ESCAP is the regional development arm of the United Nations and serves as the main economic and social development centre for the United Nations in Asia and the Pacific. Its mandate is to foster cooperation among its 53 members and 9 associate members. ESCAP provides the strategic link between global and country-level programmes and issues. It supports the Governments of the region in consolidating regional positions and advocates regional approaches to meeting the region’s unique socio-economic challenges in a globalizing world. The ESCAP office is located in Bangkok, Thailand. Please visit our website at <www.unescap.org> for further information.

The shaded areas of the map are ESCAP Members and Associate members.
TRANSPORT AND COMMUNICATIONS BULLETIN FOR ASIA AND THE PACIFIC

No. 82
Combatting Congestion
References to dollars ($) are to United States dollars, unless otherwise stated.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This document has been issued without formal editing.

The opinions, figures and estimates set forth in this publication are the responsibility of the authors, and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations.

Mention of firm names and commercial products does not imply the endorsement of the United Nations.

This publication may be reproduced in whole or in part for educational or non-profit purposes without special permission from the copyright holder, provided that the source is acknowledged. The ESCAP Publications Office would appreciate receiving a copy of any publication that uses this publication as a source.

No use may be made of this publication for resale or any other commercial purpose whatsoever without prior permission. Applications for such permission, with a statement of the purpose and extent or reproduction, should be addressed to the Secretary of the Publications Board, United Nations, New York.
Editorial statement

The Transport and Communications Bulletin for Asia and the Pacific is a peer-reviewed journal published once a year by the Transport Division (TD) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The main objectives of the Bulletin are to provide a medium for the sharing of knowledge, experience, ideas, policy options and information on the development of transport infrastructure and services in the Asia-Pacific region; to stimulate policy-oriented research; and to increase awareness of transport policy issues and responses. It is hoped that the Bulletin will help to widen and deepen debate on issues of interest and concern in the transport sector.

This issue of the Bulletin is dedicated to the theme of “Combatting Congestion”. With growing motorization, most cities in Asia and the Pacific are facing tremendous challenges in coping with traffic congestion. Congestion accentuates the health and environmental impact of motor vehicles because vehicles operating in heavy traffic pollute considerably more than those operating in free-flow conditions. Congestion also exacts a heavy economic and social toll, particularly on people living in cities, in terms of wasted time and fuel costs.

As the articles in this issue describe, there are many different ways to reduce traffic congestion. Several major cities in the region have launched mass transit projects, such as the Delhi Metro in Delhi, India; TransJakarta, the first full Bus Rapid Transit system in Indonesia and Asia; and suburban metro lines in Beijing, China. Others have implemented traffic demand management policies, such as the congestion charge scheme in Singapore and car plate auctioning systems in Shanghai, China. Despite these measures, however, urban mobility continues to deteriorate in most Asian cities. This issue of the Bulletin looks at why this is so, and also suggests some possible solutions for policy-makers, particularly at the municipal level, to consider.

The first article, on "Smarter Congestion Relief in Asian Cities", argues that the ways in which policies to reduce traffic congestion are evaluated can significantly affect urban planning decisions. If evaluated one way, congestion is considered the dominant urban transport problem and roadway expansion the preferred solution, but evaluated other ways, congestion is considered moderate compared with other transport problems and roadway expansion an ineffective and costly solution. The article describes new and better ways to solve urban traffic congestion problems, with an emphasis on "win-win" strategies that help achieve multiple planning objectives and therefore maximize overall benefits. It concludes that this "win-win" approach can be applied to many types of transportation problems, and is particularly appropriate in rapidly-developing Asian cities.

The second article makes a similar argument, stressing the case for using a "co-benefits approach" to tackle environmental externalities of the road transport sector. Such an approach looks at the global and local environmental co-benefits which can be derived from sustainable mobility policies, and presents applications of this approach to two very different Asian cities, New Delhi and Toyama, Japan. The authors evaluate policy packages to pursue congestion reduction, including promotion of public transport infrastructure and soft-mode programs. The analysis suggests that implementing a co-benefit approach to simultaneously reduce global greenhouse gases and local air pollutant emissions can tackle urban congestion and simultaneously promote social equity and economic prosperity.

The third article, "Urban transport systems and congestion: a case study of Indian cities", takes a closer look at the congestion situation in Indian cities. It describes various policies which the Government has initiated in the face of rapid urbanization, and considers their effectiveness at improving urban mobility. The authors analyse selected policies which have been tried in India and assesses the policy gaps which deter the desired impact of such policies on reducing traffic congestion. It also suggests policy measures to overcome these gaps and the way ahead.

The last two articles provide in-depth analyses from very different cities where governments have tried to reduce congestion through traffic demand management policies. One looks at Manila’s circumferential highway, the Epifanio de los Santos, or EDSA, which is a major thoroughfare for the city.
It identifies the major factors contributing to congestion along the EDSA, namely the concentration of major shopping malls and business districts alongside its course; the high number of bus terminals, particularly in the Cubao area; and the ban on jeepneys and trisikel which has led to a concentration of these vehicles on the side streets and blockages for exit of cars from the EDSA. The author also explores some of the policy options which may be considered to tackle congestion on EDSA, including rail transit, traffic demand policies and bus policies, and calls for a more integrated approach to addressing congestion issues.

The final article describes the experience of the implementation of Pedestrian Day in Thimphu, the capital of Bhutan. It presents the results of two surveys conducted in the city, the first conducted several months after the Government passed an executive order declaring every Tuesday to be observed as a “Pedestrian Day (PD)”; and the second conducted in August 2013, soon after the Government decided to withdraw the initiative completely. The authors describe the results of the two surveys, which asked different groups of people in the city about their support for the idea and their desire for it to be continued or discontinued. They suggest that the experience of Pedestrian Day in Thimphu show that prior stakeholder consultations and sufficient preparatory measures are necessary for the successful implementation of this type of sustainable transportation initiative.
**CONTENTS**

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Editorial statement ................................................................. iii</td>
</tr>
<tr>
<td>Todd Litman</td>
</tr>
<tr>
<td>M. Absar Alam and Faisal Ahmed</td>
</tr>
<tr>
<td>Yves Boquet</td>
</tr>
<tr>
<td>Ishtiaque Ahmed and Gyalmo Sithey</td>
</tr>
</tbody>
</table>
**SMarter CONGestion RELIEF IN ASIAN CITIES**

*Win-Win Solutions to Urban Transport Problems*

Todd Litman

**ABSTRACT**

This article describes new and better ways to solve urban traffic congestion problems. It emphasizes win-win strategies that help achieve multiple planning objectives and therefore maximize overall benefits. This reflects a new planning paradigm which expands the range of impacts and options considered in the planning process. Win-win strategies include improvements to resource efficient modes such as walking, cycling and public transport; incentives for urban-peak travelers to use the most efficient option for each trip; and smart growth development policies that reduce travel distances and therefore total congestion costs. This article discusses the importance of comprehensive and multi-modal transport planning, describes omissions and biases in current planning, identifies various win-win congestion reduction strategies, and provides examples of successful urban transportation improvement programs. The win-win approach can be applied to many types of transportation problems, and is particularly appropriate in rapidly-developing Asian cities.

**INTRODUCTION**

There are many possible ways to reduce traffic congestion. How they are evaluated can significantly affect urban planning decisions. If evaluated one way, congestion is considered the dominant urban transport problem and roadway expansion the preferred solution, but evaluated other ways, congestion is considered moderate compared with other transport problems and roadway expansion an ineffective and costly solution.

It is important to use comprehensive and multi-modal evaluation to identify the truly best congestion reduction strategies, since urban planning often involves trade-offs between competing objectives. For example, expanding urban roadways may reduce congestion, but creates barriers to pedestrian travel (and therefore public transport travel since most transit trips include walking links), and tends to induce additional vehicle travel which increases other transport problems such as parking costs, accident risk and pollution emissions. Other congestion reduction strategies provide additional benefits, and so are considered win-win solutions. For example, public transit improvements not only reduce traffic congestion, they can also help reduce parking problems, accident risk and pollution emissions, and they improve mobility for non-drivers. All these impacts should be considered when evaluating congestion reduction strategies.

This article describes ways to identify truly optimal congestion reduction strategies. It discusses new, more comprehensive ways to evaluate transport system performance, identifies win-win congestion reduction strategies, and describes examples of successful urban transportation improvement programs. This approach can be used to address various transport problems, and is particularly important in rapidly-developing cities where traffic problems are particularly intense and roadway expansion costs are high.

I. **URBAN TRANSPORT EFFICIENCY**

Cities are places where many people and activities locate close together. This provides a high level of accessibility, that is, by providing diverse transport options and minimizing the distances between activities they tend to reduce transportation costs. For example, urban residents often have more services and jobs within a five-minute walk than suburban and rural areas have within a five-minute drive. This maximizes urban residents' access to economic and social opportunities.
Current research is improving our understanding of factors that affect accessibility. For example, Levine, et al. (2012) found that urban density has about ten times as much influence on the number of destinations motorists can access in a given time period as a proportional increase in traffic speeds. Ewing and Cervero (2010) found that a 10% increase in roadway connectivity reduces average travel distances by 1.2%. Kuzmyak (2012) found that residents of urban neighborhoods with good travel options, connected streets and more nearby services drive a third fewer daily miles and experience less congestion delays than residents of automobile-dependent communities. These studies indicate that cities can provide high levels of accessibility, despite lower average traffic speed.

However, increased density can also increase potential conflicts, also called external costs, such as traffic and parking congestion, accident risk, and pollution emissions. Of all common activities people engage in, motor vehicle travel tends to impose the greatest external costs. Automobile travel requires far more road space, and so imposes more congestion costs than other modes, as illustrated in Figure 1.

As a result, transport system efficiency, economic productivity, and community livability tend to increase if automobile travel is minimized, particularly under urban-peak conditions. This does not require eliminating automobile travel entirely; even in large cities a portion of trips are efficiently made by car. However, as cities become larger and denser, automobile mode share should decline, as illustrated in Figure 2.

However, optimal travel patterns will not occur on their own. Many city residents can afford cars. Efficient urban transport requires policies that encourage more affluent people to walk, bicycle and use public transit when appropriate, so traffic volumes stay within the roadway systems’ capacity. As Bogotá Mayor Gustavo Petro explains, “A developed country is not a place where the poor have
cars. It’s where the rich use public transport.” Achieving this goal will require reforming common transport planning practices.

II. THE NEW TRANSPORT PLANNING PARADIGM

Transport planning is experiencing a paradigm shift, a fundamental change in the way problems are defined and potential solutions evaluated, as summarized in Table 1. Table 1 compares the old and new transport planning paradigm. As can be seen, the new paradigm applies more comprehensive and multi-modal planning.

Table 1: Transport Planning Paradigms (ADB 2009; Litman 2013b)

<table>
<thead>
<tr>
<th>Old Paradigm</th>
<th>New Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition of Transportation</strong></td>
<td><strong>Ability to obtain goods, services and activities</strong></td>
</tr>
<tr>
<td><strong>Modes considered</strong></td>
<td><strong>Multiple modes and transport services</strong></td>
</tr>
<tr>
<td><strong>Performance indicators</strong></td>
<td><strong>Quality of transport options. Proximity of destinations. Per capita transport costs.</strong></td>
</tr>
<tr>
<td><strong>Consideration of land use</strong></td>
<td><strong>Recognizes that land use has major impacts on transportation</strong></td>
</tr>
<tr>
<td><strong>Favored transport improvements</strong></td>
<td><strong>Multi-modal improvements. Transportation demand management. Smart growth development policies.</strong></td>
</tr>
</tbody>
</table>

The old planning paradigm evaluated transport system performance based primarily on the ease of driving, using indicators such as roadway level-of-service (LOS) and average traffic speeds. This favored automobile travel over other modes, which created a cycle of automobile dependency and sprawl, as illustrated in Figure 3. The result is inefficient and unfair since many urban trips are short enough for walking and cycling, and many residents cannot drive (Kodukula 2011). The new paradigm recognizes the important roles that walking, cycling and public transport play in an efficient and equitable transport system.

Figure 3: Cycle of Automobile Dependency and Sprawl

The old planning paradigm favored faster modes over slower modes, which contributed to a self-reinforcing cycle of automobile dependency and sprawl.
III. CONGESTION COSTING METHODS

Various methods are used to quantify (measure) and monetize (measure in monetary units) congestion costs (Grant-Muller and Laird 2007). How this is done can significantly affect results. One important factor is the baseline (also called threshold) speed below which congestion delays are calculated, which reflects the traffic speed considered appropriate under urban-peak conditions. Some studies use free-flowing traffic speeds (LOS A), although this is not economically optimal since it does not maximize traffic flow or fuel efficiency (Litman 2013a). Most experts recommend using lower baseline speeds, such as LOS C or D (TC 2006; Wallis and Lupton 2013).

Some congestion costing studies use excessive travel time values. Although some vehicles (e.g., freight trucks, buses and business travel) have high values of travel time, many urban motorists are quite price sensitive – they are only willing to pay modest fees for increased travel speeds (“Travel Time Costs,” Litman 2009). Another important factor is the formula used to calculate how changes in traffic speeds affect fuel consumption and pollution emissions. Fuel consumption and emission rates are usually lowest at 60-80 kilometers per hour, so a moderate amount of congestion can actually increase efficiency and reduce emissions compared with freeflow (Barth and Boriboonsomin 2009).

Congestion cost evaluation is complicated by the tendency of congestion to maintain equilibrium: it increases until delays cause travelers to shift travel times, routes and mode, and reduce trips (Cervero 2003; Litman 2001). For example, if roads are congested you might defer trips, shift modes or choose closer destinations, but if they are expanded you would make more peak-period vehicle trips. Figure 4 illustrates this. The additional peak-period vehicle travel on that roadway is called generated traffic, and net increases in total vehicle travel are called induced travel.

Figure 4: How Road Capacity Expansion Generates Traffic (Litman 2001)

Urban traffic volumes can grow until congestion limits additional peak-period trips, at which point it maintains a self-limiting equilibrium (indicated by the curve becoming horizontal). If road capacity is expanded, traffic growth continues until it reaches a new equilibrium. The additional peak-period vehicle traffic that results from roadway capacity expansion is called “generated traffic.” The portion that consists of absolute increases in vehicle travel (as opposed to shifts in time and route) is called “induced travel.”

This has the following implications for congestion evaluation (Litman 2001):

- Congestion will seldom get as severe as predicted by extrapolating past trends. As traffic congestion increases it discourages further peak-period trips, achieving equilibrium.
- Roadway expansion provides less long-term congestion reduction benefit than predicted if generated traffic is ignored.
- Induced vehicle travel increases various external costs including downstream congestion, parking costs, accident risk, and pollution emissions.
- Induced vehicle travel directly benefits the people who increase their vehicle travel, but these benefits tend to be modest because it consists of marginal-value vehicle mileage that users are most willing to forego if their travel costs increase.
Table 2 summarizes various congestion indicators. Some, such as roadway level-of-service and the travel time index only measure congestion intensity, that is, the reduction in traffic speeds on particular roads; they do not account for the amount that people drive under urban-peak conditions and so do not reflect total congestion costs. Right columns indicate whether an indicator is multi-modal (considers delays to non-auto travelers) and comprehensive (reflects total congestion delays, accounts for travel distances).

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
<th>Multi-Modal</th>
<th>Comprehensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Level-Of-Service (LOS)</td>
<td>Intensity of congestion on a road or intersection, rated from A (uncongested) to F (most congested)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Multi-modal Level-Of-Service (LOS)</td>
<td>Service quality of walking, cycling, public transport and automobile, rated from A to F</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Travel Time Index</td>
<td>The ratio of peak to free-flow travel speeds</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Avg. Traffic Speed</td>
<td>Average peak-period vehicle travel speeds</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Avg. Commute Time</td>
<td>The average time spent per commute trip</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Congested Duration</td>
<td>Duration of “rush hour”</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Annual Hours Of Delay</td>
<td>Hours of extra travel time due to congestion</td>
<td>No if for vehicles, yes if for people</td>
<td>Yes</td>
</tr>
<tr>
<td>Congestion Costs</td>
<td>Monetized value of delay plus additional vehicle operating costs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

This table summarizes various congestion cost indicators. Some only consider motorists’ delays and so ignore the congestion reduction benefits of mode shifts and more accessible land use.

When evaluating congestion costs and potential congestion reduction strategies it is important to apply realistic baseline speeds, value travel time and emission reductions, account for induced travel, and use comprehensive and multi-modal indicators that consider the congestion avoided when travelers reduce their urban-peak vehicle travel, for example, by shifting mode or reducing trip distances.

### IV. COMPARING CONGESTION WITH OTHER URBAN TRANSPORT COSTS

It is helpful to compare congestion with other urban transportation costs. Several studies have monetized various transport costs (CE, INFRAS, ISI 2011; Litman 2009; TC 2005-08). This indicates that congestion costs are moderate overall, larger than some but smaller than others. For example, annual per capita U.S. congestion costs are estimated to total between US$110 and US$390 (Litman 2013a; TTI 2012), compared with about US$4,000 in vehicle costs, US$1,500 in crash damages, US$1,000 in parking costs, US$500 in air and noise pollution costs and US$325 in roadway costs, as illustrated in Figure 5.
Congestion cost estimates range between US$110 and US$390 annual per capita, depending on analysis methods. Even the higher estimate is moderate compared with other transport costs.

This has important implications. It suggests that a congestion reduction strategy is economically inefficient if it causes even modest increases in other transport costs, such as vehicle expenses, crashes, parking or environmental damages, but provides far greater total benefits if it reduces these costs. For example, if roadway expansions reduce traffic congestion by 20%, but increase vehicle costs, accidents, parking and pollution emissions by 5% each because walking conditions decline and additional vehicle travel is induced, the congestion cost reductions are more than offset by other cost increases. However, if public transit improvements reduce congestion by 10% and also reduce these other costs by 5% each, the total benefits will be much larger than just congestion reductions.

V. ECONOMIC DEVELOPMENT IMPACTS

Proponents often claim that highway expansions support economic development (increased productivity, incomes and tax revenues) by reducing congestion costs. However, such claims are often exaggerated (Dumbaugh 2012). Building the first highways between cities tends to support economic development, but additional roadway capacity tends to provide declining marginal benefits (Shirley and Winston 2004). Figure 6 shows how U.S. highway investments provided high annual economic returns during the 1950s and 60s, but after the basic highway network was completed in the 1970s, the rate of return declined significantly.

Highway investment economic returns declined after the basic Interstate network was completed.
As previously described, congestion is just one of many factors that affect overall accessibility, and roadway expansion tends to be an ineffective and costly congestion reduction strategy by inducing additional vehicle travel. Theoretical and empirical research indicates that improving alternative modes and efficient transport pricing tend to support economic development much more than urban roadway expansions (Cambridge Systematics 2012; Jiwattanakulpaisarn, Noland and Graham 2012). Table 3 compares the economic impacts of selected congestion reduction strategies, as identified by the author.

Table 3: Economic Impacts of Congestion Reduction Strategies

<table>
<thead>
<tr>
<th>Economic Impacts</th>
<th>Roadway Expansion</th>
<th>Improve Alt. Modes</th>
<th>Efficient Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic congestion</td>
<td>Reduces congestion in the short-run, but less over the long-run</td>
<td>Reduces congestion</td>
<td>Reduces congestion</td>
</tr>
<tr>
<td>Employment pools</td>
<td>Expands car commuters’ work options</td>
<td>Expands all commuters’ work options</td>
<td>Expands most commuters’ work options</td>
</tr>
<tr>
<td>Parking costs</td>
<td>Increases parking costs</td>
<td>Reduces parking costs</td>
<td>Reduces parking costs</td>
</tr>
<tr>
<td>Vehicle and fuel imports</td>
<td>Increases</td>
<td>Reduces</td>
<td>Reduces</td>
</tr>
<tr>
<td>Land use accessibility</td>
<td>Causes sprawl, which reduces accessibility</td>
<td>Encourages compact development which improves accessibility</td>
<td>Encourages compact development which improves accessibility</td>
</tr>
</tbody>
</table>

Roadway expansions can reduce congestion in the short-run, but do little to improve non-drivers’ work options, and can have undesirable economic impacts including increased parking costs, vehicle and fuel imports, and sprawl. Other congestion reduction strategies often provide more economic benefits.

VI. COMPREHENSIVE IMPACT EVALUATION

A comprehensive evaluation framework can help identify the most beneficial congestion reduction strategies. Multi-criteria analysis considers various impacts (benefits and costs). This analysis may be qualitative (described), quantitative (measured), or monetized (valued in monetary units). For example, Table 4 uses qualitative analysis to evaluate how four congestion reduction strategies affect ten planning objectives. Roadway expansions reduce congestion and vehicle operating costs, but by degrading walking conditions and inducing additional vehicle travel, they tend to contradict other objectives. Improving alternative modes, efficient transport pricing reforms, and “smart growth” development policies (i.e. policies which result in more accessible, multi-modal communities) tend to achieve a wider range of objectives.

