Health Impact Assessment in Transport Planning

➢ Case study of a BRT corridor in Indore, India

➢ Workshop on Quantifying the Environmental, Social and Economic Benefits from Bus Rapid Transit Systems

_A SPAD Academy & Asia LEDS Partnership Workshop_
June 24 – 25, 2014

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Health Impact Assessment in Transport Planning

Case Study of a BRT Corridor in Indore, India

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Strategy Head, Research & Practice
EMBARQ India

Asia LEDS BRT Workshop
Kuala Lumpur
June 25, 2014
Outline

► Why are we interested in Health Impacts of Transport?
  ▪ Current Scenario – Urban Transport in Asia and India
  ▪ Defining Health Impacts of Transport & Evidence

► What is Health Impact Assessment (HIA)?
  ▪ HIA Process, Methodology & Framework
  ▪ State of the practice

► How to do a Health Impact Assessment?
  ▪ Indore BRT Case Study

► Q & A

► Interactive Discussion on Activity
Why focus on Health Impacts?

Global Urbanization Trends (% Urbanized)

- China
- India
- Indonesia
- Europe
- Mexico
- Brazil
- USA
Motor vehicle fleets are doubling every 5-7 years in many Asian countries.

Asian share of global vehicle fleet was 9% in 1980, 17% in 2005, expected growth to 46% in 2030 – i.e., from 1 in 10 to almost half the global total by 2030.

Asia accounts for 60% of the 1.2 million fatalities that occur every year or over 2,100 people every day.

In Thailand, Korea, and China, over 1/4 of adult population is overweight & physical inactivity is a major factor.

Health impacts translate to lost years of life & direct economic impact
**Road Deaths -- Globally Worsening Problem**

Road traffic crashes currently cause more than 1.2 million deaths a year -- but by 2030 will kill an estimated 2.4 million people per year.

### 2004 (actual)

<table>
<thead>
<tr>
<th>RANK</th>
<th>LEADING CAUSE</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart disease</td>
<td>12.2</td>
</tr>
<tr>
<td>2</td>
<td>Cerebrovascular disease</td>
<td>9.7</td>
</tr>
<tr>
<td>3</td>
<td>Lower respiratory infections</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>Chronic obstructive pulmonary disease</td>
<td>5.1</td>
</tr>
<tr>
<td>5</td>
<td>Diarrhoeal diseases</td>
<td>3.6</td>
</tr>
<tr>
<td>6</td>
<td>HIV/AIDS</td>
<td>3.5</td>
</tr>
<tr>
<td>7</td>
<td>Tuberculosis</td>
<td>2.5</td>
</tr>
<tr>
<td>8</td>
<td>Trachea, bronchus, lung cancers</td>
<td>2.3</td>
</tr>
<tr>
<td>9</td>
<td>Road traffic injuries</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>Prematurity and low birth weight</td>
<td>2.0</td>
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### 2030 (projected)

<table>
<thead>
<tr>
<th>RANK</th>
<th>LEADING CAUSE</th>
<th>%</th>
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<tbody>
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<td>7</td>
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<td>2.5</td>
</tr>
<tr>
<td>8</td>
<td>Hypertensive heart disease</td>
<td>2.3</td>
</tr>
<tr>
<td>9</td>
<td>Stomach cancer</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>HIV/AIDS</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Air pollution and vehicle ownership, 1990-2010

Figure 3: Overall ambient air pollution levels (PM$_{2.5}$), 1990 (a), and change in ambient air pollution levels (PM$_{2.5}$), 1990 to 2010 (b)

(a) Air pollution in 1990

 Ambient PM 2.5 levels

(b) Change in air pollution, 1990 to 2010

 All-air pollution sources

Change in motor vehicle ownership, 1990-2010

Figure 4: Change in motor vehicle ownership per capita, 1990 to 2010

Note: Vehicles per capita are shown. National vehicle fleet was an input used in the GBD 2010 study and was estimated based on analysis of data from multiple sources including the International Road Federation’s World Road Statistics Database.
Current Scenario – Urban Transport in India

- 20-fold rise in registered vehicles 1971-2001, 71% 2-wheelers
- Increased congestion, overcrowded roads => mental stress
- Increase in road accident deaths & hospitalizations 10 - 30%
- Lower physical activity => leading risk factor for diseases like obesity, type 2 diabetes, heart disease, and cancer.
- Constant exposure to high PM10 and PM2.5 causes adverse respiratory health problems => coughing, wheezing, reduced lung function, asthma attacks, and in some cases, heart failure, lung cancer and even early death
- 70% of particulate matter in cities like Delhi is from vehicles
Current Scenario – Urban Transport in India

