## Air Quality and Sustainable Transportation Challenge in South Asian Cities







## **Anumita Roychowdhury Centre for Science and Environment**

Joint initiative of:

Bangladesh Road Transport Authority, Work for a Better Bangladesh Trust and Centre for Science and Environment

Dhaka, April 30 2013



The stark concern.....

## Global Burden of disease: Shocking findings......



#### December 2012:

Global Burden of Disease estimated by 450 scientists from 300 global organisations including WHO found -- Air pollution related deaths have increased by 300 per cent since 2000. About 65 per cent of these deaths occur in Asia.

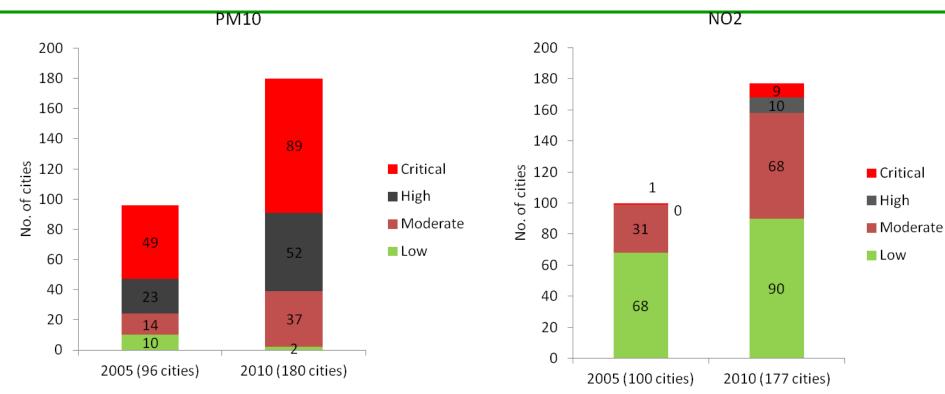
Air pollution is among the top 10 killers in the world Two-thirds of the death burden in developing Asia. South Asia most vulnerable......

#### February 2013:

**GBD findings for India:** 620,000 premature deaths a year. More than 18 million healthy life years lost due to air pollution. Air pollution triggers stroke, cardiovascular and respiratory diseases, cancer.....

## More Indian cities in grip of pollution





-- PM10 monitoring increased from 96 cities in 2005 to 180 cities in 2010.

- -- Low polluted cities fallen from 10 to 2. -Critically polluted cities (1.5 times the standards)
  increased from 49 to 89 cities.
- -- 2005: 75% of cities exceeded the standard.

2010: -- 78% of cities

NO2 monitoring increased from 100 cities to 177 cities 2005: Only 1 city exceeded the standard, 2010: 19 cities

back to pre-CNG

Nov 22, 2012

Delhi Winter

During the first week

During the first week City enveloped in smog, Delhi this winter

Gains Of Switch To Cleaner Fuel Frittered Away

Neha Lalchandani TNN

New Delhi: Delhi's air pollution has reached alarming levels. For proof, just look out of the window. The grey-white 'haze' that has been covering the city since October 28, say experts, is actually smog that is linked to the rapid rise in

147-394 Current PM10 & NO2 level higher than that on last year's Diwali day PM10 337-597 60-133

During the first week of November, Delhi went under a thick blanket of Smog. The breeze nearly stopped, and the skies turned grey and dank. Coo and calm Weather led to fumes settling close to the ground. People held masks, scarves or handkerchiefs to their faces.

The resultant outcry in the smog-hit city had officiale stubbornly insisting that this was nothing new and that it happened every

The new twist came. agricultu...

► High pollution, P 6

tre

on

Smog leaves Delhi gasping for breath

(see grapme) — mar gams

TNN | Nov 3, 2012, 01.33 AM IST

poisonous gases". Not co- air quairty, the judiciary

e billowing :--

Smog delays Sheila Dikshit's flight to Puniab

### Disadvantage Delhi: Smog here to stay

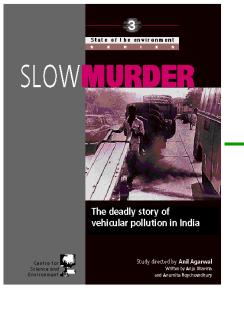
02.44AM IST

| Punjab | NASA | flight | Flashpoint | Apex

Darpan Singh, Hindustan Times Email to Author New Delhi, November 08, 2012 🖂 email 🖶 print **™ Tweet** <0

Leidhiana trip by Delhi chief minister Sheila Dikshit in a chartered g telecom industrialist family became the flashpoint of the ongoing n Delhi and Punjab when the plane was delayed by nearly three hours

The Centre for Science and Environment (CSE), in its latest report, has delivere The smog is here to stay, it has also warned that Delhi is in the grip of a multi-p matter is not the application aboling up. Mitrog



Himachal lung



# cough wheeze suffocate

## TAKÉ A STAND

PUT YOUR HEALTH ON THE POLITICAL AGENDA

CENTRE FOR SCIENCE AND ENVIRONMENT

2995 5124, 2995 6110, 2995 6399, 2995 6394

From its early stages, CSE's Right to Clean Air campaign used a variety of communication tools — such as this poster — to put out its message to the public. It built support

## Roll down the window of your bullet-proof car, Mr Prime Minister The security threat is not the gun. It's the air of Belhi



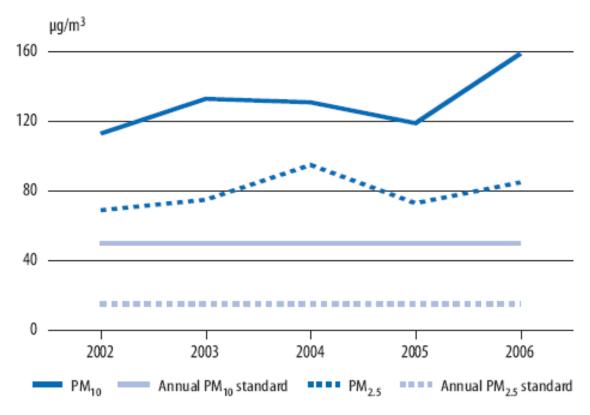


But those cars are so sexy!

## Killer particles in Dhaka's air....



#### Annual Average PM<sub>10</sub> and PM<sub>2.5</sub> in Dhaka

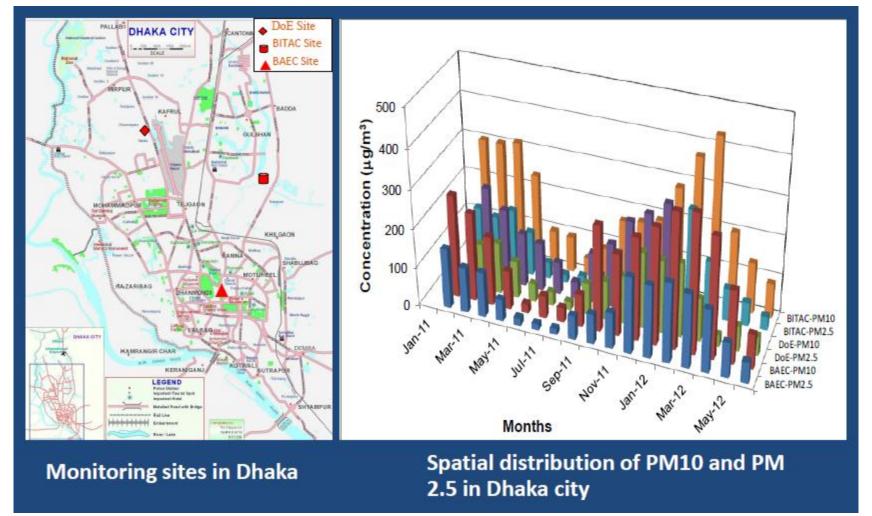


 $PM_{10} = particulate matter with a diameter of not more than 10 microns; <math>PM_{25} = particulate matter$  with a diameter of not more than 2.5 microns;  $\mu g/m^3 = micrograms per cubic meter$ 

### Severe winter pollution in Dhaka



#### Rapid build up of PM10 and PM2.5 during winter

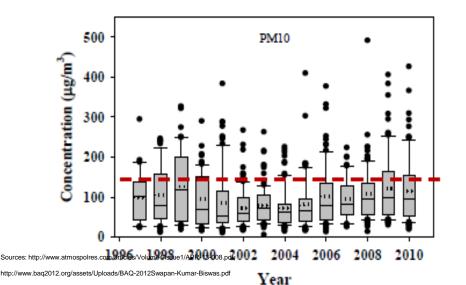


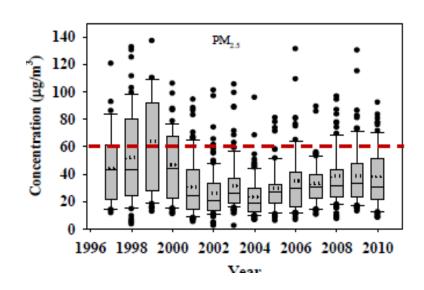
## Tiny killers Fine particulate challenge



- •Dhaka -- About 30–50% of the PM10 mass is fine particles with aerodynamic diameter less than 2.2 μm. Go very deep inside the lungs
- •These particles are mainly from transport–related sources.

Source: Atomic Energy Centre, Center for Air Resource Engineering & Science and Institute of Geological and Nuclear Sciences

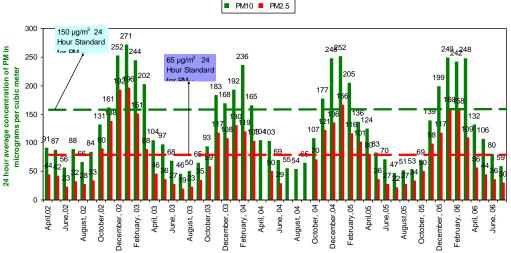






### Dhaka's air: twin challenge of PM and NOx

Air Quality Management Project
Department of Environment
Monthly Average of PM Concentration at CAMS, Sangsad Bhaban
April, 2002 to July, 2006

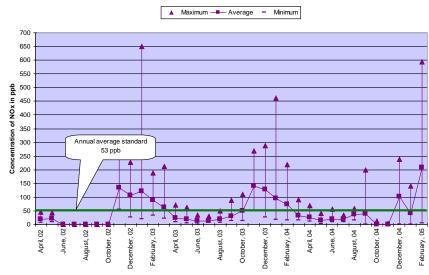


Month

#### **Trends in Particulate Matter in Dhaka City**

#### **Trends in NOx in Dhaka City**

24 Hours Average Oxides of Nitrogen at CAMS, Sangsad Bhaban Monthly Maximum, Average and Minimum NOx

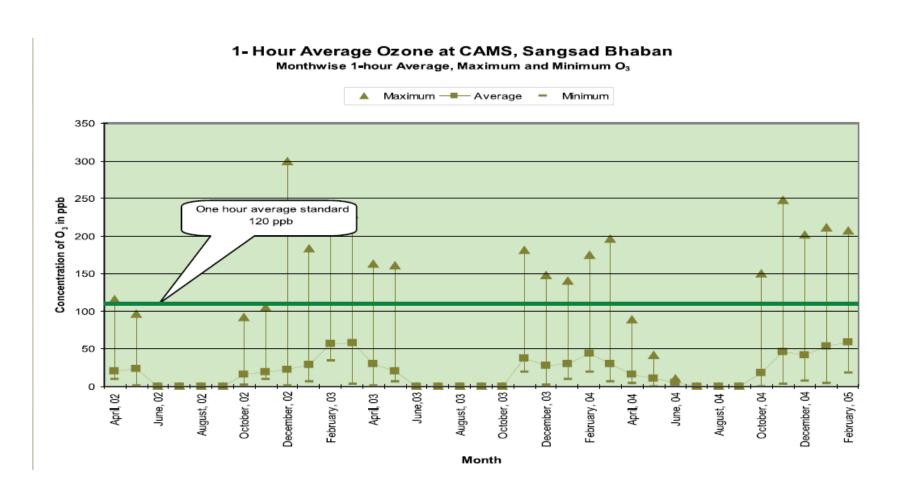


Source: Department of Environment, Bangladesh

## New threat in our cities



#### Ozone: Short term peaks exceed the standard





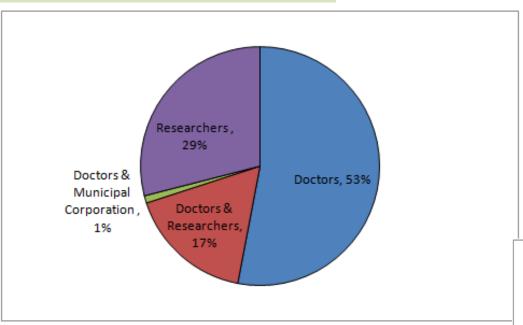
#### What about our health?



