Congestion Pricing for Bengaluru

LUTP 7 Presenter:

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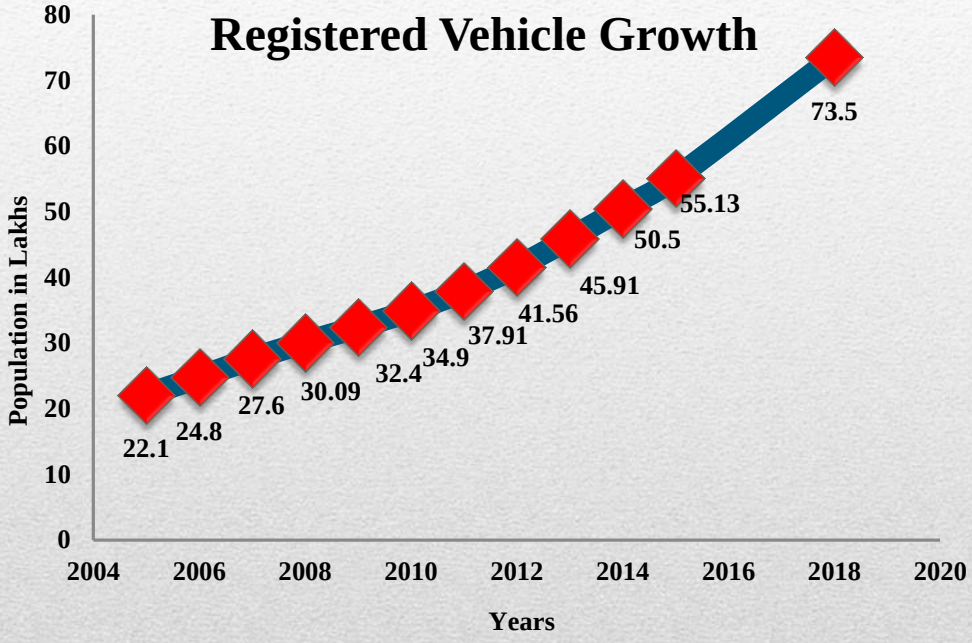
Problem

State of Mobility

More than 130 lakh registered vehicles in Karnataka

80 lakh vehicle registrations clocked in Bengaluru



IMPACT ? Sprawl – longer travel – Congestion - Pollution

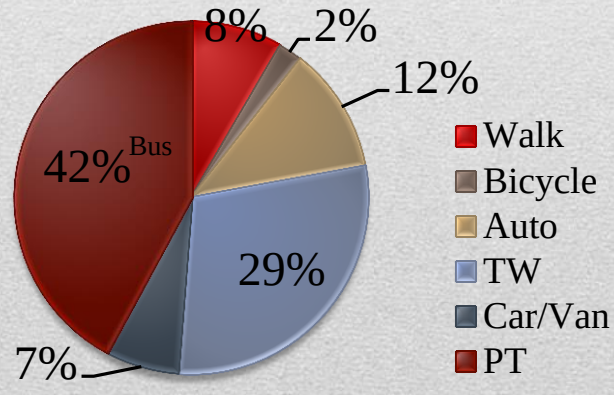
Karnataka is Urbanizing Fast…

- **One of the five most urbanized states in India**
- 39% of population in Urban areas.
- Projected to increase to >50% by 2030

Brunt of urbanization on Bangalore…

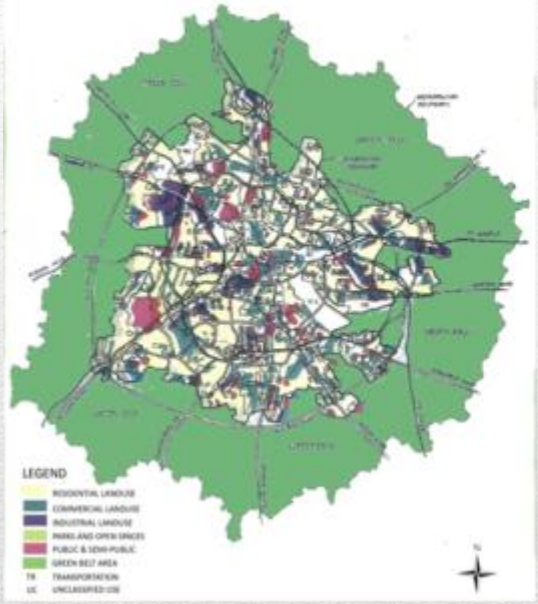
- About 1.5 lakh people move into the city each year
- **BMR population by 2031: ~ 20 million**
  - **16.5 million daily vehicle trips estimated**

How people move in Bengaluru (2011)?

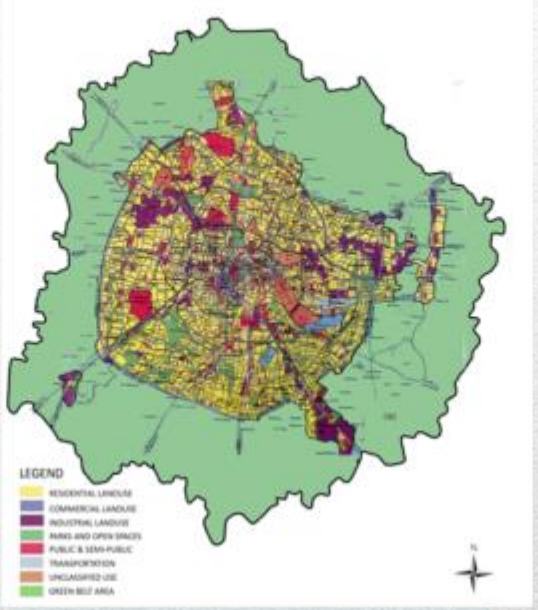


Bangalore sprawling....