Table 4: Comparing Congestion Reduction Strategies

<table>
<thead>
<tr>
<th>Planning Objectives</th>
<th>Roadway Expansion</th>
<th>Improve Alt. Modes</th>
<th>Pricing Reforms</th>
<th>Smart Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion reduction</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x/✓</td>
</tr>
<tr>
<td>Roadway cost savings</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Parking savings</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Consumer cost savings</td>
<td>✓/x</td>
<td>✓</td>
<td>✓/x</td>
<td>✓</td>
</tr>
<tr>
<td>Improved mobility for non-drivers</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improved traffic safety</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Transport and Communications Bulletin for Asia and the Pacific  

Planning Objectives

<table>
<thead>
<tr>
<th>Planning Objectives</th>
<th>Roadway Expansion</th>
<th>Improve Alt. Modes</th>
<th>Pricing Reforms</th>
<th>Smart Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced pollution</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Energy conservation</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Efficient land use</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improved fitness and health</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

(✓ = helps achieve that objective. ✗ = Contradicts that objective.) Roadway expansion helps reduce congestion but by inducing additional vehicle travel it tends to contradict other objectives. Improving alternative modes, pricing reforms and smart growth policies help achieve many objectives.

Quantitative analysis can apply weights to each objective (for example, giving twice as much weight to a 1% reduction in consumer costs as, say, a 1% reduction in air pollution). Monetized analysis assigns dollar values to each impact (for example, a 1% reduction in per capita accident costs is valued at $15). This type of evaluation can indicate when a solution to one problem contradicts other planning objectives, and helps identify win-win strategies.

Multi-modal evaluation considers how planning decisions affect various accessibility factors, besides automobile traffic speeds, including walking and cycling conditions, public transport service quality, roadway connectivity and geographic proximity. This is important because planning decisions often involve trade-offs between different types of accessibility. For example, roadway expansions can increase automobile and bus accessibility, but often degrade walking conditions, and therefore transit access since most transit trips involve walking links, and induce sprawl which reduces geographic proximity. Improving alternative modes (pedestrian and cycling improvements, transit service improvements, rideshare matching, etc.), transport pricing reforms (road tolls, parking fees, distance-based vehicle insurance, fuel price increases, etc.), and smart growth development policies may reduce vehicle traffic speeds but improve other forms of accessibility. Table 5 indicates these trade-offs.

Table 5: Congestion Reduction Impacts on Accessibility Factors

<table>
<thead>
<tr>
<th>Accessibility Factors</th>
<th>Roadway Expansion</th>
<th>Improve Alt. Modes</th>
<th>Pricing Reforms</th>
<th>Smart Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobile access</td>
<td>✓</td>
<td>✗</td>
<td>✓/✗</td>
<td>✓/✗</td>
</tr>
<tr>
<td>Active transport</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Public transport</td>
<td>✓ (bus)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Roadway connectivity</td>
<td>✗</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Geographic proximity</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

(✓ = helps achieve that objective. ✗ = Contradicts that objective.) Roadway expansions increase automobile and bus access, but by degrading active transport (walking and cycling) conditions and inducing sprawl tend to reduce other forms of access. Alternative mode improvements, transport pricing reforms and smart growth development may in some ways reduce automobile access, by reducing traffic speeds, but tend to improve other forms of access.

VII. SMART CONGESTION REDUCTION STRATEGIES

This section describes various win-win congestion reduction strategies.

7.1 Improving Alternative Modes

Alternative modes include walking and cycling, public transport (buses and trains), and sometimes, high-occupancy vehicles, carsharing, telecommuting, taxi services, and delivery services. If alternative modes are inferior (inconvenient, uncomfortable, dangerous, etc.), people who own a motor vehicle will drive even if congestion is severe, but if alternatives are improved some travelers
will shift from driving, reducing congestion. Even small shifts can provide significant benefits. For example, a 5% reduction from 2,000 to 1,900 vehicles per lane-hour typically increases roadway traffic speeds by 10 to 20 kilometers per hour.

Table 6: Typical Alternative Mode Improvements

<table>
<thead>
<tr>
<th>Walking</th>
<th>Bicycling</th>
<th>Public Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>• More sidewalks and paths</td>
<td>• More paths</td>
<td>• More routes</td>
</tr>
<tr>
<td>• More crosswalks</td>
<td>• More bike lanes</td>
<td>• More frequent service</td>
</tr>
<tr>
<td>• Traffic speed reductions</td>
<td>• Traffic speed reductions</td>
<td>• Faster service</td>
</tr>
<tr>
<td>• Improved wayfinding</td>
<td>• Improved wayfinding</td>
<td>• Grade separation (bus lanes)</td>
</tr>
<tr>
<td>• More compact and mixed development so more services are within walking distance</td>
<td>• Bike parking</td>
<td>• Nicer vehicles</td>
</tr>
<tr>
<td>• Improved safety and security</td>
<td>• More compact and mixed development so more services are within cycling distance</td>
<td>• Nicer stations</td>
</tr>
<tr>
<td>• <em>Universal design</em>, so pedestrian facilities accommodate pedestrians with disabilities</td>
<td>• Improved safety and security</td>
<td>• Improved user information</td>
</tr>
<tr>
<td>• Improved connectivity</td>
<td>• Loans and subsidies to purchase bicycles and safety equipment (lights and helmets)</td>
<td>• Improved safety and security</td>
</tr>
<tr>
<td></td>
<td>• Bicycle training and encouragement programs</td>
<td>• Reduced fares and more convenient payment systems</td>
</tr>
<tr>
<td></td>
<td>• Bicycle racks for buses</td>
<td>• Improved stop/station access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Better marketing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <em>Universal design</em>, so transit services accommodate pedestrians with disabilities</td>
</tr>
</tbody>
</table>

There are many possible ways to improve alternative modes.

Walking and cycling improvements can reduce traffic congestion in several ways. Poor walking and cycling conditions force people to drive for even short trips. In urban areas a significant portion of motor vehicle travel (typically 10-30%) consists of short trips that could shift to non-motorized modes. Poor walking and cycling conditions also force motorists to chauffeur non-drivers for local trips, for example, driving children to school and friends. Such trips often include empty backhauls, so a kilometre of passenger travel generates two kilometers of vehicle travel. Since most public transport trips include walking and cycling links, improving these modes tends to increase public transit travel.

Studies indicate that the quality of public transit service affects travel speeds and congestion delays on parallel highways (Vuchic 1999). A key factor is the relative speed of transit compared with driving, so grade-separated transit services, such as bus lanes and trains on their own rights-of-way, tend to be particularly effective at reducing congestion.

Even if transit only carries a minor portion of total regional travel, it usually carries a significant portion of travel on major urban corridors where traffic congestion is most intense. For example, although Los Angeles has only 11% transit commute mode share, transit reduces regional congestion costs by 11% to 38%; when a strike halted transit service in that city for five weeks, average highway congestion delay increased 47% (Anderson 2013). Aftabuzzaman, Currie and Sarvi (2010) concluded that in Australian cities, high quality public transit provides $0.044 to $1.51 worth of congestion cost reduction per marginal transit-vehicle km of travel, with higher values on the most congested corridors. Similar patterns are found in developing countries. Figure 7 shows that Indian cities with rail transit have less intense roadway congestion.
Traffic congestion is lower in Indian cities with higher quality public transit.

Under typical urban traffic conditions, 20 buses carry more passengers than a general traffic lane, and 45 buses carry more passengers than a freeway lane, so an urban arterial with more than 20 buses per peak hour, and an urban highway with more than 45 buses per peak hour, should have dedicated bus lanes and other bus priority features to maximize travel efficiency and attract more discretionary travelers to transit.

Improving alternative modes can provide other efficiency benefits. Travelers who shift from driving to alternative modes in response to service improvements must benefit overall or they would not change. Even if the alternative modes are slower their total costs may decline, for example, if they can walk or bicycle for enjoyment and exercise, and so avoid the need to spend time and money at a gym, or if transit passengers can relax or work, so their unit time costs (dollars per hour) are reduced (Litman 2008).

Walking, cycling and public transit improvements tend to help create more compact communities where residents own fewer automobiles, drive less and rely more on alternative modes. This can leverage additional vehicle travel reductions, so increases in walking and public transit cause proportionately larger reductions in automobile travel (ICF 2010). High quality transit also complements congestion pricing: it reduces the toll required to achieve a given reduction in traffic volumes (PSRC 2008).

7.2 Transport Pricing Reforms

Various transport pricing reforms can help reduce traffic congestion and provide other benefits. Congestion pricing, with higher fees for driving on congested roads and lower fees at other times and locations, is particularly effective at reducing traffic congestion because it can cause peak-period travel to shift to other times, routes, modes and destinations. However, congestion pricing tends to have high implementation costs and raises privacy concerns, and only applies to a minor portion of total vehicle travel. Other pricing strategies (flat road user fees, efficient parking pricing, higher fuel prices and distance-based pricing) tend to affect a larger portion of total travel and therefore tend to be more effective at achieving other planning objectives such as reducing parking costs, accident risk, and pollution emissions. Table 7 summarizes various pricing reforms and their impacts on travel and congestion.
Table 7: Transport Pricing Reforms (Spears, Boarnet and Handy 2010; VTPI 2009)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Travel Impacts</th>
<th>Congestion Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion pricing</td>
<td>Road tolls that are higher under congested conditions.</td>
<td>Shifts urban-peak driving to other times, routes, modes and destinations.</td>
<td>Tends to provide large congestion reductions.</td>
</tr>
<tr>
<td>Flat tolls and vehicle travel fees</td>
<td>Tolls and mileage-based vehicle fees intended to generate revenue.</td>
<td>Shifts automobile travel to other modes and destinations. Reduces total vehicle travel.</td>
<td>Effects are dispersed. Provides modest congestion reductions.</td>
</tr>
<tr>
<td>Efficient parking pricing</td>
<td>Fees for using parking facilities with higher rates during peak periods, and parking “cash out” (offering non-drivers the cash equivalent of parking subsidies)</td>
<td>Shifts driving to other modes and destinations. Reduces total vehicle travel.</td>
<td>Because this is implemented most in dense urban areas, it tends to provide large congestion reductions.</td>
</tr>
<tr>
<td>Fuel tax increases</td>
<td>Increase fuel prices to generate revenue and internalize external costs.</td>
<td>Shifts driving to other modes and destinations. Reduces total vehicle travel.</td>
<td>Effects are dispersed. Provides modest congestion reductions.</td>
</tr>
<tr>
<td>Distance-based pricing</td>
<td>Prorate vehicle insurance premiums and registration fees by mileage.</td>
<td>Shifts automobile travel to other modes and destinations. Reduces total vehicle travel.</td>
<td>Effects are potentially large but dispersed, so tend to provide modest congestion reductions.</td>
</tr>
</tbody>
</table>

This table summarizes major pricing reforms and their travel and congestion reduction impacts.

7.3 Smart Growth Development Policies

Smart growth is a general term for various policies that create more compact, multi-modal communities where residents tend to own fewer vehicles, drive less and rely more on alternative modes. There is debate concerning how smart growth affects congestion. Experts often assume that increasing density increases congestion (Melia, Parkhurst and Barton 2011), but smart growth also includes features that reduce vehicle travel and congestion. Table 8 summarizes how various smart growth features affect traffic congestion.

Table 8: Smart Growth Congestion Impacts

<table>
<thead>
<tr>
<th>Smart Growth Feature</th>
<th>Congestion Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased development density</td>
<td>Increases vehicle trips within an area, but reduces trip distances and supports use of alternative modes</td>
</tr>
<tr>
<td>Increased development mix</td>
<td>Reduces trip distances and supports use of alternative modes</td>
</tr>
<tr>
<td>More connected road network</td>
<td>Reduces the amount of traffic concentrated on arterials. Reduces trip distances. Supports use of alternative modes.</td>
</tr>
<tr>
<td>Improved transport options</td>
<td>Reduces total vehicle trips.</td>
</tr>
<tr>
<td>Transportation demand management</td>
<td>Reduces total vehicle trips, particularly under congested conditions.</td>
</tr>
<tr>
<td>Parking management</td>
<td>Can reduce vehicle trips and support more compact development</td>
</tr>
</tbody>
</table>

Smart growth includes many features that can reduce traffic congestion.
Empirical studies indicate that comprehensive smart growth policies tend to reduce congestion costs. For example, a major study in Phoenix, Arizona, found less intense congestion, reduced per capita vehicle travel, and less total congestion delay in older, compact, multi-modal neighborhoods than in newer, lower-density suburban areas (Kuzmyak 2012). In the urban neighborhoods, commute trips averaged about 7 miles and shopping trips 3 miles, compared with almost 11 and 4 miles in suburban areas. Overall, urban residents drive about a third fewer daily miles than suburban residents. This occurs because urban neighborhoods have more mixed development, more connected streets, better walking conditions and better public transit services.

7.4 Support Programs

Various programs can support congestion reduction strategies. These include employee trip reduction programs at worksites, campus transport management programs, mobility management marketing programs that promote use of resource-efficient modes in a community, and various other Transportation Demand Management (TDM) programs (VTPI 2009). Such programs provide an institutional framework for implementing strategies such as rideshare matching and efficient parking pricing, and information and encouragement for travelers to use efficient modes. As a result, they tend to increase the effectiveness of other congestion reduction strategies.

7.5 Summary

Table 9 evaluates the impacts of four congestion reduction strategies and the degree that these are considered in transport modeling and planning. Urban roadway expansions often provide only short-term congestion reductions, tend to increase other costs, and have few co-benefits. Conventional traffic models often exaggerate roadway expansion benefits and conventional planning tends to favor this solution. Other strategies tend to provide more long-term congestion reductions and more co-benefits, but are often undervalued in conventional transport modeling and planning.

Table 9: Congestion Reduction Strategies

<table>
<thead>
<tr>
<th>Congestion impacts</th>
<th>Roadway Expansion</th>
<th>Improve Alternative Modes</th>
<th>Pricing Reforms</th>
<th>Smart Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduces congestion in the short-run, but this declines over time due to generated traffic.</td>
<td>Reduces but does not eliminate congestion.</td>
<td>Can significantly reduce congestion.</td>
<td>May increase local congestion intensity but reduces per capita congestion costs.</td>
<td></td>
</tr>
<tr>
<td>Indirect costs and benefits</td>
<td>By inducing additional vehicle travel and sprawl it tends to increase indirect costs. Minimal co-benefits. Small energy savings and emission reductions.</td>
<td>Numerous co-benefits. Parking savings, traffic safety, improved access for non-drivers, user savings, energy conservation, emission reductions, improved public health, etc.</td>
<td>Numerous co-benefits. Revenues, parking savings, traffic safety, energy conservation, emission reductions, improved public health, etc.</td>
<td>Numerous co-benefits. Infrastructure savings, traffic safety, improved access for non-drivers, user savings, energy conservation, emission reductions, improved public health, etc.</td>
</tr>
<tr>
<td>Consideration in traffic modeling</td>
<td>Models often exaggerate congestion reduction benefits by underestimating generated traffic and induced travel</td>
<td>Models often underestimate the congestion reduction benefits of high quality alternative modes</td>
<td>Varies. Can generally evaluate congestion pricing but are less accurate for other reforms such as parking pricing</td>
<td>Many models underestimate the ability of smart growth strategies to reduce vehicle travel and therefore congestion</td>
</tr>
</tbody>
</table>
Different congestion reduction strategies have different types of impacts and benefits. Current traffic models and planning practices tend to undervalue many of these impacts.

Many of these strategies have synergistic effects – they are more effective if implemented together. For example, if implemented alone, public transit improvements, more efficient parking pricing and more compact development policies might only reduce vehicle travel 5% each, but if implemented together provide 30% reductions because travelers have both the opportunities and incentives to reduce their peak-period vehicle travel. For this reason, impacts and benefits tend to be greatest if congestion reduction strategies are implemented as an integrated program.

### VIII. OPTIMAL CONGESTION SOLUTIONS

This analysis indicates that optimal congestion reduction involves the following steps:

1. Improve alternative modes, including walking, cycling and public transit, and where appropriate, programs that support ridesharing, carsharing and telecommuting. Provide targeted improvements on congested urban corridors, such as more frequent transit services on congested roads, and commute trip reduction programs at major employment centers.

2. Manage roadways to favor space-efficient modes, such as bus lanes on urban arterials with more than 20 buses per hour during peak periods, transit-priority traffic control systems, and High Occupant Vehicle (HOV) lanes on urban highways.

3. If possible, apply congestion pricing (variable tolls or fees that are higher during congested periods), with prices set to reduce traffic volumes to optimal levels (typically level-of-service C or D).

4. Regardless of whether or not congestion pricing is applied, implement efficient transport pricing reforms to the degree that is politically feasible, including road tolls, parking pricing, fuel price increases, and distance-based insurance and registration fees. These reforms may be justified on various economic efficiency and social equity grounds.

5. Implement support programs such as commute trip reduction and mobility management marketing programs wherever appropriate.

6. Only consider urban roadway expansions if, after all of the previous strategies are fully implemented, congestion problems are significant and congestion pricing would provide sufficient revenues to finance all associated costs, which tests users’ willingness-to-pay for the additional capacity. For example, if a roadway expansion would have US$5 million annualized costs, it should be implemented only if peak-period tolls on that road will generate that much revenue. Off-peak tolls can be used to finance general roadway costs, such as maintenance and safety improvements, but not capacity expansion.

These policies and investments are not necessarily justified by their congestion reductions alone, but are often justified when all their benefits are considered, including increased social equity, since improving alternative modes and more efficient pricing ensure that non-drivers receive a fair share of transportation improvement benefits, and are not forced to subsidize road and parking facilities they do not use.

Any additional reform revenues from increased parking fees, road tolls, fuel taxes and vehicle fees can be used to help finance roadway costs, improve alternative modes, reduce transit fares, or reduce local taxes (they can be considered compensation for the impacts that urban roadways impose on adjacent communities). It is particularly appropriate to use some revenues to improve public transport and rideshare services, and provide support programs, in the areas where they are collected to help travelers shift from driving to alternative modes, and therefore reduce congestion.
IX. EXAMPLES

Many cities around the world are implementing various transportation demand management strategies to reduce traffic congestion and achieve other planning objectives (CAI-Asia 2007; Strompen, Litman and Bongardt 2012).

More than 150 cities have implemented Bus Rapid Transit (BRT) systems which provide convenient, fast, comfortable and affordable urban bus services that attract discretionary travelers (BRT Global Database). For example, Bogotá, Columbia’s TransMilenio system has 1,500 buses on dedicated bus lanes, plus 410 feeder buses. Seventy-five percent of Bogota residents rate the system as good or very good. The city has also developed an extensive pedestrian and bicycle path network, and many TransMilenio stations have large bicycle parking facilities.

In 2002, Seoul, Republic of Korea, implemented various transport innovations including removal of a major downtown highway, development of a BRT system with more than 5,000 high-quality buses operating on 107 km of busways and pedestrian and cycling improvements, plus a traffic control center which monitors traffic and parking problems on major arterials. This has greatly reduced congestion delay and accident risk.

In 1993, Kunming, China established its Public Transport Masterplan which gives priority to walking, cycling and public transport over private automobiles. The first bus lane opened in 1999, followed by a second in 2002. The plan also includes pedestrian and cycling improvements, and smart growth policies that focus new development around railway stations. Public survey found that 79% of residents were satisfied with the project in 1999, and this grew to over 96% satisfaction in 2001.

In 1975, Singapore first implemented an Area Licensing Scheme (ALS) which required motorists to purchase a paper license before entering the central area. In 1998 this was replaced by an automated Electronic Road Pricing (ERP) system which uses congestion pricing to maintain optimal traffic speeds of 45 to 65 km/h on expressways and 20 to 30 km/h on arterial roads.

In 2009, the City of Delhi, India published its Pedestrian Design Guidelines, a detailed guidebook that describes the role of non-motorized modes in an efficient and equitable transport system; defines minimum design and maintenance requirements for sidewalks, crosswalks and other pedestrian facilities; and describes international best practices for enhancing the pedestrian environment.

In 2007 Paris, France launched the Velib bicycle sharing system with 1,450 stations, 20,000 bicycles, and about 120,000 daily users. Since then, many other cities around the world have established bicycle sharing systems.

Many Asian cities have relatively few parking spaces, so motorists must often pay for using a parking space, and in some cities motorists must show that they have an off-street parking space before they are allowed to register a vehicle (Barter 2010). This tends to reduce vehicle ownership and traffic, and encourages use of alternative modes.