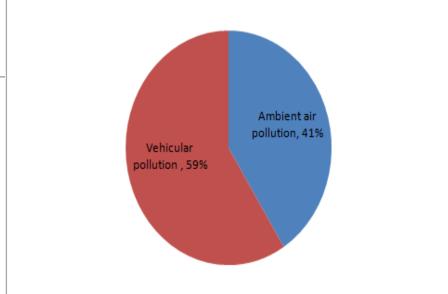
## Most studies in India done by doctors themselves......



#### Who has done the studies in India?



About 60% studies in India have focused on exposure to traffic pollution...specially those occupationally exposed...........





#### Air pollution leading cause of deaths and illness in Bangladesh

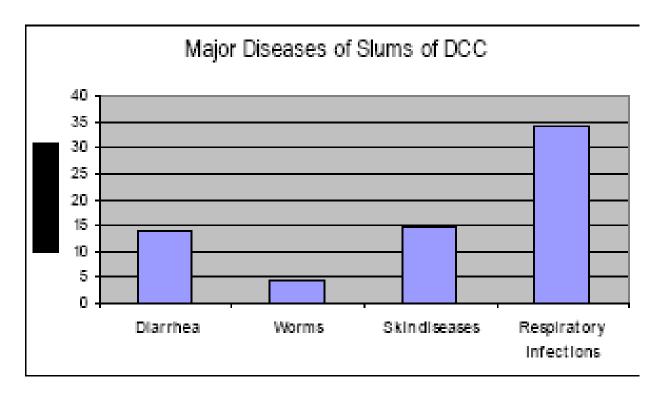
#### A jigsaw of evidences has emerged over the years that bring out the seriousness of the public health risk in Bangladesh.

- □ A World Bank study shows air pollution kills 15,000 Bangladeshis each year. Bangladesh could save between US \$200 million and \$800 million per year, about 0.7 to 3.0 per cent of its gross national product, if air pollution in the country's four major cities was reduced.
- Around 6.5 million people in those cities suffer each year. Vehicular air pollution is a major cause of respiratory distress in urban Bangladesh.
- According to the National Institute of Diseases of Chest and Hospital (NIDCH), nearly seven million people in Bangladesh suffer from asthma; more than half of them are children.
- ☐ A BUET study has shown lung function impairment in traffic policemen.

#### **Health Cost in Dhaka**



Incidence of diseases in slums and squatters of Dhaka city



Source: MCH-FP in WHO, 2002

Source: Dhaka city Sate of Environment 2005

### Mounting global health evidences.....



Scale of studies ---- Eg. the Arden Pope study (Journal of American Medical Association 2002) based on American Cancer Society data .....16 years, about 500,000 people in 116 metropolitan areas to arrive at irrefutable findings.

.......... a mere increase of 10 microgramme per cum of PM2.5 can increase the risk of lung cancer by 8 per cent, cardiopulmonary deaths by 6 per cent, all deaths by 4 percent.

These findings are equally valid for South Asia ...
Our lungs are same......

## Studies have responded to the emerging concerns in air quality...

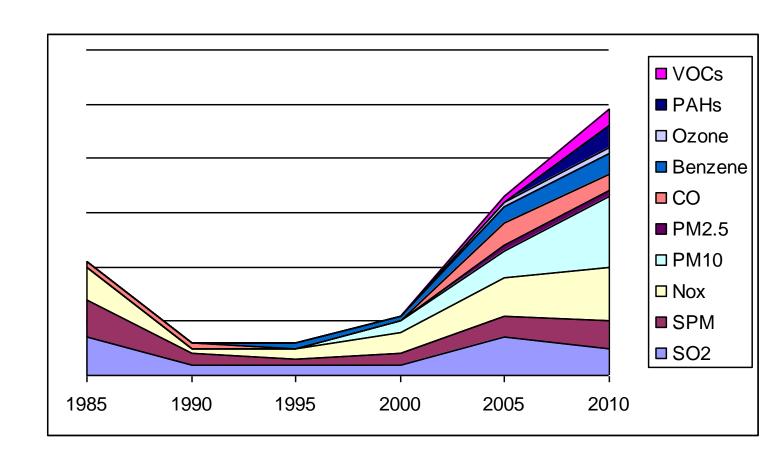


-- **Early years**: Primary focus on SPM, SO2, and little on NOX – nearly 60%

-- Subsequently: A wider pollutant

basket: VOCs, PM2.5, PAH etc

- -- Benzene and its impacts in more than 10% of studies since 2000.
- -- VOCs and PAHs in a few studies since 2000.
- -- But very little on ozone only one in Delhi....

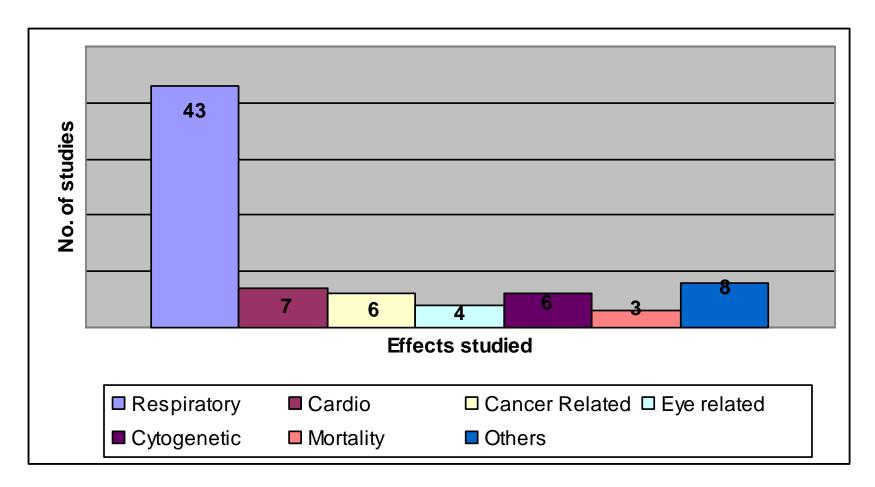


Source: CSE

## Studies looking at more diverse set of diseases....



Broadens from respiratory health symptoms to other health end points – cardiovascular, eye disorders, cellular changes, cancer, premature deaths....



Source: CSE

## Global studies ..... Looking beyond lungs ......



**Diabetes:** First large-scale population-based study links diabetes with air pollution. Increase in insulin resistance in lab test .... and an increase in markers of inflammation (which may contribute to insulin resistance) after particulate exposure.

Strong and consistent association between diabetes prevalence and PM2.5 concentrations. For every 10 μg/m3 increase in PM2.5 exposure, there was a 1 percent increase in diabetes prevalence. Counties with highest versus the lowest levels of PM2.5 pollution had a more than 20% increase in diabetes, which remained after controlling for diabetes risk factors. (Diabetes Care 2011)

#### **Heart:**

Acute Effects of Fine Particulate Air Pollution on Cardiac Arrhythmia:Conclusion: PM2.5 exposure within approximately 60 min was associated with increased PVC counts in healthy individuals. (He F et al 2011The APACR Study. Environ Health Perspect)

#### **Blood pressure**

Traffic-related Air Pollution and Blood Pressure in Elderly Subjects With Coronary Artery Disease: Found positive associations of systolic and diastolic BP with air pollutants. The strongest associations were with organic carbon, multiday average exposures, ect. (Delfino, Ralph J.a et al 2010,, Epidemiology, May 2010)

Effect on foetus: Studies have shown damaging impact of PAH on even fetus

## South Asia's unique public health challenge



- The Asiawide review of existing studies show that the estimated health effects are similar to those found in the extensive studies in western countries.
- But the risk in south Asia could be more serious. Science has yet to assess our unique risk factors
- Extremely high levels of particulates and pollution cocktail -- the problem of exposure to multiple pollutants
- Impact of poverty: Socio economic variables are not included in health studies to influence public policy. Sporadic studies elsewhere show poor are more susceptible

#### **Understand risk transition**

- Double burden of disease. Modern or community risks increasing
- This has important implication for environmental monitoring strategies

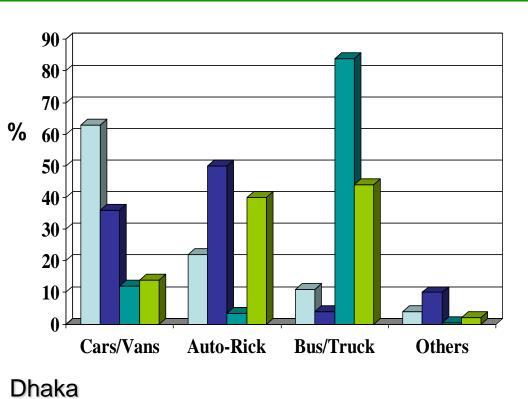
Source: CSE



Why vehicles are a special problem?



### Vehicles: major polluter in Dhaka and Delhi



□ CO
■ HC
■ NOx
■ PM

Delhi

Pollutant	Transport	Industry	Domestic & others
СО	76-90	37-13	10-16
NO2	66-74	13-29	1-2
SO2	5-12	84 -95	Nil-4
SPM	3-22	74-16	2-4

## Vehicles: special concern

- Vehicular emissions contribute to significant human exposure. Pollution concentration in our breathe is 3-4 times higher than the ambient air concentration.
- In three cities World Bank review found vehicles contributing an average 50% of the direct PM emissions and 70% of PM exposure.
- The WHO report of 2005: Epidemiological evidences for the adverse health effects of exposure to transport related air pollution is increasing.
- Public transport users, walkers and cyclists are the most exposed groups.
- Poor have a higher prevalence of some underlying diseases related to air pollution and proximity to roadways increases the potential health effects.



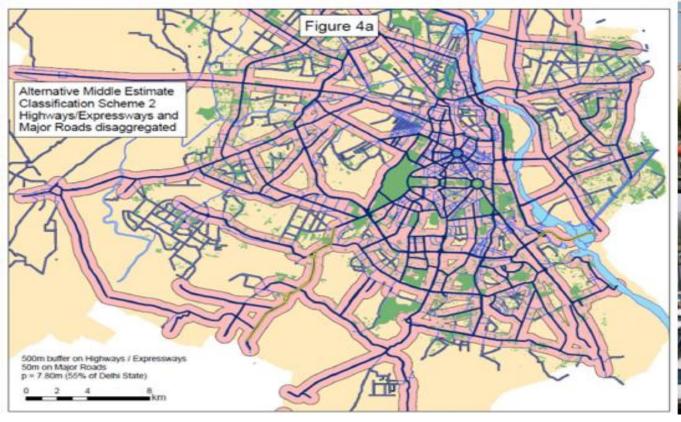
## People living close to roads are most exposed to vehicular fume

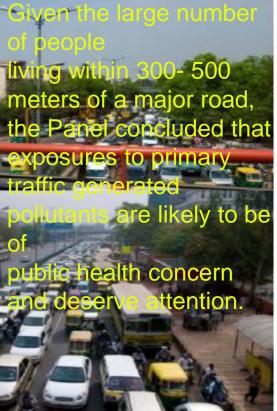
Evidence from Delhi....



## The Traffic Impact Area in Delhi:

New HEI Analysis: 55% of the Population within 500 meters of a Freeway; 50 meters of a Major Road





### First generation reforms in Delhi.....



#### Delhi has fought hard to get breathing space On vehicles

Introduced low sulphur fuels and petrol with 1 per cent benzene

Mandated pre-mix petrol to two- and three-wheelers

Moved from Euro I to Euro IV over the last decade

Implemented largest ever CNG based public transport programme

Capped the number of three-wheelers

Phased out 15 year old commercial vehicles

Strengthened vehicle inspection programme (PUC)

Efforts made to divert transit traffic

Set up independent fuel testing laboratories to check fuel adulteration

#### On industry

Relocated polluting units

Tighter controls on power plants. No new power plants.