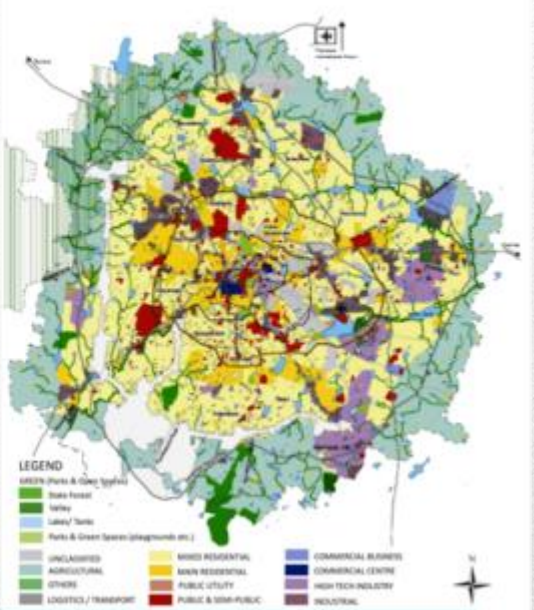
CDP 1984



CDP 1995



RMP 2015

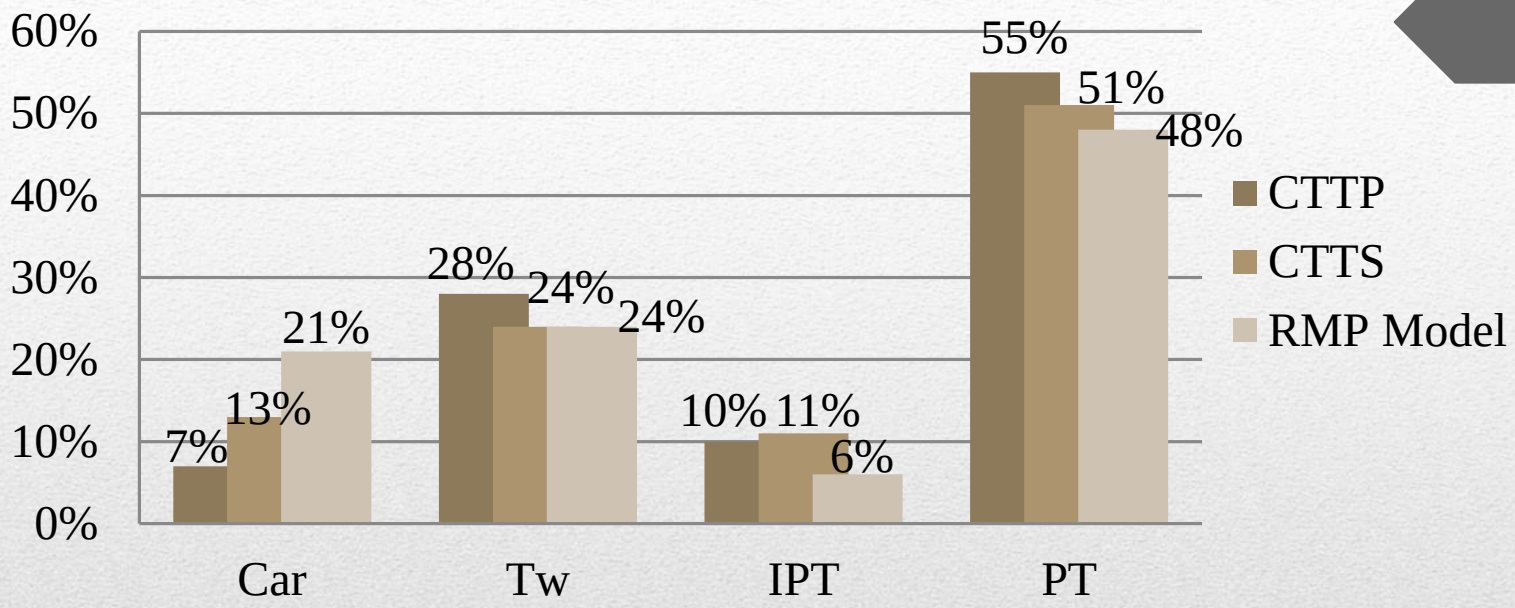


LPA Area= 1279 sqkm	LPA Area= 1279 sqkm	LPA Area= 1219. 50 sqkm*
Conurbation=449 sqkm	Conurbation=597 sqkm	Conurbation=804 sqkm
Agri Zone = 830 sqkm	Agri Zone = 682 sqkm	Agri Zone = 415.50sqkm

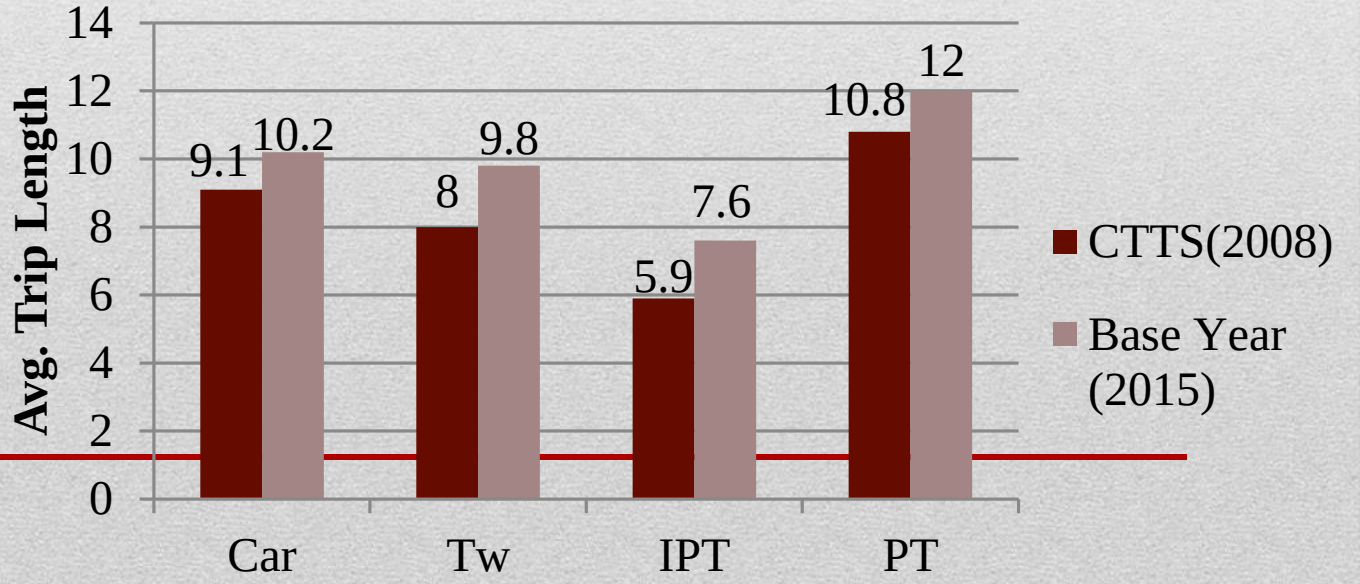
* Excluding BMICAPA Area

- **Second fastest growing economy in India -growth of 10.3%.**
- CAGR of **population 3.83 %.**

Comparison of Mode Share



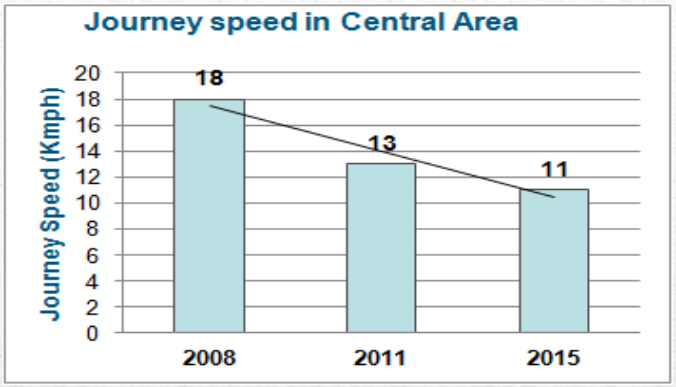
Comparison of Trip Length



Scarcity of Road Space

Road RoW (m)	Length of Major Roads (%)
Less than 20	40.7
20-30	40.0
More than 30	19.3
Total	100

Only 23% of road length has 4 or more lanes (bi-directional)



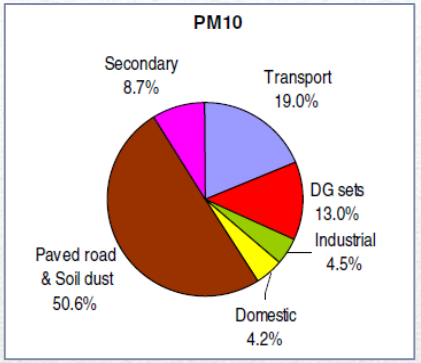
Source: Bangalore Mobility Indicators

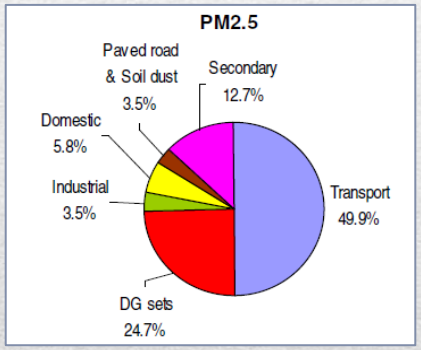
Indices	Year 2011	Year 2008
Congestion Index	0.45	0.33
Travel Time Index (TTI)	1.69	1.57
Road Safety Index (RSI)	0.079	0.047

What does Mobility Indices 2008 & 2011 say??