X. CONCLUSIONS

Traffic congestion is a significant problem in most cities. There are many possible congestion reduction strategies, some of which have significant indirect costs or benefits. It is important to use comprehensive and multi-modal analysis when evaluating these strategies.

The old planning paradigm assumes that traffic congestion is the most important urban transport problem and roadway expansion is the preferred solution. But congestion is actually a moderate cost overall, smaller than other transport costs such as vehicle costs, accident risks, parking costs and environmental damages, and roadway expansions can add significant indirect costs. It would therefore be harmful overall to reduce traffic congestion in ways that increase these other costs. A congestion reduction strategy is worth far more if it reduces other costs.
Chronic traffic congestion can be considered a symptom of more fundamental transport system problems, including inadequate transport options, underpricing, and sprawled development. Under such conditions, roadway expansions usually provide only short-term congestion relief and generally exacerbate transport problems. Roadway expansions also tend to be unfair to people who rely on walking, cycling and public transport, and therefore do not directly benefit and are harmed by increased vehicle traffic.

A more effective approach is a congestion reduction program which include a combination of improvements to alternative modes, efficient transport pricing and pricing reforms, smart growth development and land use policies, and various support activities. Though they may provide only modest short-term congestion reductions, their impacts tend to be synergistic (total impacts are greater than the sum of their individual impacts) and increase over time. As a result, these win-win strategies are usually the most efficient and equitable overall.

Win-win congestion reduction strategies are particularly appropriate in developing countries where most residents rely primarily on walking, cycling and public transport. It is important that decision makers and the general public understand these issues when choosing solutions to congestion problems.
REFERENCES


TTI (annual reports), Urban Mobility Report, Texas Transportation Institute (http://mobility.tamu.edu/ums).


TTI (annual reports), Urban Mobility Report, Texas Transportation Institute (http://mobility.tamu.edu/ums).


THE SUSTAINABLE MOBILITY- CONGESTION NEXUS: A CO-BENEFITS APPROACH TO FINDING WIN-WIN SOLUTIONS

Portugal-Pereira, J.O.*a,b, Doll, C.N.H.a, Suwa, A.a, and Puppim de Oliveira, J.A.a

a United Nations University, Institute of Advanced Studies (UNU-IAS), 6F International Organizations Center, Pacifico-Yokohama, 1-1-1 Minato Mirai, Nishi-ku, Yokohama 220-8502, Japan

b Energy Planning Program, Graduate School of Engineering, Federal University of Rio de Janeiro (COPPE-UFRJ), Centro de Tecnologia, Bloco C, Sala 211, Cidade Universitária, Ilha do Fundão, Rio de Janeiro, RJ 21941-972, Brazil

ABSTRACT

This study aims to qualitatively assess the global and local environmental co-benefits from implementing sustainable mobility policy strategies to tackle environmental externalities of the road transport sector, in New Delhi (India) and Toyama (Japan). To this end, policy packages to pursue congestion reduction have been evaluated, including promotion of public transport infrastructure and soft-mode programs. The analysis suggests that implementing a co-benefit approach to simultaneously reduce global (GHG) and local air pollutant emissions can tackle urban congestion and simultaneously promote social equity and economic prosperity. The co-benefits approach is flexible to many different contexts as the nature of co-benefits can vary according to local priorities. The implication of this is that integration of climate concerns can be mainstreamed into transport policy across many levels of development.

Key Words: road transport paradigm shift; win-win policies; environmental sustainability; congestion.

INTRODUCTION

In fast growing cities, motorization goes hand in hand with economic development and travel demand. This is due in part to rising incomes making personal motorised transport more affordable but also due to inadequate provision of public transport to meet rising travel demand. Between 2000 and 2020, the global motor vehicle fleet is foreseen to increase by twofold to up to 2 billion vehicles, mainly in emerging economies in Asia and Latin America (Sperling and Gordon, 2009). This rapid growth has led to chronic traffic congestion, which results in longer commuting times, lower productivity and reduced accessibility in urban areas. Furthermore, nearly 3,400 people die daily on the world’s roads, mainly in rapidly developing countries. If following a business-as-usual trend, road traffic accidents will become the fifth leading cause of global deaths (WHO, 2013). Road transport is also one of the main sources of air pollutants and GHG emissions in urban areas. As vehicle fleets in developing countries tend to be older and less efficient than in developed countries, they consume more fuel per kilometre and put a greater load on the environment.

In mature cities, financial problems and declining population are putting further pressure on already stressed urban environments. For instance, Japan has one of the oldest populations in the world as well as one of the lowest birth rates. According to the National Institute of Population and Social Security of Japan (IPSS, 2012), the Japanese population is projected to decline to 86.7 million inhabitants by 2060, meaning a decrease of 30% compared with 2010 levels. Ironically, energy consumption per capita tends to increase in developed cities, especially due to the road transport sector. Because public transportation costs have a scale effect, irregular demand results in unreliable and costly services. Consequently, passengers may shift from public to individual motorised modes. This increases fossil fuel consumption and intensifies emissions of local air pollutants and greenhouse gases. Furthermore, a shift to innovative low-carbon infrastructure is more costly in low intensity passenger infrastructures than high intensity ones, which can support extra costs. Low

*Corresponding author. Tel./Fax: +55 21 2562-8775. E-mail address: portugal.pereira@ppe.ufrj.br; joanaportugal@gmail.com
carbon infrastructure, such as plug-in electric rechargers in cities, implies significant investment and is only feasible in densely populated urban centres.

It is, therefore, imperative to design new patterns of urban mobility in both expanding and mature cities, in order to cope simultaneously with economic development, social inclusion and global and local environmental protection. Among a wide portfolio of options, it is essential to consider local conditions and implementation costs, and to evaluate their full impact. How will mobility patterns drive cities towards sustainable development? Which sustainable mobility policies will optimize environmental co-benefits at least cost? To clarify these questions, this paper examines strategy packages to address congestion through the reduction of private vehicle ownership and travel demand in cities. Different sustainable mobility frameworks have been analysed, including the promotion of public transport infrastructure and soft-mode programs. Through this analysis, this paper seeks to contribute to sustainable development at the city level.

Two contrasting examples of transport projects from cities at opposite ends of the spectrum were assessed: New Delhi, India, and Toyama City, Japan. While New Delhi is a rapidly growing mega-city, with a rising car ridership, Toyama City is struggling with rapid depopulation and declining use of public transportation. To reduce transport-related emissions, both cities have implemented innovative sustainable mobility packages. By comparing the different strategies, the analysis suggests that taking a co-benefit approach to simultaneously reduce greenhouse gas and local air pollutant emissions can help rationalize policy options to solve urban congestion. Furthermore, by taking environmental considerations as central criteria, multiple benefits pertaining to sustainable mobility may be achieved.

I. ANALYTICAL FRAMEWORK

In order to evaluate the potential local and global environmental co-benefits of sustainable mobility paradigms in urban areas, the present study relies on a qualitative analysis, which includes three stages: (i) literature review, (ii) case study analysis, and (iii) qualitative assessment of co-benefits.

At first, a review of previous studies available in literature is presented. This includes selected journal papers and relevant reports in order to examine key backbones related to urban mobility in cities and potential mitigation strategies to tackle the current unsustainable paradigm of mobility. Selected factors driving congestion and rising motorisation, including increasing urban population, rising private vehicle ownership, and insufficient ineffective public transportation infrastructure, are assessed. A comparative analysis between cities in emerging and developed economies was conducted, highlighting their common bottlenecks regarding urban mobility. Further, mitigation strategies to tackle congestion and travel demand, as well as foster low-carbon energy and technological shifts, were analysed.

At a second stage, best practice strategy packages were selected and are presented in the form of case studies, which looked at two contrasting sustainable mobility frameworks from New Delhi, India and Toyama City, Japan. Through a comparative assessment, the analysis highlights key strategies implemented as part of their innovative sustainable mobility packages, as well as their goals and outcomes. Finally, using the case studies as a starting point, a co-benefit assessment is described which considers both global and local environmental impacts.

II. THE VICIOUS CIRCLE OF TRANSPORTATION

Transportation is an inherent prerequisite for a sustainable high quality of life in urban areas. People require fast, affordable, comfortable and safe accessibility to bridge the gap between different functional layers within the cities. Rising income results in higher motorisation rates and travel demand both in developed and developing countries. High income citizens tend to drive longer distances and shift to private motorised modes of transport. Given the limited capacity of physical infrastructure of cities to accommodate the increased demand, this had led to traffic congestion in cities and increasing demand for fossil fuels. Consequently, levels of exhaust air pollutants and carbon dioxide emissions intensify. Further, commuting times increase, as passenger trip lengths increase. Over time, quality of life declines and the majority of people are worse off than originally.
Figure 1 describes this development trap, commonly referred to as the vicious cycle of mobility (Ortúzar and Willumsen, 2011).

Figure 1. The vicious circle of public and private transportation modes.

The following paragraphs briefly detail each of the components that contribute to an unsustainable vicious circle of mobility.

2.1. Rising travel demand

The world’s passenger travel demand is projected to dramatically increase over the coming decades, particularly in rapidly expanding cities. As shown in Figure 2, projections of travel demand in 2050 assume that demand in non-OECD countries will double, reaching 67,000 billion passenger kilometres (p.km). In OECD countries, on the other hand, travel demand growth is expected to be more moderate, as developed countries have reached a mature level of economic development. By 2050, the total demand in OECD nations is projected to be 24,200 billion p.km, a 30% increase compared to 2005 levels (IEA, 2009). This expansion is primarily due to increasing mileage of road vehicle modes. For instance, in North America, the average daily travel distance is expected to rise from 55 km (in 1990) to 130 km (in 2050) (ESRI, 2004).

Figure 2. Projection of passenger travel demand by mode in OECD and non-OECD countries.
2.2. Increasing private vehicle ownership

Together with rising travel demand, world vehicle ownership is foreseen to expand steadily.

Table 1 lays out the projected vehicle ownership and private vehicle fleets in developed and emerging economies. While in mature economies, the level of saturation is being reached, in most fast-growing economies, ownership of motorised private vehicles is expected to boom. According to Dargay (2007), private vehicle ownership increases sharply when countries reach an average income of $5,000-20,000. Therefore, in cities in emerging economies such as China, India, Indonesia, and Brazil, motorisation is expected to shoot up as the middle class expands. In India, for example, the stock of private vehicles is expected to rise from 17.4 to 156 million by 2030, which equates to a yearly increase of 7%.

Table 1. Projection of private motorised vehicles in selected developed and emerging economies in 2002 and 2050.

<table>
<thead>
<tr>
<th>Country</th>
<th>Vehicles per 1000 Population</th>
<th>Total vehicle fleet (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2030</td>
</tr>
<tr>
<td>Canada</td>
<td>581</td>
<td>812</td>
</tr>
<tr>
<td>USA</td>
<td>812</td>
<td>849</td>
</tr>
<tr>
<td>France</td>
<td>576</td>
<td>779</td>
</tr>
<tr>
<td>Germany</td>
<td>586</td>
<td>705</td>
</tr>
<tr>
<td>Japan</td>
<td>599</td>
<td>716</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>293</td>
<td>609</td>
</tr>
<tr>
<td>Australia</td>
<td>632</td>
<td>772</td>
</tr>
<tr>
<td>Brazil</td>
<td>144</td>
<td>574</td>
</tr>
<tr>
<td>China</td>
<td>16</td>
<td>269</td>
</tr>
<tr>
<td>Indonesia</td>
<td>29</td>
<td>166</td>
</tr>
<tr>
<td>India</td>
<td>17</td>
<td>110</td>
</tr>
<tr>
<td>Malaysia</td>
<td>240</td>
<td>677</td>
</tr>
<tr>
<td>Thailand</td>
<td>127</td>
<td>592</td>
</tr>
</tbody>
</table>

Source: Dargay et al. (2007).

2.3. Congestion

Congestion occurs when the volume of traffic reaches maximum infrastructure capacity. This happens when the number of vehicles and passengers go beyond the capacity of roads and cities spaces. The space needed to carry the same amount of passengers by private cars is much higher than moving by public modes. Low and Gleeson (2003) claim the relative capacities for a bus line and a train are 7,000 and 50,000 people per hour respectively, whereas only 2,500 passengers per hour move as one lane traffic in the same space.

When cars are clogged in the traffic and under stop-and-go conditions, fuel consumption steadily increases (Black, 2000). For example, in the U.S., wasted fuel spent during congestion is about 14.8 billion of litres (UNEP, 2011). A sensitivity analysis conducted under traffic activity indicates that congestion is the most important contributor to carbon monoxide and total hydrocarbon emissions (DoTRS, 2001; Zhang et al., 2011). This leads to thousands of premature deaths, especially in cities in developing countries. Time wasted in traffic is also a key backbone of citizens’ quality of life. In cities in South America, such as Lima and São Paulo, commuters lose an average of four hours a day commuting from home to work.

2.4. Increasing dependence on fossil fuels

At a global level, following a business as usual trend, transport energy consumption is expected to increase by 80% between 2005 and 2050 (IEA, 2009). This rise will be particularly sharp in the fast-growing economies across Asia such as India and Indonesia as well as China. In developing nations, the road sector is growing at 3.3% annually, which will lead to a two-fold hike of
fossil fuel consumption with the next 20 years. As shown in Error! Reference source not found., North America will be responsible for the consumption of 800 Mtoe transport-related fuels, followed by China (700 Mtoe) and other Asian nations (600 Mtoe). Although the diffusion of alternative fuels is expected to grow by 2050, the transport sector will continue to be dependent on conventional oil and natural gas based fuels.

**Figure 3. Projection of road transport fuel share by 2050 (Note CTL: Coal to Liquids; GTL: Gas to Liquids; CNG/LPG: Compressed Natural Gas/Liquefied Petroleum Gas).**


2.5. Climate change

Combustion of fossil fuels results in the emission of carbon dioxide – the largest anthropogenic greenhouse gas. Carbon dioxide is released when hydrocarbons react in the internal combustion engines with oxygen†. Fuels with higher carbon content are therefore more prone to emit higher levels of carbon dioxide (Portugal-Pereira, 2011)‡. As shown in Error! Reference source not found., 82% of total CO₂-related emissions from road transport come from diesel and gasoline fuels (IEA, 2012).

---

† Assuming completed combustion:

\[
C_xH_y + \left( x + \frac{y}{4} \right) O_2 \rightarrow xCO_2 + \left( \frac{y}{2} \right) H_2O
\]

‡ According to IPCC methodological guideline, carbon dioxide emissions is given as follows:

\[
[CO_2] \text{[g/kgfuel]} = C \text{ content } [\%w/w] \cdot 44/12\cdot1000.
\]
2.6. Local air pollution

As stated above, congestion decreases the average speed of traffic flow that affects optimal combustion conditions. Incomplete combustion of fuels in vehicular engines results in harmful tailpipe emissions. Major emissions are carbon monoxide (CO), hydrocarbons (HC), nitric oxide (NO), nitrogen dioxide (NO₂), nitrous oxide (N₂O), Volatile Organic Compounds (VOC), Particulate Matter (PM), and sulphur oxides (SOₓ). Air pollutants are associated with human disorders, including cancer, cardiovascular, respiratory and neurological diseases, skin allergies and eye inflammation (WHO, 2013). Unlike other emitters, road vehicles are diffuse sources of pollutants close to people’s breathing zone (Takeshita, 2012), which is particularly risky to human health. This is especially true in developing countries, where emission standards and mitigation strategies lag behind Western countries. Every year urban outdoor air pollution is estimated to cause 1.3 million premature deaths worldwide (WHO, 2011).

III. SUSTAINABLE SOLUTIONS TOWARDS A MOBILITY PARADIGM SHIFT

Cities need to move towards new patterns of transportation based on sustainable principles. Sustainable mobility supports the environment through the protection of the global climate, ecosystems, public health and natural resources. It also supports other pillars of sustainable development, namely economic (job creation, balanced regional development, trade activities) and social dimensions (inclusive development, poverty reduction, equity). This leads towards a virtuous cycle of mobility rather than the vicious tendency described in the earlier sections.

“Compacting” and overlapping multifunctional layers within cities reduces travel demand, decreasing the number of trips and their duration. This fosters walking and cycling trips, while reduce the trips of private vehicles. At the same time, cities should improve mass transit services, increasing the number of users and quality of services. Thus, the number of private vehicles decreases, circulation flux improves and fossil fuel consumption goes down, which leads to lower emission of GHG and improved air quality. Overall, citizens enjoy better wellbeing and quality of life, as portrayed in Figure 5.
A vision for sustainable mobility underlines radical shift from the status quo to an alternative low-carbon and innovative path. Reducing travel demand and share of private motorised trips, energy shift and technological changes will undoubtedly be part of the strategy. Figure 6 presents the current unsustainable tendencies and possible paths towards sustainability. The following discussion briefly discusses three proposed strategies to move towards a sustainable mobility paradigm: (i) reduce the share of private motorised trips (ii), energy shift, and (iii) diffusion of low-carbon vehicular technologies.

3.1 Reduce private motorised share mode trips

Reversing the rising tendency of vehicle ownership underlines a modal shift by improving public transportation and facilitating conditions to boost soft-modes. In the literature (Santos et al., 2010b), a wide number of integrated physical and soft policies are suggested as potential instruments to manage this modal shift. An increasing investment in public transport infrastructure, combined with restrictions on the use of private vehicles, can reduce traffic congestion and inherent externalities. Cities such as Curitiba, Brazil, London and Singapore have implemented measures to integrate public transport policies at a city level. Integration of land-use policies aiming at compaction and overlapping of functional layers within the cities is also essential towards modal shift. Reducing the number and length of daily trips indirectly promotes walking and cycling as a core urban mobility mode. Actions to make streets more soft-mode friendly include lower the traffic speed limits, construction of wide side-
walks and dedicated cycle paths, among others. For instance, in Copenhagen more than one third of commuters use the bicycle in their daily activities, which brings several positive externalities to the city. The promotion of car-sharing and car-polling programs, eco-driving and educational campaigns, are also triggers for behavioural change towards less impactful transport modes.

3.2 Fuel shift

Shifting from fossil carbon fuels toward low carbon energy carriers would decrease drastically CO₂ emissions from the transport sector. Alternative fuels, such as ethanol and biodiesel, are produced from biomass feedstock and described as carbon neutral. This is because the carbon released during vehicle utilisation is assumed to be absorbed by biomass growth through photosynthesis biological processes (Tilman et al., 2006). Although some critical voices advocate that large-scale conventional biofuels are highly dependent on fossil fuels and might raise land-use and food security issues, it has been argued that sustainable biofuel production can effectively mitigate climate change (Portugal-Pereira, 2011). Recently, attention has been focussed on advanced alternative fuels, produced from cellullosic and other non-edible feedstock. These fuels present greater potential to tackle GHG and do not directly interfere with food production chains (Portugal-Pereira, 2011), although expansion of this crop would result in land conversion, which could negatively affect biodiversity and ecosystem services.

Another attractive energy carrier is hydrogen. Produced from both biomass feedstock and conventional fuels (coal or natural gas), during its combustion nothing more than vapour is released, minimising tailpipe emission in urban areas.

**Error! Reference source not found.** presents the full life cycle (from well-to-wheel, WTW) GHG emissions of selected conventional and alternative fuels. Alternative fuels present a potential of reducing up to 83% GHG emissions per driven km.

![Figure 7. WTW-GHG emissions from selected conventional and alternative fuels.](image)

**Note:** EtOH – Ethanol; FT – Fischer-Tropsch; CNG – Compressed Natural Gas; LPG – Liquid Petroleum Gas; SR-H2-FC – Steam-Reformer Hydrogen Fuel Cell.

Source: prepared by authors based on JRC (2011).

3.3 Diffusion of low-carbon vehicular technologies

Advanced engine technologies show effective potential to increase vehicular fuel efficiency, and therefore to reduce the fuel input per vehicle kilometre. At the forefront of low-carbon technologies are the Hybrid Electric Vehicles (HEV). HEV use two different propulsion systems, as they combine a conventional internal combustion and an electric engine. This allows a higher efficiency of propulsion and lower tailpipe emissions than conventional engines. HEV reveal a potential to reduce up to 60% fuel consumption in vehicles. For instance, the Toyota Prius, the best-selling of all hybrid car models, uses 4.7 litres of fuel/100 km.
Major automotive manufactures have also started commercialising electric and plug-in vehicles. These technologies are free of tailpipe emissions, as batteries power the engine rather than an internal combustion engine. Therefore, these propulsion systems ought to efficiently reduce air pollution in cities. Regarding climate change mitigation potential, there are still controversial viewpoints regarding life-cycle emissions of such vehicles. In cities such as New Delhi or Beijing, where electricity generation mix is heavily dependent on coal, the power generated is carbon intensive and gains in GHG are diminished. However, in countries where renewables are part of the energy generation matrix, such as Brazil, electric propulsion vehicles would bring several local and global environmental co-benefits. Flexible Fuel Vehicles (FFV) are also an effective strategy to reduce fossil fuel dependence and air pollution in cities. FFV are capable of running on any proportion of blended ethanol fuels. Their propulsion system can burn any ethanol/gasoline mix, as a fuel composition sensor adjusts fuel injection and spark timing according to the oxygen content of the fuel. FFV are believed to curb impacts of the transport sector on urban air pollution. In Brazil, engines are designed to have a high compression ratio, which maximises the benefits of high oxygen content of ethanol and reduces fuel consumption. As a result, according to Rovere (2002), exhaust emissions in urban areas in Brazil have lessened significantly since 1999, including carbon monoxide (15%), hydrocarbons (15.2%), and nitrogen oxides (21.4%).

