

# *Sustainable Urban Transport in Asia*

*Making the Vision a Reality*

MAIN REPORT



*A CAI-Asia Program*

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# Abbreviations

ADB	Asian Development Bank
APMA	Air pollution in the megacities of Asia
ASEAN	Association of Southeast Asian Nations
BAQ	Better Air Quality
BRT	bus rapid transit
CAI-Asia	Clean Air Initiative for Asian Cities
CDM	Clean Development Mechanism
CMS	content management system
CNG	compressed natural gas
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
EMBARQ	WRI Center for Transportation and the Environment
EST-UNCRD	Environmentally Sustainable Transport—United Nations Centre for Regional Development
GATNET	Gender and Transport Network
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GIS	geographic information system
GPS	global positioning system
GTZ-SUTP	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Cooperation) Sustainable Urban Transport Project
I-ce	Interface for Cycling Expertise
IIT	Indian Institute of Technology
IT	information technology
ITDP	Institute for Transportation and Development Policy
km	kilometer
km <sup>2</sup>	square kilometer
LNG	liquefied natural gas
LPG	liquefied petroleum gas

MDG	millennium development goals
MoU	memorandum of understanding
NGO	non-government organization
NMT	non-motorized transport
NOX	Nitrogen oxides
PM	particulate matter
PM10	particulate matter with diameter less than ten micrometers
PM2.5	particulate matter with diameter less than 2.5 micrometers
PPP	purchasing power parity
PSUTA	Partnership for Sustainable Urban Transport in Asia
SF	Strategic Framework for Sustainable Urban Transport
SMSA	Standard Metropolitan Statistical Area
SUT	sustainable urban transport
SUTP	Sustainable Urban Transport Program (Bangkok)
TDM	transportation demand management
TRB	Transportation Research Board
US	United States (of America)
USA	United States of America
WBCSD	World Business Council for Sustainable Development
WHO	World Health Organization
WRI	World Resources Institute

# Acknowledgments







# Executive Summary

**T**HE Partnership for Sustainable Urban Transport in Asia (PSUTA) is an initiative of the Clean Air Initiative for Asian Cities (CAI-Asia) with support from the Swedish International Development Agency, the Asian Development Bank and EMBARQ the World Resources Institute Center for Transport and the Environment (<http://www.cleanairnet.org/psuta/>).

PSUTA was established as a response to the extraordinary—and largely uncontrolled—growth of motorized transport which threatens air quality, has contributed to increasing congestion and is responsible for hundreds of thousand persons killed each year due to poor road safety. It developed partnerships with Hanoi, Vietnam; Pune, India; and Xian, China.

PSUTA has helped to raise the awareness on sustainable urban transport and encouraged cities and governments to intensify efforts to improve the sustainability of their transport systems. At the same time PSUTA has been instrumental in building the relationship between international and regional organizations

*PSUTA has helped to raise the awareness on sustainable urban transport and encouraged cities and governments to intensify efforts to improve the sustainability of their transport systems*

working on sustainable urban transport in Asia. Together these organizations have now developed the Sustainable Urban Mobility in Asia (SUMA) project. With an anticipated starting budget of \$6.5 million, SUMA will be able to take the sustainable urban transport agenda as developed under PSUTA and make a significant contribution towards its implementation.

Following the documentation of existing resources on sustainable urban transport (<http://www.cleanairnet.org/caiasia/1412/article-60116.html>) the PSUTA partners developed a Strategic Framework for Sustainable Transport. The Strategic Framework analyses the challenges facing urban transport systems in Asia and proposes that policy makers focus on improving access of people to work, services, leisure, and each other without compromising future generations' ability to do the same. (<http://www.cleanairnet.org/caiasia/1412/article-60117.html>). The Strategic Framework makes the linkage between sustainable urban transport and effective environmental management, poverty alleviation and inclusive social development. Decision makers on urban transport and other stakeholders are guided on how the Strategic Framework can be utilized in designing and implementing effective urban transport policies and programs by adopting a consultative and participatory approach.

PSUTA together with its partners in Hanoi, Vietnam; Pune, India; and Xian, China developed indicators of sustainable transport to help decision makers in these cities to better understand the current sustainability, or lack of it, of their urban transport systems and to develop more structured and quantified approaches to policy making. The goal was not a complete set of numbers, rather a recognition of which indicators counted the most for good policy development and a strategy to get the information required for those indicators. The process to formulate the indicators showed in all three cities that while transport related information is generally available at a general level it is not shared well and not properly accessible to interested stakeholders. Air quality information is still less well developed, especially information on the contribution of transport to overall air pollution levels.

Our overall view of the sustainability of transport in these cities was pessimistic. Congestion is increasing and access decreasing; transport-caused air pollution appears to be on the increase. Accident rates per km were falling, but total fatalities per km still remain among the highest in the world. Social issues are often not considered. The economics of public transport are marginally positive, but threatened by increased use of private vehicles. Perhaps most encouraging is the way in which governance is improving, pushing hard on cleaner fuels and vehicles, and better road safety. Whether the policy process can increase safety and access for the poor, for those who still walk or cycle, still remains to be seen.



# 1

## Background

**T**HE objective of the Partnership for Sustainable Urban Transport in Asia (PSUTA) is to work with stakeholders in Asian cities to identify indicators of sustainable transport for use in the policy making process. It is a response to the extraordinary—and largely uncontrolled—growth of motorized transport through most of Asia.

PSUTA, a pilot program of the Clean Air Initiative for Asian Cities (CAI-Asia) was funded by the Swedish International Development Agency and the Shell Foundation through the Asian Development Bank and EMBARQ. The work took place between the spring of 2004 and the fall of 2005. The project focused on developing indicators of sustainable transport together with empowered stakeholders in Pune (India), Hanoi (Viet Nam) and Xi'an (China). The partnerships that underpinned this work were supported by memoranda of understanding (MoU) between ADB and the city leaders. EMBARQ provided the organizational and intellectual leadership and responsibility for this report.

*With exposure to data from their own cities, local teams learned what they did and did not know about sustainable transport, and thus obtained a better sense of what decisions they could make about transport with greater—or lesser—confidence about the challenges and possible outcomes intervention would yield*

The PSUTA has produced a number of outputs that are outlined in this introduction. Behind each of them, however, are the engagement and alliances that the PSUTA has spawned among people in its partner cities and among other Asian stakeholders. In each city, experts in safety, air pollution, traffic congestion, and transport economics worked together, often for the first time, in shared projects. Between the cities, stakeholders developed a Lingua Franca to discuss their common—and differing—sustainable transport challenges in a quantitative way. With exposure to data from their own cities, local teams learned what

they did and did not know about sustainable transport, and thus obtained a better sense of what decisions they could make about transport with greater—or lesser—confidence about the challenges and possible outcomes intervention would yield.

This engagement based on a quantitative approach is critical for the future of sustainable urban transport in Asia. For the first time, both specialists and decision makers in the various aspects

of transport (traffic congestion, safety, emissions) worked together in ways that permit them to join forces for the common goals of sustainable transport. By tying transport to local emissions, the PSUTA also introduced issues related to fuel, and therefore GHG emissions and climate change, to a broader transport community in Asia that previously had little time for this concern. This means that other forces for more sustainable transport can be harnessed to restrain growing GHG emissions from transport as well.

Unfortunately, the outcome of the project also found that passenger transport is headed in unsustainable directions in all three partner cities. Rising motor vehicle emissions, coupled with the very high share of trips people take in open air (foot, cycle, moped), means health problems from air pollution.

Rising traffic and congestion, particularly the share of individual traffic in two cities, means people are slowing down. Very high accident rates, particularly those related to pedestrian/cycle activities or moped use, are only falling slowly as overall mobility rises rapidly. While all three cities have firm plans for better collective transport, the rising ownership of cars in Xi'an and increasingly universal access to two-wheelers in Hanoi and Xi'an threaten the ridership base for good mass transit. Fortunately, the indicators work undertaken by the project in these cities helped convince city leaders that time for action is short.

*The ultimate goal of PSUTA is to stimulate empowered authorities to act to improve transportation using a quantitative approach supported by indicators*

### **Project Goals and Objectives**

The scope of the PSUTA is urban transport and environment in Asian cities, focusing on strengthening sustainability of low-emissions transport and mobility in Asian cities. The goal is to contribute toward enhancing environmental sustainability of transport and mobility in Asian cities through developing and applying quantitative measures of sustainability and progress toward sustainability in a number of selected cities. The purpose is to develop and discuss a conceptual approach of city-based sustainable transport planning relevant for Asia. The ultimate goal is to stimulate empowered authorities to act to improve transportation using a quantitative approach supported by indicators.

### **Project Structure**

The PSUTA was structured in a decentralized way. After the MoUs were signed, EMBARQ, ADB, and various leaders selected a local institute to be recipient of a subgrant from EMBARQ to gather data and develop indicators. Each partner was aided by a mentor appointed and compensated by EMBARQ to guide local experts in developing indicators. This report summarizes the key results of the work in the three cities. Reports the cities themselves wrote, edited by EMBARQ,

appear separately. The hard work of the teams for Hanoi, Pune, and Xi'an are gratefully acknowledged. Presentations of the three cities at BAQ04 can be found at <<http://www.embarq.wri.org/en/Article.aspx?id=28>>.

As the project began, ADB, through the CAI-Asia Secretariat and a consultant undertook the task of reviewing recent experience and capacity for sustainable transport in Asian countries and cities. This survey was broader than the in-depth work in the three partner cities, but gave a good overview of current activities in Asia. Results have been posted on the CAI-Asia web site (<http://www.cleanairnet.org/caiasia/1412/article-58616.html>) and summarized briefly in this report.

The second major output of PSUTA, the Strategic Framework for Sustainable Urban Transport (SF) was developed through a consultative workshop in Hanoi in August 2004. The SF will also be published separately.

The actual process of defining and collecting data for indicators was established through stakeholder meetings in each city. This was followed by one or two visits by the mentor, along with frequent contacts with the EMBARQ core staff. The PSUTA principals and mentors from each city held a framing workshop in Hanoi in late August 2004. They were joined for a second workshop in which well-known experts from around the Asia region discussed issues related to sustainable transport. Additionally, a small group of experts from around the world served as a reference group to provide advice to the entire process in Hanoi. These discussions were essential for reaching consensus on the nature of sustainable transport and a broad set of indicators that each city should strive to develop in the project.

Many of the same principal participants assembled again at BAQ-2004 in Agra, India. Each country's findings to that date were presented at a BAQ sub-workshop, and a separate side event was organized for the PSUTA participants, SIDA, and ADB to discuss the project.

### **This Report**

This report summarizes the main findings from the PSUTA. After presenting the strategic framework, a broad theory of indicators of sustainable transport is developed. This is followed by a description of some of the indicators as they were developed by the three partner cities. Their assignment was to develop indicators, noting the gaps in information and suggesting ways of bridging those gaps in the future. Noting some of the shortcomings of each city's findings, some general lessons are drawn, particularly the sustainability of transport in each PSUTA city. Recommendations are included for supporting the key aspects of filling the gaps. A key theme that runs throughout the report is that the goal of the PSUTA is not wide data collection, rather identification of what data and indicators are necessary for each city's leaders to make good decisions on sustainable transport.

### **Appendices**

This report will be followed by a series of appendices. The first of these contains the "Synthesis of Experience" on sustainable transport planning in Asia and elsewhere, focusing on available tools, challenges, existing and potential projects, research institutes, and resource persons. The second contains the three city reports, while the third will develop a short manual of sustainable transport indicators.





# 2

## Synthesis of Experience

### Documentation of Sustainable Urban Transport Resources

**T**HE Partnership for Sustainable Urban Transport in Asia (PSUTA) has been collecting, reviewing, organizing, and disseminating information on sustainable transport in Asia in order to improve sustainable transport policy processes and outcomes. The review of existing related documents is one of the project's key outputs. Since sustainable urban transport is a relatively new field, there has to be a systematic overview of the kind of information that is available. Decision makers need to have easy access to such information, which are important and relevant to the formation of good transport policies. Unfortunately, information that aids sustainable transport development is still currently missing or fragmented.

The main rationale of this exercise is to document resources on sustainable urban transport in Asia and make them available to a wider audience through the CAI-Asia web site. This information can potentially be used in policy formulation

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and development planning to create a paradigm shift toward improved transport sustainability. Although there are existing web sites that provide such information, many of these web sites usually offer only their own outputs and/or have not documented information from outside sources. The PSUTA web page in the CAI-Asia web site aims to fill this gap,<sup>1</sup> and to become a sustainable transport data and information hub.

A key objective of PSUTA is to record existing information about sustainable transport into a database and post the material on the CAI-Asia web site. The CAI-Asia web site is jointly maintained by the CAI-Asia Secretariat of the Asian Development Bank and the World Bank, although all PSUTA-related work is handled by the team based in ADB. As of 26 September 2005, approximately 342 documents were available on the CAI-Asia web site, all of which were obtained through the information collection efforts of PSUTA. These documents are available either as a downloadable file or a web link to an external web site.

To keep stakeholders informed of recent developments, projects, policy changes and documents on sustainable transport, the PSUTA News Digest is sent out once a week. On average, five to ten news links have been sent out each week since August 2004. Announcements of upcoming events and newly posted documents on SUT are also included in the digests. A monthly archive of articles that were included in the digest will be posted online as downloadable files. It should be noted that a number of organizations and projects have set up similar ways to communicate up-to-date information to a targeted audience (e.g., SUSTRAN Network; New Mob/World Transport Forum; GATNET; ITDP's Sustainable

Transport E-Update; WBCSD Sustainable Mobility; Sustainable Transport Coalition; Car Free Discussions; and the Development Gateway).

Similarly, in the case of related web sites, there are a number of regional programs with a substantive Asia presence that focus on some aspect of sustainable transport. Examples include EMBARQ/WRI ([www.embarq.wri.org](http://www.embarq.wri.org)), Interface for Cycling Expertise ([www.cycling.nl](http://www.cycling.nl)), Energy Foundation China ([www.efchina.org](http://www.efchina.org)), ITDP ([www.itdp.org](http://www.itdp.org)), EST-UNCRD ([www.uncrd.or.jp/env/est](http://www.uncrd.or.jp/env/est)), and SUTP ([www.sutp.org](http://www.sutp.org)). There are also national organizations/programs with well-established web sites such as TRIPP at IIT in Delhi.

An initial assessment of information available in these web sites supports the argument that organizations should focus their efforts on collecting and generating new information, and making this information available in a common “umbrella” site. In such cases, the source of the information will be clearly attributed.

In PSUTA's case, the CAI-Asia web site substantially modified its taxonomy to include topics and subtopics on urban sustainable transport (Box 2.1).