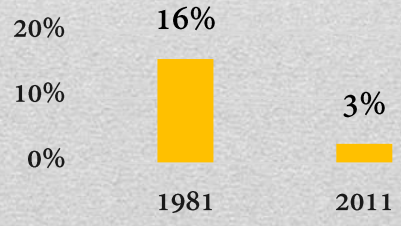
- Journey speeds reduced by 45%
- Travel time up by 69%
- Worsening road safety conditions
- 50% bus routes have journey speed < 15kmph

Road transport accounts for 43.5% of GHG footprint in Bengaluru





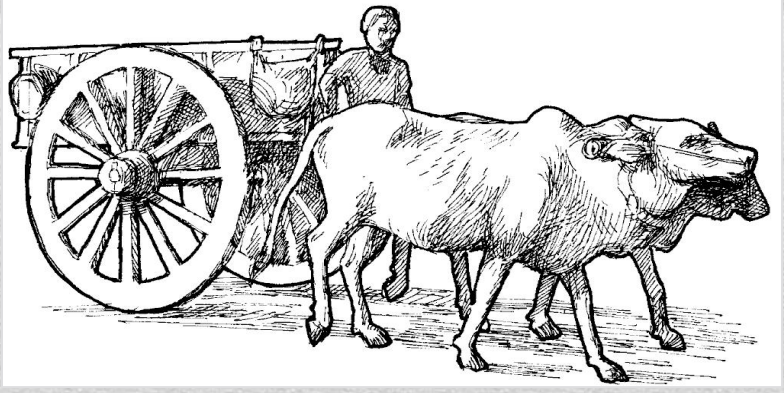
Declining Cycling Mode Share in Bangalore



What if Status Quo continues till 2031? – Vicious circle

Anticipated speeds by 2031, < 10 kmph if no innovative solution implemented for mobility.

Centuries back, Bullock Carts use to carry people at an average speed of 5-10kmph.



Economic Loss due to Congestion….

- **Bengaluru losses close to 2350 crore of import cost (towards fuel) due to congestion**
- **Total fuel lost - 2.8 lakh litres per hour (nearly 50 crore litres per year and INR 1350 crore of national loss)**
- **Man hour lost - 60 crores hours / year (monetary loss -Rupees 3700 crore/year)**

Source: Bengaluru Draft RMP 2031

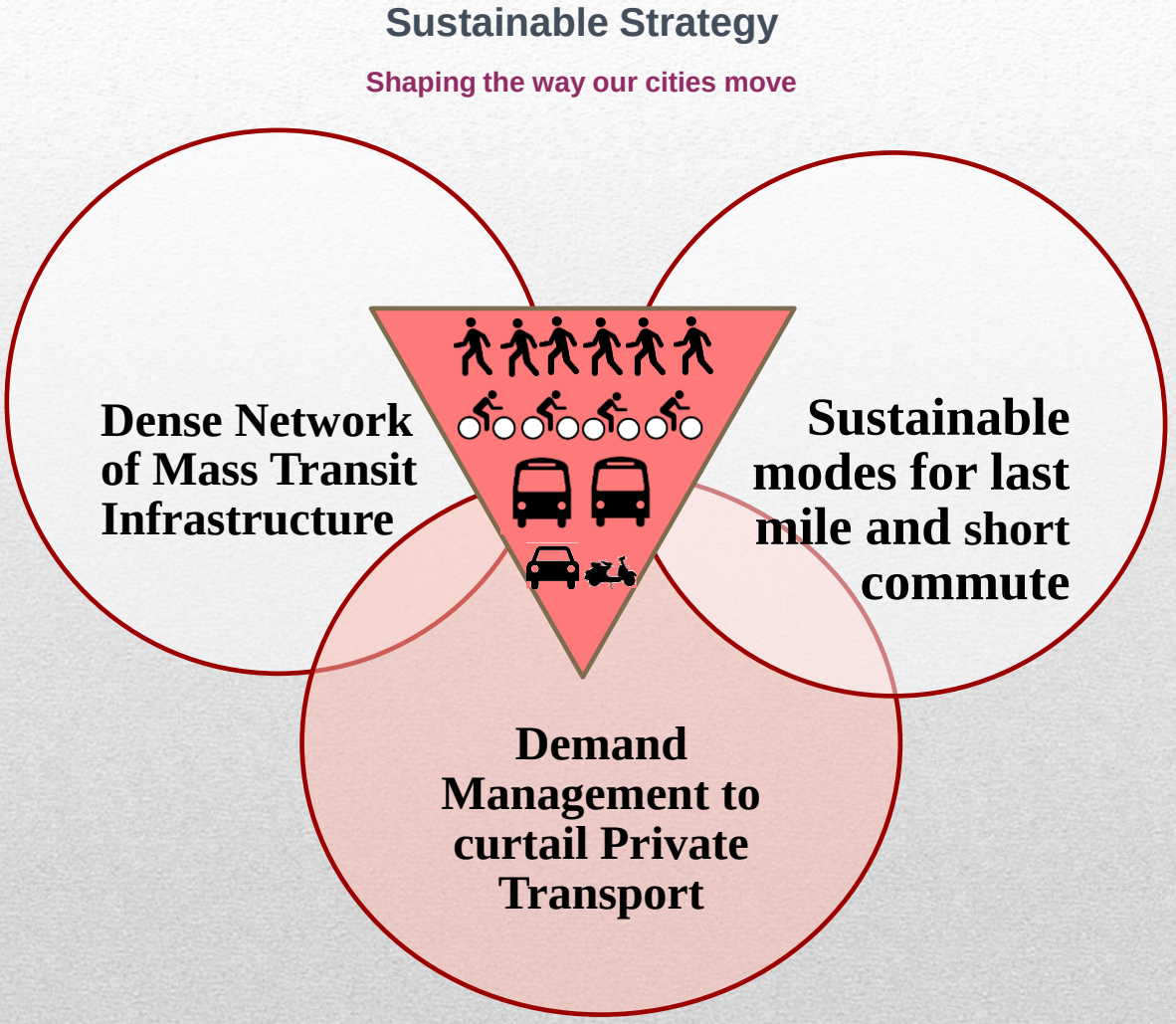
accident scene in Vijayawada. India has had the dubious distinction of high rates and a steady fatalities over the past three decades. Photo: Ch. Vijaya Bhaskar

Pollution

Death or Injury

Congestion

The Way Out…


Sustainable Strategy
Shaping the way our cities move
Dense Network of Mass Transit Infrastructure
Sustainable modes for last mile and short commute
Demand Management to curtail Private Transport

Potential Travel Demand Management Measures

- Parking charges
- Parking restrictions (odd-even)
- Annual registration taxes tied to VKT and fuel efficiency
- Congestion charging
- Auction based permits for new vehicle purchase

Comparison of TDM Measures

	Odd-Even Parking	Annual Vehicle Registration	Parking Charges	Congestion Pricing	Auction Permits for Veh. Purchase
Cost of implementation	Low	Low	Moderate to High	High	Low
Cost of enforcement	Moderate	Low	Moderate	High	Low
Political support	Moderate	High	High	Low	Low
Public acceptance	High	High	Moderate	Low	Low
Effectiveness in reducing congestion	Low	Moderate	Moderate to High	High	High

Thinking of Congestion Pricing

- Who should be charged?
- When should be charged?
- Where should be charged?
- How much to be charged?
- How should road users be charged?
- How should enforcement operate?
- How should revenues be used?
- What outcomes (mobility & landuse changes) to expect?
- What challenges/obstacles could encounter?

Review of CP schemes in other Countries

SINGAPORE

Area Licensing Scheme (ALS), 1975 Area based –

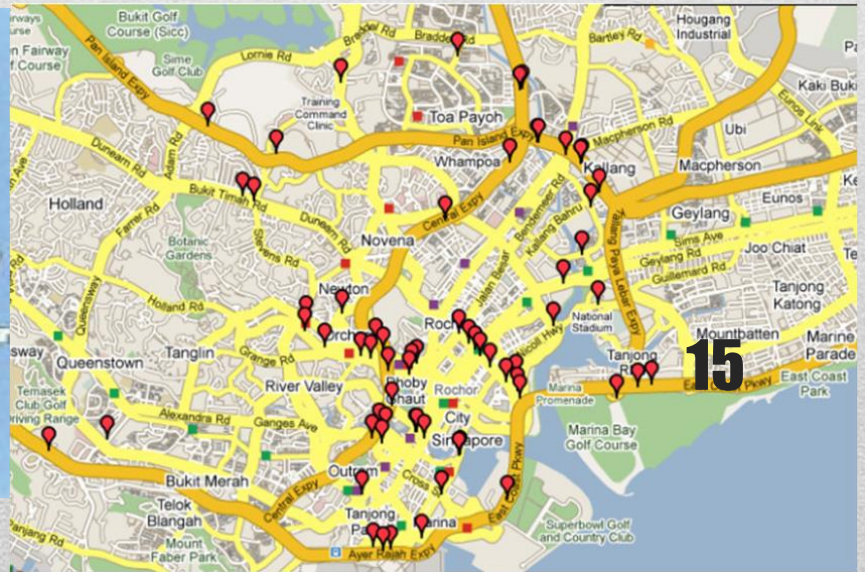
❑Manual road pricing, a flat charge on all vehicles entering the Central Business District (CBD).