IV. CASE STUDY ANALYSIS

4.1 New Delhi

i. Overview

With a total population of 16.7\textsuperscript{8} million (Census of India, 2011) for the broader National Capital Territory, Delhi is now the second largest city in India (after Mumbai). Formal planning was begun in 1957 with the establishment of the Delhi Development Authority mandated to produce a master plan for the city (Ahmad et al, 2013). In an attempt to accommodate a growing population, zones were designated for growth around the city. Consequently it has a polycentric structure with large urban sub-centres quite far apart and with sprawling mixed land use in between. Although a state in its own right, the pull of Delhi has spurred the growth of cities at its borders (e.g.: Gurgaon in Haryana; Noida and Ghaziabad in Uttar Pradesh), so at its largest extent, the wider National Capital Region incorporates many towns in neighbouring states within its sphere of influence.

ii. Challenges

Road length in Delhi expanded by more than a factor of three (8,380-30,985km) between 1971 and 2008. However, the growth in vehicles was around 10 times that (a 31-fold increase from 0.18 - 5.62 million) which lead not only to massive congestion but also to increased air pollution (Gurjar and Lelieveld, 2005). As a result, Delhi is the most motorised city in India with 1.9 million cars in 2009 (171 veh./1000 habitants), which exceeds the combined vehicle populations of Chennai, Kolkata, Lucknow and Mumbai (Gol, 2012). Although urban areas in India have motorisation rates which are higher than the national average, Delhi’s is already far past the projected level for the country as a whole in 2030. It is therefore unsurprising that pollution from vehicles is cited as the main contributor to poor air quality in the city, accounting for two-thirds of total air pollution (MOEF, 1997). The casualties due to accidents on Delhi roads quadrupled between the 1970s and 1990s (Sen et al., 2010), most of them being pedestrians and cyclists (Pucher et al., 2005). Furthermore data presented by Tiwari (2003) showed that a drop in the proportion of traffic fatalities from car users appeared to come directly at the expense of pedestrians towards the end of the period 1990-1999. At the global level, carbon emissions from diesel consumption alone in Delhi increased by a factor of four between 1980 and 2000. In such a city, sustainable mobility has clear health components and many actions taken by the city are aimed as much at improving air quality as easing congestion.

iii. Sustainable mobility solutions

Since the late 1990s, government at both the national and local level has taken action to address transport problems in Delhi. Initially command and control measures were used to reduce

\textsuperscript{8} Provisional Figure for 2011.
pollution. The phase out of commercial vehicles over 15 years old and banning the use of leaded petrol are two notable examples (Kathuria, 2002). Similarly, in response to public pressure, the Supreme Court of India mandated the compulsory use of Compressed Natural Gas (CNG) in all public transport vehicles. The Delhi government was ordered to complete the necessary changes to the entire fleet by March 2001 (Goyal & Sidhartha, 2003). Consequently, Delhi runs the largest fleet of CNG vehicles in the world (Guttikunda, 2008).

Against this backdrop, Delhi had long held ambitions to develop a metro system in the city. The opportunity to finally push through with the project was seized in the run up the 2010 Commonwealth Games, when the Governments of India and Japan agreed to cooperate on the project. A key factor in this was the establishment of the Delhi Metro Railway Corporation, which could circumvent much of the bureaucracy which had hampered previous attempts (Siemiatycki, 2006). The Delhi metro is an ambitious project set out in four phases to connect all parts of the city. The first two phases consisting of 190km over 6 lines were completed by 2010 (Sahai and Bishop, 2010). This constitutes just under half of the total projected coverage, which by 2021 will be over 400 km in length (Sreedharan, 2008) and connect the city not just radially but concentrically.

Beyond improving the public transport of Delhi, the metro incorporated a number of innovative features into its design, the most notable of which is the use of a regenerative braking system, which generates energy from the braking phase of the trains’ operation and feeds it back to the system. Around a third of the electricity consumed in the metro is generated in this manner (Sreedharan, 2008) and has been instrumental in making the Delhi metro the world’s first railway project registered under the Clean Development Mechanism (CDM). Some 41,160 tons of CO₂ are calculated to be saved annually from this system (UNFCCC, 2007).

Doll & Balaban (2013) assess that co-benefits from the Delhi metro could accrue from three sources: (i) the increasing ridership, (ii) increasing the contribution of car users who switch to the metro, and (iii) the cleanliness of electricity generation used for the metro. However, the authors note that in case of the last two factors, achieving such measures require coordination that extends beyond the remit of metro operation itself, into wider transport policy and into the realms of town planning. A suite of carrot and stick measures is needed which actively promotes use of one mode over another (i.e. away from private car use). Otherwise an ‘all of the above’ policy can simply lead to gridlock as competing entities vie for resources and revenue, which only serves to frustrate the delivery of an efficient transport system.

Whilst construction of a metro eases congestion, it arguably promotes further development along its corridor, prompting further growth of the city. It remains an open question whether alternative solutions could be deployed which deliver mobility to the masses while also constraining urban growth. However, such concerns in the capital city of one of the world’s major emerging economies are likely to take a back seat. It is somewhat ironic that the active participation of (middle class) civil society in bringing the case to the Supreme Court to mandate cleaner fuels are also active in blocking a bus rapid transit (BRT) scheme, claiming it hinders the mobility of motorists.

4.2 Toyama City

i. Overview

Toyama prefecture is located in Central-West Japan on the northern coast of the Sea of Japan in the Hokuriku Region. The capital city of the prefecture is Toyama city, the second largest city in Hokuriku after Kanazawa. The city’s population is approximately 420,000 people including seven municipalities that merged into the city in 2005. The population of its metropolitan area is estimated to be 540,000, spread over an area of about 1,240 square kilometres. As is the case with other Japanese local cities, Toyama city has been experiencing suburbanisation and loss of population from the city centre. The city faces an increasingly disproportionate age distribution within its population as the number of older citizens grows and the city must deal with problems associated with aging. Against this background, the city has taken up a series of policies to revitalise the city centre through implementing the concept of the compact city and ensuring provision of affordable and convenient public transport (Takami & Hatoyama, 2008).
ii. Challenges

The development of Toyama’s urban area over the past 40 years has been unusually sprawling compared to most Japanese cities. Consequently, the city has the second largest proportion of car owners per capita in Japan. As a result of car-dependent urban sprawl, public transport in the city has experienced a drastic decline. In particular, shuttle bus users decreased nearly 70% from 1990 to 2006, which further resulted in cutbacks in bus routes and frequency of service. At the same time, ownership of ordinary passenger cars grew 1.4 times and of compact cars 6.5 times compared to the 1990 level. According to an analysis of transportation use in the city, 72.2% of the city’s population use cars for general purposes and about 84% to commute (City of Toyama, 2009). In addition to the issue of urban sprawl, Takami and Hatoyama (2008) identify other social and demographic challenges in Toyama, namely, an aging population, a decreasing population density, and deterioration of the city centre.

iii. Sustainable Mobility Solutions

In order to respond to these challenges, Toyama city decided to formulate proactive policies to mitigate the problems in the early 2000s (City of Toyama, 2013). The plan aims at renovating public transport and gradually inducing people to live closer to areas concentrated around convenient public transportation access points. As public transportation routes radiate outward from Toyama Station, the city’s initial investments seek to strengthen these transportation systems.

The city further developed its transport plan into an Eco-Model City Action Plan as part of the national government Eco-Model City initiative, which recognises cities with proactive sustainable plans and policies. Currently 200 cities have been recognised as Eco-Model cities. Eco-Model cities are required to formulate very detailed action plans with specific quantitative GHG reduction targets, for which the city must report progress on implementation.

The Toyama Eco-Model Action Plan integrates demographic planning actions with transport-related options. It is based on three main sections: (i) a public transport policy package, (ii) a planning and demographic policy package, and (iii) a supplemental private transport policy package. Each policy option has detailed numerical targets, as seen in Appendix A. The policy options are an interesting combination of transport and development-planning provisions. Toyama city first looked at what transport infrastructure they had, then tried to improve it. The city uses a combination of financial and planning policies to increase local resident accessibility to public transport, centred around three policy packages:

As a first step, Toyama identified public transportation routes that radiate outward from Toyama Station, with the city’s initial investments seeking to strengthen these transportation systems. The city has also introduced a light rail transit (LRT) system by taking over an unprofitable railway line being operated by West Japan Railway Co. (JR-West), and laying some light rail lines in existing road lanes. In a further step, the LRT project extended to another tram line, operated by Toyama Chihou Tetsudou Inc. and completed in December 2009. Under the Eco-model city action plan, Toyama is also planning to provide more LRT in areas where LRT has not been provided. Also, the City is to increase convenience of public transport by enhancing the inter-connectivity of different public transport routes. Apart from the railways and LRTs, the City also promotes bus services. Within the city, a private company (Toyama Chihou Tetsudou) operates conventional bus services, but the city itself also operates some traditionally unprofitable bus routes.

Simultaneously, the city is trying to increase population density in the Toyama city centre. In order to do so, it provides subsidies for moving into the city centre, as well as for building new houses in the area. The demographic incentives are reinforced by other policies that enhance the attractiveness of the city centre. The city, for example, is trying to regenerate the economically stagnant areas within the central business district (CBD). The city also has a series of policy options for curbing private transport, including encouraging behaviour change (e.g. through car-free days) to promotion of walking and bicycle use. The city also sponsors group competitions to demonstrate low-carbon activities in the transport sector. The City of Toyama estimates that a reduction of approximately 570,000 t-CO₂ will be achieved through the new public transport schemes by 2013, and about 1 million t-CO₂ by 2030 (Table 2).
Table 2. Estimation of GHG reduction of Toyama city.

<table>
<thead>
<tr>
<th></th>
<th>Reduction by 2013</th>
<th>Reduction by 2030</th>
<th>Reduction by 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion of public transport</td>
<td>17,715</td>
<td>195,359</td>
<td>266,039</td>
</tr>
<tr>
<td>Development in CBD and stations</td>
<td>105,260</td>
<td>153,466</td>
<td>166,983</td>
</tr>
<tr>
<td>Compact city policies</td>
<td>1,119</td>
<td>91,673</td>
<td>182,411</td>
</tr>
<tr>
<td>Compact cities and environmental</td>
<td>422,777</td>
<td>655,676</td>
<td>945,520</td>
</tr>
<tr>
<td>enterprises</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: City of Toyama, 2009.*

The policy groups and options have specific quantitative targets, as shown in Appendix A, and progress on each option have been monitored. There is, however, a serious implementation problem: although there are detailed quantifiable targets for each option, the total of the monitored GHG reduction has only made modest progress to their own expectations. Also, some of the options have only an indirect association with the GHG reductions, e.g. giving subsidy to incentivise people to live in the CBD, which are notoriously difficult to accurately quantify. Fundamentally, quantification of all the options may not be realistic. Toyama city is planning to revise the current Eco-model action plan by 2014. It is expected that the new plan will respond to these issues.

V. DISCUSSION

5.1 Co-benefits of sustainable mobility strategies

A co-benefits approach implies the integration of global climate considerations into local level policy packages. Within the sustainable mobility context, it refers to strategies and programs to simultaneously address environmental and socio-economic goals (air pollution, noise, and road traffic accidents), whilst promoting climate change mitigation targets and reduction of fossil fuel dependence of road vehicle fleets. Therefore co-benefit policies result in multiple outputs both at local and global levels. This is seen as being particularly relevant when local governments have limited financial resources and social priorities dictate the political agenda. Thus, a co-benefit policy strategy attempts to address local needs, while mainstreaming climate change mitigation plans. As shown in Table 3, this approach takes two dimensions, one of scale (global and local) and one of impacts (environmental and socio-economic). Taken together they fill a quadrant which addresses economic prosperity, social equity and local environmental regeneration, while tackling GHG emissions and reducing fossil fuel dependence.

Table 3. Co-benefits of sustainable mobility policies.

<table>
<thead>
<tr>
<th>Environment Dimension</th>
<th>Socio-economic Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global Level</strong></td>
<td></td>
</tr>
<tr>
<td>- GHG mitigation</td>
<td>- Increasing resilience towards natural disasters</td>
</tr>
<tr>
<td>- Fossil fuel</td>
<td>- Less economic losses due to extreme climate events</td>
</tr>
<tr>
<td>reduction</td>
<td></td>
</tr>
<tr>
<td><strong>Local Level</strong></td>
<td></td>
</tr>
<tr>
<td>- Improvement of air</td>
<td>- Reduced risks to public health</td>
</tr>
<tr>
<td>quality</td>
<td>- Time saving in traffic</td>
</tr>
<tr>
<td>- Noise reduction</td>
<td>- Lower levels of stress during congestion</td>
</tr>
<tr>
<td></td>
<td>- Promotion of social equity and liveability</td>
</tr>
<tr>
<td></td>
<td>- Reduction of road accident risk</td>
</tr>
<tr>
<td></td>
<td>- Lower costs of road infrastructure maintenance</td>
</tr>
<tr>
<td></td>
<td>- Higher city attractiveness (business/tourism)</td>
</tr>
</tbody>
</table>

*Source: Prepared by the authors.*
5.2 Qualitative assessment of environmental and socio-economic win-win solutions

The case studies presented in this paper reveal a complementary assessment of co-benefits in two very different contexts: one a megacity and capital of the second most populous country in the world, the other a small city with high vehicle ownership and facing the looming effects of ageing and depopulation in a highly developed country.

In the case of Delhi, the city is struggling to accommodate an increasingly affluent population’s demand for motor vehicles and to cope with its inherent environmental impacts. The metro system plan anticipated a wide potential to environmental co-benefits through a reduction of vehicle ridership. However, in practical terms, the metro itself does not necessarily lead to a decrease in motorisation.

As highlighted by Doll and Balaban (2013), there is the need for wider and more integrated planning if co-benefits are to be maximised. It is not good enough to simply construct a metro if little or no thought is given to its use or users. Metros are a means not an end in itself. Integrated environmental planning would go beyond individual projects to consider how to restrict car use, through both incentives and disincentives (carrots and sticks) such as restricting parking (or increasing its cost) and promoting public transport. The risk with fragmented policies is that they may end up working against each other at the city scale and lead to further paralysis. A degree of realism is required in appreciating that global environmental concerns are rarely, if ever the main or sole driver to transport initiatives and similarly, the same can be said for local environmental concerns (although this may change as the environmental situation deteriorates). The co-benefits approach aims to bring in such considerations with the developmental aspects.

Similarly, in developed countries, local governments also prioritise policies that address local community’s needs. The needs and concerns of Toyama are almost completely opposite to those of Delhi. Nevertheless, it has managed to devise policies which promote public transport in combination with urban planning initiatives, aiming simultaneously to reduce private vehicle ownership. In this case, Toyama needs to maintain its attractiveness to new residents and sees its position as one of the 13 Japanese ‘eco-cities’ with the potential to attract residents who value quality of life and ‘liveability’. In this sense, there is an indirect driver to tackle environmental issues. This may become more pressing in the developed world as changing demographic structures and level of economic development encourage cities to look beyond traditional economic indicators. Here, access to public transport and relocating elderly residents in the city results in reduction of air pollution, mitigation of GHG emissions and better quality of life.

VI. FINAL REMARKS

In this paper, the authors present the vicious cycle of transport, which explains why increasing motorisation leads to poorer quality of life. Both cities in emerging and developed economies suffer from a vicious cycle, as higher incomes commonly results in high private ownership and ridership, and reduced public transportation infrastructure. This leads to urban congestion and inherent environmental externalities, resulting in decreasing liveability of cities. This study presents a qualitative assessment of global and local environmental co-benefits from sustainable mobility policy strategies to tackle the environmental externalities of the road transport sector. To this end, policy packages to pursue congestion reduction have been evaluated, including promotion of public transport infrastructure and soft-mode programs.

The analysis suggests that implementing a co-benefit approach to simultaneously reduce global (GHG) and local air pollutant emissions can tackle urban congestion and promote social equity and economic prosperity. The co-benefits approach can be applied flexibly to many different contexts as its nature varies according to local priorities. The implication of this is that the integration of climate concerns can be mainstreamed into transport policy across many levels of development.
REFERENCES

City of Toyama, (2013), Personal communication. February 2013.


### APPENDIX A. Policy package of climate change mitigation strategies and carbon dioxide reduction goals for Toyama City