### Box 2.1 Sustainable transport

#### Governance and sustainable transport in general

- Sustainable transport policy
- Bus rapid transit
- Rail and metros
- Taxi cars and vans
- Non-motorized transport
- Two and three wheelers
- Pedestrian planning
- Ferries
- Road infrastructure

#### Environment, health, and safety

- Vehicle emissions and improvements
- Air quality management
- GHG emissions

#### Economic aspects

- Urban transport financing
- Regulation, costs, subsidies
- Urban transport institutions

#### Social aspects

- Public participation
- Urban road safety
- Poverty alleviation and gender
- Transport demand management
- Sourcebook

<sup>1</sup>See <http://www.cleanairnet.org/caiasia/psuta>

This approach is particularly helpful for organizations that do not have enough resources to maintain a web site of their own. CAI-Asia has always offered its members this option. The CAI-Asia web site, through its content management system (CMS), can add, modify, and restructure content according to the needs of the members and target audience. In addition, its efforts in Phase 2 to set up local networks with secretariats offers the promise that information will come in from a large number of different locations in Asia.

It is recommended that SUT organizations disseminate existing information to as many stakeholders as possible, and cooperate with other organizations toward generating new information through groundbreaking research or dialogue.

### **An Assessment of Strengths and Weaknesses**

Information on sustainable transportation can generally be organized into the following four clusters: (1) policy and governance; (2) environment and health; (3) economic and financial aspects, and (4) social aspects and road safety. The coverage of these clusters is reflected in the taxonomy.

For the governance and general policy cluster, information on the formal sector is generally easier to collect than that for the informal sector. Motorized transport modes are sufficiently documented. Statistics on modal split, vehicle registrations, two- and three-wheelers, road length and space, and information on mass transit (rail, bus, and BRT) may be accessed from primary data or from documents and project proposals. Comparative studies on rail systems and BRT systems are available, if not in Asia then on regions with similar conditions such as Latin America. New policies are usually announced to the public prior to its implementation and are well-covered in the news. Information is much sparser on non-motorized transportation modes, like walking and cycling, which are usually not reflected in vehicle statistics and modal split data. Road facilities and their statistics for non-motorized transport (NMT) are minimal, if not

completely nil for Asian cities. Although statistics for motorized vehicles are abundant, these data require regular updates. Vehicle registrations may not reflect the actual vehicles on the road. Some Asian countries follow the practice of accounting for only newly registered vehicles, so in-use vehicles that may have been scrapped are still counted in the registry. These discrepancies can be addressed by GIS satellite images, but these are costly to acquire. Manual vehicle counts are usually limited to major thoroughfares and not updated regularly. Information on vehicle technologies that are in-use are not properly documented, as in the case of two- or four-stroke engines for motorcycles, and vehicle statistics depending on the type of fuel. While policies are widely available, it is more difficult to find information on the implementation status of these policies.

There is a wealth of information on environment and health due to vehicular emissions; their information collection had started even before the PSUTA project. Overall trends on air quality are available. Health impact studies of urban pollution are becoming more widely available. Vehicle emissions reduction strategies and targets are available for most Asian cities and are updated on a regular basis. As fuel standards are harmonized, the environmental and health impacts resulting from their emissions are well-documented, especially for conventional fuels and gas(-derived) fuels such as gasoline, diesel, CNG, LNG, and LPG. Information on alternative fuels and bio-fuels continue to increase. Although resources on health and environment due to vehicular emissions are increasing, cost-benefit studies that relate these aspects to economics, policy, and technology options are still not well-documented. Information on economic costs of health impacts due to vehicle emissions is minimal to nil. Accurate valuation of these costs requires updated emission factors and sociodemographic data. Detailed air quality data, especially for secondary cities, are lacking. While emissions data for diesel and CNG are available, their comparative results vary among the studies.

Emissions data for Asian biofuels are still minimal, and biodiesel information is usually estimated on variants from other regions outside Asia. Asian emission factors are mostly outdated by at least 10 years, which would affect subsequent studies that use these data (e.g. emission inventories, source apportionment estimates). The potential benefits of adopting environmentally sustainable transport studies are not well-documented. A recent informal survey on vehicle statistics and fuel usage shows that this information is not usually monitored. From the survey, only the Philippines, Singapore, and Sri Lanka have this information. These data carry information on conventional fuels only. Statistics on cleaner vehicle technology and alternative fuel usage are minimal and are usually not reflected on motor vehicle registrations, which are segregated by type of motor vehicle.

Substantial information gathered on economic and financial aspects is generally weak for Asia; most are in the form of news items. For developed countries such as Singapore and other westernized regions, information on road pricing and congestion charges is available. Information on the costs of different mass transit systems is also available. Information is likewise available on the use of economic incentives for the introduction of cleaner fuels, and vehicles for both Asian and non-Asian countries. There is limited data on the financial costs of public transport systems in Asia, which are often operating partly or entirely in the informal sector. The size and impact of public transport subsidies and fuel subsidies are not entirely clear. There is also no data on the costs of congestion in Asian cities.

For the social aspects of transportation, information on road safety and transportation demand management, including traffic management, have been discussed sufficiently; their data are more accessible than others. Road safety statistics and studies are available for the ASEAN member countries, China, and some South Asian countries. Transport demand management and traffic management practices and information are available for India,

Korea, Philippines, and Malaysia. Information from outside of Asia is also available. Health and safety impacts are also tackled in relation to transport demand management (TDM) measures. Even if there were data on road safety and TDM, there are still problems with regard to accessing these data and validating them. In general, road safety statistics that are reported officially do not match the estimates made from transport studies. There is a potential wealth of resources on transport demand management in several research institutions (for example, in East Asia) but the full papers or at least their abstracts are not readily accessible. Information on drivers' and other road users' understanding and capabilities on traffic regulations, proper road behavior, and their actual habits can be used as background data for transport planning activities, but these are not available at the moment. Information on gender and poverty reduction and transportation has been discussed, but these are not sufficient. Nuances on road behavior due to gender and local customs also have not been explored in detail, if at all.

### Priorities for the Future

The general concerns for future documentation exercises are on filling data gaps, providing updates, and providing/searching for analyses on these transportation themes. On governance and general policy aspects, information on the informal sector and the modal shifts from private to public transport, and motorized to non-motorized transport must be given priority. A possible review of innovative policies that can be applied to the Asian setting can also be considered in this area. Information gathering on land use planning vis-à-vis general transportation planning can also be considered as a priority. For environment, health, and safety, priority should be given to getting information on health costs due to vehicle emissions, fuel use data for motor vehicles, and usage statistics on clean vehicles. On the economic and financial aspects, much work has to be done in this area, especially information regarding stratified vehicle pricing

and taxation (including green taxes), the role of franchising and its economic effects on the transport providers and users, land valuation due to transport system improvements, and approaches that lead to sustainable financing of urban transport improvement projects. For the social aspects, the priority on transport demand management and road safety must be retained, such as information gathering on road discipline, including driver education and pedestrian/commuter behavior and the possible nuances between genders, and data on facilities (road space, vehicle space) available for the disabled.

### Conclusions

As the documentation of sustainable transportation resources is a dynamic process, it is important to continue this exercise in close coordination with institutions and individuals who are known to produce these outputs. More information, quantitative and qualitative, on current practices on the integration of air quality, access, safety, poverty, land use, and transportation in development planning are needed. From this, a survey of best practices on global sustainable urban transportation may also be conducted to complement the exercise. Indicator development may also be adjusted to provide information for local, national, and regional planning purposes.

The impact of this sustainable transport database will also depend on the relatively ease of access. The current challenge is to re-classify available documents and transfer them to the CMS, which will provide a well-defined structure of existing materials. Maintenance of the database will depend on the type of information; for example, contact information may be updated through periodic checks, while some statistics have to be checked on an annual basis only.

The database will be maintained and updated internally on a regular basis. Therefore, the value of this database could be further increased in the future as the scope of the content expands.

Finally, concerted efforts will be made to disseminate the sustainable transport information to potential audiences such as decision makers, researchers, and other stakeholders in all sectors once a well-classified database is created and made available online. A dissemination and promotion strategy will involve posting announcements in Sustran and other newsgroups, and creating reciprocal links with other web sites. The PSUTA section of the CAI-Asia web site will also be promoted during regional meetings and workshops (<http://www.cleanairnet.org/psuta>).

The information will be periodically updated by the CAI-Asia Secretariat through its full-time staff of transport researchers, who will continue to actively collect data on sustainable transport. The CAI-Asia local networks in China, Pakistan, Nepal, and Sri Lanka will also be engaged to help keep existing information current. Some types of information, such as news articles and events, will not be updated, but will be archived on the web site for reference. Other types of information, such as resource persons and research institutes, will be updated as the need arises. Updates to main PSUTA documents, such as the manual, indicators, and the three city profiles, will only be made after consulting with EMBARQ.

*The general concerns for future documentation exercises are on filling data gaps, providing updates, and providing/searching for analyses on these transportation themes*





# 3

## A Strategic Framework for Sustainable Transport

**T**HE Strategic Framework (SF) for Sustainable Urban Transport is a high-level conceptual framework that aims to guide city authorities and other decision makers in policy and investment decisions related to urban transport systems in Asia. It is a paradigm for achieving a social or policy outcome. Such a framework requires several steps. First, it requires a conceptual vision of the future of a city and how transport serves that vision. Second, leaders must define concrete goals for sustainable transport, using processes of stakeholder engagement to develop goals that are politically sustainable. This step recognizes key challenges enumerated below. Third, these challenges are overcome—at least in theory—by implementing a combination of policies (that influence behavior as well as choice of technologies) and technologies themselves, a step supported by strong governance. Fourth, results—outcomes—are carefully monitored. Fifth, the results themselves (as well as the interim steps) must be communicated to stakeholders. The process of stakeholder engagement must not be ignored—sustainable

*Leaders must define concrete goals for sustainable transport, using processes of stakeholder engagement to develop goals that are politically sustainable*

passenger transport is about moving people, not just vehicles. Stakeholders must support this process; if they do not, they may oppose what the government puts forward as the desired outcomes. The entire process is quantified through indicators, which are also used to communicate all steps in this process. Indeed, while the PSUTA is formally about developing indicators, it is really about improving or in some cases creating a process to improve transport.

### **What is Sustainable Urban Transport?**

Adapting the Brundtland Commission Report's definition of "sustainability" (1), sustainable transportation can be loosely defined as a set of transport activities together with relevant infrastructure that collectively does not leave problems or costs for future generations to solve or bear—present builders and users of the system should pay such costs today. These costs are not limited to environmental externalities, but also include social and other economic impacts caused by transportation. More formal definitions have been advanced by a variety of publications, most notably from the World Bank (2) and the U.S. Transportation Research Board's "Towards a Sustainable Future" (3). Conceptually, sustainable urban transport is transport that serves the common vision of an urban region's economic and social development.

In practical terms, sustainable urban transport (SUT) focuses on easing access and mobility for people to reach work, services, resources, and each other. SUT needs to provide access for all groups in society in a manner that is within the environmental carrying capacity of a region and is affordable to both the providers and users of transport systems. SUT also provides for smooth movement of goods within cities.

SUT is an essential precondition to maintain and improve the quality of life in Asian cities and to increase

the well-being of its citizens. To accomplish this, SUT will require a different way of thinking about the structure of Asian cities and new approaches to land-use planning. The rapid growth in Asian cities, which is expected to continue for at least the next two decades, presents decision makers in Asia with a unique opportunity to break with the past and adopt new approaches.

SUT has a direct relationship with poverty reduction. Access to affordable transport for all groups in the population is a prerequisite to improved health and education. Effective SUT systems support economic growth without compromising economic and social dimensions to a point beyond repair. SUT has the potential to act as a catalyst in the development process. Providing mobility for urban poor and other marginalized groups can help Asia achieve the Millennium Development Goals (MDG) set by the United Nations, through improving access to education, employment opportunities, and healthcare.

The sustainability of transport systems is defined by its impact on the environment (including safety), as well as social and economic sustainability. Three quick checks that decision makers can apply in making decisions on urban transport systems are:

- (1) How will decisions affect pollution and safety?
- (2) Do decisions increase or decrease congestion, and promote access to transport for all groups in society?
- (3) Do policies increase or decrease the economic robustness of the transport sector itself while decreasing the cost burden of transportation on ordinary citizens?

These criteria or pillars of sustainable transportation have quantitative and qualitative dimensions. The former are measured or estimated scientifically and should be objective. The latter provide the weightings by which stakeholders value the former, so contain an important element of political and even personal subjectivity. Different

groups within a region, or between regions, value these pillars differently. The key purpose of developing indicators is to obtain quantitative and relatively objective measures of the effects listed here. Governance must provide a transparent stakeholder engagement process that both promulgates development of the objective characteristics of sustainable transport—through indicators—as well as providing a process for making decisions based on indicators and political values.

### Key Challenges: What SUT Has to Face

The strategic framework aims to address the following key challenges to sustainable transport. The first three are related to conventional transportation externalities, and are within the first and (partly) second pillars in Figure 3.1. The second set of challenges connects transport to its socioeconomic context.

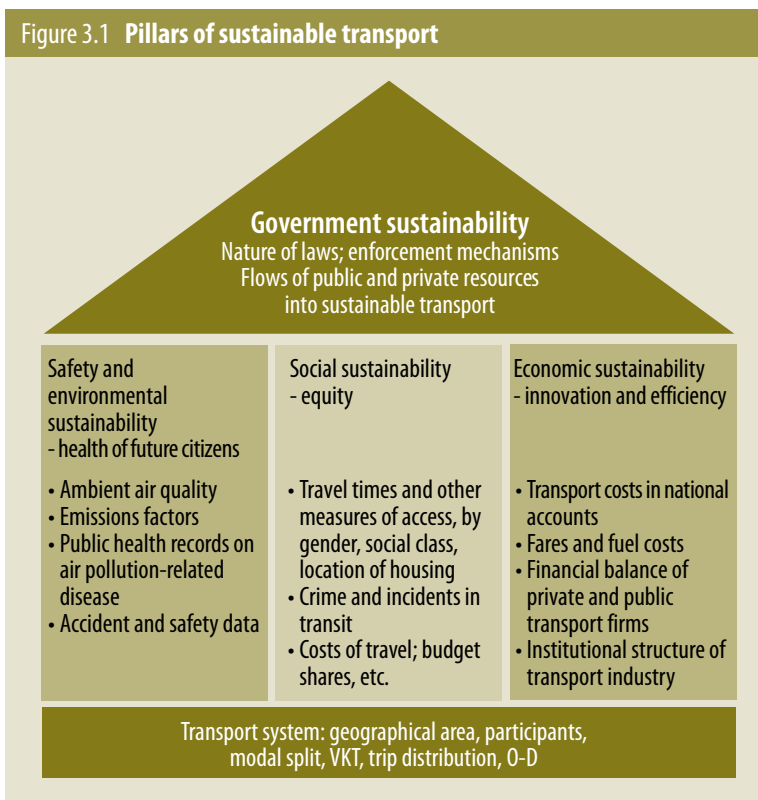
### RAPID URBANIZATION AND CONGESTION: THE SQUEEZE IS ON

Asia will continue to urbanize rapidly in the next few decades. Rapid economic growth in urban areas drives considerable growth in the demand for transport of both people and goods in urban areas, with particular emphasis on growth of 2-3 wheelers, which now dominate vehicle fleets and streets in many Asian cities. Apart from the growth in private vehicles, the population growth and increased affluence have also resulted in strong growth, in absolute terms, in the demand for public transport. In many cases, cities have had difficulties in meeting this increased demand, leading to a decrease in the quality of services provided. At the same time, the growth in private motorization, whether two- or four-wheelers, has overwhelmed the streets in almost every large Asian city, creating unbridled congestion and long commute times. Not surprisingly, non-motorized transport and collective transport have suffered as authorities

emphasize paved streets for individual vehicles. Building more roads and flyovers cannot hope to catch up with the trends. This challenge can only be met with a new approach to sustainable transport.