Electronic Road Pricing (ERP), 1998 Cordon based –

❑DSRC technology allows an automatic deduction of congestion charge.

❑Charges range 0.5-3 $. Price variables -
- Type of Vehicle
- Location of Gantries
- Time of Day

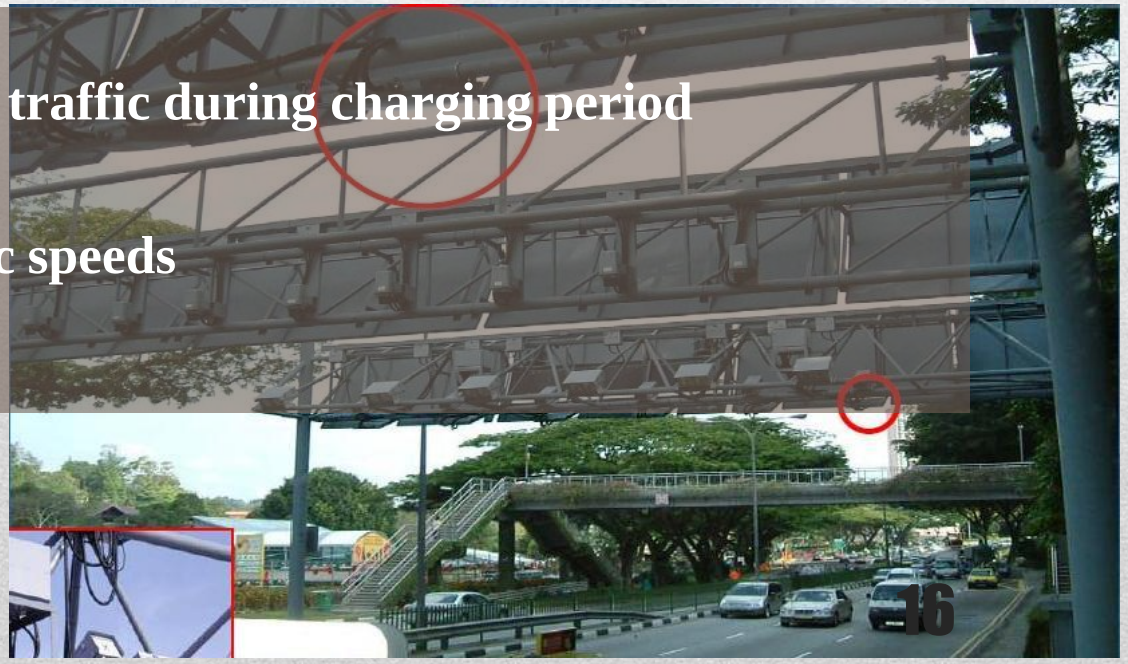
❑Mode of payment –
- CashCard at banks, post offices& petrol station



SINGAPORE

The current system is operated by a consortium including Philips Singapore Pty Ltd, Mitsubishi Heavy Industries Ltd, Miyoshi Electronic Corporation and CSE Global Ltd.

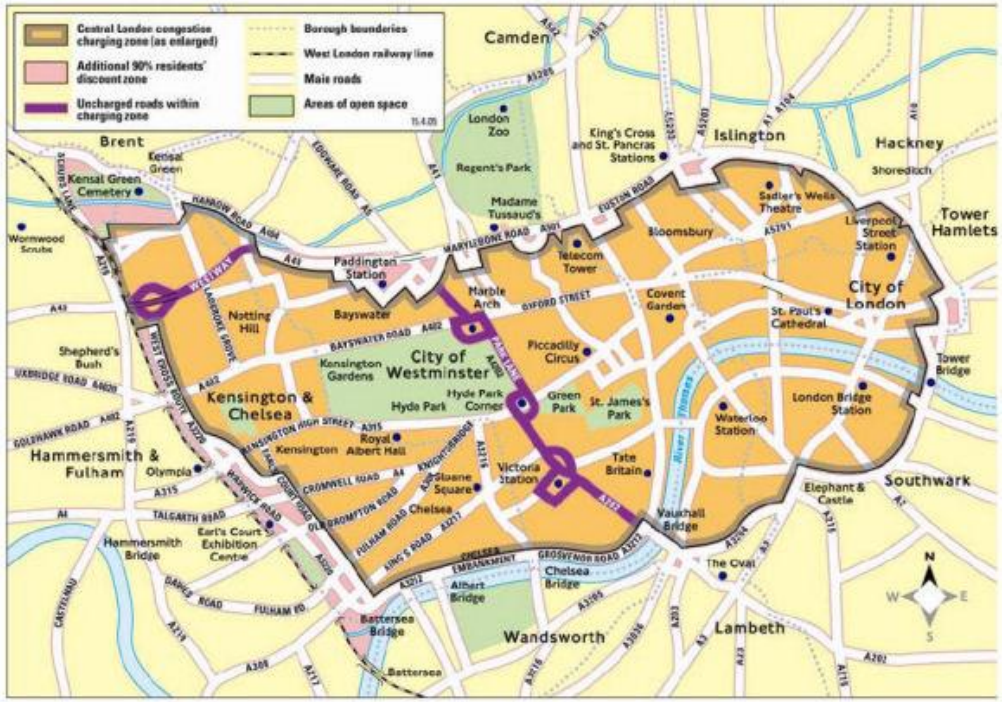
Capital cost S$200m (€120m) – 624 crore appx.
Annual Operation costs S$16 million (€9m) – 43 crore aprx.
Annual revenue $50 million (€30m) – 250 crore appx.

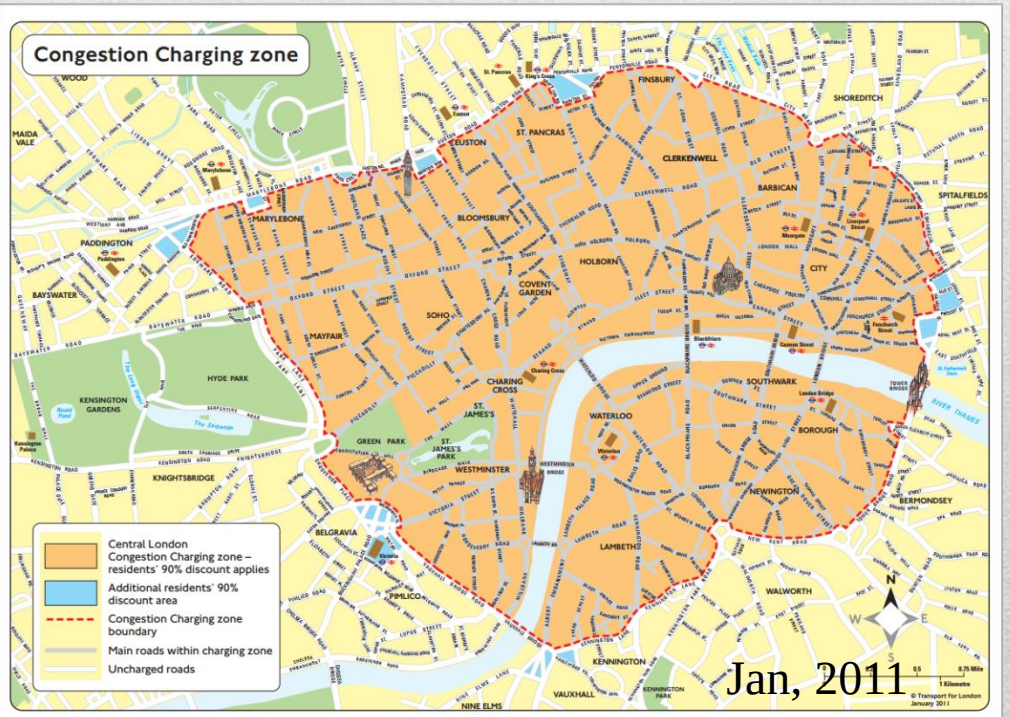


LONDON

- Area based pricing, 2003.
- User needs to pay once, no matter how many times he drive in and out of the CC zone on the same day.
- ANPR technology used- through CCTV cameras vehicles is being recognized and registered payment details are cross checked and after the transaction is done the record is deleted.
- Price 10 £. User can pay in advance or on the day of travel through the following modes.