#### Air quality monitoring

Adopted new ambient air quality standards

Expanded air quality monitoring and reporting

#### Other sources

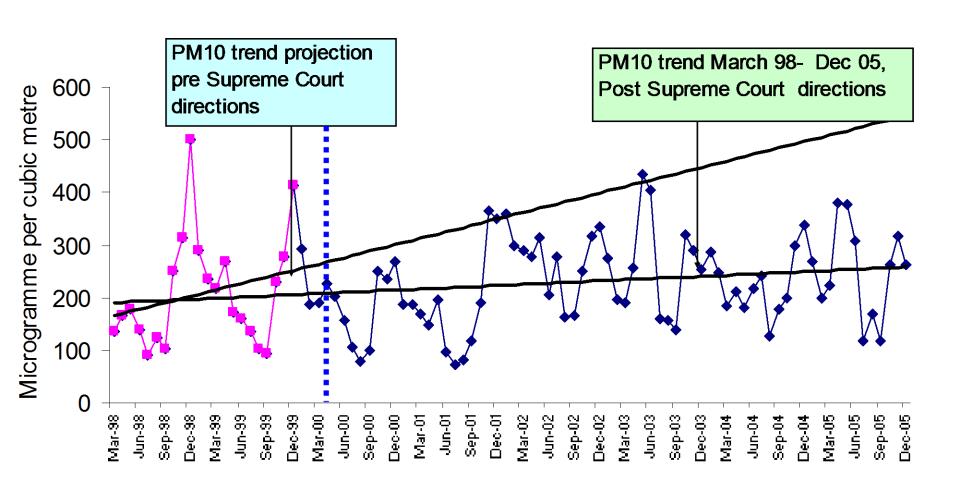
Emissions standards for generator sets

Ban on open burning of biomass

## Delhi got cleaner air: it avoided pollution



#### PM10 at ITO Traffic Intersection



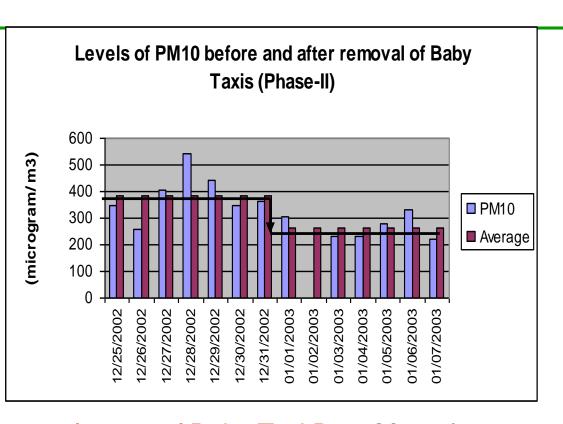
## First generation action in Dhaka



- Phase out of leaded petrol in 1999
- Introduction of Compressed Natural Gas (CNG)
- Introduction of unleaded gasoline from 1st July of 199
- Notification of lubricant standards on 1st January, 2001
- Banning of two-stroke three wheelers from 1st January, 2003
- Banning of imported reconditioned cars older than 5 years
- Banning of commercial trucks in Dhaka city during day time (8am -10 pm)
- Ban on trucks older than 25 years and buses older than 20 years from 2002
- Introduction of ambient air quality standards
- Introduction of EURO I for new diesel and EURO II for petrol vehicles from 2005.
- Introduction of in use vehicle emission standards from 2005.

### Benefits of air pollution control in Dhaka





Impact of Baby Taxi Ban: More than 900 premature deaths avoided and \$ 25 million saved in health cost per year.

With proposed national standard: Premature mortality can be reduced by about 3300 and health cost by \$474 million per year.

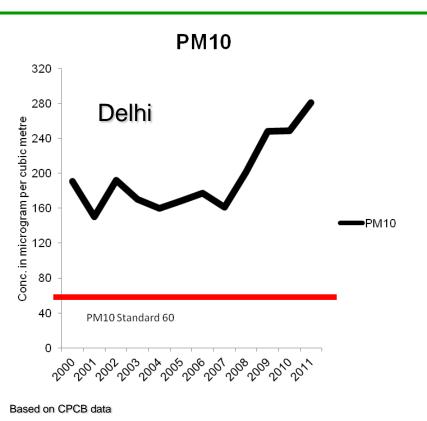


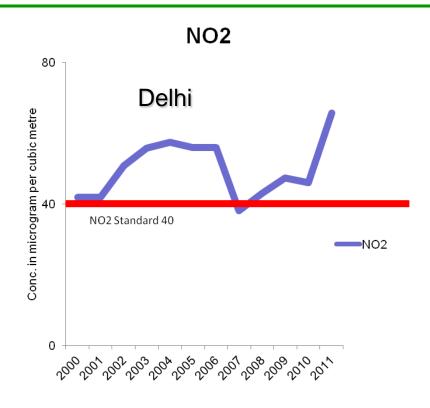
What are the newer concerns?





## Lost gains. After a short respite pollution curve turns upward





Dhaka's pollutions levels also remain elevated



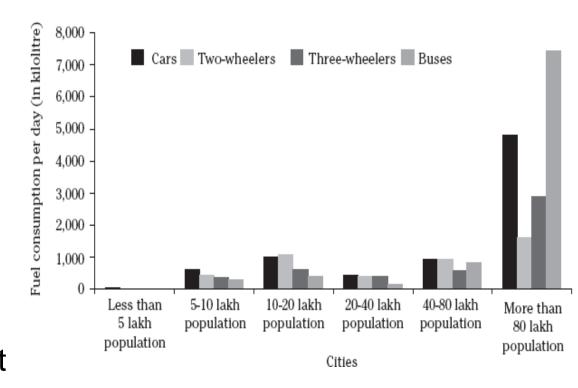
### More car centric growth - more fuel, more CO2

Highest fuel consumption in large cities of India

Personal vehicles – cars and two-wheelers – use the maximum fuel

Personal vehicles account for about 65 – 90% of the total carbondioxide emissions – linked directly with the amount of energy burnt by all vehicles in cities

#### Fuel consumption per day in different classes of cities

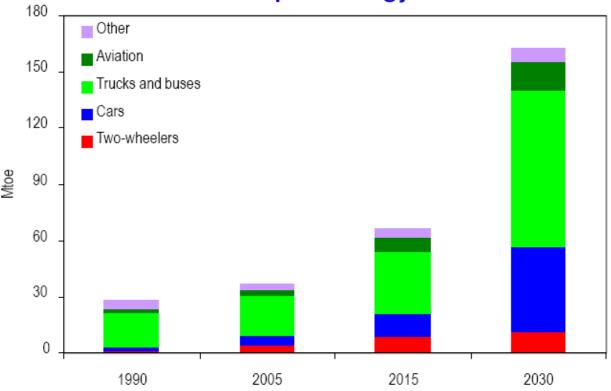


## Maximise energy efficiency gains Trend in transport fuel consumption



Trend in fuel consumption by different modes of transport in India

## WEO2007 Reference Scenario: India's Transport Energy Demand



Transport demand – mostly oil – grows rapidly as car ownership increases in line with rising incomes

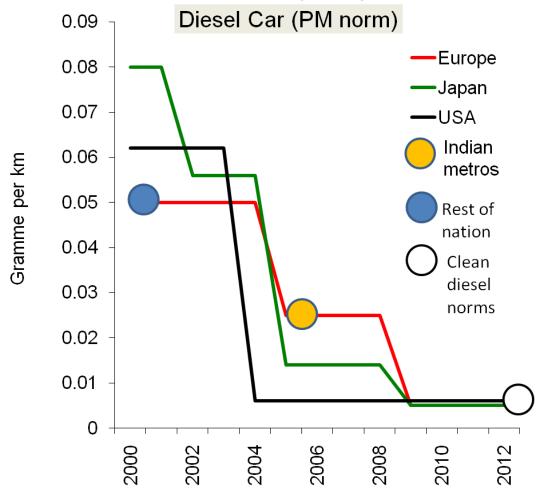


### What do we do?

#### Technology leapfrog..

- -- Bharat stage II 15 years behind Europe
- -- Bharat Stage III 12 years behind Europe
- -- Bharat stage IV seven years behind





## What experts say?

Do not replace a new petrol car with a diesel, unless they meet:

- •US Tier 2 or Euro 5 Standards
- And ULSD is Available

Source: Compiled from European Commission, MORTH, India, Diesel Net



#### Dhaka also took a very timely decision to move to CNG



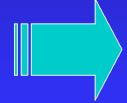


Euro 2 for Petrol / CNG Vehicles



To be known as "Bangladesh 2"

Euro 1 for Diesel Vehicles



To be known as "Bangladesh 1"

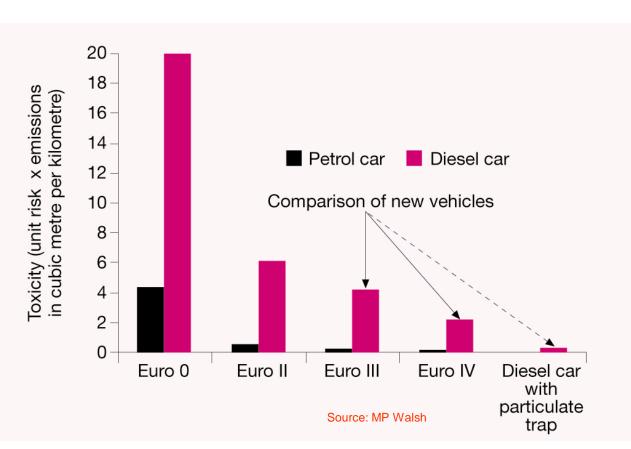
#### The shocker: Cancer risk of diesel



#### **June 2012**

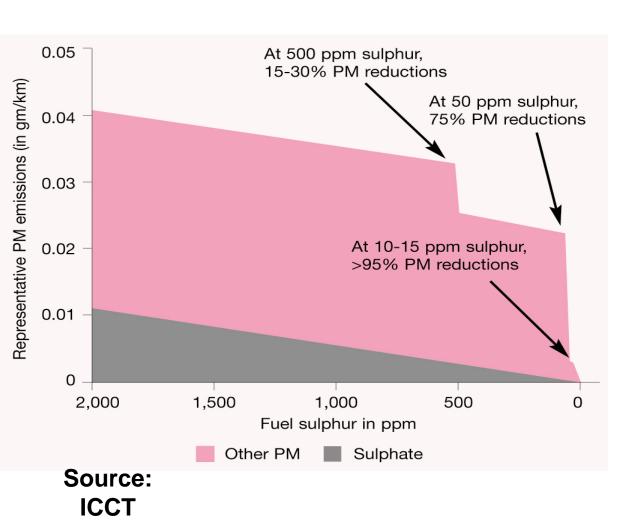
The WHO/International Agency on Cancer Research reclassify diesel emissions as class 1 carcinogen, -- same class as tobacco for its strong link with lung cancer.

But India is dieselising very rapidly



## Clean diesel technology and fuel that can reduce emissions by 90% are not available in India





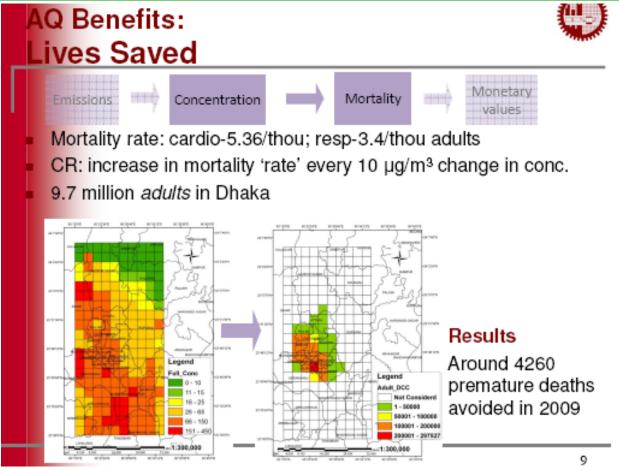
During 12<sup>th</sup> plan refinery capacity in India will expand 1.6 times -- But this is not linked with stringent emissions standards roadmap.

Need fiscal strategy to ensure import of improved technologies in Bangladesh

Sri Lanka has imposed very high duties for diesel cars close to 400 percent. On petrol its nearly half. This has changed the market

## Studies in Dhaka shows significant health benefits from the CNG programme





Cost saving is equal to around 0.9% of GDP Climate benefits, too (USD 1.2 million!

Source: Zia Wadud 2010.

