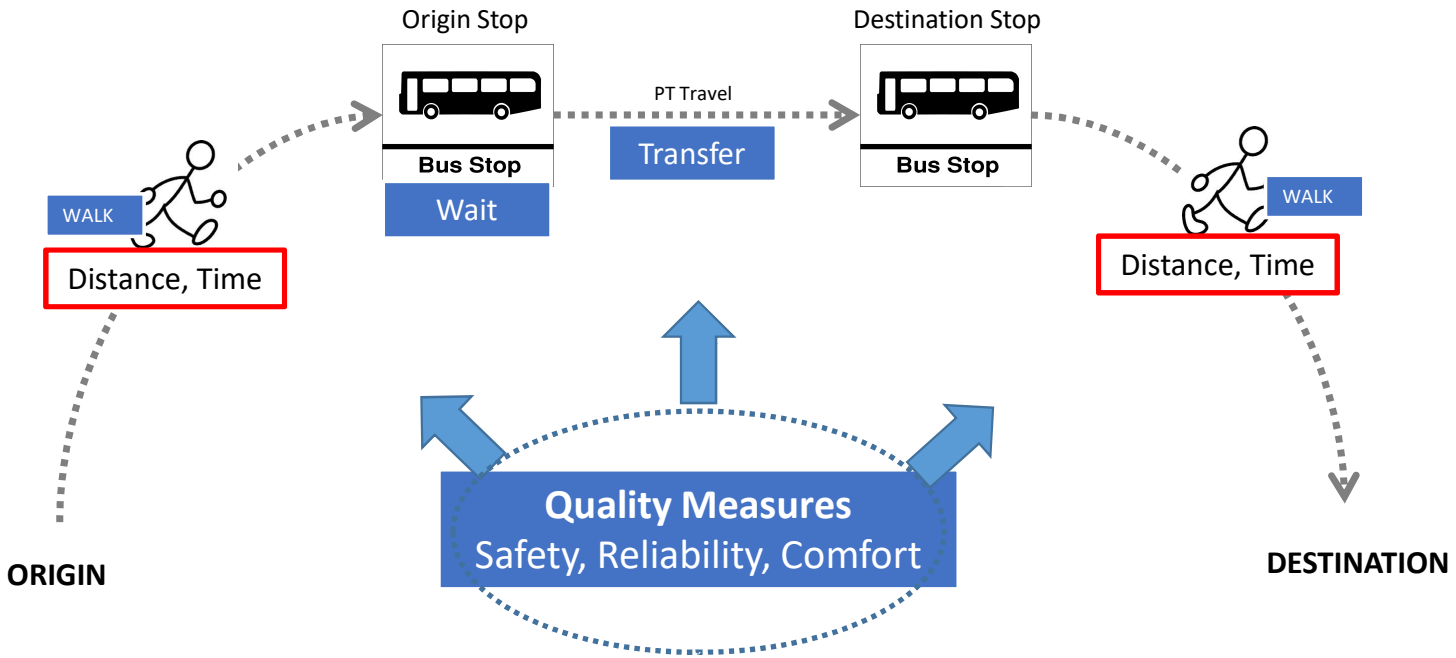
Points of Leverage

1. To reducing passenger kilometers travelled (PKT)
   - Desirable from an environmental perspective
   - But not from an economic perspective since accessibility is the key to generating agglomeration benefits
   - ***The conflict is less severe if passenger kilometers are reduced by cutting trip length rather than passenger trips.***
2. To reduce the vehicle-kilometers travelled per passenger kilometer (VKT/PKT) – Mode shift
   - By shifting to modes that use street space more efficiently
     (bus, or modes that do not use street space at all, like-grade separated mass transit)
   - Vehicles that use less road space per capita means less emissions/PKT
   - **Shift to NMT**
   - **The problem:** Trend is in the opposite direction (People are moving towards space- intensive modes (personalised vehicles- cars)
3. To reduce emissions per vehicle-kilometer travelled
   - Technology
   - Fuel switch

Transit Policy Paradox



Complete Journey – MAS (Connected)



- **Different legs of journey may be valued differently**
- **Quality of service offered may have an effect on the value**
- **Passengers perceive public transport as a bundle of service and place different valuations on various components**

Decision Areas
Collective, Connected & Electric Mobility

- Mode
  - Bus (standard, midi, mini, micro), cars, 3-wheelers, 2-wheelers
- Energy
  - Electric (capacities & network – kerb side)
- Infrastructure
  - Fare collection, information, vehicle tracking
  - Charging
  - Battery Disposal systems
- Financing
  - public – facilitation; private investments
- Regulatory framework
  - Right sizing quantity & quality (entry-exit, safety, security, price)
  - Permits vs Fee (quantity based – graded)
  - Monitoring mechanisms

Innovations require change

- Technological and Behavioural
  - Some innovations are easy to fit into existing arena (Bharat Stage 1, 2, 3..)
  - Some require behavioural change (Traffic signals)
- Incremental vs Radical Changes
  - Incremental – given societal conditions what best can be done? (Metro, electric)
  - Radical – given technological conditions what is good for society (BRTS, fuel cell)
- Which innovations to promote
  - Radical – Have potential but also challanges
    - all options with potential need to be explored may be on pilot
    - Scaling up over time
    - Focus on partnership between Public & Private

The Problem

Source: www.threestepsforIndia.com

The Problem

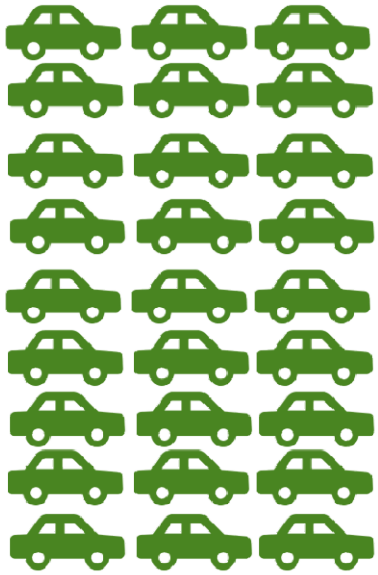
Source: www.urbanvoices.in

Approach

The problem of air pollution and GHG emission can reduce but no reduction in congestion.