1. Auto pay
2. Online
3. SMS
4. Phone
5. Shops
6. By post





LONDON

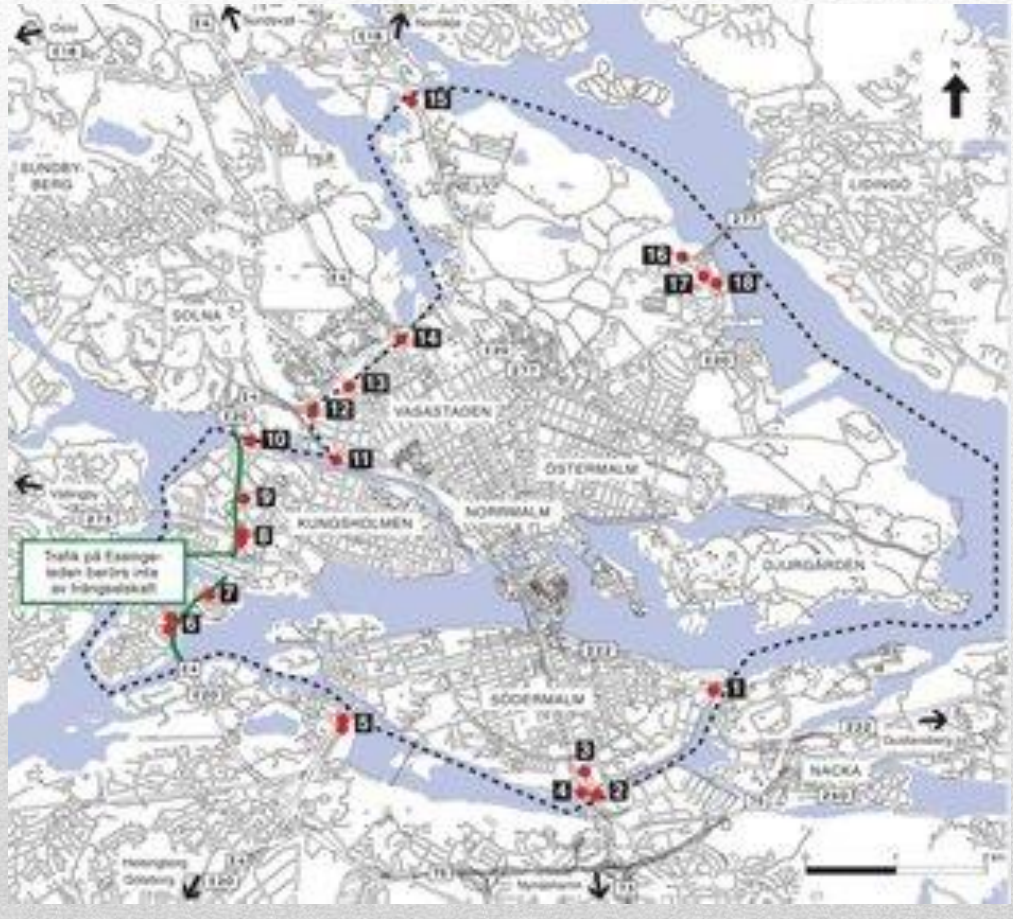
1. Transport for London (TfL) is responsible for the scheme.
2. The operation is sub-contracted to a number of outside companies. Since 2009, IBM responsible for the day-to-day operation of the charging system.
3. Siemens Traffic Solutions provides and operates the physical enforcement infrastructure.

Capital Cost - $180 m (864crores)
O&M Cost - $97 m (465.6 crores)
Annual Revenue - $165 m (792 crores)

26% traffic delays reduction in the Congestion Zone.
15% traffic reduction, 30% congestion reduction.
12% total pollution reduction
15% CO2 emissions reduction

STOCKHOLM

- Cordon based, 2007.
- RFID technology is used.
- Charges varies (10-20 SEK) with the peak /Non-peak hour time.
- Price variables-
  - Location
  - Time
  - Vehicle size
- Modes of Payment
  - Cash cards
  - Online
  - telephone
  - banks
  - retail stores



STOCKHOLM

- The Vägverket (Swedish Road Administration) is the body responsible for the administration of the charge and its system.
- IBM was responsible for solution design, development and operation. IBM built the on-demand solution using wireless (RFID) technology supplied by Norwegian company Q-Free systems, a supplier of technology for road charging systems.

Capital Cost - $260 m (1240 crores).
O&M Cost - $26 m (124 crores)
Annual Revenue - $53 m (254.4 crores)

20% reduction in traffic
4.5 % increase in use of public transit
14% emissions reduction
10% dropping of air pollutants

Comparison of CP Schemes

CITIES	OBJECTIVE	Year of Launch	Vehicles Charged		Price Charged	
			All	Private	Single Price	Multiple Price
Singapore,	1) control car usage in CBD area. 2) increase the public transport patronage	1975 (ALS) 1998 (ERP)	√		07:30 am-7:00 pm- CBD/ 7:30- 9:30 am Expressways and ring roads	$ 1.0 (8:00-8:30) $ 1.5 (8:35- 8:55) $ 1.0 (8:55-9:00)
London, U.K.	1)to reduce the congestion increase journey time reliability 2) decrease of air pollution	2003	√		7:00 am- 6:00 pm	£ 8 for private/ £7 for fleet
Stockholm, Sweden	1) to reduce the congestion 2) revenues for new infrastructure	2007		√	6:30 am- 6:30 pm	$ 1.27 - $ 2.54

CITIES	Technology Used		Cost Envolved		Annual Revenue Generation	Panalties	Legal Backing required
	ANPR	Electronic	Capital cost	O&M cost			
Singapore		On board unit and smart cards with overhead gantries	$ 130 m (624 crores)	$ 9 m (43.2 crores)	$ 52 m (249.6 crores)	n/a	Being national government, high control on indiviuals
London, U.K.	CCTV and ANPR on entry and exit		$ 180 m (864crores)	$ 97 m (465.6 crores)	$ 165 m (792 crores)	£ 3 (Rs.247) for private/ £ 2 (Rs. 165) for fleet vehicles per day	1999 London Government Act and 2000 Transport Act
Stockholm, Sweden	√		$ 260 m (1240 crores)	$ 26 m (124 crores)	$ 53 m (254.4 crores)	EUR 7 (Rs. 462) fine after 5 day/ EUR 50 (Rs. 3300) fine after 4 weeks	Common Congestion charge law with an annex relating to trial

Congestion Pricing for Bengaluru

Framework for Developing a Congestion Pricing Scheme

Step 1- Identification of Congested Zones, Routes

Step 2 – Present Traffic characteristics

Operational Model-

1. Operational Time
2. Vehicle Eligibility
3. ITS Application
4. Pricing Scheme

Supportive Measures

1. Proposed circulation pattern
2. up-gradation of PT Service
3. Provision of NMT facilities

Cost-Benefit Analysis

1. Project Cost (Capital Cost and O&M Cost)
2. Revenue Estimates
3. Estimated outcomes

Step 3 - Institutional Framework for Implementation

1. Identification of Project Partners
2. Business model
    1. Project Financing model for operation
    2. Revenue Management
3. Implementation plan