In many cases, the expansion of Asian cities is based on an urban sprawl type of land use. Urban sprawl is partly the outcome of higher affluence, as family size shrinks while families seek larger homes. Sprawl also arises because of cheap fuel and land, and the absence of effective land-use planning. This—together with flawed land pricing mechanisms, which transfer the environmental costs of the urban sprawl to the community at large—has favored the development of “motorized hungry transport” systems. Linked to the urban sprawl problem is the problem of squatting. Many Asian cities have large populations of squatters. They tend to live in very densely populated but unplanned areas, which are unserved

Figure 3.1 Pillars of sustainable transport



or underserved by urban services and transport systems. Unplanned urban development has negative environmental impacts, but also high economic and social costs. The results tend to make access and congestion worse. High densities also increase exposure to vehicle emissions, which is the second big challenge.

*The experiences of Europe, the United States, and Japan show that while technological improvements will continue to reduce emission levels on a per vehicle basis, the implementation of technological measures will fall short of reaching air quality goals*

#### **AIR QUALITY AND GHG EMISSIONS**

Air quality has worsened because of the rise in transportation, even as authorities have forced reductions in emissions from fixed sources. The main pollutants of concern are particulate matter (PM), especially PM10 and PM2.5, NOX, and hydrocarbons. Increasing NOX levels contribute to an increase in ozone levels. The rapid growth in the number of vehicles explains why ambient air quality levels do not meet guideline values set by the World Health Organization (WHO), despite the recent technical improvements. The experiences of Europe, the United States, and Japan show that while technological improvements<sup>1</sup> will continue to reduce emission levels on a per vehicle basis, the implementation of technological measures will fall short of reaching air quality goals. A particular danger for Asia is that typically more than half of all trips are walking, cycling, or in open two- or three wheelers, resulting in unusually high exposure of the mobile population to emissions.

CO2 emissions from the transport sector in Asia form a major part of the greenhouse gases responsible for climate change. There is a growing

acknowledgment that fine particulate matter emissions have climate impacts in Asia, which could be responsible for increased or decreased rainfall in specific parts of Asia. Ozone levels, which have increased in many parts of Asia due to (rapid) motorization, have started to negatively affect crop yields in various parts of Asia.

#### **ROAD SAFETY**

The rapid increase in motorization, especially motorcycles, cars and trucks, has resulted in an associated growth in the number of traffic accidents. Ironically, up to 50 percent of the victims are not occupants of motor vehicles, but pedestrians or non-motorized vehicle users. Estimates for the ASEAN region estimate the annual economic losses from road accidents at 2.23 percent of the annual gross domestic product (GDP). Additionally, an indirect consequence of rapid motorization is that pedestrians and cyclists increasingly must detour around motorized traffic to get where they are going, or risk fatal accidents while crossing traffic.

#### **ECONOMIC SUSTAINABILITY**

Urban transport systems, whether run by urban authorities or the private sector, face many economic challenges. Above all, the publicly owned and operated parts of the sector often require huge subsidies, while private operators make a profit. Only a few city-owned systems, such as the Bangalore Municipal Transport Corporation, make a small profit, as do a small number of quasi-private systems such as Hong Kong's. The many concession-based systems make some money for their operators, but only because cities pay these concessionaires more than they can take in from fare boxes. Indeed, a pandemic of cheap transport provided as a public good, while understandable as a policy of providing access for low-income people, undermines the long-term viability of collective systems and encourages sprawl. This is only worsened by public investment (aided by multi- and bilateral investment opportunities) in expensive metro and

<sup>1</sup> Ambient air pollution is contributed by mobile, stationary, and area sources of pollution. See the CAI-Asia-APMA Strategic Framework on Urban Air Quality management on the need for Asian cities to adopt an integrated approach to air quality management, which integrates the management of all these three types of air pollution sources.

rail-based systems, whose real costs no one can afford to meet.

The greatest challenges to the collective systems' economic sustainability are two-fold. In addition to rising low direct cost mobility provided by two-wheelers, a myriad of private, often "pirate" small operators are filling in gaps left by shaky public systems. In Asia, these operators include combinations of two-wheeled and three-wheeled for-hire taxis, and in many places quasi-legal mini-vans (or large three-wheelers, called "Six-seaters" in Pune). These forms of para-transit using older vehicles eke out a profit for their operators by crowding the streets, polluting the air, stealing customers from more established bus lines, and even from rail-based systems. They often do provide faster service for the fares they charge, but only by slinking in and out of traffic. Another challenge is the squeeze on transit operators between the need to hold down fares to stay competitive with private two-wheelers vs. the need for revenue to update and clean up bus fleets and fuels. A third challenge is the appearance of expensive metro and rail systems, whose fares must be held well below costs to attract riders. In short, the rapidly growing client base for motorized low-cost collective transport may be siphoned away by private transport, just as mass transport feels the pressure of the higher costs of rail-based systems. The falling customer base puts even more pressure on operators to cover costs.

### **SOCIAL SUSTAINABILITY**

Social sustainability measures whether the present transport system creates inequities of access and opportunity, or disadvantages some groups over others. In much of Asia, the most obvious aspect of social sustainability reflects the social systems that have sprung up around both mass transit and small-scale transport (three-wheelers, mini-buses) in almost every Asian country. Tens of thousands of families depend on income from small transport operators, both honest and shady. In Latin America, no meaningful transport reforms can occur without a

role for these groups as stakeholders. In Asia, three-wheeler and conventional taxi drivers can be a strong force against transport reform toward larger, more efficient vehicles and lower emissions. Transport solutions that leave these groups in strong opposition are not socially sustainable.

Equally as important for social sustainability is equity of access, i.e., the way in which impacts of congestion and poor access to transport fall most heavily on the poor or other groups. This is measured by differences in modal shares, travel times, travel ease, and travel costs (or budget shares) that arise between rich and poor, men and women, handicapped and able, or private car/two-wheeler users vs. those using other modes. Private vehicles monopolize streets; pedestrians, cyclists, and the handicapped have fewer and fewer safe choices for moving about. Giving equal access to cars and other vehicles, as well as non-motorized transport, penalizes those who walk, cycle, or ride the bus—generally the economically weak. That is because individual private vehicles take up significantly more road-space than collective or non-motorized transport. Since private vehicles are generally the privilege of the middle or upper classes, and public motorized transport is used mainly by the middle classes, this means that in rapidly urbanizing cities, the poor are left with fewer choices than others. Hence, they are also at a disadvantage seeking employment, since they cannot move as fast or far as others.

Most subtly, there may be discrimination against women, either because they face harassment on public modes, or because they simply have less access to whatever mode is fastest or safest. In short, a transport system where affordable access is not assured for all is not sustainable, because such a system freezes some people out of the economic and personal development that transport access can bring.

*Estimates for the ASEAN region estimate the annual economic losses from road accidents at 2.23 percent of the annual gross domestic product*

Finally, there are growing inequities linked to safety and clean air in Asian cities. Those walking, cycling, and riding tend to breathe the worst air; those living in some parts of the city may face more transport-based pollution than others. Above all, it is pedestrians and cyclists who suffer disproportionately from traffic accidents. And the proportion of people whose personal security is threatened when walking,

*As private vehicles monopolize streets, pedestrians, cyclists, and the handicapped have fewer and fewer safe choices for moving about*

cycling, or riding mass transit is probably higher than that of people who are riding in their own cars.

It is important that proposed transport projects be scrutinized: do they provide infrastructure or access for a small privileged group of car or two-wheeler owners or a broader group of poor or middle-class citizens. Like

economic sustainability, without social sustainability a transport system may fall apart, whether through strikes and unrest among transport providers, distress among the transported, or social unrest that arises because some groups do not have access to safe, reliable, clean transport.

### **GOVERNANCE OF SUSTAINABLE URBAN TRANSPORT**

Governance is required for sustainable urban transport. A regulatory framework is required for the transport sector, which includes pricing policies. Environmental regulations and monitoring are required to set emissions limits and clean air goals, as well as to monitor the results. Safety measures (including driver education, traffic laws, vehicle safety standards, protection of NMT) must be promulgated and enforced. Enforcing traffic and parking laws and other regulations and policies that increase access, including congestion pricing, is also a part of good governance. A great challenge in every Asian city is to overcome the obvious gaps in governance that leave

so much of transport in decay and disarray. Needless to say, without good governance, there would be no consultative processes by which stakeholders could weigh in on the social aspects of transport projects discussed above.

On a broader front, sustainable urban transport requires consistent political support and well-coordinated and transparent administrative structures and processes. Genuine efforts to strengthen the sustainability of transport systems require the involvement of all stakeholders in a structured manner and full access to information on all topics by all groups. Pro-active approaches are required to set up channels and processes to ensure genuine lasting participation by stakeholders in the formulation and implementation of SUT policies and programs. For stakeholder participation in SUT planning and implementation to function well, it is important that information on the status of urban transport systems and efforts to improve it are collected on a regular basis and made available to all local stakeholders.

Transport services in Asian cities will in the future continue to be delivered by a mix of actors in the formal and informal sector. Regulators need to assess whether and how actors in the informal sector interact with the formal sector. Financing will be required for actors providing motorized transport services. Access to financing is easier for transport providers in the formal sector. Experience has shown that a well-organized public transport sector functions better with a limited number of providers that operate in the formal economy.

### **Stakeholders and Sustainable Urban Transport**

Getting policies that are sustainable—acceptable to individuals and stable (or gaining strength) through subsequent political administrations—is a key challenge for SUT. This requires a broad appeal to stakeholders that is not common today in developing countries. Transport planning approaches in Asia are still generally closed processes geared toward increasing infrastructure supply—new roads, subways,

and flyovers—rather than reducing demand or shifting modes of transport by encouraging walking, cycling, public transit through better pedestrian facilities, dedicated bike lanes, and improved mass transit options. The lobby for sustainable transport solutions is weak and policy makers often do not prioritize sustainable urban transport. Overall, it is the stakeholders who determine the direction and power of governance.

Many of the major cities in Asia have well-developed public transport systems and have recently implemented new mass transit schemes in the form of subways or light rail schemes. Many of these are mass transport approaches that can satisfy the hunger for mobility, yet in an environmentally sustainable, socially acceptable, and financially viable manner. However, some are costly to construct.

Changing the manner in which transport systems are planned and function in the cities of Asia will require the active involvement and support of a range of different stakeholders (Box 3.1).

### Box 3.1 Different stakeholders

- Policy makers and legislators responsible for approving policies and overseeing their implementation;
- Regulators responsible for maintaining environmental quality, setting transport prices, and regulating competition issues;
- Land-use planners and transport planners providing the conceptual ideas and directions on the shape and structures of cities and the urban transport systems;
- Land developers implementing land-use plans and thereby influencing the transport demands;
- Financing groups both local and international, public and private who provide financing for transport systems;
- Technology providers, for example providers of vehicles, fuels, or Intelligent Transport Systems;
- Public and private providers of commercial goods and passenger transport;
- Private companies and public organizations requiring the transport of goods and persons;
- Consumer goods and community based organizations advocating for sustainable transport in Asia;
- Men, women, and children in Asia who want reliable, affordable and secure transport systems.

The stakeholders of this strategic framework are diverse; in several cases, their interests vary or are in conflict. Compared with the overall debate on environment and development, the debate on sustainable urban transport in Asia has been limited and fragmented. Discussions where they have taken place are usually among the planners and are focused on specific interventions. In very few cases have a wide range of stakeholders been invited to give their views on how the transport systems in their cities should develop.

Stakeholder forums to bring stakeholders together to discuss sustainable urban transport are scarce at all levels—city, national, and regional—in Asia. One of the goals of this strategic framework is to provide an opportunity for stakeholders to engage in the debate on the future of urban transport in Asia.

On the side of civil society, this will require bringing together those environmental groups that have focused on urban air quality and those groups focusing on climate change. It also calls for an engagement between environmental groups and groups focusing on road safety issues. A more effective dialogue will be for groups to advocate for improved access to affordable transport systems for the poor.

For the debate to be meaningful, it is important that it is wide in scope. To discuss the future of transport systems without discussing the shape and function of cities will limit the debate and options. The PSUTA emphasized this aspect by inviting a wide variety of local and international stakeholders to its individual meetings, as well as the PSUTA-wide meetings in Hanoi. For example, the delegation from Pune argued forcefully that even the definition of sustainable transport—as well as the key indicators measuring the sustainability of transport—must be the subject of a wide discussion. In Hanoi and in Xi'an, our meetings were routinely attended by transport, safety, and air pollution experts.

## Technologies

There are a large number of technological choices that can reduce the negative impacts of transport while promoting access and safety. Key issues include improvements in fuel quality and new vehicle emissions controls and standards. Reduction in air pollution from long-lived existing vehicles can also be improved by technologies. BAQ'04 had many workshops devoted to the timetables, costs, and expected results of these new technologies for Asian

*The appropriate mix of technology depends on population and its distribution, geography and topography, the existing distribution of fixed (rail) and shift-able modes, the public and private sectors' willingness and ability to pay, and above all the costs of alternatives and the institutional and financial arrangements that pays for and runs the systems*

cities. The key element is not technology itself, but the choice of technologies in view of costs, expected performance, the manner in which each technology makes transport more sustainable, and so on. Indicators are one tool for quantifying the costs and implications of those choices.

A good example is the path toward clean fuels. Not every country or urban region has exactly the same needs or capabilities to choose clean fuels and vehicles and enforce those choices. Each region needs a schedule of improved fuel production (or imports), strengthened vehicle emission norms, policies for inspection and maintenance, and other ways to assure that in-use vehicles remain clean. Without appropriate policies, the aim of using clean fuel and emissions technologies could fail. The indicators will play a key role in measuring costs and performance of fuel and emissions choices.

Another aspect is transportation technology itself. Vehicles can differ according to guidance (rail or

wheels), propulsion (electric or various fuels), size, speed, capacity, and of course cost. On the collective side, there is no iron rule with which to choose between underground and surface rail, conventional bus, or BRT technologies. The appropriate mix depends on population and its distribution, geography and topography, the existing distribution of fixed (rail) and shift-able modes, the public and private sectors' willingness and ability to pay, and above all the costs of alternatives and the institutional and

financial arrangements that pays for and runs the systems. On the private vehicle side, more rapid promulgation of safety, fuel quality, and emissions standards are needed to force technologies forward. A key goal is to ensure that vehicle choices and their consequences are measured against how well they meet

other challenges leading to sustainable transport.

Technologies must fit Asian urban transport needs. For example, are the materials used in two-wheeler or cycle tires and coverings of streets developed to maximize traction? Similarly, a true urban bus with a relatively low floor has not appeared on Indian streets until recently; buses were just seats connected to lorry beds with roofs. Most important, cheap two-stroke engines with dirty mixing oil have provided a false sense of low-cost individual mobility in much of South and Southeast Asia. The conclusion must be that the forces guiding both large- and small-scale transport and fuels were almost incognizant of the need for sustainable transport. These are the kinds of technological choices whose impacts must be understood in the framework presented here.