Conventional fuel cars

GHG emission: 100-150 gCO2/km
High air pollution



Electric cars

GHG emission: Zero tailpipe emission
Zero-Low air pollution

Approach

The problem of congestion, pollution and emission, all can be addressed.

Conventional fuel cars

GHG emission: 100-150 gCO2/km
60 cars= 600-900 gCO2/km
High air pollution

Conventional fuel bus

GHG emission: 15.16 gCO2/ pax km
Reduced Congestion
Lower air pollution

Electric bus

Zero Tailpipe emission
Reduced Congestion
Zero air pollution

The Problem

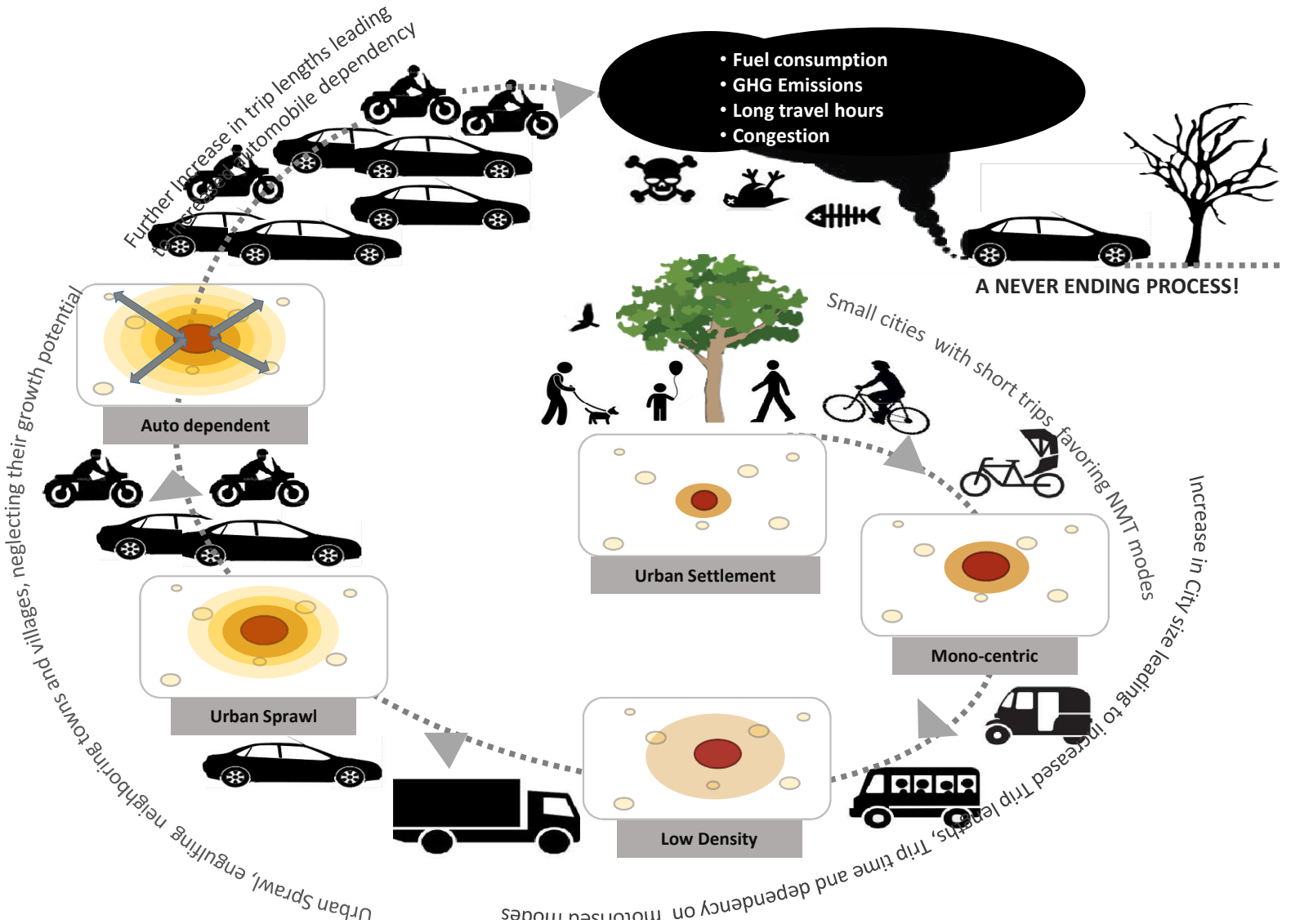
What we see

- Congestion
- Cars
- Accidents
- Inefficient Public Transport
- Air quality / GHG
- Street infrastructure
- Pedestrian & NMT Infrastructure
- Car Parking-Vs Pedestrian Movement
- Street Vending-Vs Pedestrian Movement

Root Causes

- Investments in Urban Transport
- Monitoring and Management
- Price of cars vs PT Fares
- Access (Spatial Coverage & Frequency)
- Operations (Schedules, fares)
- Integration (Fare & Physical & Operations)
- Governance System