Area Suitability for Introducing CP

- High level of congestion
- High travel delays

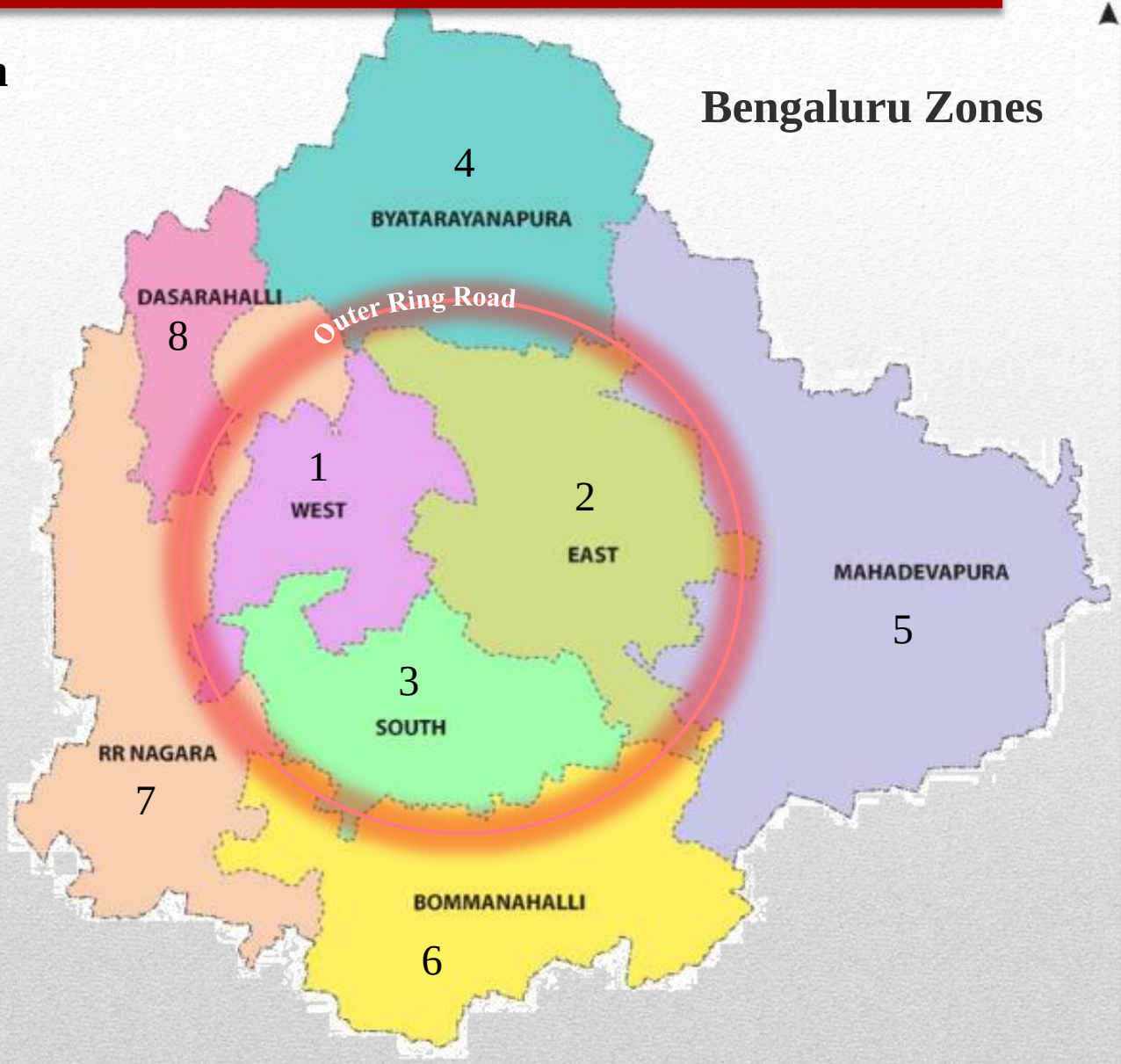
+ Good public transport service
+ Good walkability
+ Availability of alternate route

- Lower % of residential area and higher commercial/businesses

Step 1- Identification of Congested Zones, Route

Parameters for Selection of CP Zones–

1. Congestion Level (Congestion Index)
2. Travel delay (Travel Time Index)
3. Parking Demand (On Street Parking Index)
4. Public Transport Services (Coverage and Accessibility)
5. Pedestrian facilities



Congestion index = 1 – (Actual Travel Time / Desirable Travel Time)

Travel Time Index = Actual Travel Time/Ideal (free flow) Travel Time

Parking Index = 1/ (% of major road length used for on-street parking)

Public Transport Accessibility = 1/ average distance to bus stop or transit station

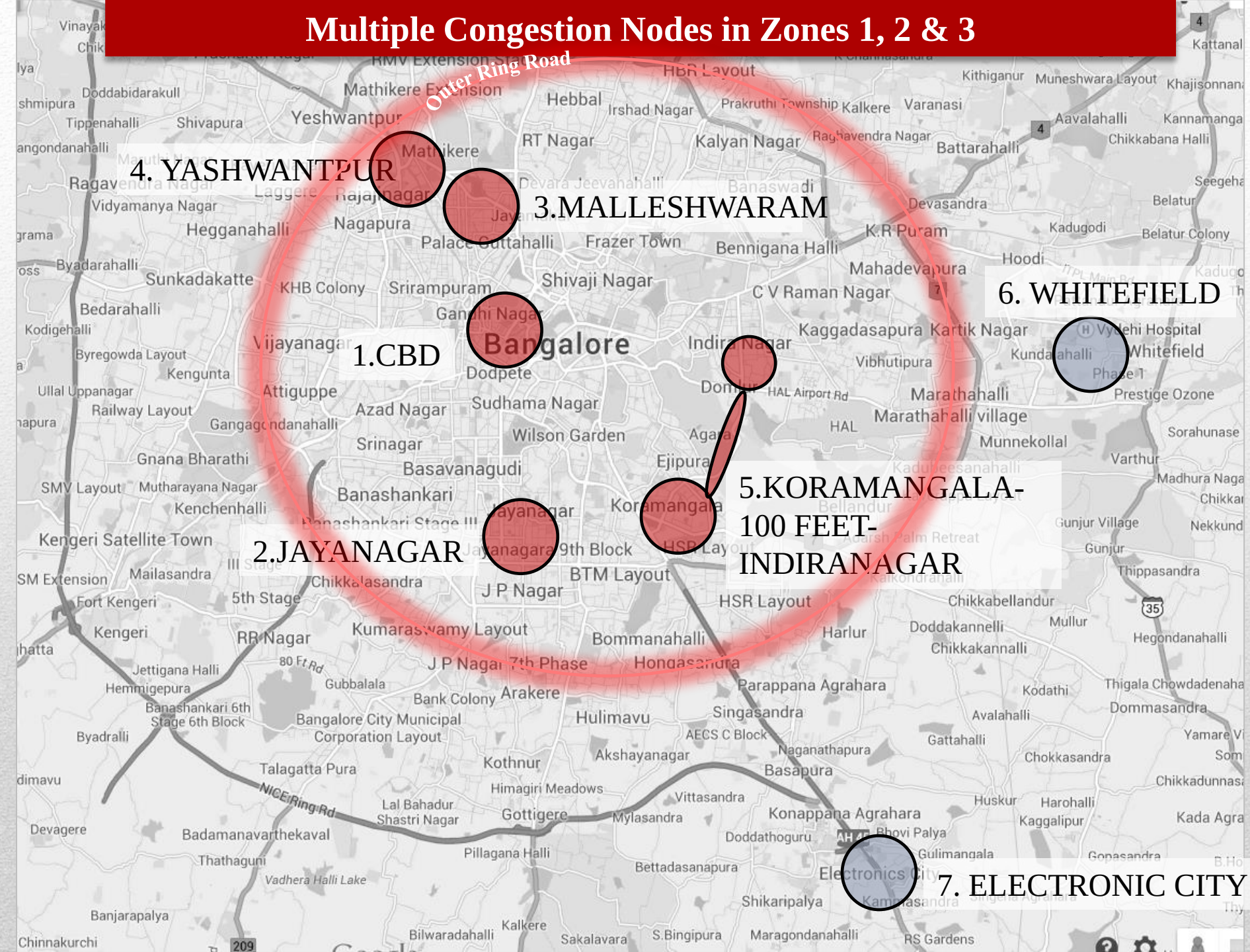
Public Transport Coverage = % of roads with PT routes

Walkability Index = (Length of Road * 2) / Length of footpath (min 1.2m width)