- Transport facilities used far beyond design capacity => Deteriorated levels of service for all users
- Incompatible mix of motorized & non-motorized vehicles traveling at widely different speeds

Probability of pedestrian getting killed

<table>
<thead>
<tr>
<th>Speed km/h</th>
<th>Probability %</th>
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<tbody>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
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<td>40</td>
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<td>50</td>
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<td>60</td>
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<tr>
<td>70</td>
<td></td>
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<tr>
<td>80</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
</tr>
<tr>
<td>100</td>
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</tbody>
</table>

Speed is a top risk factor for fatalities
175,000 deaths/year in India due to road traffic crashes in 2011, more than 50% vulnerable road users
Issues: Air Pollution

620,000 premature deaths/year in Indian adults due to PM pollution

Health costs from bad air quality = 3% of Indian GDP

Vehicles contribute >70% to air pollution in many cities

http://www.topnews.in/law/files/delhi-pollution.jpg
Issues: Air Pollution – 2004 Asthma Death Rates

Outdoor air pollution caused 620,000 deaths in India in 2010, a six-fold increase from 2000.

In 2010, 20 million people suffered from asthma.

Acute respiratory infections is among most common causes of deaths in children under 5 in India in 2013.

0.8 to 40 days lost through increased inhaled air pollution.

Particulate pollution causes, per year in India:
- 109,000 premature deaths among adults
- 7,500 deaths among children under five
- 48,000 new cases of chronic bronchitis reported
- 370,000 hospitalizations
- 7.3 million emergency room visits/hospitalizations

Outdoor air pollution 5th leading cause of disease in India.
Issues: Physical Inactivity

436,122 premature deaths/year in India from illnesses derived from physical inactivity and obesity

Source: http://www5.imperial.ac.uk/medicine/metabolic_risks/bmi/
Health Impacts – Physical Activity

- Lack of physical activity => leading risk factor for many chronic diseases -- obesity, type 2 diabetes, heart disease, cancer

- Poor/unsafe pedestrian infrastructure => shift from walking and cycling to motorized transport

- Life years gained among individuals who shift from car to bicycle estimated to be 3-14 months

- Increased physical activity improves physical fitness and health

Lack of physical activity is responsible for over three million deaths per year globally
Health Impacts of Transportation

- Negative impacts of increased motorization
  - Air pollution exposure
  - Road accidents and injuries
  - Lack of physical activity

- Positive impacts of active transportation, i.e. walking and cycling
  - Increased physical activity
  - Improved physical fitness

Transportation is one of the KEY determinants of health
Systematic process to evaluate potential health impacts of any plan, project or policy *before implementation*

Recommend appropriate corrective or preventive measures to manage health impacts of the proposed plan or policy

Can take place at any level, from site to corridor, city, regional, and national

Could be led by the private, public, or voluntary sector

HIA types

- Rapid or Mini HIA
- Comprehensive

No HIAs for transport projects done in India
**HIA Process**

**Screening**
To determine the need, value and feasibility of a HIA in the decision-making process.

**Scoping**
To identify which health impacts to evaluate, populations that will be affected & research questions that will be examined.

**Assessment**
Characterize the potential health effects of alternative decisions based on available evidence.

**Monitoring & Evaluation**
Track implementation of the decision and its impacts on health determinants & outcomes, with impacts on decision-making processes.

**Reporting**
Communicate findings and recommendations to decision-makers, the public, and other stakeholders.

**Recommendations**
Provide strategies to manage identified adverse health impacts and to maximize health benefits.
HIA Methodology

- HIA proposals should consider:
  - Nature and kind of transport investment/intervention
  - Previous research and evidence about possible health impacts of related transport projects
  - Description of the area where the investment is planned and study area for analysis
  - Demographics around the area of the proposed development
  - Likely economic impacts such as increase or decrease in travel costs as this determines change in travel behaviour
  - Possible changes to travel and traffic patterns because of the new development or policy

- Baseline data => overview of the urban population, current health status, and the existing conditions of the transportation system
# Potential Data Sources for HIA