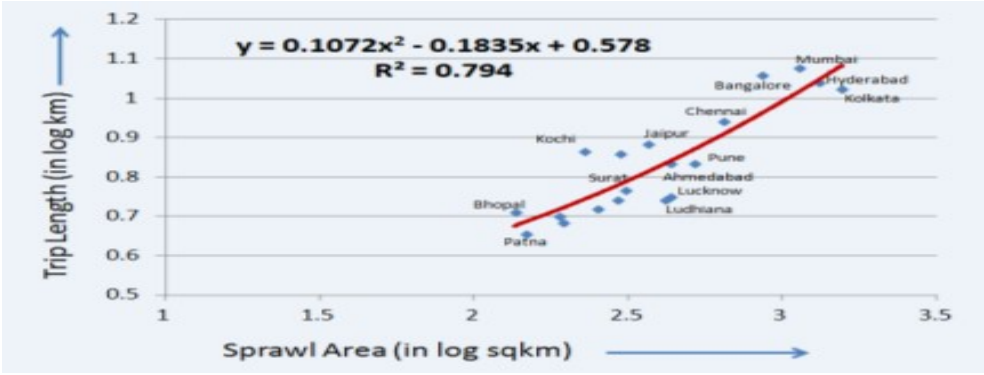
PREDICT AND PROVIDE : A Conventional Approach

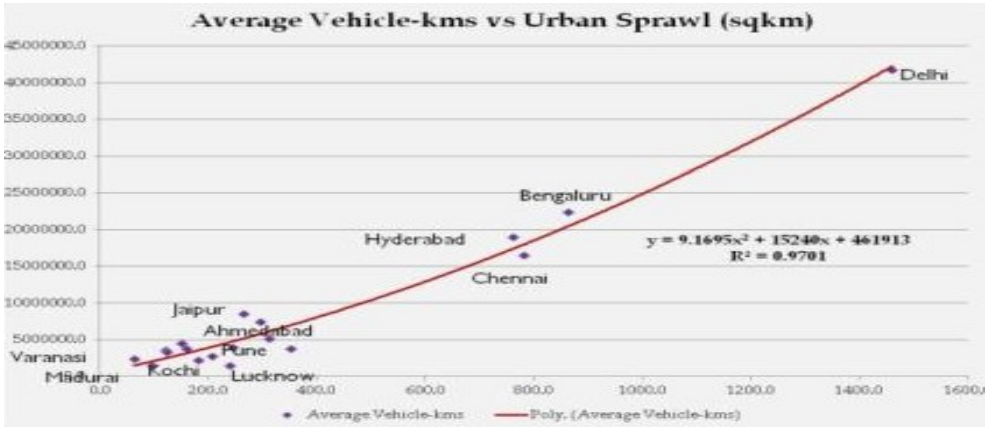


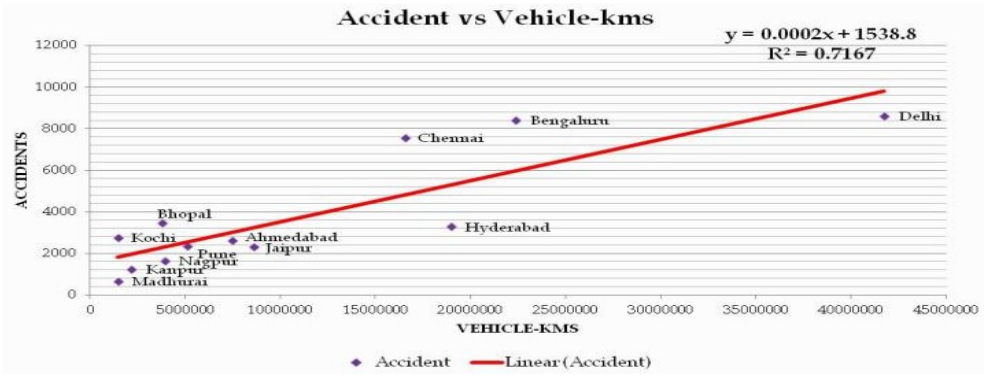
Why do we need an Alternative Approach?

Conventional approach in urban and transport planning in cities has lead to increasing:

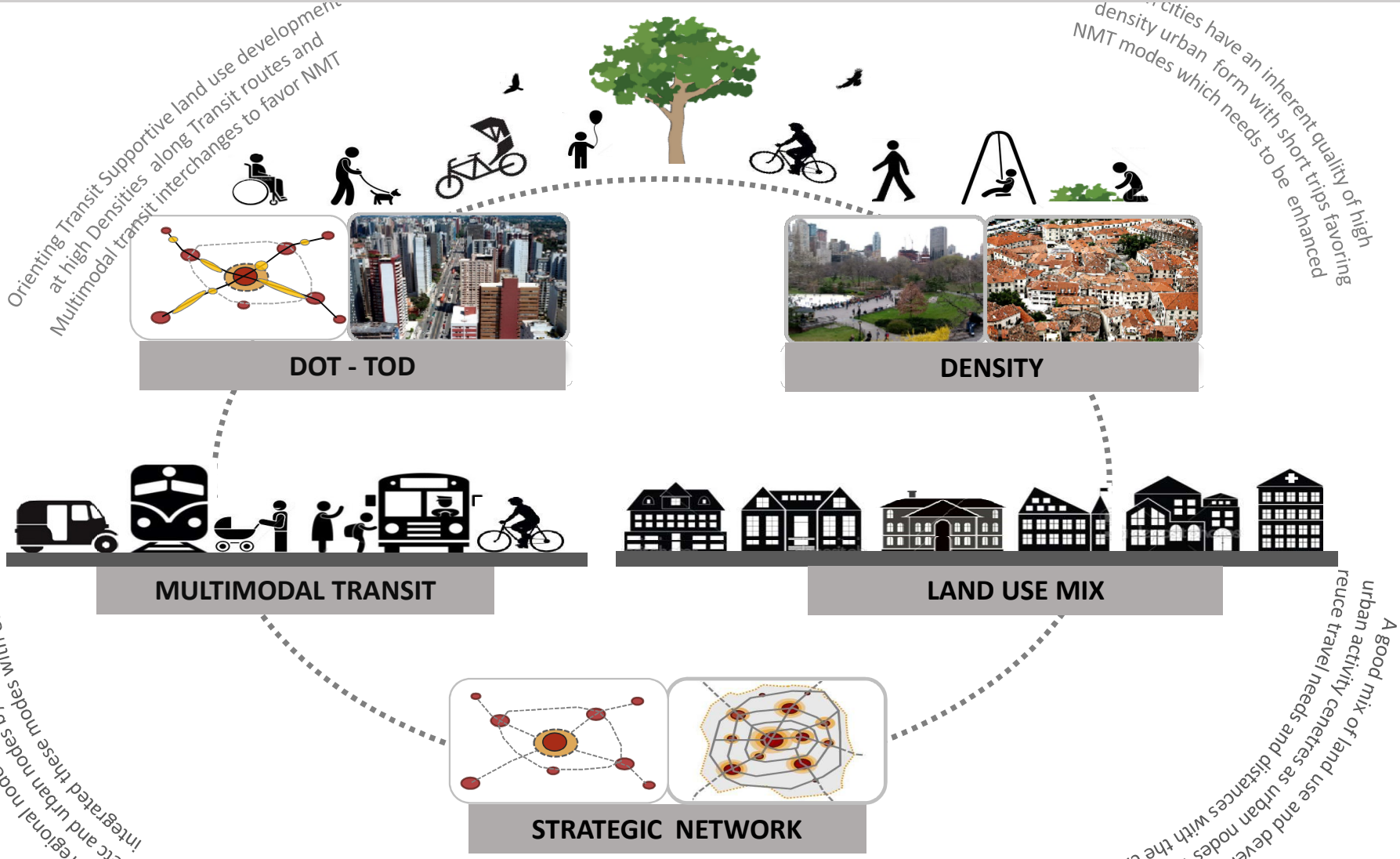
- **Travel distances and travel time**
- **Demand on infrastructure development**
- **Dependency on private motor vehicles**
- **Congestion and space constraints on roads**
- **Accident rate**
- **Deterioration of NMV facilities**
- **Increase in Fuel Consumption**
- **GHG emissions and Air & noise pollution**



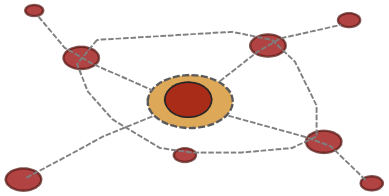




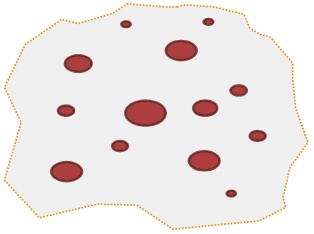
What tools are available for city planners to undertake integrated planning?



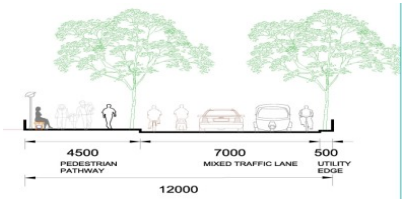
What are the key elements of integration?