#### **Draft 'Gas Utilisation Guideline' formulated**



#### Priority to sectors for use of natural gas and gradual increase in CNG price mooted

- State-owned Petrobangla recently placed a draft 'Gas Utilisation Guideline' with the Energy Ministry for final approval
- Recommends prioritization of different sectors for the use of natural gas, gradual shutdown of CNG conversion workshops by 2015 and levying higher taxes on CNG-run vehicles to discourage its use
- Fertiliser will get the highest priority followed by power in the second place; industries and tea garden as third; captive power as fourth, residential and commercial as fifth; and CNG sector as the sixth and last in getting natural gas.
- In order to limit the use of CNG its price will have to be gradually increased to a level similar to the price of liquid petroleum
- These recommendations have irked the businesses involved in the CNG sector as entrepreneurs feel this will put them in a great dilemma creating uncertainty for their huge, long-time investment. Bangladesh CNG Station and Conversion Workshop Owners Association vigorously reacted to the recommendations claiming that entrepreneurs in this sector have invested about Tk 3000 crore in last several years since 2003-04
- So far, 582 CNG re-fuelling stations were set up across the country along with about 70 CNG conversion workshops. All these CNG re-fuelling stations and conversion workshops came into business with the help of the government's special incentives and encouragement as part of the move to introduce environment-friendly green or clean fuel policy

## The challenge of in-use vehicle inspection.....







## Tests can be defeated...



Idle emissions increase as vehicles age. High emitters in all model years

Not effective for advanced technologies using catalytic converters

Ensure authenticity and correctness of tests. Prevent false passes and cheating. Tests and standards must match technology levels

Does not reflect real world emission performance

Measures only under Idling conditions whereas vehicles accelerate, decelerate and cruise at higher speeds where more pollution occurs

NOx / PM can't be measured





### Upgrading in use vehicle inspection



India 2004: Revision of in-use emissions norms and testing procedure – after 14 years. Too little too late.....

**Diesel vehicles**: Smoke opacity norm of 65 HSU not changed. Mandates oil temperature and engine rpm measurement.

#### Gasoline/CNG vehicles:

CO: Pre Euro II – 3% (by volume)

Post Euro II – 0.05%

HC: Pre Euro II – 1500 ppm

Post Euro II – 750 ppm

#### **Two-wheelers:**

CO: Pre 2000 - 4.5%

Post 2000 - 3.5%

HC: Pre 2000 – 9000 ppm (Both 2-stroke and 4-stroke)

Post 2000–4,500 ppm for 4-stroke, 6000 ppm for 2-stroke

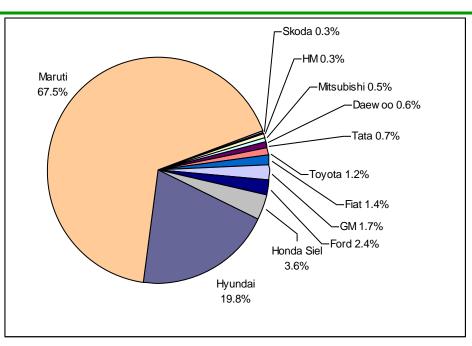
-Lambda test recommended but not mandatory

2010: New norms for Euro IV compliant vehicles

Plans to link vehicle inspection with annual vehicle insurance for compliance

## The Lambda fiasco

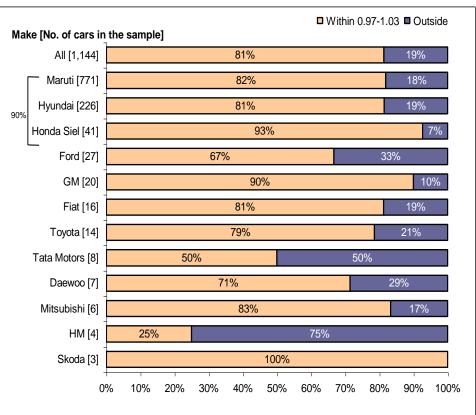




Share of different makes in the sample

### lambda value of $1 \pm 0.03$

#### Make-wise lambda result



## The Lambda fiasco



Make	Lambda specification						RPM	
	< Rich (Probability for high CO and HC)		Desired limit		Lean→ (Probability for high NOx)			
	0.93	0.95	0.97	1.03	1.05	1.07	1	
							Min.	Max.
Others							2,500	
General Motors							2,500	2,500
Maruti							2,000	2,500
Fiat							2,000	2,500
Tata Motors							2,000	2,500
							2,000	2,500
							2,000	2,500

# CNG buses pose maintenance challenge

















## Clean fuel... but need more robust technology.. Maintenance challenge



2004 Survey of smoky CNG three wheelers by the Delhi transport department shows 50 per cent of the problem vehicles were four stroke engines





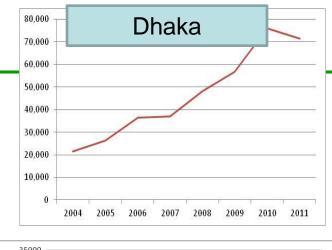


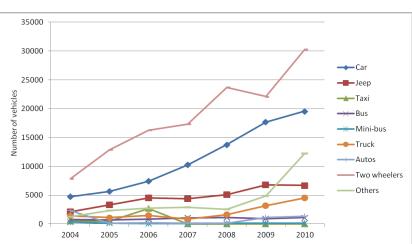
### Mobility crisis in our cities.....

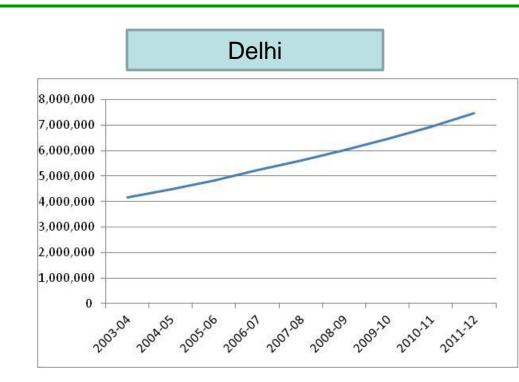
..... an increasing share of our daily trips are being made by cars that occupy more road space, carry fewer people, pollute more, guzzle more fuel. They edge out pedestrians, bicycles, cycle rickshaws and buses......

#### Increasing vehicle numbers in Dhaka and Delhi









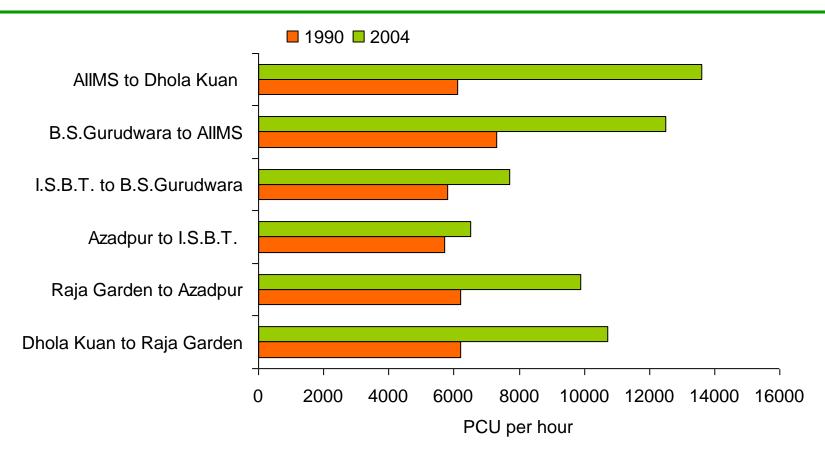
**In Dhaka** the annual vehicle registrations have almost increased by 2.7 times since 2005. As of 2011, Dhaka has registered about 6,76,306 vehicles with annual registration of about 71344 vehicles during 2011. It means 195 vehicles are being registered per day. Private cars are 27.1% of the fleet but cater to only 5.1% of total trips.

Delhi has 6.95 million vehicles. Registers 1,317 vehicles a day (2011)

## Peak volume traffic – dominated by personal vehicles -- has increased phenomenally in Delhi



Nearly 123 per cent growth on many Delhi roads (in PCU/hour)



## Public perception of emerging challenges in Dhaka saying?



#### **CSE-WBB Trust survey captures angst and worries of citizens of Dhaka**

- Centre for Science and Environment and Work for Better Bangladesh
  Trust is carrying out an opinion survey of select group of stakeholders
  in Dhaka to assess the public perception of the growing problems
- About 80 per cent of the survey respondents travel daily by bus, or use cycle rickshaws and walk; 20 per cent use cars.

## What is Dhaka saying?



#### About air pollution and health

- Majority -- about 60 per cent -- say there is no change in Dhaka's air quality; it is as
  polluted as ever; 40 per cent say air pollution is worsening.
- 87 per cent say air pollution is increasing because of growing number of vehicles. About 13 per cent say industrial units are responsible.
- 74 per cent have said that air pollution causes respiratory problems and respiratory symptoms have increased in frequency in the last two months.
- Nearly 80 per cent have said that their doctors have mentioned that air pollution aggravates respiratory problems.
- Nearly 40 per cent have said that they face more respiratory-related discomforts during winter.

#### **About city bus services**

- Access, ease to use and convenience of city bus services 53 per cent respondents rated it as poor and 47 per cent as average
- Availability of bus services 73 per cent rated as average and 27 per cent as poor
- Quality of bus services 87 per cent rated as poor
- Reliability and punctuality of bus service -- All respondents rated it as poor
- Safety 53 per cent rated as poor and 47 per cent as average
- Overall satisfaction in city bus service 67 per cent rated it as poor and 33 per cent as average

## What is Dhaka saying?



#### About walking and cycling facilities (pavements, footpaths, cycle paths)

- Availability of walk paths 67 per cent respondents rated it as average and 33 per cent as poor
- Ease of use and convenience 60 per cent respondents rated it as poor and 40 per cent as average
- Continuity (access encroached or obstructed) 60 per cent rated as average and 40 per cent as poor
- Availability of safe crossings at grade 73 per cent respondents rated it as poor and 27 per cent rated as average
- Security from crime 80 per cent rated it poor and 20 per cent as average
- All respondents said facilities are poor in terms of disabled-friendly infrastructure

#### About intermediate transport options (auto rickshaws/taxis)

- Access, ease of use and convenience 47 per cent rated it as average and poor.
   Only 7 per cent found it good
- Availability of services 53 per cent rated it as average and 47 per cent as poor
- Reliability 53 per cent rated it poor and 47 per cent as average
- Safety 53 per cent rated it as average and 40 per cent as poor
- Overall satisfaction 47 per cent rated it as average

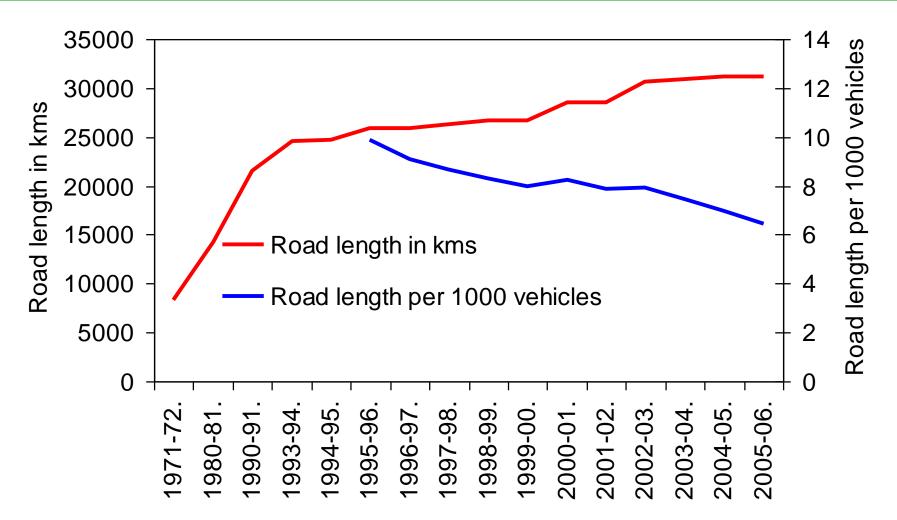
#### The survey brings out overwhelming support for public transport



Can more roads be the answer?