<table>
<thead>
<tr>
<th>Policy Package</th>
<th>Measures (number and description)</th>
<th>Timescale t-CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-a</td>
<td>LRT networking development</td>
<td></td>
</tr>
<tr>
<td>1-a-1:</td>
<td>Shift to LRT of the Toyama port line&lt;br&gt;-Continue safe operation of loop line&lt;br&gt;-Conducted maintenance of facility by the City for secure and safe operation</td>
<td></td>
</tr>
<tr>
<td>1-a-2:</td>
<td>Shift to loop line from the city train&lt;br&gt;-Kept the current facility, conducted maintenance and made plan for constructing new station at Nishi-machi, the center of the city.</td>
<td></td>
</tr>
<tr>
<td>1-a-3:</td>
<td>Combine South and North tram lines (plan)&lt;br&gt;-Formulated the basic plan for combination of South and North tram lines&lt;br&gt;-Had consultation with operators</td>
<td></td>
</tr>
<tr>
<td>1-a-4:</td>
<td>Shift to LRT from Kamidaki line of Toyama Chiho Train (Plan)&lt;br&gt;-Survey for shift to LRT was initially planned, city consulted with Toyama Chiho Train for entering city (LRT) trains into Kamidaki line&lt;br&gt;-Conducted a pilot program of increased frequency to promotion ridership and revenue</td>
<td></td>
</tr>
<tr>
<td>1-b</td>
<td>JR related development</td>
<td>Target same with 1-a</td>
</tr>
<tr>
<td>1-b-1:</td>
<td>Land reallocation (station zoning plan) in Toyama station area&lt;br&gt;-Compensation to owners for removal of buildings in order to construct open space at the front of south exit of Toyama station (project progress rate is 43.9%)</td>
<td></td>
</tr>
<tr>
<td>1-b-2:</td>
<td>Interchange in Toyama station area&lt;br&gt;-Started constructing viaduct (elevated station)</td>
<td></td>
</tr>
<tr>
<td>1-b-3:</td>
<td>Shift to regular trains of JR Hokuriku line&lt;br&gt;-Developed the first management plan and determined investment ratio and stake to a preparatory company</td>
<td></td>
</tr>
<tr>
<td>1-b-4:</td>
<td>Improvement of main train stations area&lt;br&gt;-Improvement of open space, bicycle pool, toilet and sign in main stations&lt;br&gt;-Established a town promotion committee by local citizens</td>
<td></td>
</tr>
<tr>
<td>1-b-5:</td>
<td>Upgrading of transportation of city trains&lt;br&gt;-Operated stably systems of guide display and announcement</td>
<td></td>
</tr>
<tr>
<td>1-b-6:</td>
<td>Image enhancement&lt;br&gt;-Introduced a large non-step bus with excellent design to a main bus line</td>
<td></td>
</tr>
<tr>
<td>1-c</td>
<td>Promotion of general public transport and modal shift</td>
<td>Target same with 1-a</td>
</tr>
<tr>
<td>1-c-1:</td>
<td>Pilot program for activation of JR Takayama main line&lt;br&gt;-Keep increased operation schedule, a few temporally stations, and P &amp; R parking lot</td>
<td></td>
</tr>
<tr>
<td>1-c-2:</td>
<td>Pilot program for P&amp;R at Toyama port line&lt;br&gt;-Keep P&amp;R parking lot at not only Toyama port line but also another line</td>
<td></td>
</tr>
<tr>
<td>1-c-3:</td>
<td>Testing operation of a electric bus&lt;br&gt;-Tested actual operation of electric bus at a bus route</td>
<td></td>
</tr>
<tr>
<td>1-c-4:</td>
<td>Community bus&lt;br&gt;-Introduced community bus into no-public transportation area, supported money-losing routes operated by private sectors and locally operated bus</td>
<td></td>
</tr>
<tr>
<td>Policy Package</td>
<td>Measures (number and description)</td>
<td>Timescale t-CO2</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
</tbody>
</table>
| #1-c-5:        | IC card  
- Introduced IC card system to local train lines and ID card of city officials                                                                                                                                                                                                                                                                                                           |                |
| #1-c-6:        | Promotion of public transportation use for elderly people  
- Introduced IC card for pass                                                                                                                                                                                                                                                                                                    |                |
| #1-c-7:        | Pilot program for operation of environmentally friendly boats for students’ learning  
- Continued the pilot program                                                                                                                                                                                                                                                                                                 |                |
| 1-d            | modal shift                                                                                                                                                                                                                                                                                                                                                                         |                |
| #1-d-1:        | Voluntary return of drivers licenses of elderly people  
- Provided public transportation pass to people 65 years old who voluntarily returned drivers licenses                                                                                                                                                                                                     |                |
| 2-a            | Increase population in city centre                                                                                                                                                                                                                                                                                     | 2013 8,641 2030 58,665 |
| #2-a-1:        | Promotion of suitable housing in the town  
- Subsidy for city housing                                                                                                                                                                                                                                                                                                         |                |
| #2-a-2:        | Promotion of constructing houses near public transportation  
- Subsidy for housing                                                                                                                                                                                                                                                                                                          |                |
| #2-a-3:        | Public renting service (private apartment)  
- Implementation of the service                                                                                                                                                                                                                                                                                                 |                |
| #2-a-4:        | Promotion of elderly people to relocate from their own houses to those in town near public transportation for elderly people  
- PR on the system                                                                                                                                                                                                                                                                                                            |                |
| 2-b            | Increase viability in city centre                                                                                                                                                                                                                                                                                      | Target same with 2-a  |
| #2-b-1:        | Community bus in downtown area  
- Introduced community bus in the several routes                                                                                                                                                                                                                                                                     |                |
| #2-b-3:        | Regeneration of Nishi-machi South area  
- Established and subsidy to a preparation office                                                                                                                                                                                                               |                |
| #2-b-4:        | Regeneration of Nishi-machi East-south area  
- Constructed buildings  
- Subsidy to establish a management office                                                                                                                                                                                                             |                |
| #2-b-5:        | Regeneration of Chuo street  
- Constructed buildings  
- Subsidy to establish a management office                                                                                                                                                                                                            |                |
| #2-b-6:        | Control of large construction at suburb  
- Implemented regulation                                                                                                                                                                                                                                            |                |
| #2-b-7:        | Introduction of facilities related to local daily lives  
- Opened agricultural food markets in the downtown  
- Established a rehabilitation center for elderly people to a vacant lot  
- Combined public facilities and fish market and relocated to a vacant lot                                                                                                                                                                                  |                |
| #2-b-8:        | Shopping sale to attract costumers  
- Implemented in a local business union and a big shopping mall                                                                                                                                                                                                   |                |
| #2-b-9:        | Introduction new shops  
- Subsidy to renovation and rental                                                                                                                                                                                                                                                                       |                |
| #2-b-10:       | River development project  
- Still under planning basic plan for city center (not yet established)  
- Park golf course and open space in public transportation area                                                                                                                                                                                                                               |                |
| 2-c            | Increase livability in city centre, etc.                                                                                                                                                                                                                     | Target same with 2-a  |
| #2-c-1:        | PR on housing subsidy system  
- Implemented PR on the system                                                                                                                                                                                                                                                                                     |                |
<p>| #2-c-2:        | Collecting information of empty houses                                                                                                                                                                                                                      |                |</p>
<table>
<thead>
<tr>
<th>Policy Package</th>
<th>Measures (number and description)</th>
<th>Timescale t-CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-Collected information of empty houses with cooperation of housing association</td>
<td></td>
</tr>
<tr>
<td>#2-c-3:</td>
<td>Eco-smooth road</td>
<td>2013 20</td>
</tr>
<tr>
<td></td>
<td>-Considered newly implemented location</td>
<td>2030 88</td>
</tr>
<tr>
<td>3-a</td>
<td>Carbon efficiency of housings</td>
<td></td>
</tr>
<tr>
<td>#3-a-2:</td>
<td>Subsidy to housing with eco-system in public transportation area</td>
<td>2013 187</td>
</tr>
<tr>
<td></td>
<td>-Survey and review of incentive scheme</td>
<td>2030 5,548</td>
</tr>
<tr>
<td>#3-a-3:</td>
<td>Subsidy to renovation of detached house in residential and public transportation area</td>
<td>2013 87</td>
</tr>
<tr>
<td></td>
<td>-Implemented the incentive</td>
<td>2030 4,688</td>
</tr>
<tr>
<td>3-c</td>
<td>Residential development alongside with public transportation</td>
<td>2013 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2030 2,774</td>
</tr>
<tr>
<td>#3-c-1:</td>
<td>Subsidy to housing development in public transportation area</td>
<td>2013 0</td>
</tr>
<tr>
<td></td>
<td>-Survey and research about plan and demand in the area</td>
<td>2030 2,774</td>
</tr>
<tr>
<td>4-a</td>
<td>Residential development alongside with public transportation</td>
<td></td>
</tr>
<tr>
<td>#4-a-1:</td>
<td>Car free day and eco-commute</td>
<td>2013 468</td>
</tr>
<tr>
<td></td>
<td>-Implemented car free day around Toyama prefecture</td>
<td>2030 414</td>
</tr>
<tr>
<td>#4-a-2:</td>
<td>Promotion of Bicycle use</td>
<td>2013 146</td>
</tr>
<tr>
<td></td>
<td>-Implemented group registration system and one day pass and increased members</td>
<td>2030 146</td>
</tr>
<tr>
<td>#4-a-3:</td>
<td>Electric Vehicle (EV) City plan</td>
<td>2013 0</td>
</tr>
<tr>
<td></td>
<td>-Facilitated a battery charger (200v) in the city hall</td>
<td>2030 58,365</td>
</tr>
<tr>
<td>4-b</td>
<td>Public awareness</td>
<td></td>
</tr>
<tr>
<td>#4-b-1:</td>
<td>Team Toyama</td>
<td>2013 121</td>
</tr>
<tr>
<td></td>
<td>-Now 345 teams with a total of 20298 participants. 10 teams are in transport sector</td>
<td>2030 1,679</td>
</tr>
<tr>
<td>4-d</td>
<td>City office management</td>
<td></td>
</tr>
<tr>
<td>#4-d-7:</td>
<td>Low pollution car</td>
<td>2013 21</td>
</tr>
<tr>
<td></td>
<td>-Introduced 2 EV car for official use</td>
<td>2030 89</td>
</tr>
</tbody>
</table>
ABSTRACT

Traffic congestion is a public policy issue and solicits a policy response which can strike a balance between urbanization and urban mobility. In the case of India, several policy initiatives have been undertaken but have not yielded desired outcomes. This is primarily because the focus has only been on public transport improvement measures, while traffic demand management measures have largely been neglected. This paper studies the traffic scenario in select Asian cities and the policy measures undertaken by their respective governments. It revisits relevant policies in India and assesses the gaps that deter the desired impact of such policies on reducing traffic congestion. It also suggests policy measures to overcome these gaps and the way ahead.

INTRODUCTION

Most cities in Asian countries are experiencing multi-faceted problems as a result of rapid urbanization. Urban congestion is one such problem afflicting urban agglomerations in Asia and has multiple effects on urban economies. Urban congestion is broadly defined as excess demand for travel over its supply. In fact, the reason why governments are forced to revisit their policies for urban mobility is because of growing demand for travel with limited supply of services. The presence of urban congestion prevents free movement of traffic. For example, according to the International Association of Public Transport (UITP) in 2001, the average speed of vehicles on Bangkok streets was 15 km/h, while that in Manila, Jakarta and Singapore was 18 km/h, 19 km/h and 20 km/h respectively (BOQUET Yves, 2010).

There are various policies and initiatives underway to improve urban mobility in Asian cities, primarily aiming to enhance and strengthen urban infrastructure. In addition, some Asian countries have also adopted congestion pricing and policies to restrict private car ownership. However, some of the conventional causes of congestion are still rooted in growing cities owing to policy overlaps and distorted policy implementation. These include insufficient and inefficient public transportation, mixed use of dedicated roads, low-price parking policies, lack of connectivity between modes, poor driving behaviour, lack of transport planning, and the absence of intelligent transport systems, among others. In addition, the presence of informal operators in public transport system also has a critical impact on congestion. Therefore, it is certain that the creation of new infrastructure alone will not solve the problems, and that other aspects also deserve consideration.

This paper first describes some of the factors contributing to congestion in Asian cities in general. It then discusses the status of congestion in Indian Cities and various measures which the Government of India and municipal authorities have implemented. It finally discusses the policy gaps which hinder the effectiveness of these measures and advocates a strong institutional mechanism for better policy planning to address such critical concerns.

I. CONGESTION IN ASIAN CITIES

In many respects, rapid urbanization is an indicator of economic growth in Asia, and it is expected to continue. As per an estimate by the Asian Development Bank (ADB), about 44 million people are added to Asia’s urban population every year.¹ Asian cities are also characterized by high population density. For instance, Dhaka, Bangladesh, grew rapidly during the last decade and became the most densely populated city in the world, whereas Mumbai stands at number two. Also,

Chinese cities are among the most densely populated cities in the world, with China having the most cities with high density of population.\(^2\)

With such a rapid increase in urban population, there has been an increase in demand for mobility, and with it, an increase in motorised vehicle ownership. As per a report by Wards Auto Research, the overall vehicle population growth in China was 27.5% in 2010 as compared to the preceding year. The estimates show that the total vehicles in operation in China "climbed by more than 16.8 million units, to slightly more than 78 million, accounting for nearly half the year’s global increase" (Sausanis, 2011). Similarly, “India's vehicle population underwent the second-largest growth rate, up by 8.9% to 20.8 million units, compared with 19.1 million in 2009” (Sausanis, 2011). The vehicle population in China has been increasing at more than 30%, and at around 10% in India. However, this has recently dropped to negative growth in the first quarter of 2013.

Similarly there were more than 11.3 million motor vehicles in Jakarta in 2011, while the city population is below the population of motor vehicles i.e. 9.6 million (Arditya, 2011). It is said that 70% of city households own motor vehicles. Moreover, it is expected that the number would increase to 12 million as around 1500 new motorcycles and 500 new motor cars will continue to be injected into the city on a daily basis (Arditya, 2011).

In terms of mobility, there are 21.9 million trips taking place daily in Jakarta, of which motorcycles occupy a major chunk (Slamet, 2012). It is also estimated that only 2% of the trip is covered by public transport in the city. As a result, speed flow decreases to 10-20 km/h (Slamet, 2012). The scenario is not much different in Bangkok, Manila and other cities like New Delhi and Mumbai. During peak hours, the speed flow on roads in Delhi and Mumbai also drops to 10-20 km/h.

The causes of traffic congestion are categorised in terms of micro-level factors and macro-level factors (Rao and Rao, 2012). Asian countries have devised several policies to tackle congestion problems which encompass both level of factors. Many countries define congestion in terms of lower speed of vehicle on a particular stretch and accordingly devised policies. However, the benchmark of low-level speed of vehicle varies from country to country. Even within a country, this benchmark varies significantly. For instance, in California, if the speed falls to the level of 35 km continuously for 15 minutes then it is referred to as congestion; whereas in Minnesota, congestion occurs when the average speed falls from the speed limit is 45 km per hour during 6 a.m. to 9 a.m (Rao and Rao, 2012). In the Republic of Korea, traffic congestion is said to be occurring when traffic flow is below 30 km/h or congestion continues for more than 2 hours a day. This implies that different practices are prevailing to measure congestion across various cities.

Most observers argue that the phenomenal increase in private car ownership and the resulting growth in the number of private vehicles are responsible for the high level of congestion in cities. However, in comparison to developed countries, car ownership remains low in most of the developing economies in Asia. As the number of motor vehicles kept increasing in most Asian cities, policies initially focused on strengthening the relevant infrastructure. Then the policies shifted slightly from building infrastructure to accommodate increasing numbers of motor vehicles towards facilitating alternate infrastructure for urban transport in combination with traditional approaches. For example, Bangkok increased the number of streets to accommodate more vehicles. Similarly, Shanghai reduced urban congestion through a network of elevated freeways. Manila and Jakarta have also undergone such transitions to create more space for urban vehicular movement. Singapore created state-of-the-art urban transport facilities.

These policies were expected to be a way forward to accommodate more vehicles on roads, but led to further congestion in these cities. In order to reduce congestion, policies for managing the demand side were then adopted. Local municipal councils of Asian cities agreed to implement traffic management programmes. Manila, for instance, adopted a Vehicular Volume Reduction Programme, which prevented car mobility on specified days on the streets of Metro Manila. Similarly, through its Green Transportation programme, Beijing adopted a strategy to promote green modes of transport among both residents and visitors and reduce emissions through curtailing travel demand. The municipal government of Beijing has also undertaken decision to reduce number cars in the city by

\(^2\) Demographia World Urban Areas, 2013
adopting rotation of tail number plates of driving vehicles in the regional rush hours on working days (Municipal Government of Beijing, 2013). As part to reduce pollution, the city municipality also plans to reduce number of plates for new cars to be sold in coming years.

Also, Singapore successfully restrained car traffic demand through its Vehicle Quota Management Scheme and congestion pricing within the Central Business District, which consists of the core financial and commercial area in Singapore. Some of these policy measures and their features are presented in table 1.

### Table 1: Congestion Related Demand Side Policies in Asia

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Policy</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>Singapore</td>
<td>Area Licensing Scheme</td>
<td>System of tolls to enter the restricted zones</td>
</tr>
<tr>
<td>1991</td>
<td>Singapore</td>
<td>Weekend Car Scheme</td>
<td>Encouraging public transport use</td>
</tr>
<tr>
<td>1994</td>
<td>Singapore</td>
<td>Of Peak Car Scheme</td>
<td>Encouraging public transport use</td>
</tr>
<tr>
<td>1995/1998</td>
<td>Singapore</td>
<td>Road Pricing Scheme and Electronic Road Pricing</td>
<td>Congestion pricing</td>
</tr>
<tr>
<td>1998</td>
<td>Shanghai</td>
<td>Quota for New Car Registration</td>
<td>Setting yearly or monthly quota for new cars in the city</td>
</tr>
<tr>
<td>1996</td>
<td>Seoul</td>
<td>Toll Fee on private cars passing through Namsan Tunnels 1 and 3</td>
<td>Congestion pricing based on occupancy</td>
</tr>
<tr>
<td>2004</td>
<td>Seoul</td>
<td>Use of integrated payment system for transport services such as T-Money in Seoul</td>
<td>Discounts on travel in using t-money on public transport system</td>
</tr>
</tbody>
</table>

Source: Author’s compilation from various sources

However, traffic congestion does not occur only due to increasing level of motorized vehicles. If that was the case, then cities with low levels of motor vehicles should not be congested. For instance, in the cases of Dhaka in Bangladesh and Varanasi in India, traffic flow is slow and causes heavy congestion. Notably, Varanasi has only 7% of total motorized vehicles in Delhi.\(^3\) It suggests that congestion also occurs due to mismanagement between demand for and supply of transport services. In other words, imbalances in managing factors affecting demand and supply for transport services is also responsible for traffic congestion. These factors may include direct and indirect elements such as increasing levels of vehicles and a constant level of road infrastructure, low cost private transport services, psychological factors, lack of policy interventions, and other factors. In this context, it becomes imperative to decipher traditional policy gaps to understand the sources of congestion. That can lead to congestion policies which address the issue in a comprehensive manner, including policies such as congestion pricing, parking policies, land use planning, and so on.

## II. CONGESTION IN INDIAN CITIES AND POLICY RESPONSES

As per the 2011 census, India’s urban population has grown from 290 million in 2001, to 377 million in 2011, and accounts for over 30% of India’s total population. Rapid urbanization has come with several problems, including increased congestion. Policies are now committed to the development of urban infrastructure. In particular, India is passing through the same phase of early urbanization which has already occurred in countries like Japan, Republic of Korea, and Singapore. The growth scenario in Indian cities is not commensurate with the conditions for sustainable transport. The per capita trip rate for all modes of transport is expected to increase from 0.8%-1.55% in 2007 to 1%-2% by 2030 (Planning Commission, 2011). Moreover, the share of public transport is also expected to decrease as there is a likely decrease in the speed flow of public transport from 26-17

\(^3\) Ministry of Road Transport and Highways, Year Book, 2011
km/h to 8-6 km/h during the same period (Planning Commission, 2011). Figure 1 shows the city-wise ownership of motorised vehicles.

**Figure 1: Share of Types of Motorised Vehicles in 2011**

The average journey speed in Indian cities is also low, particularly in cities which have high car volumes (Ghate and Sundar, 2013, p. 34). In 2007, a study commissioned for the Ministry of Urban Development, Government of India, found that the average journey speed in Delhi was around 16 km/h and only slightly higher in Mumbai. The study found the average journey speed to be below 20 km/h in Hyderabad, Chennai and Bangalore, as well as low in cities with slow moving vehicles such as Varanasi and Bhubaneswar (Wilbur Smith Associates, 2008).

In New Delhi, Delhi’s Master Plan 2021 aims to attract 80% of road travel to public transport by 2020. An estimate indicates that by the year 2021, travel demand in Delhi will increase to 27.9 million passenger trips as compared to 13.9 million passenger trips in 2001. This increase in travel demand is more than double. It implies that in future, public transport will cater to 22.3 million passenger trips. However, according to the statistics of the Ministry of Road Transport and Highways, the number of registered buses in New Delhi have seen little growth, while private vehicles, particularly two-wheelers, are increasing at their highest rate over the last few years.

Similarly in Mumbai, congestion on roads is a regular phenomenon. Despite the fact that in Mumbai, sub-urban rail link meets most suburban travel demand, road congestion is not reduced. During peak hour, traffic in Mumbai flows at a speed of 5 km/h speed (Kumar, 2013). The total vehicles in Bangalore and Hyderabad are around 6.8 million, of which around 70% are two-wheelers. On the other hand, cars and other passenger vehicles such as jeeps, taxis, and auto-rickshaws, account for around 25%, while buses account for only 0.7% of the total motorised vehicles registered in the cities of Hyderabad and Bangalore. This indicates that there is a growing tendency of ownership of two-wheelers, cars, taxis and others in Indian cities.

In response to the above trends, a comprehensive national level policy to manage congestion in urban areas is being solicited through policy debates. Notably, the Working Group on Urban Transport for 12th Plan period (2012-17) has suggested measures to manage urban congestion. The Working Group also highlighted a number of causes leading to urban congestion, including inefficient urban planning and poor implementation of regulations. However, most of the causes that are spelt out in the Working Group document pertain to the lack of adequate urban infrastructure;

---

4 Delhi Master Plan, Future Transport Policy
5 The data is given as of 31 March 2011
consequently, many of their solutions are also related to increasing the capacity of urban transport, such as the creation of new infrastructure, planning and coordination of road works, efficient traffic signals, increasing lanes of roads and creation of one-way streets. Some of the policies which may be expected to ease congestion include the following:

2.1 **Better Integrated Urban Planning**

Currently, urban transport policies are regulated by city municipalities in the country. At the national level, the Government of India’s Jawaharlal Nehru National Urban Renewal Mission (JNNURM) mandated to transform urban areas, particularly urban transport. To get funds under this programme, states and municipalities are required to adopt specific reforms in urban development policies, which relate to the management of funds and adoption of new regulations pertaining to urban land ceiling and public discourse law, etc.

2.2 **Promotion of Public Transport**

The Working Group on Urban Transport for 12th Plan period recognizes the important of public transport. In India, metro rail transport is already in operation in cities like New Delhi and Bangalore. The same facilities are also underway in other major cities like Mumbai, Chennai, Hyderabad, Jaipur and Kolkata.

2.3 **Promotion of Intelligent Transport Systems**

The draft document of 12th Five Year Plan clearly spells out that there is a need for intelligent transport systems. Under JNNURM, there is a scheme called the Urban Infrastructure and Governance (UIG), which provides buses enabled with intelligent transport systems. Around 15,260 low-floor buses are already in place. Similarly, under JNNURM, 21 projects including Bus Rapid Transit (BRT) System with an approved cost of 5,211 crores was sanctioned (Planning Commission, 2012-17).

### III. POLICY GAPS

The above initiatives, together with policies to dis incentivise private car vehicles and promote non-motorised transport, will go some way towards easing congestion in Indian cities. However, the Working Group on Urban Transport for 12th Plan period document is silent on policies to address the mismanagement of demand or supply side of transport services, though scattered references to them may be found. There are also important “gaps” in the policies, both at national level and municipal level. Some of these policy gaps are described in more detail below.