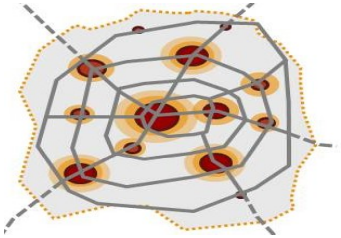
Enabling Urban Structure



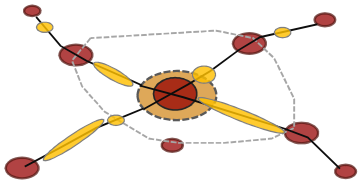
Complete Networks and Complete Streets



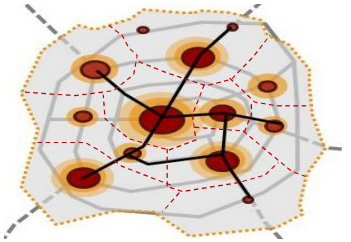
Strategic Alignments



Transit Oriented Development &Value Capture



Integrated Multimodal Transit Interchange Facilities

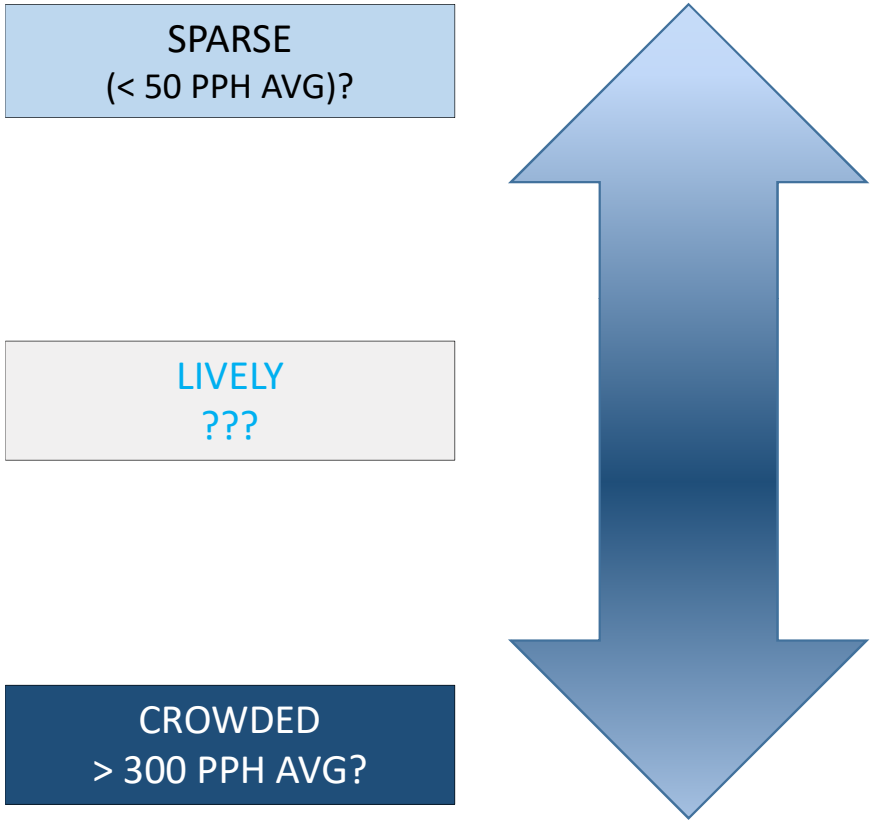


Accessibility Improvements - Local Area Plans

Re-development and Re-vitalization

Ideal Density ??

- It is now accepted that higher densities are more efficient and sustainable than very low densities
- However the desirable density is contextual – cultural, social, economic, climatic, ecological
- Density in different parts of the city can and should be different



Urban Scale & Densities

City Density

City	Average Pop Density for city People/sqkm	Average Pop Density for city People/hactare	Range
Mumbai	25316	253	High
New York	9272	93	
São Paulo	6832	68	
Mexico City	5786	58	
London	4497	45	
Shanghai	3136	31	
Berlin	3737	37	
Istanbul	2380	24	
Johannesburg	1963	20	Low

Inner City Density

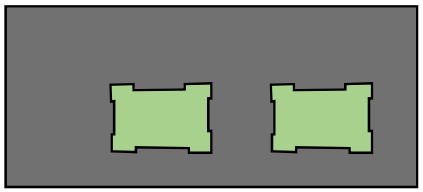
City	Average Pop Density for Inner city People/sqkm	Average Pop Density for Inner city People/hactare	Range
Mumbai	45021	450	High
Shanghai	23227	232	
Istanbul	20128	201	
New York	15353	154	
Mexico City	12880	129	
São Paulo	10376	104	
London	8326	83	
Berlin	6683	67	
Johannesburg	2203	22	Low

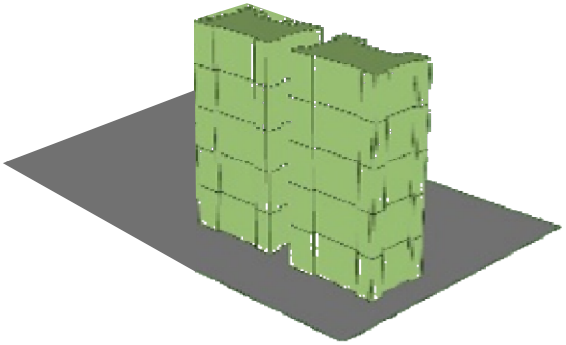
Local Area Density

Area within city with highest population density	**Highest Density Within City People/sqkm**	**Highest Density Within City People/hactare**	**Range**
Kamathipura, Mumbai	121312	1213	High
Güngören, Instanbul	77267	773	
Luwan, Sanghai	74370	744	
Upper East Side, New York	58530	585	
Molino de Santo Domingo, Mexico City	49088	491	
Berea, Johanneseburg	42398	424	
Santa Cecilia, Sao Paulo	29704	297	
Schillerkiez, Berlin	24186	242	
Novtting Hill, London	17324	173	Low