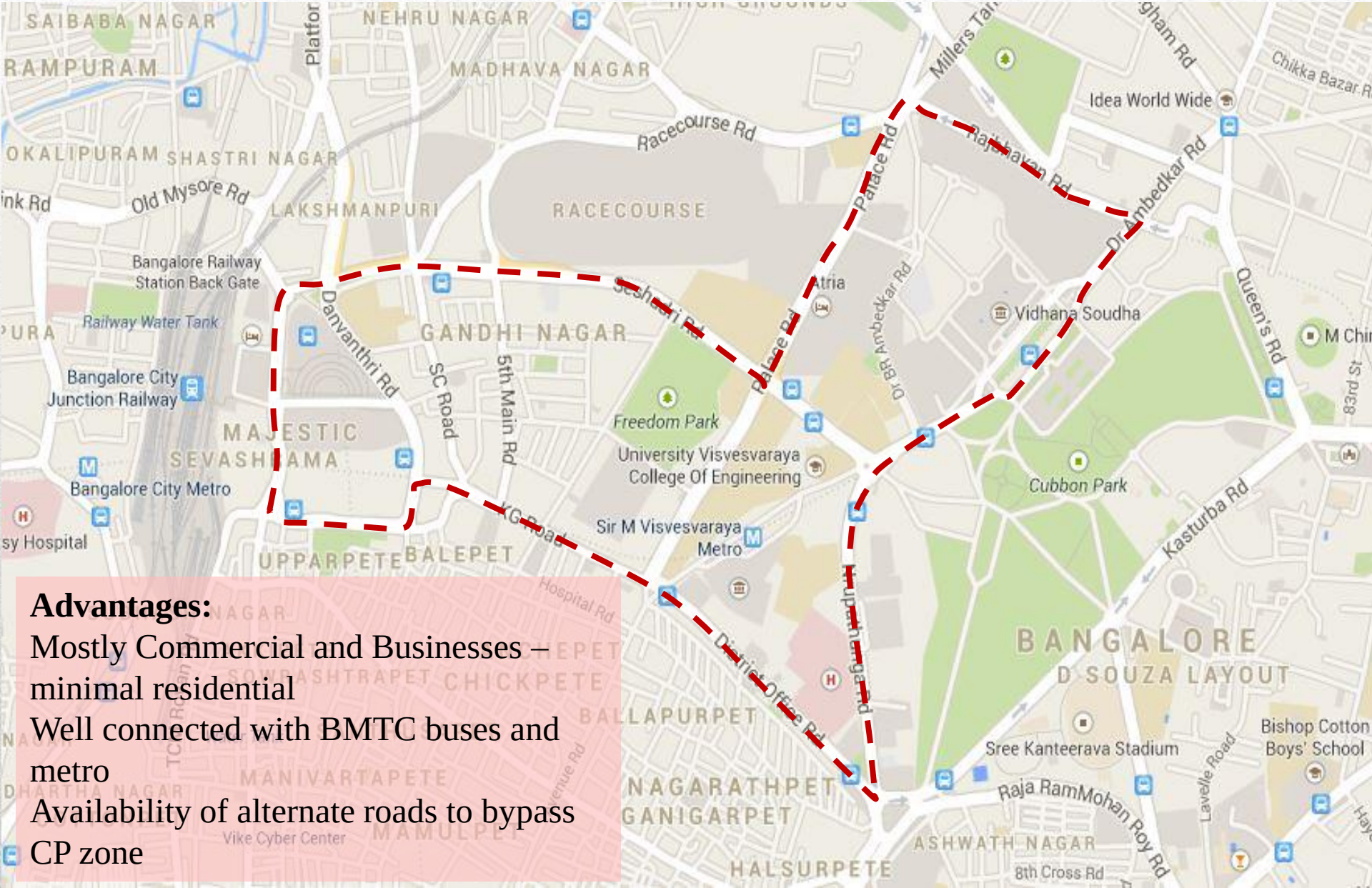
Parameters	Desirable	Zones							
		1	2	3	4	5	6	7	8
Congestion Index	0	0.56	0.53	0.53	0.22	0.48	0.31	0.1	0.2
Avg. Journey Speed (kmph)	25-35	19.2	21.2	20.8	33.0	22.4	27.5	37.0	34.7
Travel Time Index	1	2.2	2.1	2.1	1.3	1.9	1.5	1.1	1.3
On street Parking	20	1.42	1.52	1.72	1.82	1.93	4.1	3.2	3.6
PT Accessibility	>=2	2.1	2.1	2.2	2.3	1.7	1.1	1.2	1.3
PT Coverage	100%	92%	78%	94%	32%	36%	31%	43%	40%
Walk ability Index	1	0.5	0.57	0.56	0.21	0.16	0.1	0.29	0.15

Data source: BMI, 2011 (DULT)

Multiple Congestion Nodes in Zones 1, 2 & 3



CBD – Candidate CP Zone for Phase 1 (~2 sq. km.)



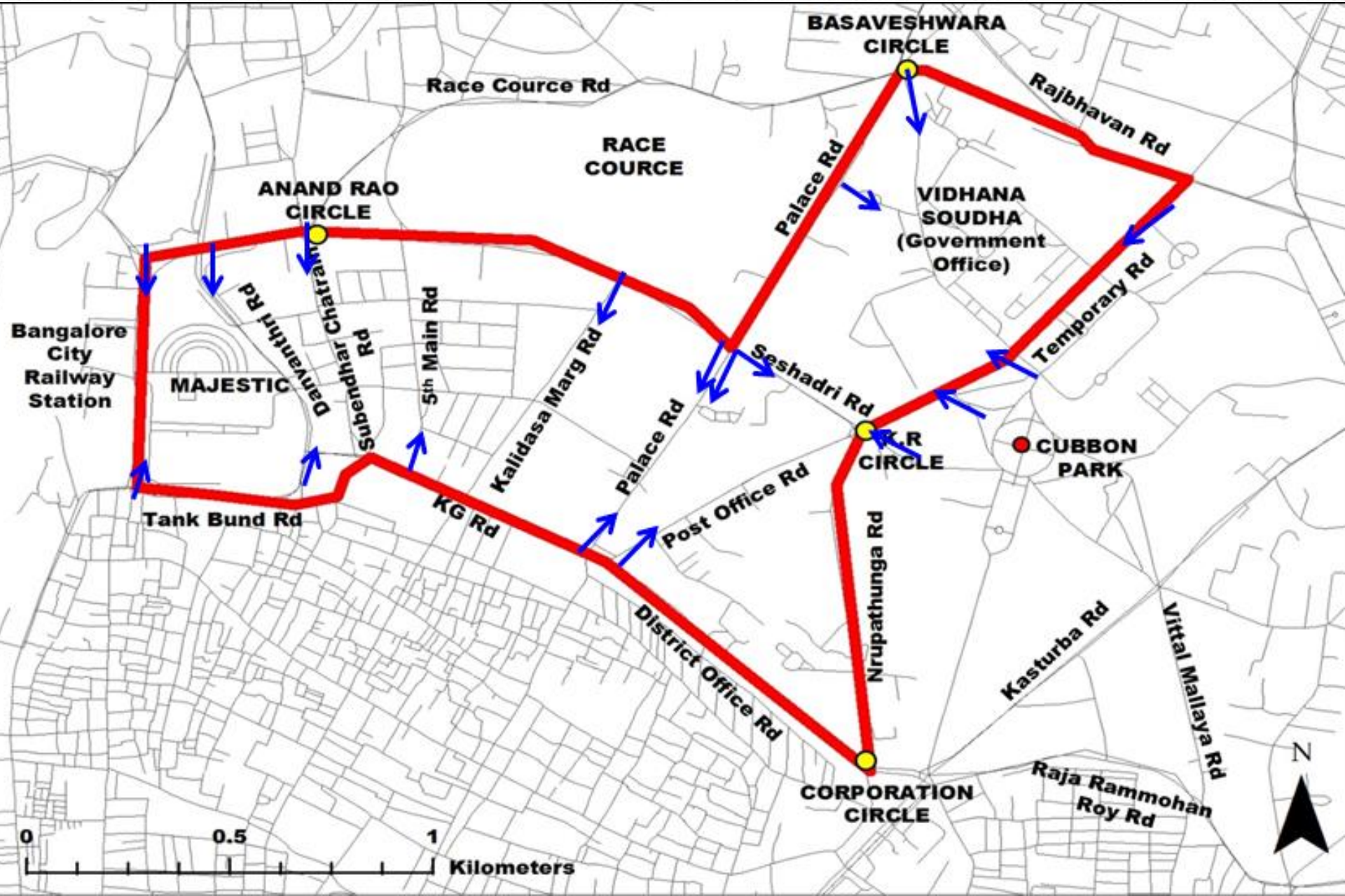
Advantages:

Mostly Commercial and Businesses – minimal residential

Well connected with BMTC buses and metro

Availability of alternate roads to bypass CP zone

Charging Points



Technologies for Congestion Pricing

Three feasible technology that can be accommodated for Indian condition.