Roads hitting dead end in Delhi
Roads expansion cannot keep pace with rising number of vehicles. Delhi has built 65 flyovers......Yet congestion is getting worse by the day







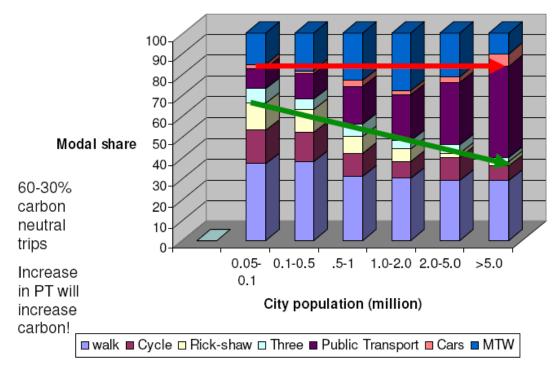
**Need public transport strategy.....** 



## Strength of our cities....

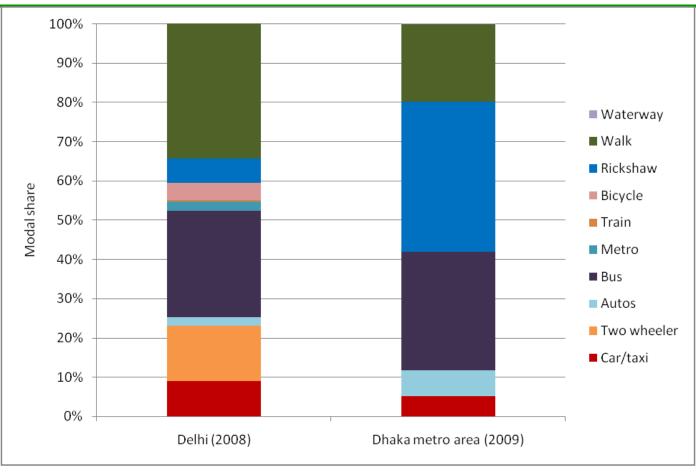
### Urban Mobility

PT and NMV based, MTW majority personal vehicles



## Strength of Dhaka and Delhi





Source: Graph based on:

1. 'Developments in Environmentally sustainable transport in Bangladesh', Ministry of Environment and Forests & Ministry of Communication, 2010

2. RITES 2008,



### We have inherited sustainable cities....



Dhaka like other South Asian cities was meant to be walkable .... To be sustainable

Source: Sida

### Our cities are built differently ......Compact and accessible









Source: Urban age

Kolkata **Bangalore** 

Mumbai

London

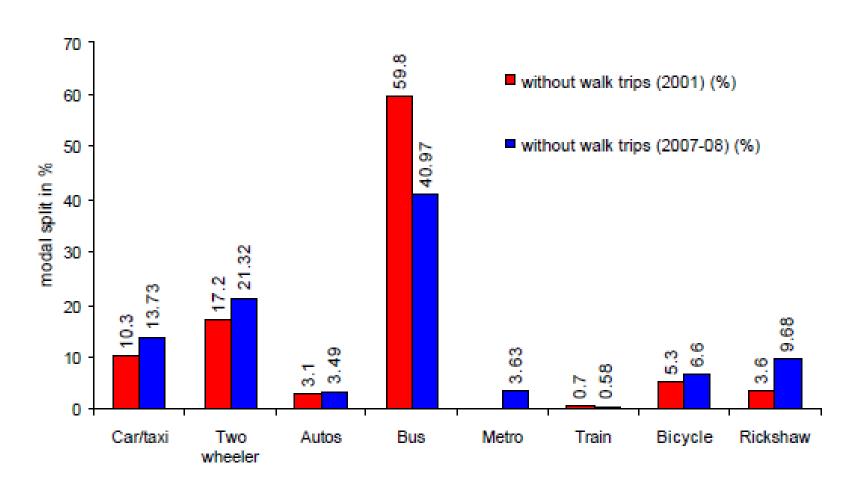
- -- In a typical city the core can just be 5 km across and easily walkable within a reasonable time.
- -- More than 40 to 50 per cent of the daily trips in many of our cities have distances less than 5 kilometers.
- -- These have enormous potential to convert to walking and non-motorised trips.



Kolkata in 19<sup>th</sup> century

## Reality check in Delhi Public transport losing ground







Need bus.....

## Take the bus.....



#### Bus transport can make a big difference...

- BANGALORE: An increase in bus share from 62% to 80% saves equal to 21% of the fuel consumed in the base case. Leads to 23 per cent reduction in total vehicles and frees-up road space equivalent to taking off nearly 418,210 cars from roads. CO2 emissions can drop by 13 per cent. PM can drop by 29 per cent and NOx 6 per cent.
- DHAKA: An increase in bus share to 60% saves fuel equal to 15 per cent
  of the fuel consumed in the base case. Frees up road space equivalent to
  removing 78,718 cars from the roads. CO2 emissions drops by 9 per cent.
   PM can drop by 13 per cent and NOx less than 1 per cent.
- COLOMBO: A increase in bus share from 76% to 80% can save 104,720 tonnes of oil equivalent, or 3% of the fuel consumed in the baseline case. This means 5% reduction in total vehicles and freeing up of roadspace equivalent to removing 62,152 cars.







Congestion in Motijheel area, Dhaka: High usage of buses and cycle rickshaws is sustainable and can be well managed.



Car congestion in Delhi This is not sustainable.

## Need bus deployment strategy



#### Dhaka modernising bus fleet

- The BRTC imported about 290 double-decker buses along with the articulated buses under the US \$ 1.0 billion credit line. Concern over driving space for articulated buses from Joydevpur to Motijheel
- Traffic experts say, during the day time when the pressure of traffic on the roads remains severe, running of the buses would not be easy and also its efficacy in easing the traffic congestion
- Experts say, It is comparatively easy to embark and disembark an articulated bus because of its several doors but some pre-requisites are needed to be met to make the service passenger-friendly and successful in reducing traffic congestion. Before introduction of the new bus service, it is necessary to adopt a policy aimed at improving the city's bus routes and bringing discipline on the streets
- Articulated bus need either a dedicated lane or a disciplined road, comparatively a straight road for driving as the length of these buses are twice the normal bus size because of two rigid bodies connected by a pivoting joint

### Why buses?.....



- -- Spine of public transport: Buses provide the bulk of public transport services as much as 40-60 per cent in cities that have city bus services.
- -- High targets for public transport: MPD 21 targets 80% public transport share by 2020; Pune 80%; Kolkata 90%... Delhi buses along with bus rapid transit system can help to meet at least 73% of the target.
- -- Buses allow greater flexibility, geographical coverage, cost effectiveness, and space efficiency. Can flexibly and easily meet the needs of changes in demography and land use. It can cover areas with lower travel demand.
- -- A bus occupies twice the road space taken by a car but carries 40 times the number of passengers. Bus can displace anywhere between 5 and 50 other vehicles and allow enormous oil and pollution savings (IEA).
- -- Poor people are most dependent on affordable and cheap public transport to access jobs and services. Urban poor can use upto 25-30 per cent of their income on transportation.
- -- Per person emissions several time less than cars

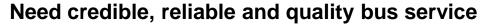






## Bus fleet requires massive renewal and modernization Delhi has initiated a massive renewal process

New buses to meet the urban bus specifications of the Ministry of Urban Development. Cities find it difficult to buy low floor buses needed for level boarding and make them disable friendly without any back up plan for funding.



Improvement in service level of bus service -- Technical planning for route reorganisation, frequency, reliability, coverage, reliable information, ITS enabled passenger information service, improvement in ticketing system, bus priority, signaling, GPS enabled deployment strategy, Performance monitoring system, Innovative contracting and tendering, among others.

Reorganise informal sector: Delhi has introduced cluster bus system

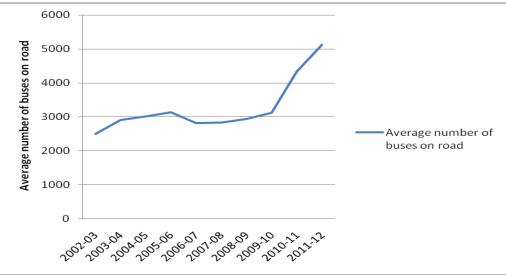




## Change in Delhi.....



Average number of buses on road, 2002-03 to 2011-12, DTC





Revival of bus numbers: Average number of buses augmented to 5892 in 2011-12. ....

Revival of ridership: Within a span of one year -- 2010 - 2011, the ridership of DTC has increased by 25%. The turn around happened when it increased to 2.4 million in 2009-10 and hit 3.0 million in 2010-11.

Revival of earnings: DTC
earnings show major gains.
During 2005-06 this was Rs
279 crores. This has
increased three times to
Rs794 Crore in 2010-11.

Yet long way to go....

## **Build bus funding strategy**



- -- Improve overall economic efficiency of bus transport
- -- Reduce tax burden on buses
- -- Waive off interest payment that is weighing down DTC
- -- Rationalise budgetary allocation in the transport sector. A lot money tied to signal free roads and flyovers that impede bus routes can be ploughed into bus transport. This will release enormous amount of money.
- -- Reform rates and policy of some key revenue heads like advertisement, parking, and vehicle taxation to be able to tap substantial amount of earnings from them.
- -- Mandate bus companies to undertake commercial development in their depots and terminals
- -- Apply travel demand management measures to increase taxes on personal vehicles. Use the additional revenue for public transport.
- -- Explore best practice model in other cities -- like tax on wage bill, station naming, fuel surcharge, congestion tax etc, TDM measures to generate revenue, and increase bus ridership
- -- All future bus agreement and contracts must be based on high quality service level guarantee

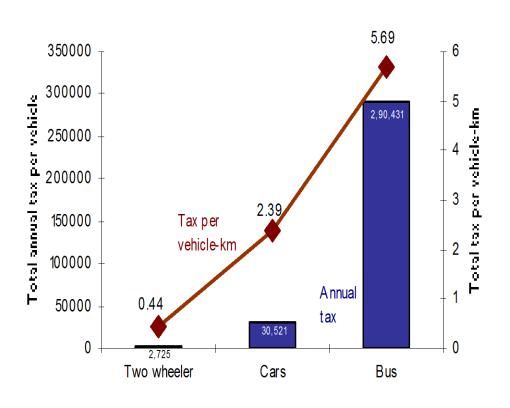
We cannot afford to miss the bus.....

# Rationalise taxes on transport Buses bear significantly higher tax burden in India than cars and two-wheelers...



If not corrected and bus fares are raised, a substantial public transport ridership can be lost to two wheelers that have a running cost of a mere Re 1/km

This must be rationalised



#### **BRT Corridor in Dhaka**



- A 20-kilomtre Bus Rapid Transit (BRT) corridor will be implemented from the Hazrat Shahjalal International Airport to Gazipur
- Cabinet has approved in principle a proposal for the creation of a special organization for operating BRT between Shahjalal International Airport and Gazipur to curb the capital city's traffic congestion
- The donor-funded \$ 240 million BRT project would be jointly implemented in three years from June 2012 to 2015 by the Local Government Engineering Department, the Bridge Division and the Roads Division
- A 4.5 km dedicated elevated expressway would be built for the BRT, to be designed to speed up traffic movement at the major gateway to the capital city

# Dhaka can benefit from increased bus ridership?



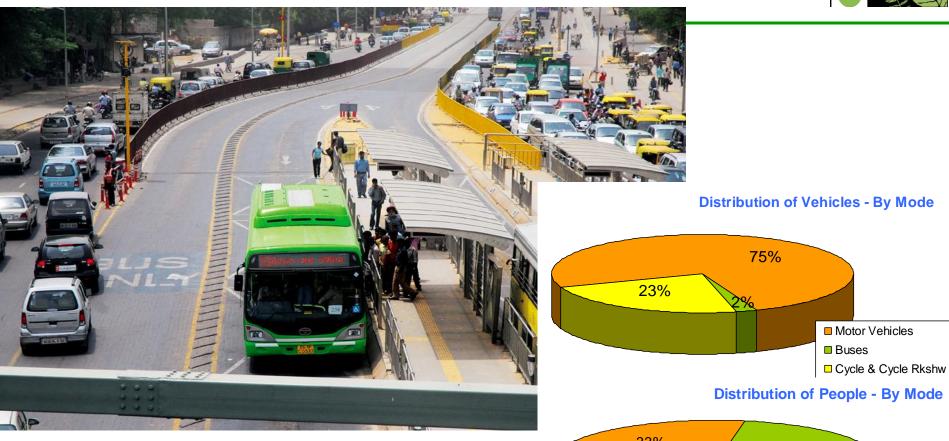
- A ten minute reduction in travel time by bus produces estimated market share for bus mode increase by more than 5 percent.
- This increase in market share for car mode is less than 5 percent resulting from a ten minutes reduction in travel time by car.
- This is indicative of higher value of time for bus compared to car suggesting that reduction in travel time due to reduced congestion can have substantial benefits for population.
- A doubling of full cost per trip for the car alternative will produce an estimated market share for the car down by 2% only.
- Reducing travel time appears most important next to comfort/service for people to choose bus vis-à-vis private car. Motivating commuters to switch to alternate mass transit may require innovative incentive scheme(e.g. road pricing, tax increase!)
- Source: An interesting study "Travel Mode Choice Preferences of Urban Commuters in Dhaka: A Pilot Study" by researchers at Bangladesh Institute of Development Studies and University of Dhaka shows that:

Reorganise roadspace to allocate more space to public transport. You may ask – where is the space? But available road space is used inefficiently Look at Delhi. So much roadspace is wasted. Only one lane available for motorised traffic



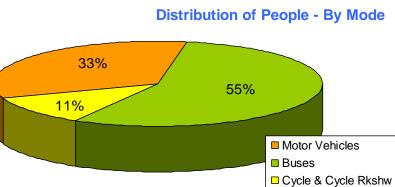
# The Transition.....Reallocation of road space. More space to low carbon and clean modes and majority commuters





Moving vehicles vs. moving people

### Delhi Bus Corridor





Everybody walks.....