Technologies, particularly IT, can have some beneficial impact on congestion or access, reducing costs and time for boarding public transport, monitoring congested areas, and providing warnings

to travelers. Technologies can also make vehicles, sidewalks, and other aspects of the transport system safer and cleaner. Stakeholder engagement is crucial for helping shape choices. And the same engagement provides respect for the monitoring of the impact of those choices using indicators. Finally, governance and enforcement are important to assure technologies are used properly and produce desirable results.

The PSUTA did not consider technologies and their supporting policies explicitly. Rather, it focused on the use of indicators to help the choice of technologies by diagnosing problems, modeling impacts of cures, forming prognoses, evaluating results, rebalancing the approach if results were slow in coming, and communicating the situation to all stakeholders.

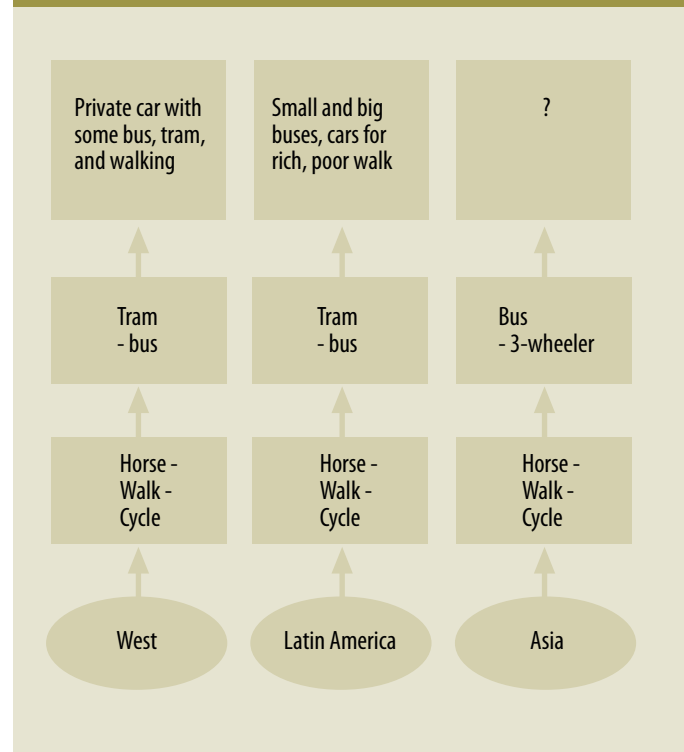
### Use of Strategic Framework

The sustainability of urban transport systems cannot be expressed in absolute terms. In many cases, it is a vision that cities work toward. The strategic framework helps decision makers in taking policy and investment decisions to bring cities closer to the vision, rather than to take them further away. Indicators measure how much more (or less) sustainable the results will be.

This framework can help policy and decision makers to “step outside the box” and challenge the status quo on transport policy. Policy makers in many of the cities in Asia still have a choice on the developmental model (Figure 3.2) that they want to follow. Do they want to adopt the American model, which is heavily based on the use of private cars, or will they look at Europe, Latin America, and Japan, where public transport still plays a more important role?

The framework allows for a trade-off process between the environmental, social, and economic dimensions. The outcome of the trade-off process will be different from location to location. Within such a trade-off policy, policy makers will need to develop a strategy on how to satisfy the demand for mobility once incomes go up and people are able to spend more on transport. Indicators quantify the likely outcomes of systems based on these highly different approaches.

Figure 3.2 Schematic of transport paradigms



### Implementation of Sustainable Urban Transport at the City Level

This strategic framework is comprehensive and presents a vision to guide decision makers and other stakeholders in designing policies and making investment decisions. In most cases, the implementation of this strategic framework will occur in cities with existing transport systems. This does not mean that it is not possible to adopt bold, visionary, and comprehensive changes in the way that goods and people are transported. The examples of Bogotá, Seoul, Jakarta, and now Mexico City, with its new BRT system, show that it is feasible to make radical changes.

Teamwork within government is required to achieve the common goal of SUT. This will require improved coordination between the national and the local government, as well as between different departments such as transport and environment, which can be achieved through a reorganization of institutional mandates or the creation of dedicated administrative structures.

Reaching a consensus on the shape of new transport systems is important, but in many cases decision makers will have to come up with creative ideas on what to do with existing transport systems, rather than coming up with new ones. In all cases, the actual implementation of the policies agreed upon will be most difficult.

Visionaries or champions are needed to move the process forward. Effective communication strategies and stakeholder processes are important. The adoption of a sustainable transport vision as outlined in this document will affect the daily livelihoods of thousands of people who earn a living in the current (unsustainable) transport systems in Asian cities. Strong lobbies might prevent the adoption and implementation of sustainable transport policies.

A first prerequisite in the communication process is explaining what SUT is and why it is important for Asia. Different stakeholders have different interests and need to be approached differently. Decision makers within various line departments, as well as political decision makers, in many cases started their careers before SUT was a common concept. In many cases, they will need to change their mindset, which is a long process. Representatives from the transport sector need to understand why and how transport services influence the sustainability of transport systems. NGOs, community-based groups, and other special interest groups (such as environment or road safety groups) need to understand that decision making on transport systems needs to combine

environment, social, and economic issues. The future of sustainable urban transport in Asia will be enhanced by broad-based awareness and willingness of the public to change behavior and investment patterns.

### **Getting There—The Role Of Indicators**

Transforming urban transport systems into sustainable urban transport systems is a long-term process. It starts with a diagnosis of the current situation in the context of existing policies. Implementation of policies and interventions needs to be carefully monitored and evaluated. Sustainable transport planning, like other developmental planning processes, is a cyclical process, and monitoring and evaluation need to be followed by adjustments in policies and projects. It is important throughout the process to keep all stakeholders well-informed.

Indicators can help in analyzing current sustainability levels and to support the planning and implementation of SUT policies and investments. Performance assessment indicators define the transport system and describe the performance of the system; impact indicators can be used to assess, for example, the environmental and social impact of transport systems. Experience in the application of these indicators has shown the importance of defining institutional coordination structures, assigning institutional mandates, and providing adequate financial resources for regular ongoing data collection.



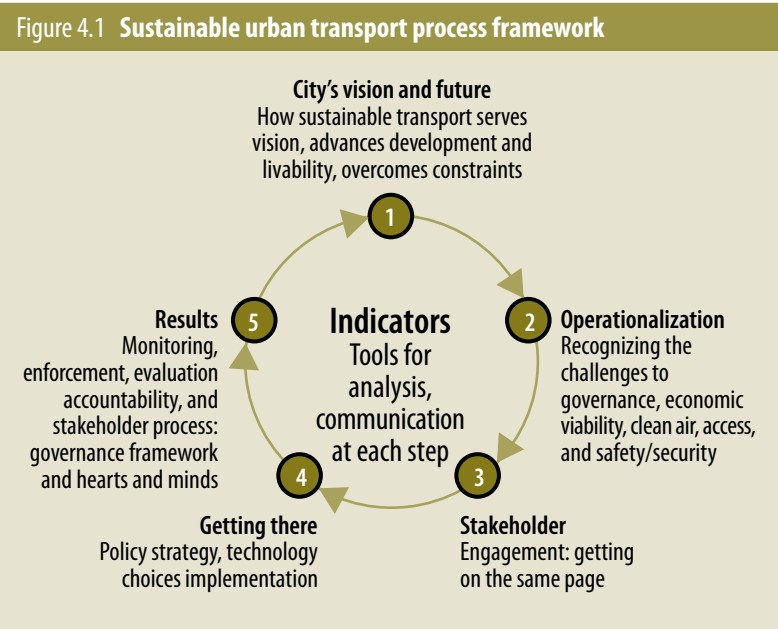
# 4

## Indicators to Measure Sustainable Transport

**H**OW do we know if transport is becoming more sustainable and how can we enact policies to strengthen sustainability? Data that measure both the details of transport activity and its side-effects and externalities are required. These data can be transformed into useful tools used for the diagnosis, choice, and implementation of cures for transport problems, as well as the impact of implementation, evaluation of progress, and corrective rebalancing. With such functions, sustainable transport indicators will bolster the policy process.

The tools or indicators describe the levels of clean air, safety and access, or their opposites, air pollution, accidents, and congestion. Other indicators measure economic aspects of transportation; yet others measure the social and equity characteristics of the system. Finally, a group of indicators describe the state of governance. Above all, these indicators allow stakeholders to quantify the past, present, and current changes in transport and its sustainability.

*Ultimately, the goal of developing a system of transportation indicators is to build powerful tools for policy making; these tools summarize trends and relationships that describe the most important activities, outputs, and side effects—both positive and negative—of transportation activities*



mayor or other senior policy makers need simple indicators of problems and solutions or goals. These officials are supported by specialists and advisors who draw on the large body of indicators in the lowest box to produce key messages in the three fields of access, safety, and air quality. Indicators in the lowest box also provide the most basic description of the urban region, its people, and economy. At the same time, the public is represented at the same levels—they debate with decision makers using the highest level indicators, they discuss with specialists over the values of predictive indicators, and they may even discuss (or often dispute) the fundamental data indicators draw upon.

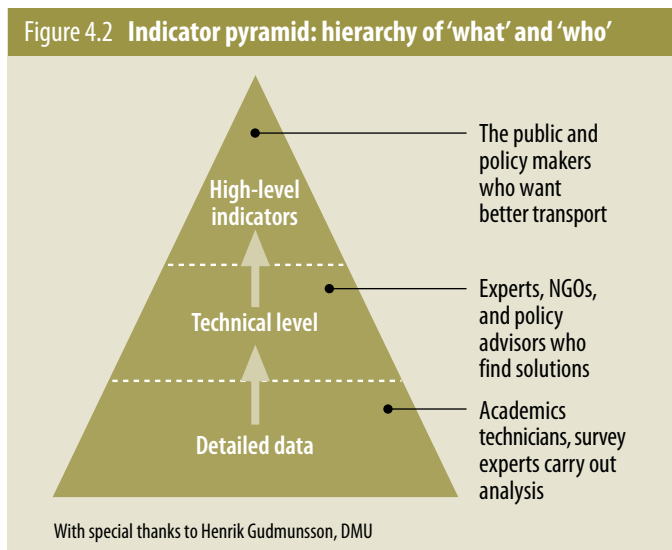
Ultimately, the goal of developing a system of transportation indicators is to build powerful tools for policy making. These tools summarize trends and relationships that describe the most important activities, outputs, and side effects—both positive and negative—of transportation activities. These tools describe the progress of transportation from vision to reality, as suggested in Figure 4.1. In addition, the same indicator base supports communication with stakeholders.

Stakeholders are the “who” of the indicator process. Figure 4.2, from Gudmunsson, illustrates various levels of stakeholders. At the highest policy level, the

**Indicators of the Major Transport Challenges**

The “what” is the substantive content—indicators of congestion, accidents, and pollution, or in a positive framework, access, safety, and clean air. Additionally, indicators cover economic and governance dimensions, as described below.

- Access indicators convey speed and travel time, flow of traffic (i.e., lack of congestion), proximity of homes and jobs to fast transit facilities, and affordability of transport services (related to economic indicators). The underlying predictive indicators measure distances, modal shares, and fares.
- Safety indicators convey low rates of accidents and deaths, injuries, or hospitalization related to traffic accidents. Underlying predictive indicators map out the kinds of accidents and their causes, the victims (drivers, passengers, pedestrians/cyclists or bystanders), and the nature of injuries.
- Environment/clean air indicators convey air quality (usually in concentrations), days exceeding health limits, etc. Predictive indicators include emissions factors for each vehicle/fuel combination, total emissions, fuel quality, and consumption.



In addition to the major externalities of transport described above, there are two other important concerns suggested by the World Bank:

- Economic sustainability indicators describe both the supply side (profitability or subsidy, turnover, fleet renewal and investment) and the demand side (fares, household budget shares for transportation); more detailed indicators measure costs and turnover on individual lines, investment in infrastructure and rolling stock (including IT), detailed fares for use of different modes, family expenditures by location of household, income, and social status.
- Social sustainability indicators focus on equity, cutting across the other concerns and are included in each of those groups.

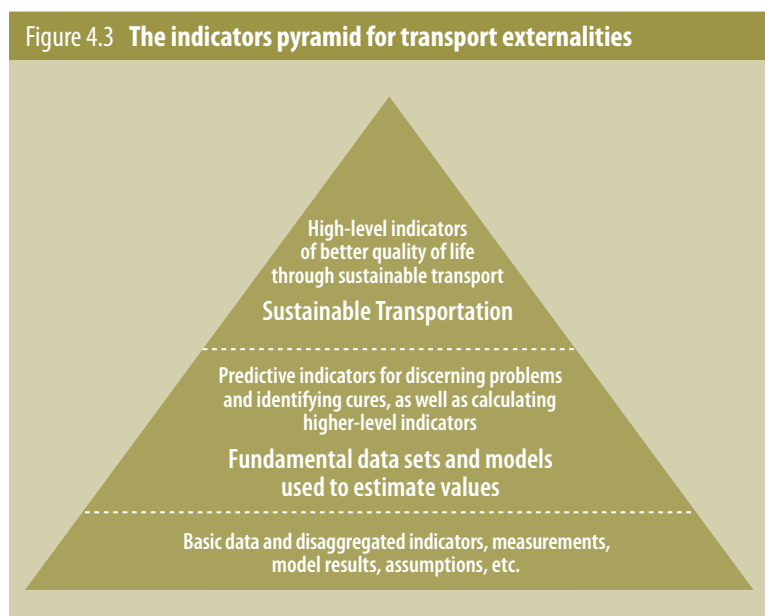
Finally, governance indicators show how laws, regulations, and other agreements affect these elements of sustainable transport.

There is an important social dimension to all of the above indicators, namely the way in which each indicator describes different socioeconomic groups in terms of where they live or work. Transport may be affordable and convenient on average, but expensive and time consuming for a sizeable minority of people according to where they live, their incomes, or even gender. Air

quality may be worse for some groups than others, particularly affecting those on foot, cycle, moped, or waiting at bus stops more than those in cars. As these points suggest, sustainable transport must apply to all groups, but aggregate indicators often hide important differences that imply gross inequities between groups.

Like Figure 4.1, Table 4.1 shows that indicators overlap and link to each other both because of their data content and their conceptual base.