3.1 **Fuel Subsidies**

The deregulation of prices of fuel to cut subsidy remains an important issue in public discourse in India. To this effect, the Government of India recently partially deregulated fuel prices. Oil companies have been permitted to raise prices of fuel for retail. However, the use of diesel for both goods and passenger transportation (private cars) are not differentiated under this policy. This implies that both types of users are paying the same price. The impact of partial deregulation of fuel prices on demand side management of travel demand by diesel cars has yet to be studied. The difference between the prices of diesel and petrol remains an important attraction for diesel cars (in addition to efficiency of diesel cars over petrol cars).

Still, diesel has a capped subsidy (reduced by 40%), which is again benefiting private car users. Government subsidy also covers petrol, which is mostly consumed by private vehicles. In 2011-12, diesel accounted for about 45% of total under recovery amount by marketing companies (where private vehicles also have a large share), while the equivalent figure for petrol 4.49% (Singh, 2013). According to a newspaper article published in 2012, out of every 100 litres of diesel, 22 litres goes for private usage. Again, it is difficult to ascertain how much diesel is being used by private cars, which gets subsidy at the same rate as freight traffic. One estimate by the Working Group of

---

6 Times of India, August 22, 2012, The statement was made by R. P. N. Singh, Deputy Minister for Petroleum and Gas in the Parliament, on 23 August, 2012
Petroleum Sector, 12th Plan and the Society of Indian Automobiles Manufacturers indicates that total transport sector consumption is around 59% of total diesel consumption, of which goods vehicles consume 37.9% of the total consumption of diesel in the economy. It also implies that rest of the consumption by the transport sector is consumed by other modes of transport. The estimates also indicate that personal cars account for 0.6% of the total diesel consumption. However, the consumption by buses is 6%. The sectoral share of diesel consumption by the group is presented in figure 2.

Figure 2: Sectoral Consumption of Diesel

![Sectoral Consumption of Diesel](source)


However, previous reports of the Expert Group on “A Viable and Sustainable System of Pricing of Petroleum Products” under the Ministry of Petroleum mention that in 2010, the share of private cars was 10% of the total use of diesel. The contradiction in the data suggests that further research is required, particularly on diesel use in cities. If we take consumption of diesel by the transport sector in major cities, the scenario would be different. The point is that the consumption of diesel shall vary in cities, where private vehicles are in the majority and constitute a major component of passenger transport. A discriminatory measure may need to be used to eliminate the intake of diesel subsidies for private cars.

3.2 Mismatch of Policies on Public Transport and Investment in Public Transport Vehicles

The fleet strength of State Road Transport Undertakings (SRTUs) is not increasing at the expected rate as per the statistics of SRTUs. The total fleet strength during 2000-01 and 2010-11 increased from 115,000 to 130,611. During the decade, the fleet grew at around 1.3% per annum. During the same period, passengers carried by state transport undertakings have also grown by about 1% per annum, from 63.6 million passengers in 2000-01 to 70.5 million passengers in 2010-11. This indicates that the capacity of public transport is still underutilized. Of the total fleet strength, Delhi Transport Corporation (DTC) has around 29.71% over-aged buses, while Andhra Pradesh SRTC city has 5.84% and Bangalore Municipal Transport Corporation has 5.60%.

Fleet utilisation also varies from city to city. For instance, in Delhi, 75.1% of total fleet strength is utilized, while in Bangalore this was 92.3% in 2010-11. In Andhra Pradesh, urban transportation had 99.9% fleet utilisation during the same time period. It is important to rejuvenate the state transport undertakings to strengthen urban transportation. Public transportation, as measured by the performance of SRTUs, needs more attention in urban areas. It is found that average breakdown of SRTUs in urban areas is higher than that in rural areas. In rural areas, the breakdown per 1000 km

---

7 Data taken from CIRT, State Transport Undertaking Profile and Performance: 2010-11
was 0.13 while in urban areas, breakdown was 0.78 in 2010-11.\(^8\) This is partly because of the low level of bus transport services in rural areas as compared to urban areas. However, it indicates that the reliability rate in urban areas is a matter of concern for SRTUs.

Meanwhile, while several dedicated transit corridors for urban mass transit are in operation, they are no longer dedicated to urban transit. The mixed use of road is a common phenomenon. This usage rendered Delhi Bus Rapid Transit (BRT) Corridor a failure. The success of metro rail in Delhi indicates that road also needs a dedicated transport corridor, which should be exclusively interlinked. Delhi metro and road transport are not able to congregate themselves to make public transport more comfortable, though the Government of Delhi is taking adequate measures to streamline it. A monorail project is also proposed in Delhi which will be a significant landmark in ensuring state-of-the-art connectivity.

Interestingly, Delhi metro rail also attracts private car users as well for their daily purposes. However, there should be exclusively designed roads for public transport in Indian cities, which must be integrated with other mass transit systems. It should also adopt integrated use of land in these cities. To this effect, policies need to be designed considering the behavioural aspects of commuters. This will also help in ensuring the inclusivity of public transport for all sections of the society.

### 3.3 Driver Education and Road Safety

Both large and small cities in India have poor safety standards due to poor driving behaviour, inadequate driving education and poor standard of driving tests. As a result, India has around 1% of the total vehicles in the world but accounts for 18% of the world’s road deaths.\(^9\) As per a national daily, every sixth accident in the world happens in India.\(^10\) In the year 2010, total death by road accidents in India was estimated to be .23 million out of 1.24 million in the world.\(^11\) According to a Delhi Traffic Police survey, majority of drunk drivers are educated, young and familiar with traffic rules. However, their behaviour while driving is irresponsible. The survey found that more than 85% of drivers were car drivers.\(^12\) This is again a serious concern for urban safety, as these drivers are well aware of driving norms but are negligent when it comes to following such norms. On roads in Indian cities (both major and small cities), drivers of private cars are generally car owners under the age of 40. Regulation of such drivers on roads needs the strict enforcement of laws.

Driving education manuals are presently related to traffic manuals. More comprehensive manuals for drivers’ education, which can also encompass social and environmental impacts of road transport, need to be developed. At municipal and institutional levels, training programmes are being carried out. These programmes require manuals for both municipal as well as state levels. The traffic guidelines for car drivers by Delhi Traffic Police make no mention about issues such as congestion, pollution, etc.

### 3.4 Promotion of Automobile Industry

The Planning Commission has constituted a Working Group on Automotive Sector. This Working Group highlights the automotive sector as the next sunrise sector in the Indian economy, pointing out that the sector’s contribution to GDP has increased from 2.77% in 1992-93 to 6% in 2010-11 (Planning Commission, 2012-17). According to the Report of the Working Group on Automotive Sector for the 12th Five Year Plan, the number of passenger vehicles produced is projected to reach 5 million units in 2015 and 9 million units in 2020 (see figure 2). In such a scenario, policies which discourage private passenger vehicles will also have a negative impact on such targets. A combination of measures targeting better management of both the economy as well as environmental problems needs to be encouraged.

### 3.5 More Effective Parking Policies

Parking policy is featured in the National Urban Transport Policy (NUTP) and JNURM programme. The NUTP clearly spells out the need for high parking fees, which represents the land value. In addition, the policy also calls for encouraging parking places to catalyse the use of public

---

\(^8\) Ibid
\(^9\) WHO, Road Traffic Deaths by Country in 2010
\(^10\) Times of India, 8 October, 2012
\(^11\) WHO, Road Traffic Deaths by Country in 2010
\(^12\) Delhi Traffic Police Survey, January-March 2012
transport through connectivity with urban mass transit systems. JNNURM has also linked its financing with availability of adequate parking. The programme advocates provision of parking lots through public private partnerships.\textsuperscript{13}

However, parking policy is generally not seen as an important instrument for decongesting cities. In Delhi, the Environmental Policy (Prevention and Control) Authority has submitted a report in 2004 indicating that there is an urgent need for an exclusive parking policy to manage travel demand. Even the Supreme Court of India directed the government of National Capital Territory of Delhi to have an action plan for parking policy in 2005. At that time, recommendations were made by the government, and in 2006 the recommendation on increases in parking charges was accepted by the Supreme Court as well.

Increasing parking charges is not the only remedy for congestion. The evolving nature of parking policy has an impact on reducing travel demand in Delhi, but it is one of the least effective measures which is not able to control the rising demand for private car travel in the city. A report of Centre for Science and Environment on parking in Delhi shows that while the transportation reform agenda under JNNURM has a mandate to fund urban renewal projects including parking projects, the National Urban Transport Policy (NUTP) states that urban agglomerations must have parking areas built on the basis of public-private partnerships. Under NUTP, state governments are directed to award building bye-laws in all cities which have a population of more than 1 million. This is adopted to make available adequate parking space for all residents. The two important aspects of NUTP and JNNURM have different perspectives, in that “the floor area ratio (FAR) laws are made more liberal and multi-level parking is made mandatory in cities” (CSE, 2012).

The main issue with parking policies in cities is the informal and rent-seeking characteristics of parking areas. In Delhi itself, parking is still unorganised and not systematic. A variance in rates on parking lots can also be seen at different places. Another important aspect related to parking is that Indian cities have the lowest parking charges compared to other cities in the developing and developed world. An estimate indicates that Indian cities have around 13 times lower parking charges than Hong Kong, China, and more than 20 times lower parking charges than Singapore.\textsuperscript{14} Though the same cannot be replicated in India, yet it solicits a policy space for reconsideration. The dilemma is that parking management is still naïve. Road accessibility is not smooth because it is given for car parking, which increases the level of congestion.

\section*{IV. THE WAY AHEAD}

Due to increasing levels of urbanization, public transport in Asian cities is characterized as that of high dependency and low availability. It also suffers from huge deficiencies both in terms of infrastructure availability as well as operational efficiency. Considering the policy gaps in Indian cities, the following measures are recommended to reduce congestion in mega cities. These recommendations are in addition to those related to congestion pricing and other charges, which may be levied to reduce personal vehicle travel.

1. There is a need for integrated transport policies to address problems of urban transport and urban infrastructure development through an integrated institutional mechanism. For example in India, a National Transport Development Policy Committee was set up to formulate such policies. The committee also recommends developing effective institutional frameworks at centre/state and city level.

2. A national policy needs to be designed to address more environmentally sustainable and urban growth. Alienated sectoral policy frameworks do not have the desired impact on urban transportation. For instance, if India wants to reduce personal vehicles in cities like Delhi, Mumbai, Hyderabad and Bangalore, then policies to address issues related to manufacturing of automobiles also need to be formulated. In the case of NTDPC, the Working Group on Urban Transport speaks about urban transport tax, green cess, increase on diesel prices; while on the other hand, the Working Group on Automobiles Sector speaks about emerging as the world’s 5\textsuperscript{th} largest car producer and largest

\textsuperscript{13} Revised guidelines for JNNURM

\textsuperscript{14} Colliers International (2011) - CBD daily parking charges (in US $)
manufacturer of three-wheelers, with the automotive sector expected to increase its share of India’s GDP from 5% in 2006 to 10% in 2016.

3. Urban transportation needs strict parking policy and uniform parking charges at national level for mega cities. There is also a need to increase parking charges as it has an impact on parking demand as well. It is also important to link parking rates with the commercial viability of parking structures in mega-cities.

4. There is a need for exclusive lanes for public transport in Indian cities. For instance, in Delhi, land availability for transport infrastructure is less. In this context, integrated approach of land use is important for different transport modes.

5. State transport undertakings need to be strengthened to ensure safe and reliable public transportation.

6. There is a need for driving manuals for drivers at both municipal and state levels.
REFERENCES


BATTLING CONGESTION IN MANILA: THE EDSA PROBLEM

Yves Boquet

ABSTRACT

The urban density of Manila, the capital of the Philippines, is one the highest of the world and the rate of motorization far exceeds the street capacity to handle traffic. The setting of the city between Manila Bay to the West and Laguna de Bay to the South limits the opportunities to spread traffic from the south on many axes of circulation. Built in the 1940's, the circumferential highway EDSA, named after historian Epifanio de los Santos, seems permanently clogged by traffic, even if the newer C-5 beltway tries to provide some relief. Among the causes of EDSA perennial difficulties, one of the major factors is the concentration of major shopping malls and business districts alongside its course. A second major problem is the high number of bus terminals, particularly in the Cubao area, which provide interregional service from the capital area but add to the volume of traffic. While authorities have banned jeepneys and trisikel from using most of EDSA, this has meant that there is a concentration of these vehicles on side streets, blocking the smooth exit of cars. The current paper explores some of the policy options which may be considered to tackle congestion on EDSA.

INTRODUCTION

Manila is one of the Asian megacities suffering from the many ills of excessive street traffic. In the last three decades, these cities have experienced an extraordinary increase in the number of vehicles plying their streets, while at the same time they have sprawled into adjacent areas forming vast megalopolises, with their skyline pushed upwards with the construction of many high-rises. The joint processes of globalization, outsourcing, and the relocalization of manufacturing activities have been accompanied by a rise in the purchasing powers of many people in developing Asian countries, which has allowed them to acquire motorized vehicles, motorbikes and automobiles, even if profound inequalities exist in regard to the capacity to acquire a vehicle (Cervero 2013). It has resulted in a rapidly increasing congestion of the streets, especially in cities where the urban fabric is traditionally made of narrow roads not suitable for heavy traffic. Congestion not only slows down considerably the speed of travel, and therefore diminishes the efficiency of the overall economy, but also has nefarious effects on the environment (air pollution) and public health (chronic asthma, bronchitis, eye irritation). It also is blamed for an excessive use of fossil fuels.

The paper will examine the case of Manila and the Epifanio De los Santos Avenue, or EDSA, which is the main thoroughfare of the entire metropolitan area. It will then present a number of possible scenarios to improve traffic in the Philippine capital, including rail mass transit, traffic demand management, and improvement of bus traffic.

1 Unless it refers to the municipality of Manila, we will use the name Manila, or Metro Manila for the whole metropolitan area, made up of 17 municipalities, even if the EDSA Avenue, focus of this paper, does not run on any part of the territory of Manila stricto sensu.
Congested bumper-to-bumper traffic makes travel very slow but creates some opportunities for vendors. Rail traffic can be very efficient to beat road traffic

I. MANILA, A CITY CHARACTERIZED BY VERY HIGH DENSITIES

Greater Manila is a classic case of excessive concentration of people and economic activity on the small territory of a national capital city. It accounts for 35.7% of the Philippines’ economic output, 18% of its population and 28% of its motor vehicles, on barely 0.2% of the country’s land area. The population density of Manila is among the highest of the major metropolitan areas in the world with a comparable land area (see table 1). It is almost twice as dense as New York City, for example, and only surpassed by Mumbai and Dhaka.

Table 1: Population Density of Selected Metropolitan Areas in The World

<table>
<thead>
<tr>
<th>City</th>
<th>Land area (sq.km)</th>
<th>Population (millions)</th>
<th>Population per square km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbai (India)</td>
<td>603</td>
<td>13,830 (2011)</td>
<td>22.937</td>
</tr>
<tr>
<td>Dhaka (Bangladesh)</td>
<td>360</td>
<td>7,001 (2008)</td>
<td>19.447</td>
</tr>
<tr>
<td><strong>Metro Manila</strong></td>
<td><strong>639</strong></td>
<td><strong>11,855 (2011)</strong></td>
<td><strong>18.567</strong></td>
</tr>
<tr>
<td>Seoul City (Korea)</td>
<td>605</td>
<td>10,442 (2012)</td>
<td>17.259</td>
</tr>
<tr>
<td>Cairo (Egypt)</td>
<td>453</td>
<td>9,120 (2011)</td>
<td>17.190</td>
</tr>
<tr>
<td>Lagos (Nigeria)</td>
<td>999</td>
<td>15,320 (2010)</td>
<td>15.236</td>
</tr>
<tr>
<td>Jakarta (Indonesia)</td>
<td>740</td>
<td>10,920 (2011)</td>
<td>14.743</td>
</tr>
<tr>
<td>Tokyo 23 wards (Japan)</td>
<td>622</td>
<td>8,949 (2010)</td>
<td>14.390</td>
</tr>
<tr>
<td>Kolkata (India)</td>
<td>1026</td>
<td>13,216 (2001)</td>
<td>12.883</td>
</tr>
<tr>
<td>New York City (USA)</td>
<td>784</td>
<td>8,337 (2012)</td>
<td>10.640</td>
</tr>
<tr>
<td>Moscow (Russian Federation)</td>
<td>1080</td>
<td>11,472 (2011)</td>
<td>10.622</td>
</tr>
<tr>
<td>Tehran (Islamic Republic of Iran)</td>
<td>730</td>
<td>8,244 (2011)</td>
<td>10.328</td>
</tr>
<tr>
<td>Delhi (India)</td>
<td>1484</td>
<td>12,566 (2011)</td>
<td>8468</td>
</tr>
<tr>
<td>Singapore</td>
<td>690</td>
<td>5,184 (2011)</td>
<td>7513</td>
</tr>
<tr>
<td>São Paulo (Brazil)</td>
<td>1523</td>
<td>11,244 (2010)</td>
<td>7383</td>
</tr>
</tbody>
</table>
Many parts of Manila experience heavy traffic congestion, especially in areas of high population density (more than 70,000 people / sq. km in Tondo) and narrow streets in old neighborhoods such as Quiapo (Manila) or Guadalupe (Makati). In these areas, street vending encroaches on the limited road space, further slowing down an already busy vehicular traffic, largely made of jeepneys and trisikel. Heavy downpours during the rainy season, from June to November, make some low-lying streets often impassable, due to widespread flooding, a major topic of concern in the Manila metropolitan area. Its root causes are many (Bankoff, 2003, Zoleta-Nantes, 2009, Alcazaren, 2013a), both physical (monsoon rains, typhoons, low altitude, sea-level rise) and human (urban sprawl and hard surfacing reducing the water absorption capacity of soils, slow sinking of alluvial soils under the weight of city structures, deforestation in the hills around Manila, role of squatter settlements and garbage disposal impeding the normal flow of rivers). Flooding adds to traffic woes in many parts of the Manila area.

A major component of the quality of traffic is the availability of road space. In this regard, Manila is also one of the cities most likely to be congested, since the density both of roads per square kilometer and roads per resident appears very low in Manila, compared to other metropolitan areas (see table 2). There are simply not enough roads to allow for smooth traffic. The provision of roads per square kilometer in 1980 was quite low in Asian cities, before the rapid rise of motorization rates. This issue cannot be solved quickly, unless there is drastic redesign of the whole urban fabric, which only China has attempted on a large scale. Data in table 2 do not indicate the width of the streets, the design of street patterns, and the presence of traffic lights or stop signs, which may substantially alter the speed of circulation flows.

### Table 2: Road Density of Selected World Cities in 1980

<table>
<thead>
<tr>
<th>City</th>
<th>Road density (km/km²)</th>
<th>Road density per person (in meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo (Japan)</td>
<td>19.87</td>
<td>6.20</td>
</tr>
<tr>
<td>Copenhagen (Denmark)</td>
<td>13.07</td>
<td>5.00</td>
</tr>
<tr>
<td>Seoul (Korea)</td>
<td>12.95</td>
<td>4.70</td>
</tr>
<tr>
<td>Sydney (Australia)</td>
<td>10.91</td>
<td>4.50</td>
</tr>
<tr>
<td>Frankfurt (Germany)</td>
<td>10.80</td>
<td>4.30</td>
</tr>
<tr>
<td>London (UK)</td>
<td>10.70</td>
<td>4.00</td>
</tr>
<tr>
<td>New York City (USA)</td>
<td>9.31</td>
<td>1.90</td>
</tr>
<tr>
<td>Los Angeles (USA)</td>
<td>9.00</td>
<td>1.90</td>
</tr>
<tr>
<td>Chicago (USA)</td>
<td>8.75</td>
<td>1.00</td>
</tr>
<tr>
<td>Singapore</td>
<td>8.32</td>
<td>0.90</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>6.75</td>
<td>0.70</td>
</tr>
<tr>
<td>Jakarta (Indonesia)</td>
<td>5.46</td>
<td>0.46</td>
</tr>
<tr>
<td>Guangzhou (China)</td>
<td>4.94</td>
<td>0.38</td>
</tr>
<tr>
<td><strong>Manila (Philippines)</strong></td>
<td><strong>4.62</strong></td>
<td><strong>0.38</strong></td>
</tr>
<tr>
<td>Paris (France)</td>
<td>4.35</td>
<td>0.25</td>
</tr>
<tr>
<td>Bangkok (Thailand)</td>
<td>3.47</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Source: Ingram & Liu 1997

In Metropolitan Manila, according to MMDA data (Vergel de Dios, n.d.), there are currently 5034 kilometers of roads (37 km of tolled expressways, 992 km of “national roads”, 2366 km of “local
roads” and 1639 km of “private/subdivision roads”). In 2008, Manila counted 1.7 million registered motor vehicles, of which almost 10% (163,000) were registered for-hire vehicles: buses, jeepneys and trisikel.

