

The Developing World's Motorization Challenge

DANIEL SPERLING
EILEEN CLAUSEN

Soaring personal vehicle use is producing great benefits but also potentially enormous costs.

Motorization is transforming cities and even rural areas of the developing world. The economic and social benefits are enormous. It provides individual flexible transportation in urban areas and reduced manual labor and improved market access in rural areas. In the longer term, however, motorization may stifle local development, increase pollution, and create unprecedented safety hazards. Without careful attention to the motorization process, disaster looms for cities of the developing world--disaster from which the industrialized countries cannot be isolated.

In rural areas and small cities of China and India, millions of small indigenous three- and four-wheel "agricultural" trucks are proliferating. In China, these vehicles are banned in large cities because of their slow speed and high emissions, but agricultural vehicle sales in China still outnumber those of conventional cars and trucks by more than five to one. Costing anywhere from \$400 to \$3,000 each, these vehicles are the heart of millions of small businesses that transport farm products to local markets and that move construction materials and locally manufactured products; they also serve as the principal mode of motorized travel in rural areas. They are analogous to the Model T in the United States. Agricultural vehicles are essential to local economic development and to the creation of entrepreneurial business activity in rural areas.

Motorization in cities is also soaring and highly valued. Personal vehicles, from scooters to large company cars, provide a high level of access to goods, services, and activities, as well as unmatched freedom. They provide access to an expanded array of job and educational opportunities. For many people, vehicles are also desirable as a status symbol and a secure and private means of travel. For businesses, they are an efficient means of increasing productivity.

But personal mobility and motorization also impose enormous costs, especially in cities. The well-known litany of costs includes air and noise

pollution, neighborhood fragmentation from new and expanded expressways, and high energy use. There are also costs with global implications. Motorization is the largest consumer of the world's petroleum supplies, making it central to international concerns over energy security and political stability in volatile regions. And it is an increasingly greater source of greenhouse gas (GHG) emissions contributing to climate change. Worldwide, GHGs are rising faster in transportation than in any other sector, and fastest of all in developing countries.

Developing cities and countries are in a difficult situation. They must accommodate the intense desire for personal mobility while mitigating the heavy economic, environmental, and social costs of motorization. For countries such as India and China, which look to automotive manufacturing as a pillar of economic development, the challenges are even more intense.

The good news is that many opportunities exist to mitigate the adverse effects of motorization while still allowing personal transport to spread. Moreover, many strategies to manage motorization in developing countries respond to a variety of concerns that are locally compelling, including high roadway costs, stifling traffic congestion, and worsening air pollution. Developing countries confront choices regarding the timing, extent, and form of motorization. Those choices will have a great long-term impact on the quality, pace, and sustainability of their development. Fortunately, too, the strategies needed to respond to local concerns are largely consistent with those needed to respond to the global concerns of petroleum use and climate change.

Car talk

Motorization is soaring virtually everywhere. The number of motor vehicles in the world is expected to reach about 1.3 billion by 2020, more than doubling today's number. The fastest growth is in Latin America and Asia.

These figures and forecasts, like almost all published data on vehicle ownership, do not include motorized two-wheelers. China alone has more than 50 million scooters and motorcycles. The costs of these vehicles are low and dropping. New mopeds (with engines under 50 cubic centimeters) and small motorcycles can be purchased for as little as \$200. They are found throughout much of Asia and are starting to spread to Latin America. The proliferation of these low-cost scooters and motorcycles is accelerating the motorization process in the developing world. They encourage an early leap from buses and bicycles to motorized personal travel. No longer do individuals need to gather considerable savings to buy a vehicle. In Delhi, where the average income is less than \$1,000 a year,

close to 80 percent of households have a motor vehicle, most of which are two-wheelers.

The benefit of these motorized two-wheelers is expanded access to personal mobility; the downside is more pollution, more energy use, and further undermining of public transport services. Public transport is heavily subsidized in almost all cities because of its large positive externalities (reduced need for roadways and reduced congestion) but also to ensure access by poor people. Nevertheless, many poor people still cannot afford transit services. Thus cities face pressure to keep fares very low. But in doing so, they sacrifice bus quality and comfort. Middle-class riders react by buying cars as soon as they can. With low-cost scooters and motorcycles, the flight of the middle class is hastened, transit revenues diminish, and operators reduce quality further as they serve a poorer clientele. Although the quality of service suffers first, a decrease in quantity of service often follows. This hastened departure of riders is creating even greater pressure on cities to manage public transport systems better. In virtually all cities in the world, in industrial as well as developing countries, public transit is losing market share.

Motorization's enormous stress on city development and finances is pivotal. A study by the National Research Council asserts, "with very few exceptions, rapid growth in demand for motorized transport has swamped transport [infrastructure] capacity in the cities of the developing world." The World Business Council for Sustainable Development, in the first commissioned report of a multimillion-dollar study on sustainable mobility, warns: "The major challenge in the developing world is to avoid being choked--literally and figuratively--by the rapid growth in the number of privately owned motorized personal-transportation vehicles . . . [Personal mobility] is deteriorating in many areas where it had been improving in the past." Many cities in developing countries, with a fraction of the car ownership of the United States, now experience far worse traffic congestion and pollution than exist in the United States.