The indicators pyramid, Figure 4.3, illustrates the “how”, or path from very detailed indicators at the bottom, those that predict states and outcomes, to



**Table 4.1 Sustainable transport elements**

<b>Externalities pillar/roof</b>	<b>Clean air/air pollution</b>	<b>Safety/accidents</b>	<b>Access/congestion</b>
Environment and safety	New car emission standards/ I-M for existing vehicles	Death and disease from polluted air	Excess pollution from congestion, circuitous routing
Equity/social	Different exposures by region, gender, group	Different accident rates for walkers, bikers, drivers, women/men	Different delays and travel times by gender, group
Economics	Health and property costs of pollution, costs of abatement (extra costs of vehicles, fuels)	Social and direct costs of accidents; expenditures on safety and driver training	Money value of losses of time, transport business profits
Governance	Clean air agency, enforcement laws monitoring stations	Seat belt laws, driver training requirements, new/existing vehicles safety standards	Emergency plans on polluted days, HOV lanes

meaningful but simple aggregates at the top. These top-level level indicators, used mostly by policy makers, should be clearly related to the quality of life and other high-level goals to which stakeholders aspire—clean air; rapid, affordable, and safe transport; and well-defined laws and regulations. They can relate both as diagnoses (for example, “the level of bus use is too low”), as goals (such as “50 percent of trips should be on buses”), and evaluation tools (such as “we raised bus trips to 48 percent this year, next year we need to try harder”). Policy indicators describe situations, quantify solutions, and describe end points that are widely shared as goals.

The middle levels contain more complex quantities that help predict the outcomes or explain the situation illustrated by the highest-level indicators. These predictive indicators are used by analysts and stakeholders alike. These are the basic aggregate parameters of the system, such as the number of vehicles or number of kilometers people travel each day. Such indicators may be single data, time series, or comparative, such as a comparison of the same indicator over many cities in Asia. Socio-demographic characteristics of the population and households are also good predictors of travel behavior. Trends used for forecasting and for scenarios and assumptions are built from these indicators

Predictive indicators also yield diagnostic or consequential indicators. They can illuminate problems with the system, such as pollution arising as a consequence of using motor vehicles or accidents resulting from speeding on certain streets. Not surprisingly, these indicators are built on a large base of data.

The lower levels of the pyramid contain the basic data and model outcomes that are combined to produce the predictive indicators. Some “data” may be model or simulation results, assumptions, and often information borrowed from other, ideally similar regions. A key element may be emission factors from vehicle-fuel combinations.

The pyramid symbolizes the compacting of information that takes place in going from detailed data and observations, to indicators that help diagnose and predict, and eventually to simple indicators that politicians prefer. For example, the average emission factor for automobiles is a valuable indicator for saying how much a new standard would reduce emissions from the average in-use vehicle. The average factor must be calculated from the numbers of each kind of car, their emissions control systems (usually a factor of vehicle age), and the average distances they are driven. As long as the process of aggregation is transparent, both analysts and high-level policy makers can trust the compression of information. Transparency is thus key to the indicator process.

For each of the substantive categories of indicators there is a pyramid from the most aggregate policy indicators down to the most detailed data. Figure 4.4 illustrates those pyramids. Note that there are many overlapping data used in two or three of these pyramids, particularly those that normalize many indicators: population, GDP or income, distance vehicles move, distances people travel, and numbers of vehicles.

Figure 4.4 Individual indicator pyramids

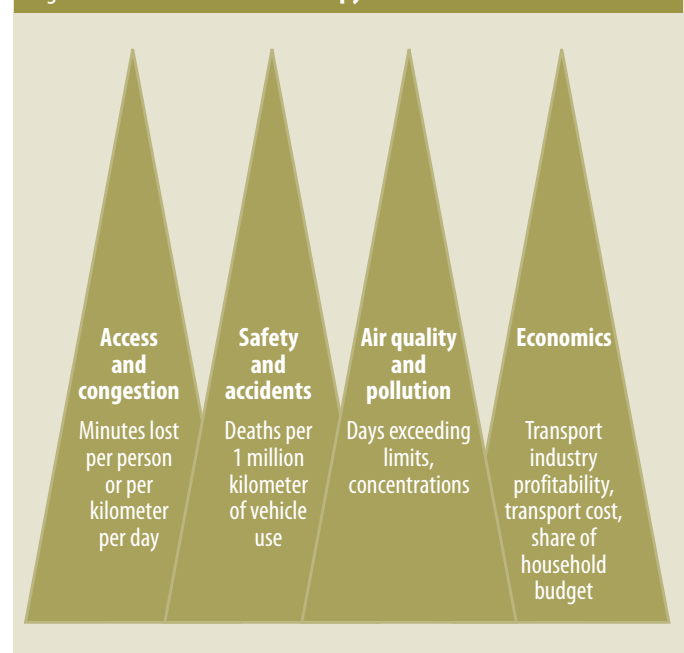
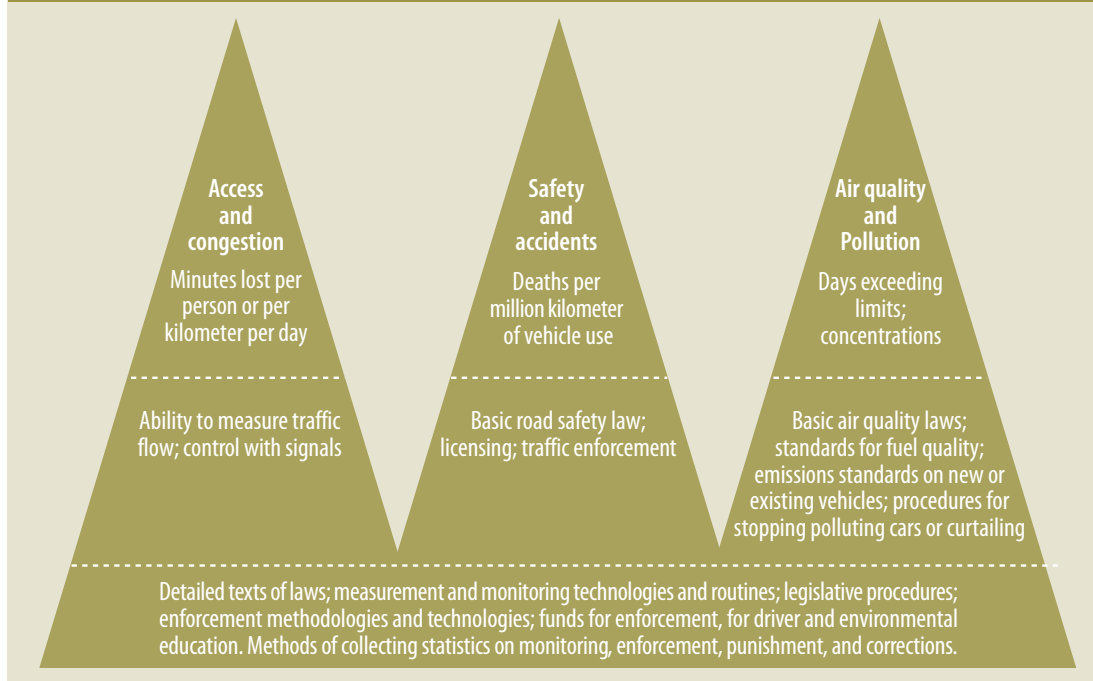


Figure 4.5 Governance indicators



### Governance Indicators

Can authorities deal with the problems of transport and the environment? The answer is described by the indicators of governance. Governance indicators point to the legal authority to regulate or control transport and environmental problems, the funding of diagnostic and monitoring capability, and the legal basis for enforcement. Does driving require a government inspection of emissions? Are there motor vehicle tail-pipe emissions and fuel quality regulations? How are these enforced? Are smoking vehicles caught by remote electronic sensors or only by visual means? Is there a criminal sanction against the driver or owner of a smoking vehicle? Above all, is there a legal means for authorities to change vehicle use when there is an extreme air pollution problem? Figure 4.5 suggests indicators that help answer these kinds of questions.

### Economic Indicators

Economic indicators demonstrate the financial health—and burden—of transportation. They describe the transport industry, in terms of economic turnover, employment, firm structure, investment,

etc. They describe the economic dimensions of the transport system. And they quantify the economic burdens of end-users, in terms of fares, fuel costs, and household budget shares dedicated to transport. In this sense they may be developed across traditional economy groups, i.e., from poor to wealthy families. Economic indicators may also illustrate the costs of transportation as a function of family time, household location, job type, etc.

Clearly economic indicators are related to externalities. The costs of air pollution on human health, the costs of accidents on health and property, the value of time lost in congestion are all economic indicators that provide one way of measuring the costs of externalities. Conversely, the costs of solutions, such as improved fuel quality, tighter emissions standards, stronger guardrails along roads, wider, more protected pedestrian or cyclist space form valuable economic indicators.

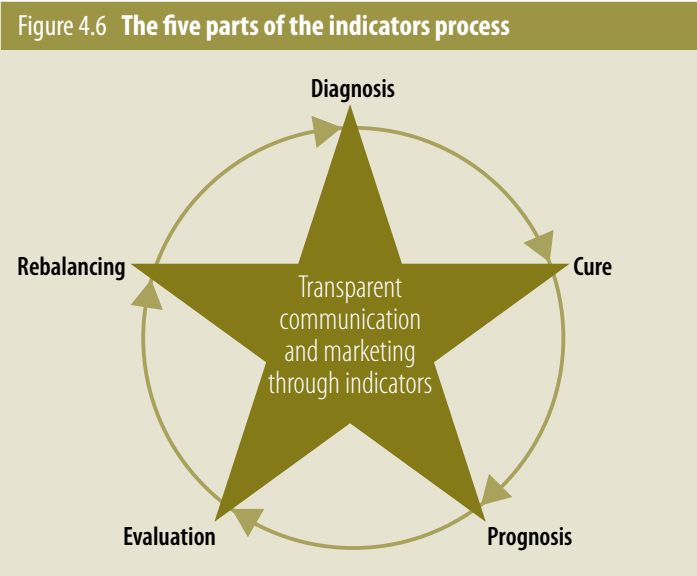
Virtually all of these can be expressed per passenger kilometer traveled, enabling economic costs and impacts to be measured in a comparable way across projects, around regions, or over time.

### Communication

The final dimension of indicators is purpose, or the “why.” Indicators are used at several steps of a process—to diagnose problems, sort through potential cures, form a prognosis from the cures implemented, evaluate progress, rebalance or retune the system if it strays from the prognosis, and finally to market and communicate the results. These are shown in Figure 4.6. This progression is one of the express purposes of the PSUTA partnership—launching real improvements in transportation through an improved quantitative approach to sustainable transport.

Communication is important for improving transportation. Governance is not exercised by chance—technical experts have to prepare convincing evidence of the nature of air pollution through indicators. The sources—in this case, motor vehicles and the technical and policy options—must be illustrated with indicators. That evidence must be passed up to senior policy advisors, who prepare simple arguments for the most senior policy makers, often the mayor. As Figure 4.6 suggests, at each step in the process there are many forces selling the importance of action.

A key element of the indicators process is transparency. Stakeholders must have access to data, formulas, models, and above all discussion processes to understand how indicators are formed, what data and assumptions are used, and how robust or uncertain the data are. International and local data sets that are either confidential or veiled in obscure or private data sources and assumptions are not useful—they cannot be traced back to origins, updated from the same sources, calculated using different assumptions, or verified independently. In short, sustainability transport indicators are as much about the process of developing sustainable transport as about the indicators themselves.





# 5

## Case Studies of Indicators: the PSUTA Partner Cities

**U**NDERSTANDING the process of constructing indicators was one of the key tasks each group of partners in each city faced. This required cooperation among agencies and bureaus that belonged to entirely different branches of local, regional, or national government. For example, in Xi'an, local environmental data are collected by the national government, while in Hanoi they are collected by local and national government. Constructing indicators often requires assembling one kind of data (say accidents) and normalizing with another kind that belongs to a different authority (vehicles or kilometers driven). In all three cities, the project leaders and mentors helped the local partner work with various groups and build their confidence. Hanoi environmental authorities had access to transport data for the first time, while the transport experts who were PSUTA partners obtained data on ambient air quality for the first time. Similarly, in Xi'an and Pune diverse groups with ownership of key information were brought together. This process produced a number of middle-level indicators from the data available.

*Understanding the process itself of constructing indicators was one of the key tasks each group of partners in each city faced; this required cooperation among agencies and bureau that belonged to entirely different branches of local, regional or national government*

### Background on the Three PSUTA Partner Cities

The cities—Xi’an, Hanoi, and Pune—have many similarities and many differences (Table 5.1). Their populations are between 2 and 7 million, depending on how one draws boundaries and counts commuters from outlying areas. Greater Pune and Hanoi have over 1.3 million motor vehicles and Xi’an just over 500,000. Pune and Hanoi have rivers dividing them, while Xi’an is divided internally by its city wall. All cities face major challenges and choices in making transportation sustainable.

Pune is in many ways the most motorized of the three cities, with nearly 1.4 million motor vehicles. Given its higher GDP per capita, more vehicles were expected, but relative to other Indian cities, Pune is one of the most motorized as well. Pune has more private cars than Hanoi, but fewer than Xi’an.

Each city faces challenges as transportation expands. But each city has different challenges, even though the overwhelming number of individual vehicles in both Hanoi and Pune are striking. Each of the key policy issues each city confronts can be diagnosed and remedied using indicators as policy tools. The PSUTA partnership will help the cities prioritize challenges, respond with forward-looking policies, and make its own transport system more sustainable.

The PSUTA focused primarily on the indicators representing externalities of transport, namely, accidents and safety, air pollution and health, and access and congestion. Each city team indicated, however, that indicators of the economic health of the transport system were generally available, as were indicators related to governance.

**Table 5.1 Basic indicators describing the cities, people, and systems**

Sample indicators	Hanoi	Pune	Xi’an
General indicators (2003)			
Population, urban area (mn)	3.1	2.7	5.1
Population, metro area (mn)	4 <sup>a</sup>	3.8	7.2
Urban area, km <sup>2</sup>	921	271	3,547
Metro area, km <sup>2</sup>	9,573	375	9,983
2003 GDP/capita (PPP)	2,051	4,140	3,277
GDP/capita (in local currency)	15,670,810 dongs	22,817 rupees	15,155 yuan
Transport indicators (2003)			
Total no. of motor vehicles (metro)	1,323,664	1,354,000	516,719
Total no. of motor vehicles (urban)	–	1,057,000	372,000
Motor vehicles/1000 pers (metro)	330.9	356.3	71.8
Cars/taxis (urban)	49,714	72,000	157,890
2-wheelers (urban)	1,150,000	677,000	136,824
Buses (urban)	680	1,061	3,736
Car/1000 pers (urban)	16.2	26.7	31.0
2-wheelers/1000 pers (urban)	375.8	250.7	26.8
2-wheelers/GDP (urban)	0.183	0.061	0.008
Buses/1000 pers (urban)	0.51	0.39	0.73

Note: Standard Metropolitan Statistical Area (SMSA) used by the U.S. Census Bureau and other agencies in national statistical reports.

<sup>a</sup> Metropolitan population of Hanoi is only an estimate. “Metro” refers to a wide area, including suburbs. “Urban” refers to the cities proper.

Sources: PSUTA (6, 7, 8).

### Construction of Indicators: Some Examples from the PSUTA Cities

The key facet of indicators shown here is that a few simple quantities or indices can contain a very large amount of information. Sometimes the indicators need only measure relative performance; that is, more or less, or better or worse. But indicators related to traffic accidents and deaths, and to traffic-related pollution and public health problems need also make clear the absolute size of the human problems of unsustainable transport.