<table>
<thead>
<tr>
<th>Data Needs</th>
<th>Potential Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population Growth Rates &amp; Demographic Data</strong></td>
<td>Census or survey data</td>
</tr>
<tr>
<td><strong>Community/public Health Indicators</strong></td>
<td>City health services agency/dept.</td>
</tr>
<tr>
<td>Life Expectancy in Population</td>
<td>National/urban health departments</td>
</tr>
<tr>
<td>Incidence of Asthma (# of patients)</td>
<td>Hospitals, health agencies, or survey</td>
</tr>
<tr>
<td>Incidence of Diabetes (# of patients)</td>
<td>Hospitals, health agencies, or survey</td>
</tr>
<tr>
<td>Incidence of Heart Disease (# of patients)</td>
<td>Hospitals, health agencies, or survey</td>
</tr>
<tr>
<td>Incidence of Obesity (# of obese people)</td>
<td>Hospitals, health agencies, or survey</td>
</tr>
<tr>
<td>Incidence of Mental health/stress/road rage</td>
<td>Hospitals, health agencies, or survey</td>
</tr>
<tr>
<td><strong>Transport &amp; Physical Activity Data</strong></td>
<td>Survey data</td>
</tr>
<tr>
<td>Baseline Physical Activity Levels</td>
<td>City police data or national data</td>
</tr>
<tr>
<td>Traffic Injury Data &amp; Fatalities by Vehicle Type</td>
<td>Urban Mobility Plans, city scale travel demand modelling</td>
</tr>
<tr>
<td>Transport Indicators (mode shares, trip lengths, etc. by vehicle type)</td>
<td></td>
</tr>
<tr>
<td><strong>Air Quality Data</strong></td>
<td>Direct Measurement of Air Quality</td>
</tr>
</tbody>
</table>
HIA Methodology Framework

**Current Exposure to Emissions**

**Calculation of Passenger Trips and Vehicle Kilometers Traveled (VKT) by Mode**

**Current Traffic Injury and Fatalities**

**Current Level of Physical Activity**

**TRANSPORTATION SCENARIO**

- Change in total emissions (by mode) = Change in VKT x Emission Factor x No of trips
- Air Pollution (PM2.5) tons/year
- Mortality risk associated with PM2.5 exposure based on exposure-response function

**WHO Heat Tool Methodology adapted to India**

Scenario and baseline - Mortality Rate x Passengers x Relative risk of mortality for active vs sedentary lifestyle, based on volume of activity

**Change in Physical Activity Levels**

**Change in Fatalities per VKT**

**Lives Lost or Saved**
Activity Structure Intensity Fuel (ASIF) method to assess total transport emissions from mode share & transport activity

Combine pollution data with population data to estimate the increase in population weighted air pollution

Quantify health impacts using the following equation

\[ \text{Mortality Risk} = (\text{Total Transport Emissions} \times \text{Exposure-Response Function}) \]
Quantify the Health Impact of Traffic Injuries & Fatalities

- Quantify traffic safety impact based on VKT reduction alone – did not infrastructure improvements
- Higher congestion, correlated with higher VKT, may reduce speeds so accidents are less severe
- Predict local fatality rate in fatalities per million VKT based on historic trends.

Expected Fatalities = Deaths/VKT based on historic data] * Projected VKT
Quantifying the Health Impacts of Physical Activity

- WHO HEAT tool widely used to estimate reduced mortality rates from physical activity.

- Includes factors for reduction in relative risk of all-cause mortality among regular bicycle users and regular walkers, compared to non-users.

- Estimate reduction in mortality rate and lives saved as:

  \[
  \text{Reduction in Mortality Rate} = 1 - \text{Relative Risk (volume of walking or cycling/reference volume of walking or cycling)}
  \]
Indore Case Study – Current Scenario

- Largest city in the state of Madhya Pradesh, 11th most populous city in India
- Major economic center in Central and Western India
- Vehicular traffic primary source of air pollution
- **Motorized 2-wheelers and unorganized public transport**, i.e. auto-rickshaws, mini buses and vans
- By WHO standards, “Unhealthy” concentration of particulate matter levels in Indore.
Indore implemented BRT operations on 12-km long corridor in May 2013, cutting across city.

One of the most polluted areas in Indore.

Baseline 2012 survey was done of 2,200 residents who live within 1 kilometer on either side of corridor, respondents were asked about health and physical activity information.

Scenario studied: In 2014, the bus operating agency in Indore plans to triple buses on BRT corridor from 15 to 45.
Baseline 24-hour mean concentrations of PM2.5 were measured at bus stops along corridor and inside buses.

Assumptions

- BRTS service replaced equivalent bus services and TATA Magic trips in 2014.
- Trip rates and trip lengths remain constant.
- Mode shift based on ridership and user survey data in 2013 and ridership increases based on increase in buses from 2014-2017.
- Dedicated BRTS bus-only lanes did not significantly worsen congestion in other lanes.

WHO guidelines specifying mortality risk from exposure to PM2.5 concentrations above its recommended guideline values were applied to estimated 2017 levels.
Using a conservative population growth rate of 2% per year, transport mode shift changes for 2017 were calculated.