II. EDSA, A THOROUGHFARE ESSENTIAL FOR METRO MANILA

Epifanio De los Santos Avenue was built in 1939-1940 under the presidency of Manuel Quezon as part of a grand scheme of road organization in greater Manila. Envisioned as an elegant parkway, it was to be a link between the new city of Quezon City, created in 1939 to be the capital of the Commonwealth of the Philippines, and the Manila airport established in Makati in 1937. This “North and South Circumferential Road” was renamed ‘Highway 54” in 1945 by the American occupying forces, while some Filipino lawmakers wanted to call it “19 de Junio” (birthdate of the national hero and poet Jose Rizal). The Philippine Congress finally decided in 1959 to honor a renowned multi-talented Filipino intellectual, Epifanio De los Santos y Cristobal (1871-1928). The long name being a mouthful to pronounce, the road quickly came to be known as EDSA.

EDSA serves as a major connector between the Northern and Southern part of the metropolitan area, as well as South Luzon to North Luzon in general, due to the geographical setting of the metropolitan area between the water bodies of Manila Bay to the West and Laguna de Bay to the Southeast (mountains prevent any major transportation activity on the eastern side of central Luzon). It runs for 24 kilometers from Caloocan, in the Northern part of the metropolitan area, starting at the Andres Bonifacio Monument (“Monumento”) to Pasay in the South, ending on a traffic circle adjacent to the famous SM Mall of Asia shopping complex. It arcs in a semi-circle through the Eastern part of the metropolitan area, crossing also parts of Quezon City (Balintawak, Kamuning, Cubao), San Juan, Mandaluyong (Ortigas) and Makati (Guadalupe, Buendia, Ayala). It is an essential component of the spatial structuration of the Manila metropolitan area. Its powerful role in shaping the geography of activities within the metropolitan area is apparent with the location of the shopping malls, car dealerships, business centers, hotels, government agencies and provincial bus terminals alongside this axis of circulation.

On most of its length, the EDSA is a controlled-access highway, 3 to 5 lanes wide in each direction with few at-grade crossings: an urban freeway, built mostly at street level, unlike the Shanghai or Tokyo freeways. In a few spots, vehicular traffic crosses EDSA either underground (Boni-Pioneer tunnel in Mandaluyong, Quezon Avenue in Quezon City) or above it (Skyway in southern Makati, Shaw Boulevard in Mandaluyong). A major cloverleaf interchange marks the connection between North Luzon expressway and EDSA at the Quezon City / Caloocan border and a very intricate interchange exists at Magallanes with the South Luzon Expressway. In parts of Makati, EDSA is located in a trench below the level of regular street pattern, which makes it quite vulnerable to flooding in the Magallanes section.

In other places, EDSA is elevated to cross transversal roads (Ortigas Avenue Flyover in Mandaluyong, Santolan Road in Quezon City). But EDSA has some at-grade crossings with other major roads: Taft Avenue Rotunda (Pasay), Katipunan Avenue, Aurora Boulevard in Cubao, Kamias Rd and Kamuning Rd, East and South Avenues, North and West Avenues, Roosevelt and Congressional Avenues (Quezon City), and also at Monumento in Caloocan (Rizal Ave and McArthur Highway). This impairs the smooth flow of traffic. In different parts of EDSA, vehicles use left side U-turns on EDSA: right turn into EDSA, followed by a change of lanes from the outside to the inside lines, to reach a U-turn spot, then more change of lanes back to the outside lanes and finally a right turn exit out of EDSA. It is inefficient, accident-prone and complicates traffic, even more when the U-turning vehicle is a bus.

A number of pedestrian overpasses have been built, some (15) associated with rail transit stations, some just to cross the avenue (9). In other words, there are 24 safe crossing points for pedestrians for a 24 km long highway: just one per kilometer. At-grade crossings are discouraged but not impossible, at the pedestrian’s own risk.

2 Merger of several small towns: Diliman (site of the University of the Philippines), San Francisco del Monte, Novaliches and Balintawak… Quezon City was officially the capital of the Philippines from 1948 to 1976, when the site of power was reverted to Manila.

3 After the 1948 transfer of the airport to its current site in Pasay and Parañaque, the Makati airport runways were later used for two major intersecting streets of that city: Paseo de Roxas and Ayala Avenue.
Traffic is usually lighter than in the central section of EDSA, but the width of the avenue and the risk for crossing pedestrians justifies the construction of this bridge, which is not accessible to people with disabilities.

On the right-of-way of EDSA, between 1997 and 2000 the Philippine authorities built a rail-transit line, the MRT (Metropolitan Rapid Transit), mostly running above the middle of EDSA, but sometimes running parallel to it. An extension of the LRT 1 line (Light Rail Transit) from Monumento to Roosevelt covers the northern section of EDSA. MRT and LRT rails between Roosevelt and North Avenue are linked, but there is no service between the two end stations, forcing commuters to walk or use road public transport. In Cubao (Quezon City), LRT-2, the East-West line, crosses the MRT, but the uneasy connection (stations apart by about 500 meters) also takes passengers back into the streets. It is a little easier in Pasay, at the Taft Avenue end of MRT for the connection with LRT 1 (EDSA station), where an elaborate network of pedestrian overpasses have been built, comparable to what exists in Quiapo between the Recto (LRT 2) and Doroteo Jose (LRT 1) stations.

III. VEHICULAR TRAFFIC ON EDSA

The excellent accessibility of EDSA sites has clearly attracted a lot of commercial investment and strategic implantation. But this abundance of shopping centers, office plazas, and places of employment generates at the same time an enormous amount of traffic on EDSA. According to MMDA data, about 350,000 people use the EDSA roadway everyday (156,000 vehicles, with a density of 565 vehicles/kilometer. Buses, provincial and local, represent a large part of the traffic on EDSA, and are often blamed for the traffic woes. The most common problems are: too many transport providers, unreliable service, and irregular and/or unpredictable frequency. Route coverage is poor, because buses concentrate on few corridors while neglecting other parts of the city. This results in low profitability, leading to poor quality vehicles, a poor safety performance, exaggerated pollution and mediocre consideration for passengers (Vergel de Dios n.d.).

City buses run on 254 routes, operated by 165 bus companies, some with a rather large fleet (Santrans 150 buses on 8 different routes, Pascual Liner 153 buses on 2 routes, RRCG 163 buses on 5 routes), some of them very many small companies (California Bus Lines 3 vehicles, Valdez Quirino only 1 bus). On the most competitive routes (see table 3), more than 10 bus companies (and up to 20) are fighting for passengers, including in traffic, where buses position themselves to block other buses
from moving forward, in a wild concert of horns barely covering the voices of “konduktors” calling for passengers “Alabang! Alabang!”. 171 routes (67%) are run using part of EDSA.

**Figure 3: EDSA in Mandaluyong, from the Boni Avenue Station Overpass**

Buses fighting for passengers. The red roof bus swerves to the right to stop in front of the white roof bus, forcing the yellow bus to move to the left, into the path of an incoming taxi. This scene is repeated in many sections of EDSA and is a major contributor to slow traffic, as well as more potential accidents, which aggravates the traffic situation even more.

**Table 3: Busiest Bus Routes within Metro Manila**

<table>
<thead>
<tr>
<th>Main route (South to North)</th>
<th>Main road used</th>
<th>Competing bus companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabang (Muntinlupa) - Novaliches (Quezon City)</td>
<td>SLX, EDSA</td>
<td>9 (395 buses)</td>
</tr>
<tr>
<td>Alabang (Muntinlupa) - Plaza Lawton (Manila)</td>
<td>SLX</td>
<td>14 (343 buses)</td>
</tr>
<tr>
<td>Baclaran (Pasay) - SM Fairview (Quezon City)</td>
<td>EDSA, Quezon Avenue</td>
<td>17 (330 buses)</td>
</tr>
<tr>
<td>Santa Cruz (Manila) - Sapang Palay (S. Jose del Monte, Bulacan)</td>
<td>Quirino Hwy</td>
<td>10 (328 buses)</td>
</tr>
<tr>
<td>Alabang (Muntinlupa) - SM Fairview (Quezon City)</td>
<td>SLX, EDSA, Quezon Avenue</td>
<td>15 (328 buses)</td>
</tr>
<tr>
<td>NAIA Airport (Pasay) - SM Fairview (Quezon City)</td>
<td>EDSA, Quezon Avenue</td>
<td>15 (301 buses)</td>
</tr>
<tr>
<td>Baclaran (Pasay) - Navotas</td>
<td>EDSA</td>
<td>14 (288 buses)</td>
</tr>
<tr>
<td>Baclaran (Pasay) - SM Fairview (Quezon City)</td>
<td>EDSA, Quezon Avenue</td>
<td>20 (254 buses)</td>
</tr>
</tbody>
</table>

7736, or about 60 percent, of the 13,067 registered buses plying Metro Manila roads are provincial buses, linking the Manila metropolitan area with regions across the Philippines. Even if other parts of Manila have bus terminals (Gil Puyat LRT 1 in Pasay, Sampaloc near Quiapo : LRT1/LRT 2 junction), most companies have established their terminals alongside EDSA, with major concentrations in Pasay (Saulog, Philtranco, Victory Liner, DLTB, Silverstar, Alfonso Liner...), and in the Cubao-Kamuning stretch (Superlines, Santrans, HM Transit, Baliwag Transit, Dominion Bus, De la Rosa Liner, Dagupan Bus, JAC Liner, JAM Transit, Victory Liner, Philtranco, DLTB, Daet Express, Lucena Bus, Florida Bus, Genesis, Five Star ...).

**Figure 4: Private Bus Company Terminals alongside EDSA in Cubao, Quezon City viewed from the MRT train**

Photo Y. Boquet, June 21st, 2013

The section of EDSA between the Cubao and Kamuning stations of the MRT lines has the highest density of bus terminals of the entire metropolitan area. Superlines buses serve distant provinces in the Bicol region of Southeast Luzon, while Five Star buses serve mostly provinces North of Manila in central Luzon (Pampanga, Tarlac, Pangasinan). On this Northbound stretch of EDSA, Southbound buses share the roadway with northbound traffic before they can U-turn to go the right direction.
Jeepneys can use this section of EDSA, since there is no MRT going towards SM Mall of Asia further West (beyond the background of this picture). Many jeep passengers are transferring to/from two metro lines (MRT Taft Avenue station, end of the line, and LRT 1 EDSA station). Vendors are encroaching on the roadway, jeepneys jostle for position using 4 of the 6 lanes of traffic, and passengers have to find their way in traffic, even with children in their arms. This leaves little space for taxis, individual cars and buses.

IV. SEARCHING FOR SOLUTIONS TO EASE MANILA’S CONGESTION

What could be the solutions to solve Manila’s traffic problems, particularly alongside EDSA, which appears clearly as the major circulation problem in the Manila region? Answers to traffic problems have been looked about in many cities around the world, and in Asia in particular (Cervero 1998, Ieda 2010, Suzuki & al. 2013). Based on these experiences, some major possible policy options can be suggested.

5.1 Rail transit

Over the last two or three decades, many cities in Asia have developed impressive heavy rail transit systems designed to increase the share of rail in the commuter transportation mix. Manila has done timid efforts in that regard (see figure 6 and table 4), with only three lines at this time, the smallest network of any major Asian city, except for Mumbai and Jakarta, which have no metrorail transit at this time, even though they have suburban trains. The Philippines has only a tiny rail network limited to Luzon island. In terms of ridership, Manila’s three lines carry only 1.1 million passengers per day, much less than in comparable sized cities in other Asian countries. Manila metro ridership is barely above Munich in Germany, a much smaller city.
Figure 6: Length (in kilometers) of Metropolitan Rail Transit Networks in Selected Asian Megacities (excluding suburban trains)

The 1999 start of MRT alongside EDSA has increased the overall passenger-carrying capacity of the EDSA corridor. It serves about half a million users every day. But it has been criticized for the limited size of the trains and their relatively low frequency. Passengers at rush hour are packed beyond the limits of comfort, and often must wait for the next train or even the third or fourth train before they can finally board. A higher frequency of trains and an increase in their length would be beneficial. It is possible since the trains are made of 3 sets of rail cars, and platforms can easily accommodate a fourth one. The policy, enforced by guards controlling the stations’ platforms, of reserving one of the sets of railcars for women and elderly people leads to relatively low passenger load in the women's section, and in contrast an excessive density of people in the two other sections.

Trains on the MRT, as well as the LRT1, are clearly undersized, both in length and width. However, the LRT 2 line is a pleasant experience, with much wider trains offering a feeling of space and a relatively low passenger load. It feels much more like a heavy rail transit system than the MRT 3 and LRT 1. If technically feasible, the adoption of LRT2 rolling stock for the two other lines would offer a welcome reprieve.

Table 4: Characteristics of Manila Urban Rail Transit Compared to Other Asian Megacities

<table>
<thead>
<tr>
<th>City</th>
<th>Opening date</th>
<th>Length (kilometers)</th>
<th>Lines (stations)</th>
<th>Average daily ridership</th>
<th>Passengers / km / day</th>
<th>Passengers / station / day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seoul</td>
<td>1974</td>
<td>526</td>
<td>19 (411)</td>
<td>6.9 millions/day</td>
<td>13,100</td>
<td>16,800</td>
</tr>
<tr>
<td>Beijing</td>
<td>1971</td>
<td>456</td>
<td>17 (227)</td>
<td>7.6 millions/day</td>
<td>16,700</td>
<td>33,500</td>
</tr>
<tr>
<td>Shanghai</td>
<td>1995</td>
<td>439</td>
<td>12 (288)</td>
<td>6.7 millions/day</td>
<td>15,300</td>
<td>23,300</td>
</tr>
<tr>
<td>Tokyo</td>
<td>1927</td>
<td>316</td>
<td>13 (285)</td>
<td>8.6 millions/day</td>
<td>27,200</td>
<td>30,200</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>1997</td>
<td>215</td>
<td>8 (144)</td>
<td>5.6 millions/day</td>
<td>26,000</td>
<td>38,900</td>
</tr>
<tr>
<td>Delhi</td>
<td>2002</td>
<td>193</td>
<td>6 (145)</td>
<td>2.3 millions/day</td>
<td>11,900</td>
<td>15,900</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>2004</td>
<td>178</td>
<td>5 (137)</td>
<td>2.4 millions/day</td>
<td>13,500</td>
<td>17,500</td>
</tr>
<tr>
<td>Opening date</td>
<td>Length (kilometers)</td>
<td>Lines (stations)</td>
<td>Average daily ridership</td>
<td>Passengers / km / day</td>
<td>Passengers / station / day</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------</td>
<td>------------------</td>
<td>-------------------------</td>
<td>-----------------------</td>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>1979</td>
<td>174</td>
<td>10 (82)</td>
<td>4.2 millions/day</td>
<td>24,100</td>
<td>51,200</td>
</tr>
<tr>
<td>Singapore</td>
<td>1987</td>
<td>146</td>
<td>4 (89)</td>
<td>2.4 millions/day</td>
<td>16,400</td>
<td>27,000</td>
</tr>
<tr>
<td>Osaka</td>
<td>1933</td>
<td>138</td>
<td>8 (125)</td>
<td>2.3 millions/day</td>
<td>16,700</td>
<td>18,400</td>
</tr>
<tr>
<td>Taipei</td>
<td>1996</td>
<td>113</td>
<td>10 (102)</td>
<td>1.8 million/day</td>
<td>15,900</td>
<td>17,600</td>
</tr>
<tr>
<td>Bangkok</td>
<td>1999</td>
<td>82</td>
<td>7 (57)</td>
<td>0.9 million / day</td>
<td>10,700</td>
<td>15,200</td>
</tr>
<tr>
<td>Manila</td>
<td>1984</td>
<td>51</td>
<td>3 (45)</td>
<td>1.1 million / day</td>
<td>22,000</td>
<td>24,900</td>
</tr>
</tbody>
</table>

Source: compiled from the websites of metropolitan transit authorities

Stations also appear undersized, compared to those in other large Asian cities. They do not allow for very long trains and usually have only one exit, unlike, for example, Chinese metro systems with multiple exits. Access to LRT 1 and MRT 3 stations is often difficult. They are located above ground with many steps to climb, while vendors and begging children use some of the steps. Existing elevators in some stations are crowded. There are only 3 or 4 ticket vending booths per station. Security controls slow down the access to platforms, while the card reading machines, both at entrance and exit, often malfunction. The overall experience may be unpleasant, even if the LRT and MRT offer fast transportation at low cost.

An expansion of the rail transit system in Manila is needed. While routes of future new lines have been drawn for a long time (Razon 1998), financing for construction has not been secured. There are also issues with land ownership along the planned routes, and with clearing the right-of-way where ground-level rail track already exists, since it is often colonized by squatters. Reducing the crowds on EDSA-MRT trains would require a huge effort to develop alternate routes. At the present time, the choice for most people is to either endure overcrowded trains or suffer traffic jams in EDSA-plying buses.

5.2 Addressing supply constraints and managing demand

One obvious temptation is to allocate more space to vehicles and therefore reduce congestion. This policy would have two sides. The first one would involve developing new infrastructure. The second one would limit the number of vehicles authorized at any time.

Developing new road infrastructure means investing heavily in state-of-the-art overpasses and urban elevated roads, in the Shanghai mode. Where should these roads be built? Since EDSA is the major metropolitan-wide traffic problem, should it be widened? The heavy building of shopping malls and office towers alongside its route makes it difficult, considering that EDSA for most of its length is already a very large roadway, almost a freeway in some sections. Should a super-EDSA, above the current one, be built? There are logistical problems in some area such as Cubao where the LRT 2 already passes above the MRT which is itself above the EDSA roadway. In an metropolitan area potentially prone to major earthquakes, would it be wise to make thousand of cars “fly” 20 or 30 meters above ground? There is also the classic dilemma of building for more cars which allows smoother traffic, for a while until the new road space fills and the whole process of widening must be started again.

Reducing the number of cars on the road has been attempted with a vehicular license scheme which bans on certain days vehicles with certain license plate ending numbers. It is very easy to go around this restriction. Some have suggested to use the vehicle type as the base for restrictions: no Toyotas on Mondays, no Hondas on Tuesday… Is it feasible? Toyota is largely dominant. A Toyota ban on some days would create huge uproar. Would it also apply to ubiquitous Toyota taxicabs?
Linking the restriction to the level of polluting by these vehicles may not be effective in Manila, since most private cars are fairly new Japanese or Korean models with good pollution performances, while the biggest contributors to vehicular pollution are jeepneys and tricycles, as well as buses. A better coordination of traffic lights, with timing adjusted to traffic density, would be a beneficial measure to insure a smoother flow of traffic and therefore less air pollution.

Should access be linked to the number of passengers, following the example of United States HOV (high occupancy vehicle) lanes? In a societal and economic context closer to the Philippines, Jakarta has implemented a system limiting access to its Central Business District (CBD) to cars carrying at least 3 people. It may be more difficult to implement in Manila since the CBD is in multiple locations. It would have really an impact if all cities with major CBDs (Makati, Mandaluyong, Taguig, Quezon City) were to act together, under the umbrella of MMDA. Car-pooling should be encouraged and rewarded, possibly with free parking in business centers.

A recent measure bans trucks from EDSA during daylight hours. But trucks are not the problem; they represent a very small portion of EDSA traffic. However, the question of trucks is more intense near Manila’s port. In the last two decades, some port activities have been transferred out of Manila harbor towards Subic Bay and Batangas, about 100 kilometers away from North and South Manila, respectively. Manila’s harbor is very close to the oldest part of town and the high densities of Tondo. Decongesting the port activity would limit the traffic of trucks in the metropolitan areas close to it and contribute to improvement in local traffic.

5.3 Bus policies

Jakarta has decided to go the South American way by developing a BRT system. Could a BRT system be implemented in Manila, especially on EDSA? Since most major bus routes use EDSA it may be possible to run it the same way as in Guangzhou, China, where bus, both public and private, enter and exit the BRT corridor. It could be done at a minimal cost by reserving some sections of the existing road to buses, doing in fact a "BRT light", the same way Paris has implemented bus lanes where cars are not allowed. This could be attempted quickly before a more complete BRT system can be implemented. Financing for a small make-over of EDSA could be obtained by charging a special tax on users, to be used exclusively for improvements on bus transit. However, the very essence of the BRT model, as created in Curitiba and followed elsewhere, is to operate the bus vehicles in a metrorail mode, with controlled access stations, clearly separated right-of-way and payment of bus in station and not on board the buses.