In the following sections, key indicators are discussed from each major facet of sustainable transport as provided by the partner cities. The cities were not able to provide a full set of indicators, nor was that the goal of PSUTA’s engagement. Our selection represents those that the city partners and leaders themselves felt were most important.

This discussion focuses on middle-level indicators for the three main externalities. Information on social sustainability was difficult to find, although a few examples of indicators across groups are given. Partners were uncertain how to capture the indicators of governance, other than with lists of laws and

regulations. Finally, with few exceptions, no city was able to demonstrate a complete pyramid of indicators starting with data. This was due to the lack of data, not the approach itself, which city teams were able to conceptualize and discuss in the abstract in the city reports. In a more through (and expensive) effort, the teams could doubtless produce one or two high-level indicators from a maze of basic data through a number of predictive indicators.

### AIR POLLUTION AND HEALTH

Air quality/pollution or emissions from vehicles can also be portrayed with indicators. Air quality often is measured by concentrations of known pollutants, such as NO<sub>x</sub>, ozone, or particulate matter (PM). These measurements are compared with emissions of pollutants from vehicles and fixed sources, using atmospheric circulation and chemical models to calculate how emitted pollutant is converted into smog and other irritants, spread around, and in some cases diluted or washed from the air. The actual concentrations can be compared with “maximum” levels recommended by international authorities. Instead of giving an indicator measuring concentration, some give the number of days the “maximum” is exceeded. From the “source end,” inspections and tests of in-use emissions from a wide range and large number of vehicles can reveal what share of the vehicle population meets or exceeds a certain emissions standard for a key pollutant, or by how much newer vehicles are improved over older ones. Again, a wide variety of technical data can be combined into a few key indicators of air quality, air quality relative to a widely known health standard, and vehicle emissions standards.

Like accidents, clean air indicators have a certain absolute quality about them. If emissions per kilometer fall, but the number of kilometers increases by a greater rate, overall atmospheric loading of pollutants from traffic increases, and so do the concentrations of pollutants in the air and the number of days when key levels exceed norms. This increases



Photos by L. Schipper



Photos by L. Schipper



Photos by L. Schipper

the number of people affected by air pollution. While lower emissions/km is heartening, the absolute advance in pollution and those affected is not.

Xi'an city has a number of buses whose engines run on compressed-natural gas (CNG), as well as CNG

taxis. These vehicles are painted green to indicate their “low emission status.” There have been no careful and systematic emissions tests to provide the basic data that would yield emissions factors, in grams/km, for each pollutant from vehicles before and after conversion. There is no detailed transportation-related air pollution emissions inventory, which measures the total amount of each pollutant put into the air by the transport sector. What is the average reduction in emissions from each CNG vehicle? What is the impact of each conversion on the total inventory in the air? To answer these questions, one needs a good database on the numbers of vehicles by engine and fuel type, distances the vehicles run in a day or a year, and the emission factors from each combination of vehicle-engine-fuel-emissions controls. Indicators could also measure the impact—likely to be positive—of a BRT system on overall air quality.

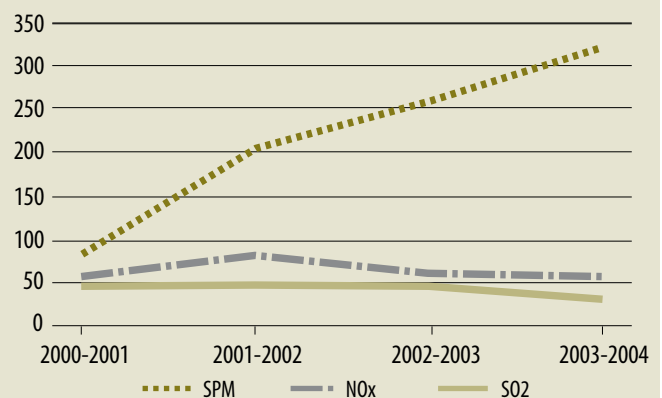
Pune’s ever-present two- and three-wheelers are predominantly two-stroke motors that use low-grade mixing oil. Direct exposure to riders and nearby pedestrians is high, while air pollution is a problem. Hanoi is somewhat different than either Xi’an or Pune. First, there are fewer heavy diesel buses, and most of those are relatively recent. There are fewer cars than in either city, but there are far more two-wheelers. Fortunately, most are of the relatively clean four-stroke variety.

Unfortunately, none of the partner cities has high quality data and indicators of clean air. Above all, no city has a system for feeding air quality measurements from a wide variety of places into a model that develops indicators for overall air quality; Xi’an and Hanoi have never attempted mobile-source emissions inventories, and little or no work has been done on exposure of people to exhaust emissions or air pollution. While authorities have compared concentrations of key pollutants at certain stations with allowable levels, it is difficult to characterize the overall state of clean air in any of the cities, except to say it is not clean.

### Ambient Air quality

The most dramatic indicators are those measuring the number of days in which concentrations of ozone or particulates (like PM<sub>10</sub>) surpass recommended levels. The PSUTA cities had limited measurements of ozone, but better measurements of PM, NO<sub>x</sub>, CO, and other pollutants in varying places. None had an air quality model that could be used to provide an integration of the various point observations. The example given in Figure 5.4, for Pune, develops concentrations of three pollutants based on measurements in a number of places that are simply averaged in a linear way. The example for Hanoi (Figure 5.5) focuses on particulate matter in different years, although carbon monoxide (CO) is important in many streets because of the large numbers of two-wheelers. The Xi’an data (Figure 5.6) shows PM as monthly averages over several years, with the seasonal variation of the levels. The relatively wide year-to-year differences in some months reflect measurement uncertainties, but there is a troubling lack of any definite downward trend over the years covered. Compared with the apparent increases in PM measured in Pune and Hanoi, this may be good news, but authorities want to see improvements. However approximate, these indicators underscore a primary concern of officials in all three cities, namely particulate matter.

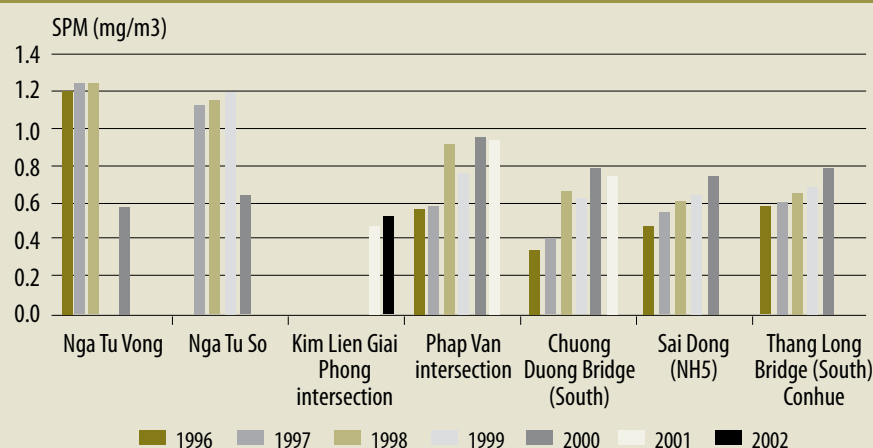
**Figure 5.4 Concentrations of key pollutants in Pune measured at three stations, over time**



Note: Annual average pollutant levels for Pune, ug/m<sup>3</sup> (limits: NO<sub>x</sub> = 60, SO<sub>2</sub> = 60, SPM = 140).

Sources: Pune State of Environment Report (11) and PSUTA partners (7).

Figure 5.5 Concentrations of suspended particulate matter in Hanoi, 1996–2002



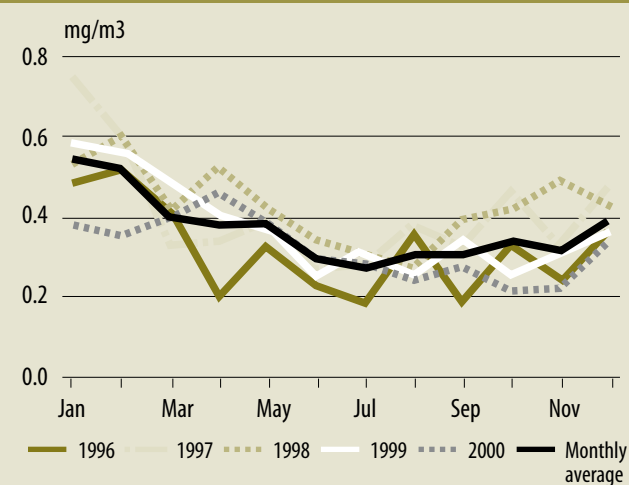
Note: Various locations.

Sources: Department of Natural Resources, Environment and Housing (unpublished data), and Center for Environment of Towns and Industrial Areas (unpublished data).

in cycle rickshaws (Pune and Hanoi), not to mention in three-wheeled motorized rickshaws (in Pune). This means that exposure to direct exhaust, particularly PM, is very high for most people. Add to that those waiting on crowded and narrow roads for buses, and exposure information would form a key set of indicators predicting respiratory disease. No good exposure data were found in this project reflecting the

impact of transportation-related emissions.

Figure 5.6 Monthly average concentrations of PM10 in Xi'an (unpublished data)



### Transportation-related exposure and measured health impacts

The three cities provided maps showing “hot spots,” sections of streets with the highest levels of pollutants and emissions. Although each city had some data on incidence of respiratory disease, there was little or no information on real exposure to pollutants. Greater than 60 percent of all trips in each city are walked, cycled, in two-wheelers (as driver or passenger), or

### Emissions factors and overall mobile source emissions apportionment

Xi'an officials showed us an attempt to produce a mobile source emission inventory using 1995 estimated emission factors “borrowed” from a U.S. model. There were no more recent data using actual emission factors and yearly driving distances. For Hanoi, no attempt at all was observed to produce an inventory. For Pune, there have been some emission factor measurements and distance estimates, but a single inventory still has not been produced.

In conclusion, each PSUTA city had some partial data on ambient air quality, poor information on in-use emissions from transport, and little information on exposure or health impacts. The best that could be constructed were these kinds of indicators illustrating air quality, but no complete pyramids. At the most basic level, authorities know where and when air quality is bad or worse. However, they are unable to quantify the impact of transportation on poor air quality or human health, and cannot measure accurately the improvements that good policies and technologies could bring. Without the insights indicators would bring, managing air quality will be difficult.

### SAFETY AND ACCIDENTS

Are the streets of the PSUTA cities safe? An often overlooked fact about traffic in developing cities is that most victims of accidents are not in motor vehicles, but pedestrians or cyclists. Measured on a per capita basis, traffic accidents and fatalities seem low. Measured on a per passenger-km basis, they are very high, because of the relatively low mobility of people, measured in passenger-km. Even per motor vehicle, fatalities are as high or higher than in the United States.

Table 5.2 Safety indicators (2001–2003)

Sample indicators	Hanoi	Pune (01)	Xi'an
Traffic fatality/year	503	282	545
Traffic fatality per 1 mn pers	152	76	76
Traffic fatality per 1000 vehicle	0.46	21	1.05
Traffic fatality per mn passenger-km	22	6.3	7.6

Sources: PSUTA (6,7,8).

In addition to many two and three-wheeled bicycles and the highest incidence of walking, Xi'an has a number of two-wheelers, as well as a rising number of cars. Not surprisingly, there are increasing numbers of traffic accidents and fatalities, with pedestrians and cyclists often being the victims. While this is certainly true in most developing country cities, the constraints on space within Xi'an's walls make the problem critical there. Hanoi and Pune have similar safety problems. Because both have much higher rates of two-wheeler ownership, citizens of these cities are also at great risk in the chaotic mixed traffic of large vehicles, ox-carts, and motor cars. What compounds the problem for Hanoi is that two-wheeler popularity is very recent. Neither authorities nor individuals have really had a chance to adjust their behavior during the spectacular ten-year rise in popularity of these vehicles. The sidewalk shown in Figure 5.8 is blocked by parked two-wheelers, a common scene in Hanoi.

Pune, by contrast, is the home of Bajaj, one of the world's most important manufacturers of two- and

Figure 5.7 Dangerous mix of cycle and car traffic in Xi'an



Photos by L. Schipper

Figure 5.8 Parked mopeds on a sidewalk in Hanoi



Photos by L. Schipper

Figure 5.9 Bus accident on a bridge in Pune



Photos by L. Schipper

three-wheelers. The high density of vehicles on the roads everywhere and erratic traffic make driving, walking, or cycling hazardous. When a bus ran off the roadway on a bridge (fortunately no fatalities), as shown in the picture in Figure 5.9, the other traffic passing by moments later seemed unfazed.

In conclusion, it appeared that each city had good data on various details of accidents, injuries, and hospitalization. Spatial distribution of accidents was well understood, too, particularly as a function of maximum road speed. Before our partnership, however, such data were not even used to form simple predictive indicators like deaths/vehicle or deaths/veh-km, and little effort was undertaken to understand how accidents affected different mobile groups (drivers, passengers, riders) or different segments of society. In short, the accident and safety indicators referred more to vehicles and traffic than people. In theory, however, the pyramids could be built and the implications of accidents over different groups expressed as well.

### ACCESS AND CONGESTION

The broadest indicators of access give modal shares, distance traveled, and time spent traveling. Precise indicators of access have many possible ways of measurement, such as time to get to work, or the fraction of the population living within 500 meters of a fast rail, bus, or metro stop. This would be done using a GIS-based population or household register. Studies suggest that people living (or working) within a 500-meter radius of major transport system nodes are much more likely to use the nearby systems than those living or working farther away. An economic measure could be derived from household expenditure surveys to measure the share of household budgets used for transportation of all forms. In this case, a higher value for the indicator might suggest transport is a burden on some groups. A lower value of time or money means easier access.

Congestion, the opposite of access, might be measured by the time lost by vehicles on a course

consisting of a number of main streets, relative to free-flowing traffic. A traffic measure could total the fraction of main arterials where traffic queues are longer than a given amount, or where typical transit times were greater than a given multiple of free-flow transit time. Time can be measured with cameras and vehicles. Congestion can also be measured on a city-wide scale by modeling all of the trips people take to work and estimating how long they really spend relative to a free-flow condition. This lost time is often converted into economic values, giving a macroeconomic estimate of the losses from congestion (10) (Table 5.3).

**Table 5.3 Example of access indicators**

Sample indicators	Hanoi	Pune	Xi'an
<b>Modal Split (year)</b>	<b>2003</b>	<b>2000</b>	<b>2000</b>
Walk	22.4%	29.1%	23.0%
Cycle, pedicab	28.8%	13.9%	24.5%
2-wheeler	42.3%	28.7%	4.8%
Private car	0.5%	6.1%	4.8%
Bus (all)	5.6%	13.9%	37.3%
Rail <sup>a</sup>	n/a	0.2%	n/a
Road space (% of city area, 2003)	6.1%	4.0%	7.9%
Average daily travel/person	7.25	12.64	10.00

<sup>a</sup> None of the PSUTA cities have metro systems. Pune's railway system has two stations located in the city, providing possible intra-city transportation. Hanoi also has a system that makes two stops in the greater urban area.  
Sources: PSUTA (6, 7, 8).