# Pedestrian policy Public transport can work only if cities are walkable. Who walks in our cities?



**High modal share of walk trips in Indian cities:** 30-50% of daily commuting trips

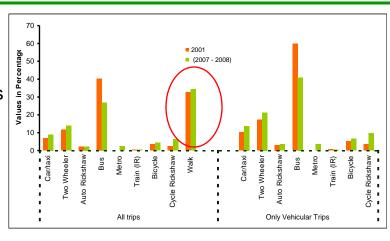
Walking for work, education and services.....Of all education trips – 58% walk trips; Service and business trips – 31% walk trips (RITES 2001)

**Walking and urban poor......** About 40-60% of people live in low income localities. 22% of people with less than Rs 2000/month income walk in Delhi.

**Disability and walking.....** 58% of the disabled find steps, ramps, difficult to negotiate; 45% of elderly find steps and ramps daunting; 20% find uneven, narrow sidewalks difficult. Engineering guidelines for disables are not implemented (samarthyam survey)

**Urbanity and life style.....**Corelation between active transportation (walking and cycling) and obesity. China – 1.8kg weigh gain after and twice as likely to get obese for a Chinese who acquired a car.

**But unacceptably high accident rates......**Total number of road accidents in Delhi are 2.5 times higher than that of Kolkata, 2.1 times higher than Chennai – personal vehicles cause most of these accidents....Nearly half of fatal accidents in Delhi involve pedestrians



Source: RITES 2008

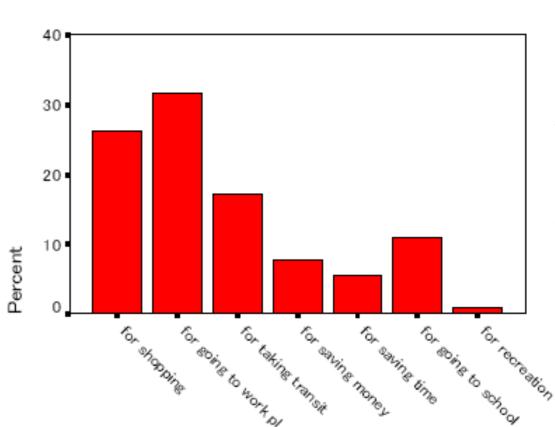
# Absolute numbers change the ranking of cities... Delhi has one of the highest count of cycle and walk trips





#### Impressive walk share in Dhaka





More than 60% of daily trips in Dhaka are walk trips.

Field survey shows more than 30% walk to work

Less than 10% use cars and twowheelers

50% travel trips below 2 km

Why policies to create more space for cars and reduce for public transport?



### Highly encroached walkways

Don't let cars take over walkways.....



Source: CSE



## Unusable infrastructure: Wasteful



Unusable infrastructure:
Wasteful
Guidelines of Indian Road
Congress are inadequate

Eg. In the absence of proper guidelines on height of pavements unacceptably high pavements without proper gradients are being made.....



#### Car centric unsafe roads









But.....





### Jay walking....asserting their right to cross where convenient

### But car centric design does not allow safe, quick and shortest crossing







Sai Chowk, Patparganj

Scindia House, CP

Seamless and signal free traffic is interrupting shortest direct route for pedestrians. This is inciting jay walking

### Car infrastructure severing neighbourhoods and pedestrian routes

(All India Institute of Medical Sciences intersection)





**Before** 

**After** 

Cloverleaf flyover disrupt at-grade continuity and direct shortest route, increase walking distance for the ailing visitors using public transport At least in one direction use of subway is unavoidable

### With seamless traffic and FOBs pedestrians disappear from the roads





#### **Proposed Asaf Ali Road, Delhi**



Source: I Trans – A Arora

#### Retrofitting changes.....





**Connaught Place** 



Sidewalks are now being rebuilt in Delhi



#### It is possible to change

Redesigned streets in a small town of Nanded in Maharashtra





**Before** 

#### **After**



Source: Pradeep Sachdeva



#### **Dhaka**





Making change.....

Source: Maruf Rahman WBB trust

# Message from the new road design: ......Human dignity and respect



Walking and cycling lane in the bus rapid transit corridor



BRT Corridor SG Architects



#### Where will you feel more safe to walk?





Why do we have building setbacks and boundary walls?



#### Checking out the universal design





City regulators crossing roads on wheelchair to understand universal road design

Disability and walking......Samarthy am survey: 58% of the disabled found steps, ramps, difficult to negotiate; 45% of elderly found steps and ramps daunting; 20% found uneven, narrow sidewalks difficult. Engineering guidelines for disables are not implemented

Source: CSE

#### Need to change the practice



While car owners resent expansion of walk space ..... ...public voice gets stronger for liveable walking city

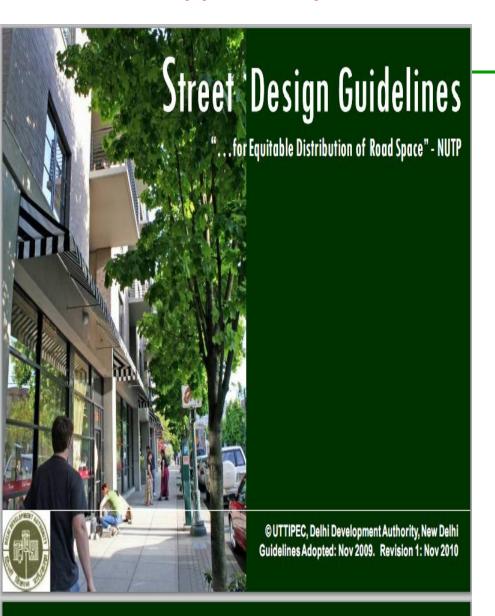


Public protest against PWD roadwidening for the Commonwealth Games at Siri Fort to save the footpaths

PROTESTS PERSIST: Locals says the government body doesn't have necessary approval to sundertake the work

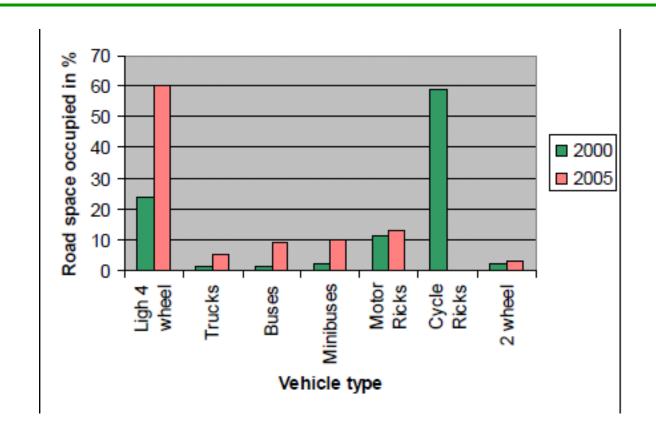
#### **Opportunity in Delhi to influence road building**





#### **Dhaka**





Comparative scenario of Mirpur road after banning the rickshaws

Source: Maruf Rahman WBB trust

#### **Zero emissions street in Dhaka?**



### Cycle rickshaws are part of the solution....

High share of short trips make para transit convenient and affordable. Even buses are not convenient for short distances.

#### Delhi is reorganising this sector:

Cycle rickshaw policy in Delhi under preparation.

- -- Three-wheeler policy evolving: All threewheeler drivers to get public service vehicle badge and smart cards.
- -- GPS connectivity to improve the meters and compliance.
- -- In-use vehicle fitness and emission testing systems
- --Integrate with mass transit system.



**Environmentally Sustainable streets in Dhaka** 

#### Vehicle of the future......"Dial a rickshaw"

#### Patiala Green Cabs

Fazilka Ecocab





**Delhi:** Supreme Court has not allowed Delhi to restrict cycle rickshaws



**Amritsar Ecocab** 

#### Digital number plates for cycle rickshaws in Dhaka



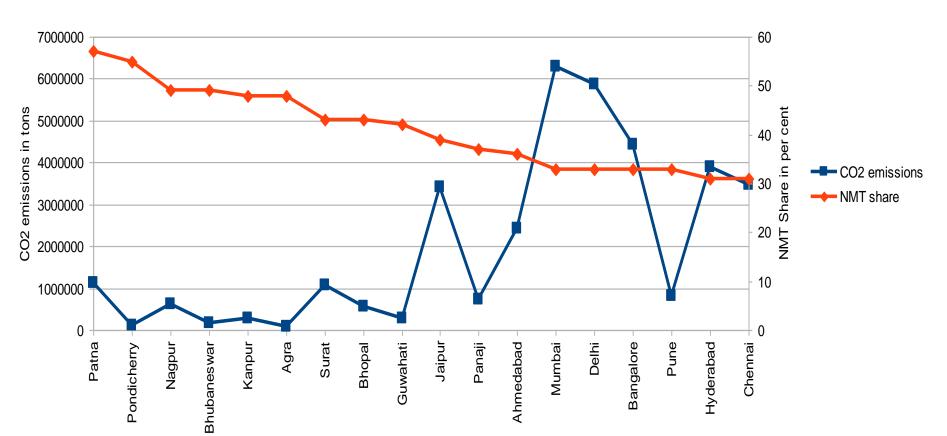
#### Snippets of action on cycle rickshaw

- Dhaka City Corporations: digital number plate for the non-motorised vehicles for easy identification
- The Dhaka South City Corporation (DSCC) involved in updating the list of non-motor vehicles
- Preparing number plates under a digital programme will be undertaken
- According to the list, over 70 thousand rickshaws are to be renewed under the DSCC while over 26,800 rickshaws under the DNCC
- The DSCC in 2012-2013 fiscal year targeted to collect Tk 1.5 crore while the DNCC targeted Tk 50 lakh as revenues from the sector. But no revenue was collected form this sector in the last two fiscal years
- For digitisation of the number plates, the suppliers would supply a machine capable of identifying the licence and also the name of the city corporation which provides the licence
- It will also identify the rickshaws without registration

# Leverage our advantage of non-motorised transport...



Cities with higher walking and cycling have significantly low CO2 levels Studies show a nominal increase of walk trips by 5% can cut CO2 by at least 10% (CAI)





Multi-modal interation.....

#### **Need multi-modal integration**

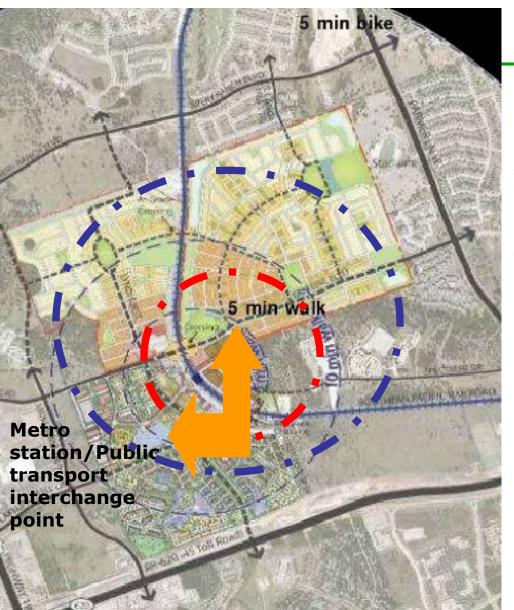
**QUTAB Metro station, Delhi: Very poor access** 





Source: CSE

### Delhi is developing guidelines for modal interchange location



Delhi-- UTTIPEC/DDA guidel

Bus stop, cycle rental: within 50 meter walk from station exit

Cycle and two wheeler parking: within 100 meter level walk from station exit

Auto rickshaw stand: within 150 meter level walk from station exit

Private car/taxi/auto rickshaw "drop off": with barrier-free of exiting pedestrians and NMT

Pedestrian exits, bus-stops and Cycle-rickshaw stands must be closest to main pedestrian exits from station.