Source: Urban Patterns For A Green Economy Leveraging Density

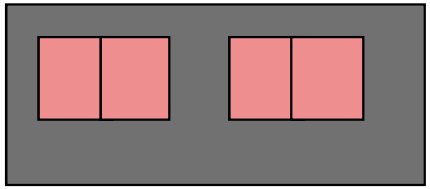
Multi Family
Mid Rise housing

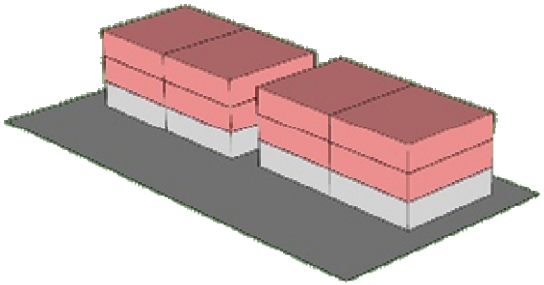




12 houses, 80% open space

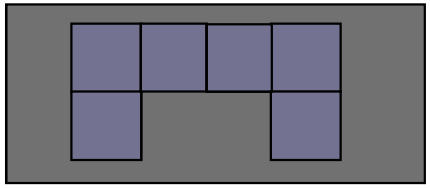
Multi Family
Low Rise housing

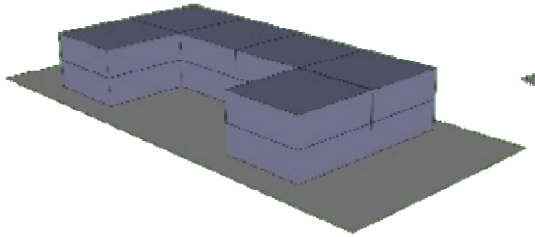




12 houses, 72% open space

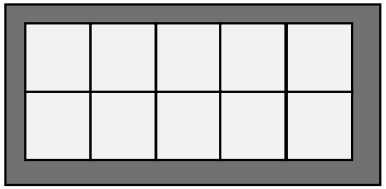
Multi Family
Low Rise housing

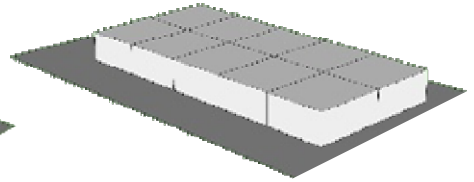




12 houses, 60% open space

Single Family
Row housing



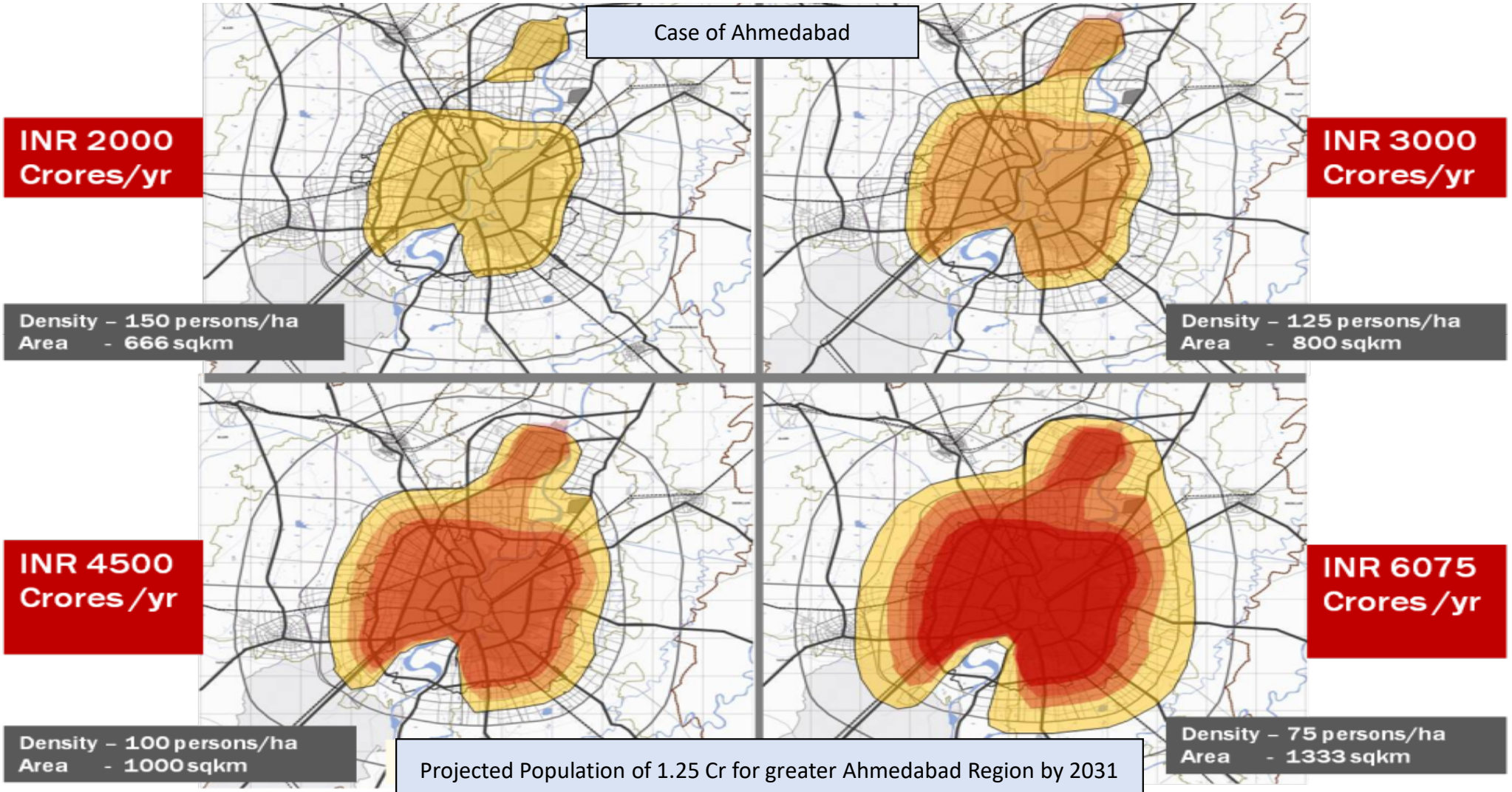


12 houses, 35% open space

How big will the city grow in future?