Xi'an is an old city with an intact, high wall that is 4 km long on each side. There are four main gates to the walled city. Not surprisingly, traffic is lined up from the main entrances to the famous Bell Tower in the center during many hours of the day. Hanoi, with fewer large vehicles, is a well-laid out city with what appears to be a great deal of road space. Yet the swarms of two-wheelers dominate the streets and the sidewalks. With more motor vehicles than Mumbai, yet only one-fourth the population, Pune is one of India's most congested cities. Pune has nearly one two-wheeler per household, but its roads are winding and has weaker infrastructure than the other two cities.

Figure 5.10 Rising congestion looking directly onto the Bell Tower in Xi'an



Photos by L. Schipper

Figure 5.11 Mopeds dominating every intersection in Hanoi



Photos by L. Schipper

Figure 5.12 Traffic chaos in Pune



Photos by L. Schipper

Travel is slow in the PSUTA cities. This is a function of both traffic congestion on streets and the large fraction of people walking, cycling, or moving in hand-drawn rickshaws. Hanoi shows the lowest nominal congestion and highest “speeds,” mainly because of the constant weaving in and out of two-wheelers, which carry a majority of the trips. Pune appears the most congested, both because of the high numbers of both cars and two-wheelers and the lack of good sidewalks, forcing all traffic (including bullock carts) to mix in many narrow streets. With the numbers of cars and two-wheelers in Hanoi and Pune doubling since 1997 and the number of cars now rising rapidly in Xi'an, congestion can only get worse. Xi'an reports “the average travel speed on the arterial road was 24.94 km/h in October of 2001, the average delay was 33.74 s/km, and in September 2002, the average speed on the arterial road was 19.27 km/h, the average delay was 62.86 s/km.” This dramatic slowdown occurred over only 1 year, during which the number of cars rose some 20 percent. None of the cities have “mass” transit in the form of BRT, metro, or high-capacity light rail, although Xi'an and Hanoi are completing plans for both BRT as well as city rail.

Cities also provided information on land use. Population density in inner Hanoi, for example, reaches close to 20,000 people per km<sup>2</sup> but falls by nearly two orders of magnitude toward the outskirts. Hanoi noted that 6 percent of its area was given to streets, as compared with 4 percent in Pune and 8 percent in Xi'an. By comparison, even New York and European cities have much higher area devoted to streets. Per vehicle, these road-area figures may seem comparable, but the figures for the Asian cities suggest congestion can only get worse. Of the three cities, only Xi'an has built a structure of very wide boulevards and even motorways, although all three cities have ring roads. Presently, each city has a very dense core with a grid of streets that cannot stand much increase in the onslaught of traffic. The dilemma for authorities is how to deal with the inevitable move of people to larger homes located farther away from the center, a

move that will burden the road system even if it is greatly expanded.

Other important indicators of access were emphasized by the Pune team. Indicators included the share of buses falling behind their scheduled times (or even canceled), the number of modern buses, and other indicators related to the performance of the public transport system. In Hanoi, the modern bus system was started in the late 1990s, but is closing in on more than 500,000 riders per day, roughly 10 percent of all daily trips. But another measure of access, walkable space, was elusive. Many stretches of main road in Pune lacked walkable sidewalks. The ample sidewalks in Hanoi were crowded with mopeds, hawkers, and even restaurants. Xi'an's many roadways immediately adjacent and parallel to the main roads, formerly given to bicycles, are now jammed with buses and taxis.

A key indicator combining social, economic, and access concerns is the share of the family budget devoted to transport. Xi'an assembled data that show an interesting rising trend with incomes. The lowest income households spend under 2 percent of their budget on transport; the highest income households are above 2.75 percent. This reflects the impact of rising ownership and use of private vehicles, as well as decreased use of (free) walking and cycling.

All three cities face a dilemma. In Hanoi and Pune, two-wheelers are the rising form of transportation, causing increased congestion and (in the case of Pune) severe pollution. Xi'an has acted to ban two-wheelers from its historic center and has fewer cars than Pune, but the very presence of the wall with only a few main arteries in and out bodes ill for congestion in the future. Authorities in all three cities identified congestion as a future problem, particularly if cars begin to substitute for two-wheelers, or the car population skyrockets in Xi'an as it has in other Chinese cities. With Hanoi recently abandoning its attempt to restrict two-wheeler ownership in the inner districts as ownership skyrocketed anyway, the outlook for access in all three cities is grim.

In conclusion, all three cities were able to derive predictive indicators like modal shares from basic data.

All cities had information on the most congested arterials and some information on the amount of delays. Xi'an came close to being able to construct a pyramid for time lost. All three cities also had some detailed information about the problems of access and congestion across different parts of the city or different groups, but none were able to make a systematic assessment that yielded a complete pyramid.

### **Gaps: Indicators The PSUTA Cities Could Not Develop**

The PSUTA itself was not intended to produce complete data sets and indicators. The goal was to develop a process for gradually developing and using indicators. Partners were not asked to produce detailed databases, although some spreadsheets were collected with the basic data and indicators they did find. Nevertheless, it is worth pointing out the systematic gaps in information that appeared. These were particularly important for air quality and to some extent for access.

It was heartening to see relatively good information on movements of people from travel or origin-destination surveys as the background of many transport initiatives. But even a two- or three-year-old database is out of date because of rapid growth in city size, changes in public transport provision, and above all skyrocketing ownership and use of two-wheelers and cars. Without better quantitative measures of these changes through indicators, authorities making transport policy will be basing policies on yesterday's, not tomorrow's world. A crucial step is to develop ways of extrapolating from one survey until the next is available, using readily available traffic counts and other inexpensive and commonly used approaches (some of which are regularly employed in Sweden and other western countries) to keep information and indicators accurate and timely.

Unfortunately, it was disappointing to see how little real information was used or available on key aspects of clean air, namely vehicle emissions, ambient air quality, and human exposure. Pune had the most

ambient air quality data, but they were very sketchy. Hanoi was able to pinpoint the locations of the most pollution-intensive hot spots on roads, but not give information on exposure of people to those pollutants. Xi'an complained rather bluntly that the emissions data they were told to use by national authorities were based on a 1995 model, not on the real Xi'an traffic and fuel conditions.

Emissions data—both individual emission factors and the overall emissions inventory—are important for key elements of a sustainable transport strategy. First, they tell authorities which vehicles are the highest emitters, based both on emissions per km and km run each year. Second, they verify that vehicle/fuel combinations supposedly meeting tighter standards really do so. Finally, they permit measurements of emissions before and after fuel conversions or other measures designed to reduce emissions in existing vehicles.

Another big gap is in the informal transport sector, both its real role in mobility and its economic robustness. Almost no quantitative analysis of pedestrian and cycle behavior has been undertaken. And there is little quantitative analysis of the role of para-transit; that is, the informal motorized (and non-motorized) transit sector. The “six-seaters” that ply certain routes in Pune, the private mini-buses in Xi'an, as well as pedicabs in all three cities could become the most important providers, as they did in many Latin American cities while authorities looked the other way. Lack of a good quantitative measure of real changes in transport was one reason no one took any action.

Another key area with which our partners were unfamiliar concerns the equity aspects of transport. The differential impacts of transport on men vs. women and poor vs. rich were not analyzed. Differences around parts of the metropolitan area were noted, but only analyzed by Xi'an. Given that all three cities do have good sampling frameworks for travel behavior surveys, the most recent surveys could be mined for more information. More important, future surveys could plug key gaps.

### **Conclusions About The PSUTA Cities: Indicators Show The Way Forward To Sustainable Transport**

No single indicator sums up the state of transportation in an urban context. However, from visits, presentations of material from the cities, and the reports the cities prepared, it can be concluded for the PSUTA cities that transportation is largely on an unsustainable path. This is because the number of individual vehicles is growing much more rapidly than public or private forces can accommodate them and is slowing all traffic. Traffic deaths are low relative to population, but high relative to distances actually traveled. Average speeds are low, except in the outlying regions of cities, but there the high speeds lead to greater traffic deaths. Air pollution from motor vehicles is particularly serious in Pune, but bad in Xi'an and in Hanoi. Because roughly 50–70 percent of all trips in these cities are made on foot or by two- or three-wheeled vehicles, exposure of a majority of people to direct emissions from motor vehicles is a problem. Table 5.4 summarizes the findings by area of concern.

It was not tried to combine all of the various indicators into one “bottom line” indicator of transport sustainability. This is neither possible nor useful. It would require a system of weightings amongst the various parameters and indicators that would be difficult, if not impossible to make in an objective way. And even if that were possible, compressing the entire transport system into one or two indicators, akin to representing a population and its economy only by population and GDP, would distract stakeholders from the very challenges that such a grand indicator would hide. Elsewhere it is argued that a similar aggregate indicator, the ratio of energy consumption to GDP, promotes a similar kind of blindness among stakeholders by hiding the key elements of energy supply and product that stakeholders need to understand (11).

Indicators have been used in all sectors of the economy for many years. Indicators of sustainable transport are formed from basic data and estimates describing the transportation system and the people

Table 5.4 Major findings in PSUTA cities under the ‘Pillars of Sustainable Transport’

Pillar	Hanoi	Pune	Xi’an	Note
Safety	Very high accident and fatality rates, but falling (improving). Two-wheeler drivers pay no attention to common rules of the road.	Moderate accident and fatality rate, but falling (improving). Many two-wheeler drivers pay no attention to rules of the road.	High accident and fatality rate, but falling (improving).	Particularly vulnerable are walkers/cyclists. Mixing of slow and fast modes in all three cities remains a great danger.
Clean air	Low NOx and smog, but high CO and PM.	Noxious air in many places, high CO, NOx, and PM.	Noxious air in inner city, high CO, NOx, PM, compounded by dust.	New emissions standards and fuel quality will help, but volume of traffic rising rapidly.
Social	No clear trends in transport impacts on gender, rich/poor.	No clear trends in impacts, but some “women-only” facilities reflecting gender harassment threats.	Trend that higher income families have higher share of motorized collective or private transport, thus higher share of transport expenses in total expenses.	Teams were not familiar with indicators of social sustainability of transport.
Access and social sustainability	Remarkable ease of access for those on two-wheelers, but at cost of those on cycles or feet. Poor walkability because of blocked sidewalks. New bus service now providing 10 percent of daily trips.	Poor access by any mode. Poor walkability and cycling: lack of protected walking or cycle space. Buses steadily losing customers to two-wheelers and cars.	Fairly good access on buses, but traditional cycle ways losing to bus and car traffic. Walkability and cycling still acceptable, but threatened by encroachment by buses and cars. Buses still have large share but slowing down in traffic.	Growth in individual vehicle use in all three cities overwhelming all measures to improve access.
Economic	New bus company gaining customers and doing well economically; high gasoline prices pushing two-wheeler users onto buses.	Bus company strong technically but vulnerable economically as riders lost to two-wheelers.	Bus operators 95 percent self-sufficient. Transport expenses small fraction of household budgets.	Main threat in all cities is continued loss of mass transit passengers to two-wheelers and in Xi’an cars.
Overall	If bus, BRT, and light rail can win large share of present two-wheeler mobility and private cars do not replace two-wheelers, and if modern fuel and emission standards take hold, transportation may be sustainable.	If mass transit modes hold their share and a radical reduction in two-wheeler emissions takes place and some kind of policy reduces traffic in the crowded city center, Pune will see progressively more sustainable transport.	With low two-wheeler ownership but rising car ownership, challenge is to bring in metro and BRT (particularly the latter) as quickly as possible to expand access before cars become locked in.	

who use it, the physical infrastructure of the region, the economic activity transport generates, as well as the pollution and other measures of environmental problems associated with transport. Used properly, transport indicators provide a powerful toolbox for understanding how today’s transport system evolved from that of the past, and how it could change in the future. Above all, they illustrate our power to improve future systems and to achieve sustainable development.

In the PSUTA project, empowered authorities and experts identified major gaps in their common knowledge about the state of transportation in their respective cities. They agreed that some of the gaps were serious, particularly those related to emissions. They mapped out the gaps of mission information. In the next few years, they can bridge those gaps with sensible clean-air transport strategies. But the record in Asia so far is mixed, as countless presentations

in the Clean Air Initiative-Asia “Better Air Quality” meetings of 2003 and 2004 suggest (12, 13).

At greatest risk to sustainable transport is access because of the seemingly unstoppable appeal of individual two- and four-wheeled transportation. Initially, those at greatest risk are pedestrians and cyclists, who lose security on the road to larger and faster vehicles. Safety for vehicle occupants is likely to improve as driver education, rule enforcement, and improved vehicles save lives, but this does not ensure safety for those walking or cycling. The outlook

for cleaner air is brighter because so many Asian nations are moving to cleaner fuels and emission controls for new vehicles (14). By 2010, most of Asia will have standards that in theory are close to where Europe or the United States was in the 1990s. Given how early the Asian nations are in their development of motorized transport, this move to lower emissions is remarkable. But a system of monitoring of real results—which yield indicators—is necessary to validate that these lower emission levels are achieved in reality.



# 6

## Lessons from the Indicators and Strategic Framework

**A**S TABLE 5.3 summarizes, trends in the three PSUTA cities point to much more congestion, more accidents (albeit at lower fatalities rates), and higher total emissions (albeit at lower emission factors). These unsustainable trends could reverse sooner or later. Actions, in some cases without perfect information, are called for. What has the PSUTA project taught us about how we—the project leaders, SIDA, and other assistance organizations from the bilateral, multilateral, and other sectors—could help?

### **The Importance of Building Local Competence for Quantitative Indicators**

A key element in improving transportation is to engage local leaders in a quantitative manner. Data collection was not the key goal of the PSUTA, rather the building of a process. There were several key elements of this process that were new for Asia: the building of a local network of stakeholders who cooperated and accepted the results, the sharing of concerns among cities

*In contrast with internationally collected (and often sold) data bases, the PSUTA data were rooted in local experts and stakeholders in transparent and scientific ways*

at BAQ, and above all the appreciation of the importance of measuring quantitative impacts of sustainable transportation.

A variety of partners and empowered stakeholders in each PSUTA city supported the PSUTA work, provided data or comments, and recognized in meetings in their respective cities the importance of this process of quantifying transport. In contrast with internationally collected (and often sold) databases, the PSUTA data were rooted in local experts and stakeholders in transparent and scientific ways. One

*In spite of our encouraging outcome, it was not surprising that the greatest barrier to using indicators was the lack of cooperation among government bureaus, as well as between government and other sectors*

of the outputs from each PSUTA team was a listing of who had key data or already used key indicators. And a consistent complaint from every city was that previous local efforts to develop data for local or bilateral projects seldom produced information consistent with the previous (or

next) project. In short, a useful network of experts who understood the strengths and weaknesses of the data on sustainable transport was created. This network will serve future projects, such as those under discussion by the World Bank and others.

Having injected a new understanding of quantitative trends in sustainable transport into empowered leaders, it could be seen clearly at BAQ 2004 that they could communicate with each other about their respective cities' transport systems better. And what was clear was that the use of indicators allowed them to quantify "better" or "worse" in ways useful for learning from each other's experience. What this means is that leaders in the PSUTA cities did deepen their appreciation for a quantitative approach to sustainable transport. They are more willing than ever to invest their own resources in filling the

gaps the PSUTA exposed, and they are more likely than before to demand to evaluate the impacts on sustainability of all future transport projects.