At the current time, Philippine authorities have decided to attack directly the bus problem on EDSA with two complementary measures, aimed at providing more fluidity in bus transit. The first one is to try to put some order in the way people embark and disembark from local buses. In December 2012, a “bus segregation scheme”, divided buses in three groups, A (Edsa-Alabang), B (Edsa-Bacoor) and C (others). Alternate bus stops have been erected alongside EDSA: “A” buses can only pick up/drop-off passengers in “A” designated stops (colored red), while “B” buses stop B stops (blue color). “C” buses may use both “A” and “B”. The hope is to limit the number of sudden stops of buses and the jockeying into position of rival buses. The A, B or C sign is prominently displayed in the front of the bus.

The second measure, which will take effect on July 15th, 2013 and possibly revolutionize the transportation system of Manila and the whole Philippines, is to remove all provincial buses from EDSA by creating integrated terminals on the outskirts of the metropolitan area, where provincial buses will stop and transfer passengers to metropolitan transportation. The scheme is inspired by what has been done in the Republic of Korea (Seoul’s Gangnam district), as well as in Indonesia (Surabaya’s Purabaya/Bungurash integrated bus terminal). The first integrated terminal will serve the provinces of Batangas and Cavite, to the Southwest of Manila. “Coastal” is located near Unionwide Mall, between Mall of Asia and Manila’s airport. It will remove all Batangas or Cavite-bound buses from EDSA, therefore starting to reduce the bus-caused congestion. Buses from the LRT1 and MRT end stations and bus routes leading to “Coastal” will allow transfer between local transportation and provincial buses, also possible in Alabang in Muntinlupa, for years a major ending/starting point for local bus

Other possible routes for BRT in Manila include the North-South Roxas Boulevard, Quezon Avenue and Commonwealth Avenue in Quezon City, which are both wide enough, long enough and used enough to justify BRT.
lines and a popular transfer point. Two mixed-use terminals (transportation, offices, shopping) are planned for other routes.

Figure 7: Transferring Provincial Buses Traffic Out of EDSA: The Integrated Bus Terminal

On the former Food Terminal site in Taguig, for buses going Southeast of Manila towards Laguna and Quezon provinces and the Bicol region of South Luzon, a new complex named “Arca South” is built by Ayala Land Inc., a major real estate developer. This group will also be the lead planner and manager of the northern integrated terminal, in Quezon City, next to Trinoma and SM North Mall, close also to the planned Quezon City CBD. “Vertis North” will serve all bus routes going North, towards the peri-metropolitan provinces of Bulacan and Pampanga and all points in northern Luzon.
Integrated bus terminals already exist in Philippines provincial cities, often at their edge – Mabalacat-Dau near Angeles City (Pampanga) and Lucena (Quezon), –, but the task at hand is much bigger for the megacity of Manila. When all is implemented, probably in 2016, there should be no more provincial buses on EDSA. This is expected to change the habits of people, who are used to hopping on the first bus passing by on EDSA. Under the Korean-inspired integrated bus terminal system, tickets with designated seat numbers will be issued to passengers (De La Cruz 2012). This is to ensure orderly boarding and some safety for passengers, since the identity of fellow travelers will be traceable in case of theft on board the buses. It may also end the practice of buses traveling with many extra passengers standing in the aisles, with no concern to their safety. Departures and arrival of buses will be synchronized, with a hoped-for 10 minute turnaround time of buses, as achieved in Seoul.

There is strong resistance from the bus companies to change their traditional ways of operation, but a corresponding decisiveness from the chairman of MMDA and the transportation minister of the Philippines, pushed to act by the growing impatience of the public about traffic jams. However, a number of unresolved issues remain, including the aggressive style of driving of bus conductors, oversupply of local buses running half-empty, and poor emission standards for buses. Many bus companies are controlled by well-connected personalities, politicians, military officers, showbiz or sports celebrities, who have the political clout to resist attempts to rationalize the supply of bus service and implement strict norms for buses. The same resistance is seen from the many small operators of jeepneys and tricycle, who are politically powerful as a rich source of votes. Political will is necessary to implement measures aimed at taking out of circulation aging and polluting vehicles to reduce vehicular traffic, both on EDSA and on local roads.

CONCLUSION

Solving congestion on EDSA – and in the Manila metropolis as a whole – will not be quick or easy (Santiago 2012, Alcazaren 2013b). The street pattern cannot be altered in one year, and local congestion will remain. Building more roads may not be efficient on the long term. Instead, more effective policies would be to improve the rail system, with more lines, more frequent spacious trains, better connected stations.

In some parts of EDSA, intermodality appears to work quite well, with easy transfer from MRT and buses to jeepneys and trisikel; this should be replicated as much as possible in other areas. To diminish the level of pollution generated by these vehicles, strict and mandatory emissions controls and effective standards implementation to phase out non-compliant vehicles should be imposed, while keeping in mind their everyday usefulness for commuters including students (half of the trips in Greater Manila), and their job-creation potential (250,000 jobs in Metro Manila). There should be an effort towards e-jeepneys, but vehicles currently tested are much smaller than current types, 12-15 seats instead of 20 to 30. Should the jeepney, an icon of Filipino culture, disappear as a dirty and inefficient transport vehicle? If traffic is tamed, clean jeepneys could continue to play a role, as would the lowly trisikel and pedicab, serving small neighborhood streets, with much higher standards of comfort and emissions.

The effectiveness of the new policy on provincial buses will quickly become apparent if traffic volumes diminish substantially after the opening of the Coastal integrated bus terminal. But a substantial reorganization of the whole bus system should also be attempted, by encouraging bus companies to regroup into a smaller number of operators able to manage their fleets more efficiently, which would allow them to invest in a reduced fleet of clean, fuel-efficient clean vehicles, while providing good service to the traveling public. Twenty operators on one route, which share 75% of its length, and another route served by 15 other small operators does not make much sense. Three or four players on the main routes would be more than sufficient, and would allow more brand identity and differentiation. The same could be said of the myriad micro-enterprises engaged in trisikel or jeepney management. Private management of bus, jeepneys and trisikel companies (and why not companies operating all 3 types vehicles as one integrated transport system?), under public government guidelines, could become the new norm, as it is in London or Seoul. This will not require much public investment in a country strapped for funds.

Making Manila a more sustainable city will imply profound changes in the way the transportation system of the metropolitan area is managed.
Acknowledgement

The author gratefully acknowledges the support of the University of the Philippines - Diliman for a 4-month stay in Quezon City as invited professor in the Department of Geography. Special thanks to M.S. Martinez for the drawing of the map.
REFERENCES


“PEDESTRIAN DAY” EXPERIENCE IN THIMPHU, BHUTAN

Ishtiaque Ahmed and Gyamlbo Sithey**

ABSTRACT

Thimphu, the capital city of Bhutan faces significant traffic congestion and air pollution as traffic continues to grow rapidly. In June 2012, the Government designated every Tuesday as a vehicle free day in the core Thimphu area, known as the Pedestrian Day (PD). A considerable number of people resisted the initiative with dissatisfaction. The Government then announced in November 2012 that the PD would be observed on the first Sundays of each month. Ultimately the entire initiative had to be withdrawn in August 2013. Results of a survey conducted by the Center for Research Initiatives (CRI) after the PD initiative was just initiated were compared with the results of a new survey conducted once the PD initiative was withdrawn. While the first stage survey showed that 57.8% of respondents supported the concept and 54.0% wanted discontinuation of the PD, the study found that at the second stage, more respondents, i.e. 62.0%, supported the idea but also more respondents (63.3%) did not want the PD to be continued. Primary factors identified were; a) lack of stakeholder consultation; b) inadequate implementation planning; and c) inadequate facilitation of alternatives. The experience of Pedestrian Day in Thimphu suggests that prior stakeholder consultations and preparatory measures are necessary for the successful implementation of this type of sustainable transportation program.

Keywords: Pedestrian Day, Sustainable Transport, CBD Traffic, Thimphu Traffic.

INTRODUCTION

Thimphu, the capital city of Bhutan is a small city with a population of 140,000 (2013), spread across an area of 26 square-kilometres. The city is located in a mountainous area with altitudes averaging approximately 2325 metres above the mean sea level. The population of the city is growing fast at a rate of 12% annually. However, the vehicular growth is even faster, as indicated by an increase of 75% between 2007 and 2012 in the Thimphu region. As of 31 December 2012, out of the 35,965 registered vehicles in the Thimphu region, 22,103 were private light vehicles (LVs) including cars and 3617 taxis (Road Safety and Transport Authority, 2013). The city is already facing housing shortages, traffic congestion, air pollution and chaotic pattern of developments. Private and public agencies, as well as individuals, are going for “city building” in a disjointed and adhoc manner. This results in “spotty growth,” whereby fragmented pockets of development require services and infrastructure. These dispersed pockets are not large enough to support any given city service system, and are too far apart to efficiently link with city level service systems (Department of Urban Development and Engineering Services, 2004).

The core area of Thimphu, with an area of 1.2 square-kilometres, is the heart of the city and consists of various types of land-uses, including the major business activities. There are three major streets in the core area known as a) Norzin Lam; b) Chang Lam; and c) Doebum Lam, with Norzim Lam being the most popular and the most congested.
The revised Thimphu Structure Plan of August 2004 (Department of Urban Development and Engineering Services, 2004) mentions that planning for the movement of people and vehicles in Thimphu city goes beyond fulfilling the basic issues of connectivity. Any transportation plan for Thimphu city has to take into consideration a myriad of factors. Social isolation occurs when the ‘bread winner’ drives off in the only family car, leaving the wife and children to find for their own transportation. Servants and labourers, as well as young professionals and office staff have differing mobility needs. The high rate of vehicle ownership in the city, i.e. 35,965 vehicles for 140,000 population (Road Safety and Transport Authority, 2013) contrasts with the culture of “Walking” which is an integral part of the Bhutanese lifestyle. The private vehicles driving down narrow city roads threaten the safety of pedestrians. Public transit routes are under-utilized and today, the citizens give more priority to own a car than a house. These trends have a significant impact on the social aspects too: the informal interactions during short walks to nearby shops or during a bus ride to work do not take place anymore, as people prefer to drive private vehicles to the vegetable market, to the restaurant, or to the work place (Department of Urban Development and Engineering Services, 2004).

According to the revised Thimphu Structure Plan of August 2004 (Department of Urban Development and Engineering Services, 2004), Norzin Lam, one of the three main streets of the central core area, was proposed to be pedestrianized. In addition, and coinciding with World Environment Day on June 5, 2012, the Government passed an executive order declaring every Tuesday to be observed as a "Pedestrian Day (PD)". It was to be observed in all twenty (20) districts as a measure to sensitize the public on environment and to reduce the carbon foot-print. From 8 a.m. to 6 p.m., core urban areas including Thimphu and Phuentsholing were to become a pedestrian zone, and only service vehicles such as ambulances, fire brigades, armed force vehicles, buses, taxis and bicycles were allowed to ply the core city area roads. The “even” and “odd” registration number plate taxis would be allowed in alternate PDs. The plan was shaped by five implementing agencies - the National Environment Commission Secretariat, Thimphu City Corporation (Thimphu Thromde), Road Safety and Transport Authority (RSTA), Thimphu Traffic Division and the Bhutan Post.1

Contrary to the Government’s expectations, the media cited immense public dissatisfaction with the manner in which the initiative was implemented. Consequently, in the SMS and online poll

1 The PD was not a new idea in 2012, as a similar initiative was introduced by the agriculture ministry in August 2008, interestingly called “the HEHE (Helping Environment, Health and Economy) walk” expected to save 300 litres of fuel every Tuesday. However, the initiative lasted only for a year as the enthusiasm could not persist.
organized as part of a live debate organized by the Bhutan Broadcasting Services (BBS), an overwhelming 2,847 votes were cast against the PD while only 1,315 supported it. It may be noted that people who participated in an online or SMS poll are those who have access to the internet or a mobile phone, and most likely to have a car. On the other hand, a National Environment Commission (NEC) survey in Thimphu said that of 500 people interviewed, 316 said “yes” to the PD, 94 said “no” and 90 remained “neutral”. While the BBS poll was accused of being hijacked by the anti-PD groups, the NEC survey was criticized as being biased, given that the commission was in favor of the PD (Centre For Research Initiatives, 2012).

However, under pressure from the public, the Government changed its policy in November 2012. The Lhengye Zhungtshog (Cabinet of Ministers), during its 146th session held on November 13, 2012, decided that henceforth Pedestrian Day shall be observed on the first Sunday of each month beginning Sunday, December 2, 2012. In addition, June 5, which is World Environment Day, was also to be observed as Pedestrian Day every year in the country (Cabinet Secretariat, 2012). In spite of this change, however, the dissatisfaction of the city dwellers persisted and in August 2013, the first sitting of the Cabinet decided that Pedestrian Day would be discontinued with immediate effect. The Cabinet arrived at this decision after an internal discussion showed that the PD caused problems for the general public, especially in times of emergency, and affected the business community drastically (Bhutan Observer, 2013).

Considering the public interest and aiming to arrive at an independent understanding of the PD, a comprehensive set of surveys were conducted by the Center for Research Initiatives (CRI), Thimphu, Bhutan on September 15-16, 2012 (Center for Research Initiatives, 2012). The findings of the first survey (henceforth referred to as the first stage survey) revealed that Thimphu city dwellers liked the concept of the PD, but did not want it to be continued. Then immediately after the Government announced the discontinuation of Pedestrian Day, a second survey was conducted (referred to as the second stage survey). The objective of this paper is to compare the perceptions of the city dwellers of Thimphu of the Pedestrian Day initiative at the two different stages or points in time.

![Pedestrian Day Road Map](Source: Traffic Police, Thimphu Division)
I. METHODOLOGY

To facilitate a comparison between the two different stages of surveys, the same methodology that was followed in the first stage survey was adopted during the second stage survey. The primary sampling units were clusters stratified by population size according to the National Statistical Bureau (NSB) and the household selection was administered through simple random sampling basis. In the first stage, 1000 respondents were surveyed, while at the second stage, 300 respondents were surveyed. Of 72 areas of Thimphu listed by NSB, 30 were selected by Probability Proportionate to Size (PPS) method. Random route procedures were used to select sample respondents. Unless an outright refusal occurred, interviewers made up to three attempts to survey the sampled household. To increase the probability of contact and completion, attempts were made to meet at different times of the day and on different days of the week. If an initial sampled household could not be interviewed, a simple substitution method was applied.

II. RESULTS OF THE SURVEYS

2.1 First Stage Survey (September 2012)

The first stage survey was conducted by the Center for Research Initiatives (CRI) when the PD day observance had just been initiated. A sample of 1,000 people over the age of 18 and living in Thimphu was chosen. Of the respondents, 49% (529) were male and 51% (550) were female, while only 15.5% were not educated. Meanwhile 35.4% (383) were civil servants, 19.9% (215) housewives, 21.2% (229) private employees, 12.8% (139) business people, and 0.9% (10) were taxi drivers. About 50.4% respondents used their private cars for daily transportation, while 22.4% used taxis, 16% city buses, and 8.9% walked.

According to the findings of the first stage survey conducted by CRI in September 15-16, 2012, the PD was something good for taxi drivers, and so their support to it was the highest at 70.0%. About 63.3% of private employees and 61% of civil servants and housewives also supported the idea. The lowest support came from business people, at 50.4%.

However, the feelings of the city dwellers were mixed as more were in favor of discontinuation of the initiative than for continuing it. The majority (80%) of the taxi drivers said PD should be lifted and discontinued for the primary reason that the even/odd number plate rule applied in addition to the PD brought taxis from other districts, making the taxi business competitive and affecting their incomes. In addition, 58.3% of housewives, 55% of private employees, 50.3% civil servants and 48.9% of the business persons/shop keepers wanted the PD to be discontinued.
The basic findings of the first stage survey conducted by CRI are tabulated in Table 1:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting PD</td>
<td>57.8%</td>
<td>32.6%</td>
<td>6.5%</td>
<td>100%</td>
</tr>
<tr>
<td>Discontinue PD</td>
<td>54.0%</td>
<td>29.9%</td>
<td>12.1%</td>
<td>100%</td>
</tr>
</tbody>
</table>
2.2 Second Stage Survey (August 2013)

The second stage survey was conducted in August 2013, when the PD day scheduled for the first Sunday of each month was just withdrawn. The sample selection was done following the same procedure as followed by CRI for the first stage survey. A sample of 300 people above the age of 18 and living in Thimphu was chosen. Of the respondents 49.6% (149) were male and 50.3% (151) were female, while 17.5% were not educated. About 50.8% respondents used their private cars daily, while 20.3% used taxis, 18.1% city buses, and 10.2% walked.

The second stage survey revealed that in a similar way to the first stage survey, the concept of the PD was considered something good for the taxi drivers and their support to it was the highest at 72.4%. About 64.13% of private employees, 68.0% of civil servants and 63.1% housewives also supported the idea. The lowest support came from the business people at 52.24% this time as well.

In the second stage survey, the support towards continuation of a PD was found to have gone down in general. The feelings of the city dwellers were again mixed, with more and more in favor of discontinuation of the initiative. At this stage, 65.3% of the taxi drivers said PD should be lifted. Also 62.7% of the housewives, 65.0% of private employees, 55.5% civil servants and 71.3% of the business persons / shop keepers wanted the PD to be discontinued. Out of the 300 persons surveyed, 190 respondents wanted the PD to be discontinued.

Figure 3: Percentage of Respondents Supporting the PD (Second Stage)
The basic findings of the survey conducted in this study are tabulated in Table 2:

Table 2: Basic Findings of the Second Stage Survey

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Not Sure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting PD</td>
<td>62.0% (186)</td>
<td>28.3% (85)</td>
<td>9.7% (29)</td>
<td>100% (300)</td>
</tr>
<tr>
<td>Discontinue PD</td>
<td>63.3% (190)</td>
<td>34.3% (103)</td>
<td>2.3% (7)</td>
<td>100% (300)</td>
</tr>
</tbody>
</table>

2.3 Comparison of two surveys

The results of the two different stages of surveys were compared, as shown in Figure 5 and Figure 6 below.
The study showed that the city dwellers in principle were in favor of the Pedestrian Day (PD) concept in Thimphu, Bhutan. However, the majority of them did not want the PD to be continued. Through comparison of the results of the two different stages of surveys, one important finding of the study is that more and more people started liking the concept of the PD through awareness, experience and with time. However, as time elapsed and with difficulties experienced during the PDs, more and more people started asking for discontinuation of the initiative.
Following the information gathered from the CRI survey of the first stage, at the second stage of the survey (as a part of this study), one of the items in the questionnaire was that why the respondent wanted the PD to be discontinued (provided it was applicable) and six choices were available. Multiple selections were allowed. The following bar chart shows the reasons chosen by the respondents that why they did not want the PD to be continued.

Figure 3: Reasons for Wanting Discontinuation of the Pedestrian Day

Other reasons for wanting the PD to be discontinued included a) unregulated taxis and overcharging of taxis during the PD; b) poor bus services in the core area was unable to support the additional need; c) inconvenience to parents with small school going children and d) inconvenience to the nursing mothers.

III. CONCLUSIONS

The results of the two different stages of surveys showed that the city dwellers in principle were in favor of the Pedestrian Day (PD) concept in Thimphu, Bhutan. However, the majority of them did not want the PD to be continued. Through comparison of the results of the two different stage surveys, one important finding of the study is that more and more people started liking the concept of the PD through awareness and understanding. However, as time elapsed and with people experiencing various difficulties from the PDs, more and more people started asking for discontinuation of the initiative.

The survey results revealed that a) lack of stakeholder consultation before taking the administrative decision; b) inadequate implementation planning and insufficient implementation of mitigation measures; and c) inadequate provision for alternative modes of transport were the primary reasons for disfavoring the continuation of the PD. Other reasons included additional walking and climbing hills as the topography of the core area made walking difficult and tiring and the financial loss for business owners in the downtown area.

One observation is that the decision of the PD was passed through an executive order and no systematic stakeholder consultation was done by the Government. Though some implementation planning was done, the mitigation measures taken for the observance of the PD were inadequate and not sufficiently implemented. For example, the topography of the core area did not encourage mothers with small children to walk and bus service remained at the same level as before, despite the
increased demand arising from the introduction of the PD. From the experience drawn from Thimphu, Bhutan, it can be concluded that prior to implementation of any proposed Travel Demand Management (TDM) measure in particular, and probably prior to implementing any sustainable transportation initiative, requires a) adequate stake-holder consultation; b) very thorough and appropriate planning and implementation of mitigation measures; and c) adequate supply of alternate modes to the one which is being restricted (i.e. private vehicle use).
REFERENCES