Car parking if provided, must be BEYOND 250 M distance of Station/ or PT interchange point Pairing of Origin-Destination (O-D) Nodes:

Provide cycle/ auto stands at nearby important destinations.

Signages at both end locations.

Private car parking only at Terminal Stations.

Discourage car parking at Stations within inner-city urbanized areas.



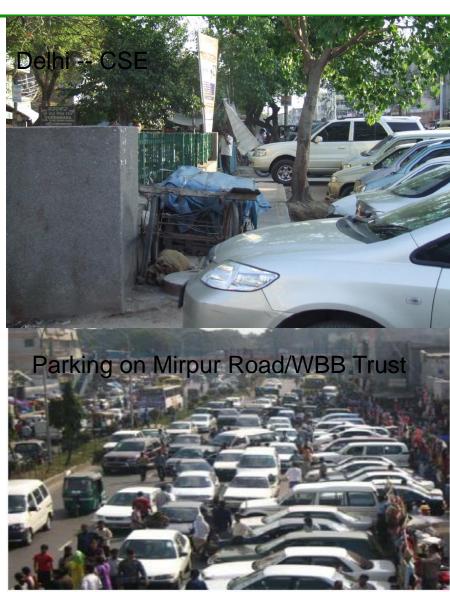
Parking.....

#### Parking crisis

#### Cars lead to inequitous use of urban land and congestion

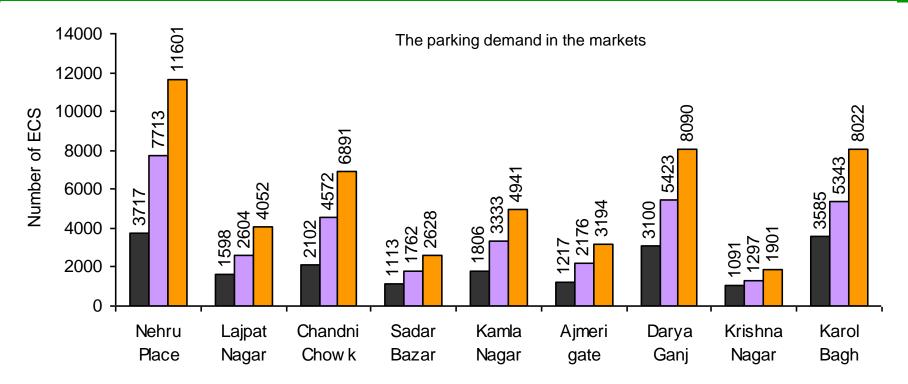
- Parking: most wasteful uses of cars: Out of 8760 hours/ year total steering time of an average car is 400 hours. For about 90 to 95 per cent of the time a car is parked.
- Insatiable demand for land: Parking space needed for the car fleet in Delhi is 10% city's urbanised area. Delhi's forest cover -- is 11.5 %.
- In Delhi new car registration created demand equal to 310 football fields.
- In Dhaka close to 80-90 foot ball fields
- Inequitous use of land: A car is allotted 23 sq m for parking. A poor family 18 sqm under low cost housing scheme.

Land is limited. Where will cities find more land to park cars?



### Conventional planning .... Bridge the gap between demand and supply ... make more parking





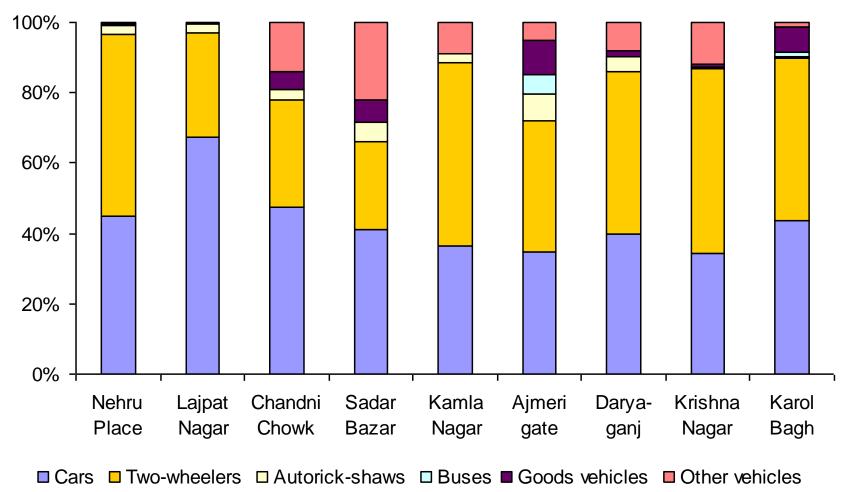
■ Total parking supply (ECS) □ Current peak parking demand (ECS) □ Maximum projected demand in 2010 (ECS)\*

Note: \*Compound annual growth rate of car (10 per cent) and two-wheeler (6 per cent)

Source: Based on CRRI 2006, Congestion and parking problems of selected locations in Delhi, Final report, New Delhi

## Cars and two wheelers dominate peak parking demand





## Parking supply by Dhaka City Corporation: Should limit parking



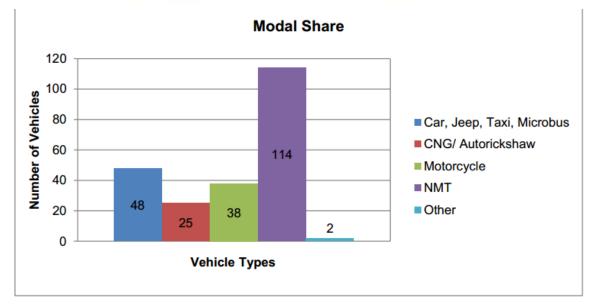
- •The DNCC plans to establish as many as 70 parking lots to ease acute gridlock in the metropolis -- Kawran Bazar, Gulshan, Uttara, Mirpur and Banani police stations
- •Large chunk of land has already been turned into a parking lot in Kawran Bazar area and now the corporation is working to modernize it.
- •69 more wayside places in different areas had already been earmarked
- •Several committees formed to set up car parking spots at public places and abandoned plots of land beside roads.
- •The proposed committees will look after parking lots and collect tolls from cars using those.
- •Taka 10 would be taken from each car using parking place under the DNCC leading to revenue earning

### Need place to move NMT rather than occupy that space for parking





A total of 227 vehicles were found during the one hour survey. 50% if the vehicles are NMT Private car are 21%, motorcycle 17%. Other vehicles need unloading facilities.



Source: Proceedings of the Global Engineering, Science and Technology Conference 2012 28-29 December 2012, Dhaka, Bangladesh "Parking Policy: Neglected but Important" A. Ahmed and M. S. Hoquehttp://www.gistconpro.com/811-Asif.pdf

Figure 1: Modal share at Eastern Plaza.

# Parking strategy is identified as the first gen car restraint measure in Delhi.....



#### 2006

- "Land is limited and there is a limit to the additional parking space that can be created in the city. This will also require .... well thought out pricing policy to control the demand for parking."
- The provision of parking for personal motorised vehicles cannot be considered as a matter of public good.
- Individual user of personal vehicle should pay for the use of the space for parking and parking facilities. The 'user pays' principle should govern the pricing of parking.
- Government should not subsidise this cost
- Use a wide variety of tools for pricing parking -- time variable rates -etc.
- On the basis of these principles MCD, DDA, NDMC should frame the rationalised pricing policy for all types of parking facilities...

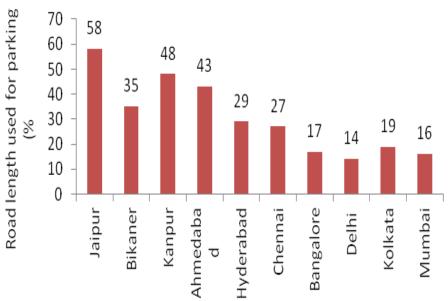
Supreme Court takes this on board. Issues directives for a parking policy as a demand management tool......

# On-street parking..... Roads under pressure





## On –street parking on major road corridors in Indian cities



On-street parking: A serious challenge



## Enforcement: The first steps......

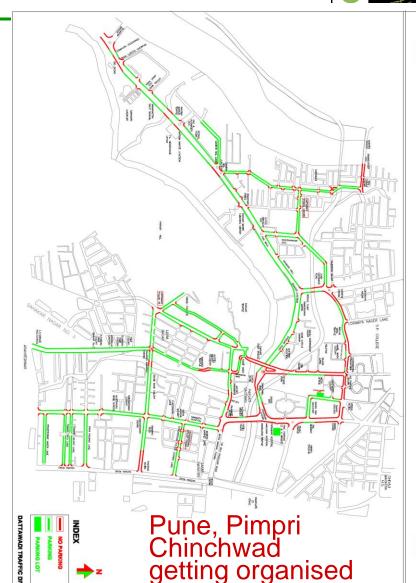


#### Find method in the madness....Tame the chaos

EPCA directives to MCD, NDMC in Delhi

- -- Demarcate legal parking spaces. Organise them well.
- -- Inventorise the parking spaces. Put out the list on the website
- -- Prevent encroachment of walkways
- -- Put up signages and information systems
- -- Introduce metering
- -- Impose penalty
- -- Similar moves in other cities Chennai, Pune, Pimpri Chinchwad etc

On-street parking cannot be eliminated. Needs to be managed well.







### Proposed Asaf Ali Road, New Delhi



Source: I Trans, A Arora

## But multi level car parks without local area management plans ....







### Sarojini Nagar, New Delhi

- -- MLP stay woefully underutilised
- -- Poor guidance and signals for people
- -- Approach roads ill designed, get clogged easily. Long queues.
- -- Delays due to long retrieval time
- -- Technical hurdles and delays
- -- Only cars allowed. Others crowd in surface areas
- -- Rebound effect additional parking demand from the commercial area in the MLP
- -- Poor design of surface parking
- -- Poor enforcement
- -- Shopkeepers' cars dominate
- -- Para transit and cycles not integrated with parking plan
- -- Illegality



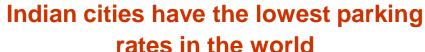


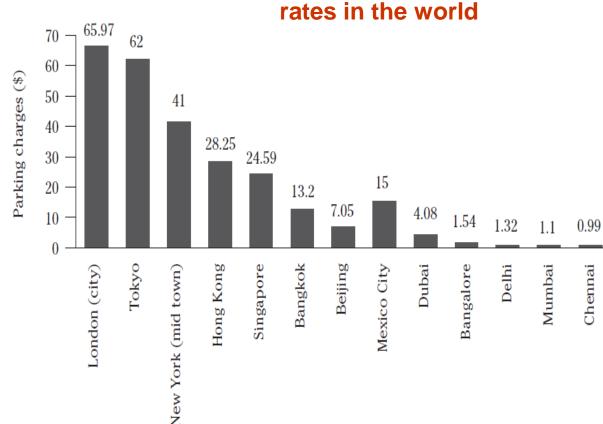
#### Global studies show:

Shifting from free to cost recovery parking rates can reduce automobile commuting by 10-30 per cent especially if linked with other transportation choices

# Parking charges influence commuting choices:

People will opt for alternatives; delay journey to avoid peak parking charges; or go somewhere else.....

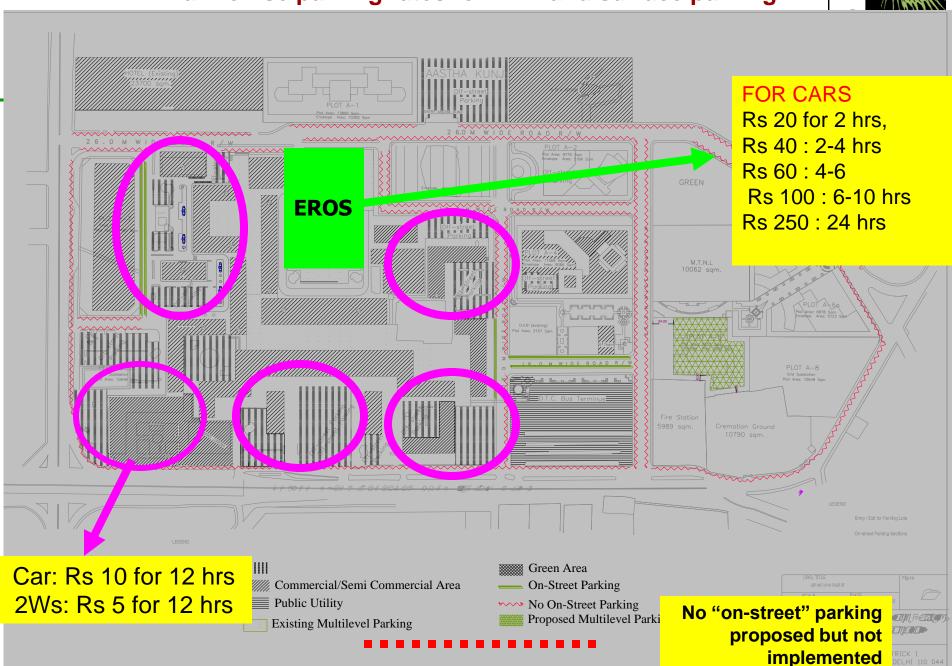




Source: Colliers International (2011) - CBD daily parking charges (in US \$)

### Harmonise parking rates for MLP and surface parking





# Need parity of rates between structured and surface parking



#### Mumbai: Discrepancy in rates can lead to underutilisation of MLP

INOX the multiplex in Nariman Point: Before construction of MLP: No. of surface parking spaces: 140, Utilisation: 100% during office hours

**After:** No. of parking spaces: **540**, Utilisation of MLP during office hours: **10%** Parking rates are Rs 5 per 30 minutes or Rs 10 per hour.