Finally, much of our work involved building alliances of diverse people and institutions within each city. These groups are essential for sustainable transport planning. A key challenge to these cities will be to develop the capacity to keep the channels among these individuals and bureaus open and functioning, and provide funds and expertise for them to continue to develop and share information.

### **Most Systematic or Pervasive Gaps in Indicators Formation and Barriers—Analytical, Data, and People Problems**

In spite of our encouraging outcome, it was not surprising that the greatest barrier to using indicators was the lack of cooperation among government bureaus, as well as between government and other sectors. In Hanoi, PSUTA brought together stakeholders and experts who ordinarily did not meet. Fortunately, PSUTA was able to forge alliances that will extend beyond our own engagement in each city.

The other discovery made was the universal complaint that so much of the information gathering was supported by individual bilateral or multilateral projects with no concern for previous or existing expertise or data. The data and indicators for the Master Plan in Hanoi were not consistent with either similar previous work for other projects or with data supported regularly by Hanoi authorities. The usual villain cited was "money"—no funds for each city to do its own work carefully, hence a dependence on individually funded projects that hurriedly assembled needed information.

The key issue for indicators is that they require information spread across different parts of the public and private sectors. An emissions factor is measured in grams/km; to convert that into the total daily or yearly emissions from any given set of vehicles, the total number of km they travel in a day or year must be estimated. This is something transportation or police

authorities can assist with. If these authorities will not provide (or invest in) the required data on vehicle use, a real emission inventory cannot be built. Indeed, data on vehicles are important across all categories of indicators normalized to vehicle populations or use. Our experience is that environmental authorities usually have few of these required data.

A final local barrier is the lack of cooperation between cities in the same country or between local, regional, and national governments. This may be due to political constraints, but more often just old-fashioned tradition or simply geography. Hanoi city officials welcomed national officials (Vietnam EPA and Vietnam Register, the national standard-setting organization) to our PSUTA meetings, and the latter had no trouble attending, but they are less commonly seen in meetings in Ho Chi Minh city. The same traditions made it complicated to combine nationally and locally supported data on ambient air quality in Hanoi into one consistent data set. In Xi'an the ambient air quality is measured by national officials. These differences were often great barriers to sharing information. The artificial boundaries must be removed.

A strong recommendation can be made for support for building and maintaining basic indicators of sustainable transport used in this project. Those would cover vehicle emissions, ambient air quality and human exposure (every 2 years); an Origin-Destination travel survey coupled to vehicle use data and traffic counts (every quarter for traffic counts, every year for vehicle use data, and every 5 years for the O-D survey). The goal of such support would be development of a package of transport indicators supported by local and national transport planning agencies. Such a package must be supported by the range of local authorities who have interests in collecting the data. Such support should be preconditioned on each city agreeing that the implementing team will be multidisciplinary and cross both local administrative and local/national administrative lines.

### **Bridging the Gap: Filling the Most Systematic Holes in Local Data**

The PSUTA team strongly recommends a careful and systematic effort to build good mobile emissions inventories, data on human exposure to everyday air pollution, and a long-term effort to improve collection of ambient air quality data and construction of reliable indicators of air quality. Much of this can be accomplished by developing an Asian City package that addresses all of these needs, one that would be adaptable to virtually all important cities in Asia. The goal of near-term assistance is to put local environmental authorities in position to support this regularly with a cost-effective package of equipment.

A key facet of this is the transfer of both know-how and equipment to local teams, perhaps regionally based. While the use of consultants in initial phases can be endorsed, the goal is for all large cities to be able to count vehicle characteristics and measure traffic and vehicle use, emissions factors, and so on from their own vehicles. In some cases, emission factors from one city can be used in others, but in every case, characteristics of vehicles and their utilization must be local. Where a region has specific geographical conditions—very dry or humid, very dusty (Xi'an), very high altitude (Kathmandu)—emissions factors must be measured locally.

Understanding the informal transport sector—through surveys and even interviews—is crucial for improving transport sustainability. Surveys and case studies (such as was done by ITDP for rickshaws in Agra and in Jogjakarta) would be very helpful, as would stakeholder engagement in the PSUTA cities and elsewhere to assure a widely agreed role for each component of this sector. But a wider need is to expand each city's ability to measure the demand side—access and mobility of all people on all modes—as well as the supply side—the true condition of all forms of transport both private and for hire. Such information is vital for improved sustainable transport planning.

Development agencies do not like to fund data gathering. Yet the kinds of information required

for the PSUTA should be gathered routinely by the alliances of stakeholders created in each PSUTA city. What is needed is support for bridging the basic gaps identified in each city, creating the competence to do this locally into the future, building further support for local funding of such an effort, and above all assuring that equipment and capacity is available locally for this information. A particular emphasis here is on emissions and ambient air quality monitoring, the area that requires the most technology and technical competence.

### **How Our Results Will be Used**

Help is on the way from international funding agencies to improve transport in these cities. Hanoi has many projects aimed at cleaning up vehicles, and is finalizing a massive urban transport project with the World Bank that will include bus rapid transit. Xi'an is also the object of a large proposal from the World Bank, as well as the beneficiary of an ADB loan for a ring road. Pune has gone through a number of projects on both transit and emission reductions.

The projects in these two cities are not trivial, and the value of each will reach to well over \$20mn. The World Bank Hanoi project involves active policies to improve air quality and reduce vehicle emissions. BRT will be developed to win share of daily travel

back from two-wheelers and complement a light-rail system being developed by a French project. The WB project in Xi'an is still under formulation but will follow along those lines, but metro rather than light rail will complement the BRT. The ADB Xi'an project has as its goal promotion of economic growth through relieving traffic bottlenecks, and promoting environmentally sustainable transport through a number of institutional measures. The ADB project will also develop emissions measurement capability and promote use of CNG vehicles. Measuring the impacts of these projects would have been difficult without our project. Instead, PSUTA has developed the institutional capabilities and indicators that will be helpful.

All three cities will use the indicators developed in this project to see whether the gaps in information can be bridged to measure and make good choices for sustainable transport. It remains to be seen whether city authorities will then cross those bridges in the context of new projects, or, better, on their own without waiting for international assistance. In the next section, some recommendations are made based on the key gaps found in the project. Filling some of those gaps in the near term would assist the cities, the World Bank, and above hasten the reversal of key trends.

# New Approaches for Sustainable Transport

## Key Issues and Next Steps

### Regional Coordination

ONE of the key outcomes of the meeting of PSUTA teams and regional experts was a clear sense that experts and decision makers had much experience to share. This sharing was facilitated through using indicators. Even more important, however, is the importance of regional coordination facilitated by indicators. Using political and economic pressures to reduce emissions or improve fuel specifications in an entire region are much more sensible than doing this piecemeal country-by-country. Finding technical and educational ways to improve pedestrian and vehicle safety in all countries where most people walk or ride on two wheels is another area where coordination helps. And developing models (including indicators) that have application in all major cities of a region is easier than starting from scratch in each place. Although the PSUTA only worked directly with three cities, it showed that such regional coordination was both necessary and possible.

*In short, transport planning must be based on a quantitative approach using indicators for diagnoses, choice of solutions/technologies/policies prognoses, evaluation, rebalancing, and communication*

One reason for regional coordination is to change investment patterns. For example, if a number of countries move toward Euro-3 or 4 fuel and emissions standards, fuel and equipment supplies as well as vehicle makers are more likely to invest in that capability than if only one country or city adopts such standards. Similarly, if a BRT system clearly succeeds in one Asian city, it is likely to be emulated elsewhere; for example, the dramatic results for Bogota's Transmilenio system have stimulated similar developments in Mexico City and elsewhere in Latin America.

ADB, the World Bank and other international organizations are aware of this effort. Both ADB and the World Bank sent several observers to the PSUTA workshops in Hanoi and participated in a number of events there. A major event on sustainable transport

*At the most fundamental level, capacity building means investing now in secondary school and university courses in environmental engineering, transport planning, traffic safety etc*

organized by the United Nations Center for Regional Development, in Nagoya in August 2005, featured several sessions around the PSUTA and sustainable transport indicators. Several of the lessons from the PSUTA project and the Strategic Framework for sustainable urban transport were reflected in the statement adopted in the First Regional Forum on Environmentally Sustainable Transport, whose output appeared as [www.uncrd.or.jp/env/est/regional\\_est\\_forum/docs/First\\_Meeting\\_Report\\_Aichi\\_Statement.pdf](http://www.uncrd.or.jp/env/est/regional_est_forum/docs/First_Meeting_Report_Aichi_Statement.pdf).

More important than these and other meetings however, is that both important lenders understand that projects that claim they are promoting sustainable transport require a quantitative basis for measuring impacts. With relatively small grants to

each partner city, the PSUTA showed that a modest investment would yield not only information, but the intra-regional human and institutional partnerships required to support a sustainable approach to indicators.

### **SUT Planning Needs a Quantitative Approach— The Main Lesson for External Funding Agencies**

PSUTA noted the importance of assuring that externally funded data and indicators work be consistent with existing and previous work. Without such continuity and consistency, information gathered in one study cannot be combined with that in another study.

More important, however, is the role of a quantitative approach. It appears from contacts in the three PSUTA cities that little hard analysis is undertaken to choose or justify various big transport investments, particularly ring roads, flyovers, or major collective systems. Building a ring road, for example, could have a profound impact on vehicle emissions by stimulating traffic. Was this considered when the road was planned? Will pedestrian traffic be bolstered through better facilities or will the road cut off footpaths, perhaps stimulating more motorized traffic to permit long detours around the road. These are the kinds of quantifiable outcomes, often unintended, that must be understood before transport is modified.

In short, transport planning must be based on a quantitative approach using indicators for diagnoses, choice of solutions/technologies/policies prognoses, evaluation, rebalancing, and communication. The need to give a quantitative focus to all steps of transportation development—in contrast to the very approximate approach today of both planners and other stakeholders—is the most important lesson for external funders and experts.

### **Capacity Building**

Substantive capacity building is required among stakeholders (government, private sector, and civil society) to enable the formulation and implementation

of SUT policies in Asia. Capacity needs to be established among all stakeholders, focusing both on the overall concept of SUT and the roles assigned to stakeholders in the regulatory framework.

International development agencies can play an important role in introducing the rationale and concept of sustainable urban transport, the building and collection of indicators. Development agencies need to ensure that they respect the need for a strong indigenous institutional network that supports an indigenous policy formulation and implementation process and is not subordinated to the program or project interests of the development agency. Where development agencies support the formulation and collection of indicators, they need to ensure that indicator formulation and collection is an indigenously owned process. Where development agencies have a need to collect specific indicators, this should be in addition to the regular indicators and to replace existing indicators.

At the most detailed level, capacity building is needed to deploy sophisticated data collection schemes, collect results to provide indicators, and employ good models (for air pollution, congestion, traffic forecasts, safety, and so on). Presently, high-priced overseas consulting firms do most of the work in Pune and Hanoi, while Xi'an itself has a high level of capability. Previous work in Pune showed how quickly local technicians and other experts can learn how to use emissions measurement systems. Our own experience in Hanoi shows how quickly our transport and safety partners became familiar with the key elements of the mobile emissions problem. But these skills have to be raised permanently. As a leading expert in Xi'an told us, "No one ever asked about sustainable transport" before. Our partners need more training in modeling of transport and air pollution, and in developing and working with tools that help them make better decisions about future choices for sustainable transport.

At the most fundamental level, capacity building means investing now in secondary school and

university courses in environmental engineering, transport planning, and traffic safety. The phrase from "cycles to Cadillacs" certainly characterizes Hanoi and Xi'an, where senior engineering faculty members themselves were raised in a world with few cars and even fewer mopeds. Travel surveys we were shown reflect a lack of depth in questions asked. Often, PSUTA posed questions no one had ever asked before, such as the length of journeys by mode, the fraction of household income spent on transport, and exposure of humans to air pollution. It is imperative that each country invest now in a solid training background to provide balanced approaches to transport planning in the future. In this regard, Sweden and other countries in Europe have an experience at the university level that should be spread to countries of Asia and beyond.

Capacity building also means hardware acquisition, but not in a total vacuum. Hanoi has a lab for measuring emissions from mopeds and cars, but no program or mandate (or apparently funds) to do so. A modest start can be made by acquiring mobile/portable emissions measurement equipment that can be used as well with a chassis dynamometer. Better and lower cost ambient air sensing equipment can be acquired. Electronic traffic counters of various means (including systems that read license plates) can provide much better information on traffic flows.

Finally, the PSUTA process revealed that many data are unobtainable and key indicators are impossible to construct with the accuracy required for good policy choices. It goes without saying that building the local capacity to bridge the gaps with local information is important for every city. Policy making is not well served by making use of externally generated data and databases not anchored by both data and people in the region in question. In countries with many large

*It is imperative that each country invest now in a solid training background to provide balanced approaches to transport planning in the future*

cities—India and China, for example—some of this capacity building can be underpinned by national training efforts and some harmonization of approach among dozens of cities. In a smaller country like Viet Nam, initial efforts might only involve Hanoi, Ho Chi Minh City, and possibly Danang.

### **Financing of Sustainable Transport**

Since most Asian cities are from developing economies, they will have difficulties in financing sustainable transport policies and programs. This strategic framework cannot provide solutions for the overall financial position of the cities. It can recommend some actions in financing urban transport to keep it economically sustainable.

Indicators play a key role in pointing to current and future problems, and choosing among alternative solutions. Here they can measure cost-effectiveness. For example, a metro usually has the highest capacity in passengers per hour, but a metro also costs more per km or per passenger per hour. If the value of land is so high that there is no road space available and present road space is hopelessly congested, then a metro may be the only choice. But a careful modeling effort has to be undertaken to prove that after construction, the metro really will draw traffic from congested streets, rather than establish new patterns of traffic. This approach is critical for deciding how to allocate scarce transport development funds toward the goal of better access and lower congestion.

Additional funds can be generated by allowing transport organizations to accept contributions from

outside sources or new alliances. Partnerships can be built between public and private sectors within a strong regulatory framework. Strong governance must back a strong public transport sector. Development agencies may also help through increased funding for sustainable urban transport systems. Funds from the Global Environment Facility (GEF) may be utilized to catalyze and pilot test new approaches. Discussions are under way to explore whether the rules for the Clean Development Mechanism can be modified to allow its use for the transport sector.

Income may come from penalties imposed on those whose practices lead to health and environmental damage or more traffic congestion. The polluter pays principle should apply. A resulting cross subsidization based on the polluter pays principle may also be employed, which will be monitored by the Apex committee. Infrastructures can be seen as commodities; as such, their use can generate revenue through toll and other road user fees, parking fees, and the like.

Policies and measures must be in place to ensure that free-riding and developing companies do not make gains from value capture on land and decreased congestion resulting from transport measures. Balanced pricing can be introduced between transport and land value with regard to modes and social classes.

Better implementation and broadening the scope of available policies can also aid in financing sustainable urban transport. Cities and states can broaden revenue generation to enhance sustainability and self-reliance.

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