1.Automatic Number Plate Recognition (ANPR): Optical Character Recognition (OCR) is used to read license plate numbers captured by video cameras.

2.RFID: Radio-frequency identification to detect the moving vehicle using the passive OBU.

3.Dedicated Short-range Radio Communications (DSRC): Each vehicle carries a transponder that deducts payments when it passes through a gantry.

Name	Camera	Vehicle Detector	Roadside Reader	PASSIVE TAG	OBU	Gantry	Communi-cation	Backend
ANPR	✖					✖	✖	✖
RFID	✖	✖	✖	✖	✖	✖	✖	✖
DSRC	✖	✖	✖		✖	✖	✖	✖

ANPR

Technology: The ANPR cameras works using the Optical character recognition to read the number plates of moving vehicles.

On-board Components: *No On-board device required.*

Roadside Device: ANPR cameras to be installed at the validation point. The ANPR cameras are available with good quality recognition up to 95% accuracy.

Advantage:

(i) No OBU is required. Only roadside cameras can handle the validation.

(ii) The proven and mature technology.

Disadvantage:

(i) The external factor like Non-standard number plates and weather condition may affect the ANPR accuracy.

Cost:

(i) **Camera:** **INR 3 Lacs** (Approx) per Camera.

RFID

Technology: The wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects.

On-board Components: The passive On-board unit doesn't require the power attachment. The signals are provoked by getting external power from road side reader.

Roadside Device: The long range RFID reader to read the vehicle's unit and send the data to central system.

Advantage:

(i) Cheaper Cost

(ii) Temper proof

(iii) Already applied on large scale on highway projects.

Disadvantage:

(i) Only Points based validation is possible using the reader. Completely based on the reader.

Cost:

(i) **OBU:** **INR 100-200.**

(ii) **Road Side Reader:** **INR 2 Lacs** (Approx) per reader

DSRC

Technology: Higher bandwidth and data speed, supports many ITS applications works on the two way communication for accurate and long distance reading.

On-board Components: The OBU requires internal power source may be used for long reading distance

Roadside Device: It works on one-way or two-way short- to medium-range wireless communication channels specifically designed for automotive use.

Advantage:

(i) Faster reading of Vehicles OBUs.

(ii) It supports integration with various other technology like Smart card reader, GPS etc.

Disadvantage:

(i) It requires an battery power for the On-board unit.

(ii) The DSRC OBUs and readers are quite expensive comparing to the RFID based OBUs.

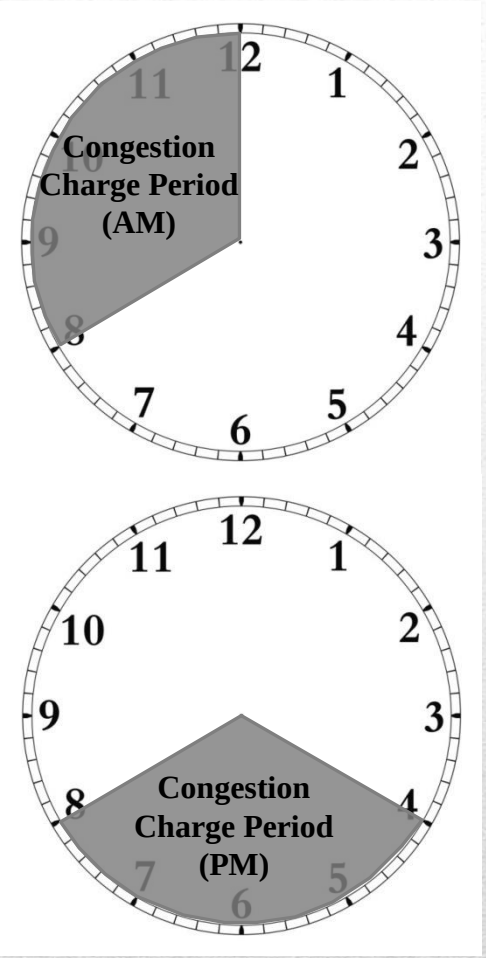
Cost:

(i) **OBU:** **INR 2000**

(ii) **Road Side Reader:** **INR 5 Lacs** (Approx) per reader

Operational Time-period

Pricing Time		
	From	To
Morning	8:00	12:00
Evening	16:00	20:00



- **Entire day - Local business may run through a loss.**
- **Only peak - Trips may get shifted. congestion may reduce but mode shift may not occur.**
- **So, the CP time can be peak hours+1hour buffer at each end (8 hours/day).**

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Charge	Charge	Charge	Charge	Charge	Charge	No Charge

Vehicles Charged

Sl. No.	Vehicle Type	Charge/ Exempt
1	**Two Wheelers**	**Charge**
2	**Cars (Private, Govt.)**	**Charge**
3	**Autos**	**Charge**
4	**Goods vehicles (LCVs, Trucks)**	**Charge**
5	Buses	Exempt
6	NMT modes (cycles, carts, rickshaws)	Exempt
7	Emergency vehicles (Ambulance and Fire Brigade)	Exempt
8	Police vans	Exempt

Initial Congestion Charges Charges

- Cost of petrol/litre
  - Rs 70 per litre
- Fare for 10km bus journey
  - Rs 50-80 for adult (for Air Conditioned Service)
- Cost of toll on the national highways in Karnataka
  - Rs 115
- **To use Rs 150 for cars (twice the current fare on an air-conditioned bus and about twice the price of 1 litre of petrol)**
- Use Passenger Car Equivalent (PCE) used by Indian Road Congress
  - If a car is set at Rs 150, then motorcycle will be Rs 75 (pcu for motorcycles is 0.5), etc.

Cost Estimation - Pilot CP Zone

CAPEX Cost

Items	Costs (in Rs)
Roadside Units	95,00,000
Control Room	50,00,000
Total	1,45,00,000

Operation Cost

Items	Costs (in Rs)
Man- power	36,00,000
Infrastructure maintenance	5,00,000
Total	41,00,000

COST BREAKUP

Sl. No	Description	Unit	Quantity	Cost per unit
	Capital Cost			
1	Gantry Points	Number	19	5,00,000
2	On-Board Units (will be paid by users)	Number	40,05,000	2,000
3	Cash Cards (will be paid by users)	Number	40,05,000	500
4	Control Room	Number	1	50,00,000
	Operational Cost (per year)			
5	Time period	Months	12	NA
6	Man- power	Number	10	30,000
7	Infrastructure maintenance	Number	Lump-sum	5,00,000

Other Demand Management Measures Proposed

- Priced parking to be introduced in other commercial areas of Bengaluru
  - Parking rates commensurate with land value in that area
  - Land acquisition and development cost transferred to parking users
- Parking to be minimized on-street; most parking provisioned off-street
  - On-street parking to be 3 times higher than off-street
  - Exponential surge in on-street parking free after short-duration (say 2 hours)
- Parking lots (off-street) around CP zone to be provisioned
- Parking around transit stations (metro, suburban, TTMCs) and multi-level parking lots to be restricted
- Parking to be managed by professional agency zone/area wise – manual intervention to be reduced wherever possible
- Revenue from CP and Parking to be ring-fenced and utilized only for development of footpath/pedestrian streets, cycle tracks, public transport improvements, public space upkeep, etc.

Way Forward

- Estimation of benefits
- Action plan for implementing supporting improvement
- Institutional mechanism for implementation of CP
- Public outreach and engagement

Thank You