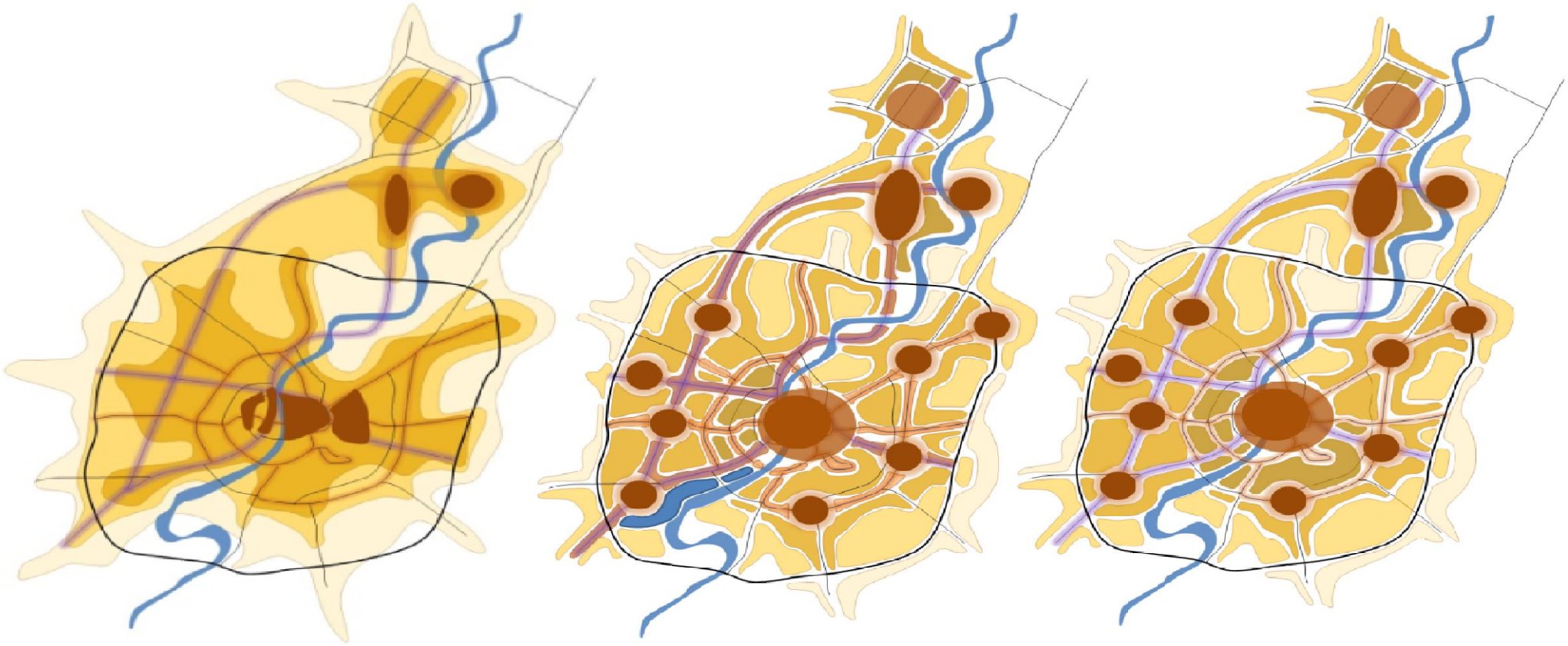
Density Vs Investment

How much to densify : Density Versus Investment



Where do we organise forecasted growth?

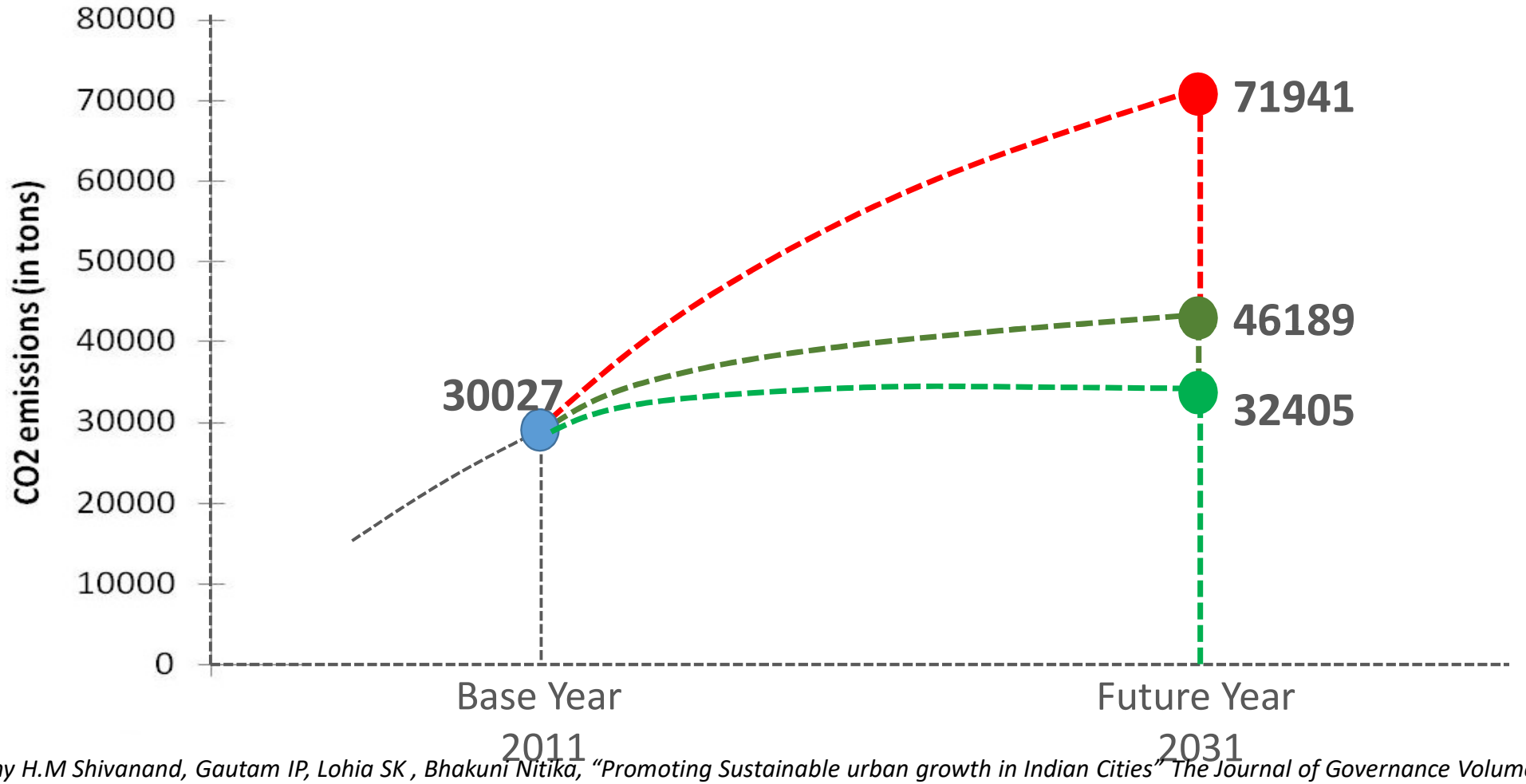
Enabling Urban Structure – Case of Ahmedabad