**Surface parking rates**: Rs 5 per hour and Rs 3 for every additional hour.

Resolve this

New game in town: Free floor space index (FSI) to builders to builders to create free parking lots.





Poor utilization

Situation in INOX Parking area on 5th May 06 – a weekday at peak time of 11:am

Source: Mumbai Environmental Social Network

### On-street parking pricing has major impact.....









No meters Meters Prices quadrupled

Grosvenor square, London

## Principles for parking pricing



• Eliminate and minimise free parking in key areas with good public transport access. This will encourage people to use other forms of transport and reduce congestion.

**Introduce variable parking rates** according to peak hour, duration of stay; commercial importance of areas; according to weekdays when demand is high, and weekends when low. Higher rates for bigger vehicles

Charge convenient parking spaces higher than the inconvenient places to reduce congestion and influence commuting choices:

**Limiting parking duration for short term users** can ensure higher customer turnover rates for local businesses and also reduce local congestion.

 Free parking should be allowed only to cycles and cycle rickshaws and battery operated vehicles and public transport vehicles. Park and ride.

**Proposal of annual lump sum payment retrograde:** Annual passes allow unlimited use and do not reduce demand. Commuter behaviour will remain unresponsive

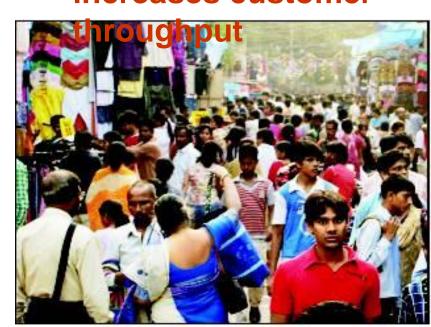
- Caution on liberal byelaws to create more parking: Need proper pricing
- How will government fix rates if cities move towards full cost pricing? Should rates be market driven?

## How parking can be leveraged for multimodal integration and to improve access?



- --- Deploy parking innovatively to facilitate shift to other modes
- --- Park and ride facilities to improve public transport usage but not in the city centre
- -- Transit oriented development policies to discourage parking within 500 meter of influence area of the transit nodes.
- --- Build them away from the busy commercial centres and MRT nodes and connect with NMT, IPT, PT and pedestrian ways.
- Public transport buses and NMT to be given priority and privileges in the design for integration.
- -- Park and walk and park and ride in targeted areas

# Park and walk – increases customer



# Other countries are limiting and pricing parking



#### Capping parking supply

**Portland, Oregon** Overall cap of 40,000 parking spaces downtown. This increased public transport usage from 20-25 per cent in the 1970s to 48 per cent in mid 1990s.

Seattle allows a maximum of one parking space per 100 square metres at downtown office San Francisco limits parking to seven per cent of a downtown building's floor area

#### Parking pricing strategy to reduce car usage. Benefits public transport

**New York**: Very high parking fees and limited parking supply lowers car ownership far below the US average.

**Bogota** Removed limit on the fees charged by private parking companies. The revenue goes to road maintenance and public transit improvement.

**Shenzhen:** Hike in parking fees during peak hours leads to 30% drop in the parking demand.

Bremen: No free parking in city centre. Parking charges higher than public transport cost.

**Barcelona** – Parking revenue directed to a special fund for mobility purposes.

**London:** parking income channeled to transportation projects.

#### Strong enforcement and penalty

**Tokyo:** Enforcement against parking violations cuts congestion drastically. Private firms allowed to issue tickets for parking violations. This makes on-street parking expensive.

**Antwerp:** parking fines are invested into mobility projects

#### Free up public space

Paris: Street space freed for bike sharing and trams
Copenhagen: Streets freed up for bike lanes etc





- Adopt flexible parking standards and move towards maximum caps to account for improved public transport access and reduction in personal vehicle travel.
  - Integrate parking design with multi-modal integration
  - More stringent controls and enforcement
  - Reforms parking pricing -- Minimise free parking, restrict on-street parking, use variable parking rates, avoid fixed annual payment, price parity between surface and multi-level parking etc. Discard one time parking charge
  - No parking on green spaces, pavement, NMT lanes etc. Non-negotiable.
  - Need parking strategy for residential areas and mixed land use areas. Promote priced, shared, common parking
  - Use parking revenue for public transport, and local area improvement
  - Stringent penalty on parking violations.
  - Develop parking strategy for special localities like hospitals, railway station, cinemas, shopping malls, schools, high impact events etc
  - Parking strategy for buses, IPT, freight
  - EIA of large commercial buildings to assess parking impacts and seek mitigation

# What other options do we have? Other governments are proposing restraints on personal vehicles use..



## Delhi High Court order: Equitable distribution of road space..... Task force to propose car restraint measures...

Other governments are enforcing tax and road pricing measures and caps on car sales to reduce congestion and pollution...

#### Congestion charges:

- -- London: This has reduced traffic delays by 30 per cent.
- -- Seven European cities are adopting congestion charges.
- -- Trondheim, Norway: peak hour traffic dropped by 10% after the introduction of congestion charges.
- -- Singapore's road pricing measures: This reduced percentage of commuters entering central areas from 56% to 23%.

Caps on cars in Singapore and Shanghai:

-- Shanghai has adopted a system of auctioning a limited number of car licenses per month. This has helped the city to cap car registration at not more than 7,500 cars per month -- or 250 cars per day.

Do not repeat the mistake of bigger cities......It is more expensive to undo mistakes

## **Change is possible: Early Singapore**



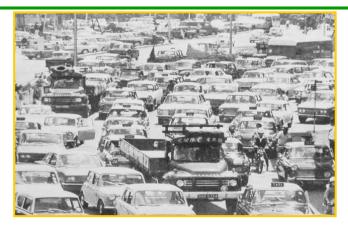






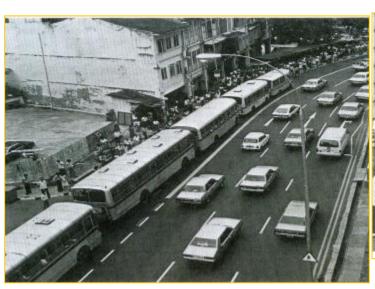






- **Severe Traffic Congestion**
- Rising travel demand
- Unreliable bus services

Some of the SIA slides have been provided by Monhinder Singh, Director LTA Academy





Source: GIZ

#### Our cities need upscaled transition Avoid future emissions Shift to sustainable modes of mobility



Indian cities have begun to work towards policies for low carbon and clean transportation. This will have to be enabled and scaled up.

#### Opportunity to provide scaled up alternatives

Public transport Infrastructure for walking and cycling

#### Reduce demand for travel and vehicle usage

Land-use planning
Road pricing
Tax rationalisation
Parking policy and charges

#### Leapfrog technology

Emissions standards Fuel economy standards

**Fund the transition**: Need tax measures to allocate resources efficiently and raise revenue. Taxes on public transport is 2.6 times higher.

### Funding biased against public transport in India



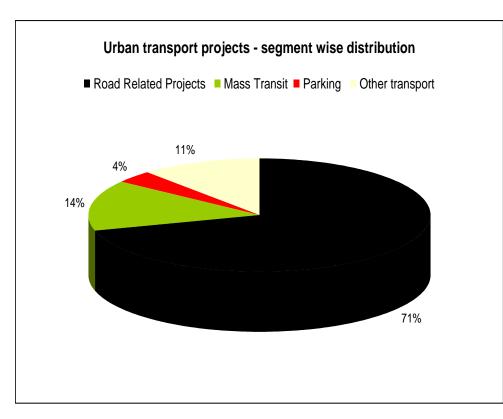
In India National Urban Renewal Mission has a reform based funding scheme for transport.

#### But.....

The investment so far is heavily biased towards road infrastructure. More than 71% of the transport related projects are road related projects.

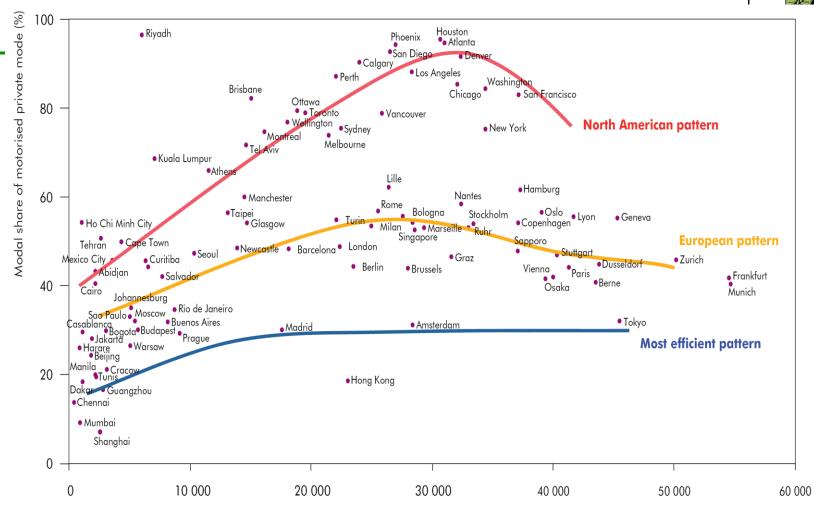
Little on public transport and barely any in cycling and walking infrastructure.

#### Funding ignores sustainable modes



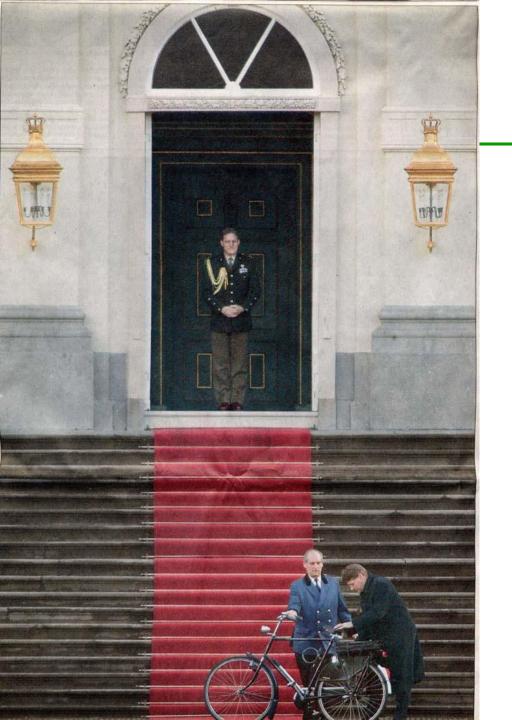
Source: CSE

# Relationship between GDP per Capita and Individual Motorised Modal Share



Decoupling of economic growth and individual motorised transport achievable!

Source: IEA, Energy Technology Perspectives, Paris 2008



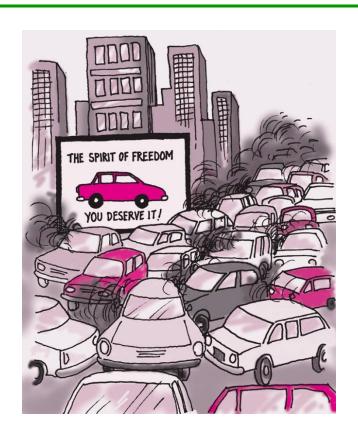


# Dutch Minister visits the queen

Source: GIZ

### Towards livable cities.....







## Thank You