### Indore Case Study – Mode Shift Changes

<table>
<thead>
<tr>
<th>Mode</th>
<th>BAU 2017</th>
<th>BRT 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Cycle</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>34%</td>
<td>32%</td>
</tr>
<tr>
<td>Rickshaw</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Tata Magic</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Car</td>
<td>17%</td>
<td>17%</td>
</tr>
<tr>
<td>Bus</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>BRT</td>
<td>0%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Passenger Trips BAU 2017

Passenger Trips BRT 2017
Indore Case Study – Air Pollution Impacts

[Graph showing transport activity and emissions pre and post-BRT implementation]
Indore Case Study – Physical Activity

➢ Current physical activity levels of residents along corridor was determined through a primary survey

➢ Estimation of lives saved in the BRT scenario due to increased physical activity from taking transit was based on assumptions used in the HEAT Tool

  • BRT scenario assumed number of people using transit would increase and their walking levels would increase.

➢ To calculate Lives Saved, Mortality Rate for Indore from the Annual Health Survey was used
Indore Case Study - Results

- About **96 deaths could be prevented along the BRT corridor compared to No BRT investment between 2013 & 2017**

- With Indore BRT
  - **14 lives** can be saved from increasing walking or bicycling, per year
  - **5 lives** can be saved from reduced traffic fatalities per year in the corridor after 2014
  - Reduction in emissions between a BAU scenario and post BRT scenario was **11%**
  - Mortality risk from PM2.5 exposure could be reduced by **1.1%**
Recommendations to link Transport & Health

- Focus on emissions reduction strategies, and also mortality and disease studies for population exposure to PM2.5
- Consider research on impacts of public transport and non-motorized transport infrastructure on reducing risk factors
- Increase the share of public transportation like BRT systems, improve facilities and their efficiency.
- Invest in infrastructure that encourages non–motorized transport modes
- Improve infrastructure for safety of pedestrians and cyclists
Key Messages

- Health impacts are significantly dependent on transport projects and policies.

- Health ministries/departments in govt not collaborating with urban planning/transport ministries/departments – while time is lost and health is impacted.

- Data challenges can be solved – improve hospital data, conduct baseline health surveys and bring data to attention of transport decision makers.

- Evidence is indisputable – need transport & public health professionals to work closely. City scale is a start!
More information at:

Interactive Activity

- Which cities have HIAs mandated?
- What data are most challenging to collect? Why?
- Which agency would do HIAs in a city?
- Any specific challenges or comments?
THANK YOU !!

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Growth in Motor Vehicles & Accidents in India
Per capita fatality rates tend to increase with per capita annual vehicle mileage but they tend to decline significantly with increase in public transport ridership.

To estimate the reduction in fatalities, the fatality rate (fatalities per million VKT per capita) for the future scenarios was assumed to be the average of the 2008 - 2010 values for the corridor.

Average daily passenger trips were estimated by multiplying the per capita trip rate (PCTR) by the population in the corridor.

The number of trips that switched to BRTS from each mode was calculated using 2013 BRTS user survey data to determine the proportion of each mode that switched to the

Constant trip rates were assumed.

Average value was then used to estimate the number of fatalities given the difference in motorized VKT between the two scenarios.
1.6 million Indians died in 2012 due to road crashes, a 73% rise from 2001.

Vulnerable road users (pedestrians and motorized 2- or 3-wheeler users) accounted for more than 50% of road traffic deaths in India:
- Pedestrians – 21%
- Motorized 2- or 3-wheeler users - 32%

Traffic crashes in Indian cities are among the primary causes of accidental deaths and hospitalizations (10 - 30%) in India.

Five to nine days lost due to an increase in traffic accidents.

India accounts for about 10% of road crash fatalities worldwide.
GURGAON RECLAIMS ITS STREETS

The first Raahgiri Day in the city saw hundreds take to the streets of Gurgaon and indulge in various car-free outdoor activities.

For once, Gurgaon streets were filled with more people than cars. Several people from all age groups took to the streets of Gurgaon on Raahgiri Day participating in activities like walking, cycling and skating. Braving the nip in the air, people engaged in various outdoor activities from 7am on Sunday. Many kids were seen skating, cycling, playing cricket and with frisbees, while others chose to perform zumba, engage in cross fit training and even running with their friends.

“I have taken three rounds of the stretch already on my cycle and I feel so happy because when you see so many people doing their own thing freely, it makes Gurgaon look like an eco-friendly city. The only bad thing is that many people who should have, didn’t turn up,” said Divya, a Class VII student at Heritage School.

Chief Guest Alok Mittal, Commissioner of Police, who also cycled a stretch of four kilometres along with other cyclists, said, “Although I don’t cycle every day my idea of staying fit involves adequate intake of food and a brisk walk, along with the conscientiousness to stay fit. I am very happy to be a part of this exciting initiative which we are planning to hold again.”

Natasha Khurana