Corridors Nodes Hybrid

PROJECTING EMISSION LEVELS IN INDIAN CITIES

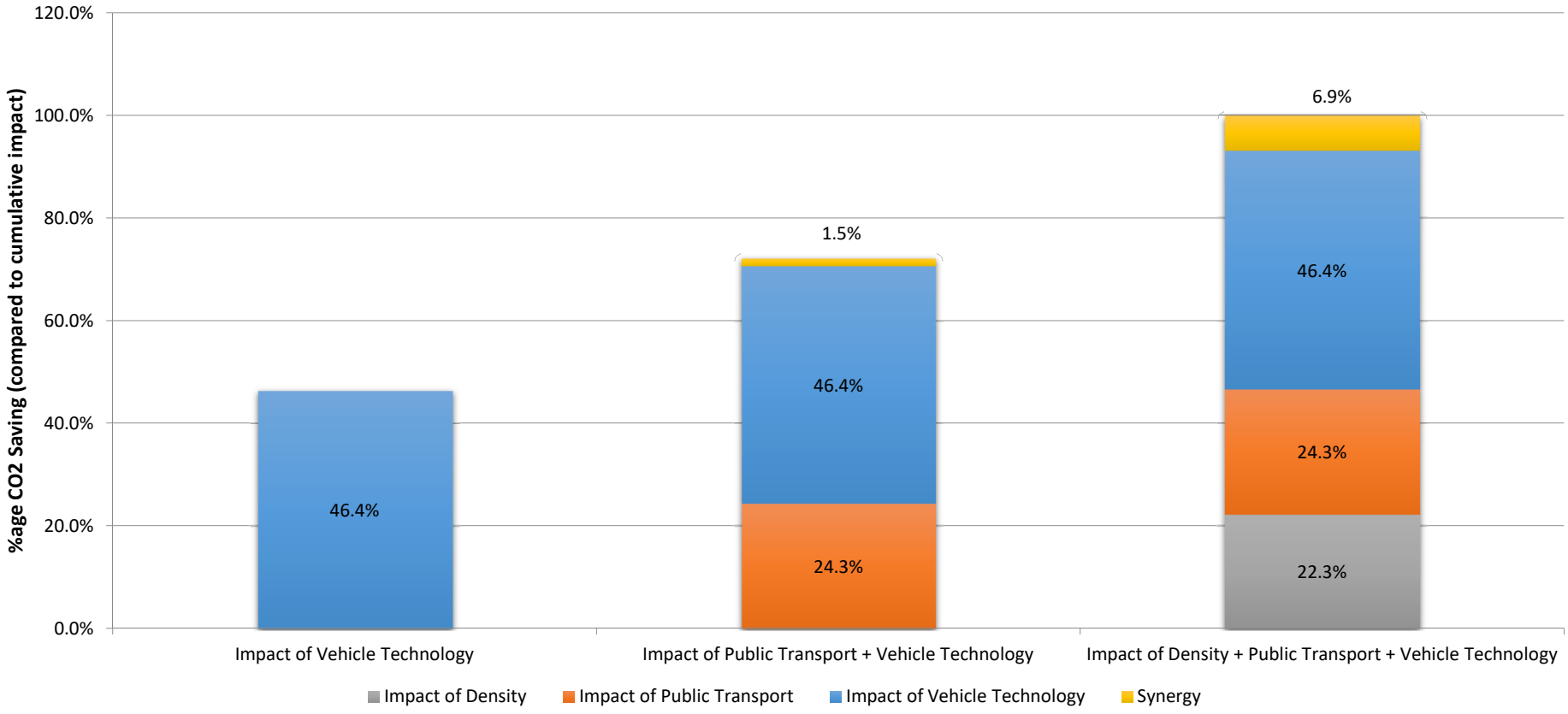
Estimating Emissions



Swamy H.M Shivanand, Gautam IP, Lohia SK , Bhakuni Nitika, "Promoting Sustainable urban growth in Indian Cities" The Journal of Governance Volume 4,January 2012 (69-85)

PROJECTING EMISSION LEVELS IN INDIAN CITIES

THE SYNERGY EFFECT



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