The roadway construction and financing challenge is not just one of economics and financing. It is also a political and social issue. Only a small minority of the population in developing-world cities owns cars and benefits from massive road-building budgets; in contrast, the vast majority suffer from increasing traffic congestion, noise, and pollution. In cities with many motorized two-wheelers, the vehicle user population is larger but still a small share of total travelers. Destruction of neighborhoods to build new expressways is starting to spark social unrest, as it did in the United States in the early 1960s.

International development banks and local privatization are playing an increasing role in financing facilities and services. There is a reluctance to

finance expensive rail infrastructure, but money for roads and bus systems is readily available. Many parts of the developing world, particularly in Latin America, are selling roads, ports, railroads, and other facilities, or sometimes just the operating rights, to private companies as a means of financing the operation and expansion of new and even existing facilities. Even China is relying on tolls to finance intercity roads. Although privatization is an attractive solution to the funding woes of developing country governments, it creates a new mix of winners and losers that merits close scrutiny.

Another adverse effect of motorization that is attracting the attention of local policymakers is air pollution. Motor vehicles play a central role, accounting for about half the pollution, even with very low rates of vehicle ownership. Cities such as Santiago, Mexico City, Beijing, Katmandu, and Delhi are now aggressively imposing new rules and laws to reduce air pollution. Most are eliminating lead from gasoline so as to facilitate the use of catalytic converters (and reduce the health hazards of lead) and are accelerating the adoption of vehicle emission standards already in place in industrial countries. The prognosis is reasonably positive, because in many cases air pollution can be reduced largely with technical fixes at relatively modest cost (thanks largely to the flow of technical innovations from the industrial world). Large international automotive and energy companies are key to this.

More troublesome, because the solutions are not obvious, is petroleum use. Motorization leads to sharp increases in oil use. In most of the developing world, cars use about six times as much energy as buses per passenger-kilometer, and about twice as much as a small modern motorcycle (with a four-stroke engine). These ratios can vary considerably, mostly depending on the level of ridership.

Bus rapid transit is viewed as perhaps the most important transportation initiative today.

Soaring oil use is not a compelling problem to local policymakers but is of great concern to national governments and even more so to the global community. The global transportation sector is now responsible for almost one-fourth of worldwide carbon dioxide emissions. The International Energy Agency projects that oil use and GHG emissions from developing countries will grow three times faster than emissions from the United States, Europe, and Japan over the next 20 years. Others project an even greater differential.

Overall, about half of all the petroleum in the world is used for transportation. Thus, greater transportation energy use translates directly

into greater vulnerability to supply disruption, greater pressure on Middle Eastern politics, and greater emissions of carbon dioxide, the principal GHG. Although the transport sectors of countries such as China and India are still small contributors, with relatively few vehicles per capita, their emissions are increasing at a sharp rate. In China, for instance, transport accounts for only 7 percent of GHG emissions. In cities such as Shanghai, however, four- to sevenfold increases are anticipated in the next 20 years.

The challenge for these cities is heightened by the fact that uniform prescriptions do not work. Motorization patterns vary widely across the globe, particularly among developing countries. In some Asian cities, for instance, conventional trucks, buses, and cars account for only 5 percent of vehicles, compared with 60 percent in others. In Delhi and Shanghai, roughly two thirds of vehicles are motorized two- and three-wheelers, whereas in African and Latin American countries, almost none are. In South Africa, minibus jitney transportation accounts for fully a third of all passenger-kilometers of travel, but in others it plays a negligible role. Shanghai has 22 cars per thousand residents, whereas much poorer Delhi has nearly three times as many. Numerous factors influence motorization. Income is the most important, but other factors more readily influenced by public policy and investments are also important. Motorization can be managed.

Although a few cities have coped well, most have not. The challenge of dealing effectively with rapid population growth, rapid motorization, and large groups of low-income travelers

would be difficult for cities with substantial financial resources and strong institutions. For developing cities with limited funds and planning expertise--and with inexperienced institutions--effective transportation planning, infrastructure development, and policy implementation are extremely difficult. In many cases, the problem is lack of political will, compounded by lack of money and effective institutions.

Priority in foreign assistance should be given to projects that enhance nonmotorized travel, transit services, and vehicle technology.

In Delhi, for instance, the Supreme Court of India responded to a lawsuit alleging a failure of local governments to protect people's health. It intervened with a variety of controversial directives, including a requirement that all buses and taxis convert to natural gas. These directives were not the result of a careful assessment of options, and they focused on technical fixes rather than more fundamental shifts in behavior and land use. The immediate result was bus shortages and violent demonstrations. These policies reflected a mood of desperation about air pollution and an exasperation with existing metropolitan institutions.

Buenos Aires, had a similar problem and found it politically impossible to pass a law to form a metropolitan transportation planning organization. In that case, the city successfully procured a loan from the International Monetary Fund to build bottom-up cooperative relationships between transportation stakeholders through small projects.

The timeline for transportation system development in today's developing countries is compressed compared with that of cities and nations that have already completed the process. The rapid speed of development creates pressure for substantial investments within a relatively short period. Finding the resources to finance the needed infrastructure investments and the expertise to manage the growth is a challenge in many parts of the developing world.

Leapfrogging is not the answer

Transportation systems are highly fragmented, with a diverse set of technologies and a diverse mix of public and private investors, managers, and users. Frustrated policymakers often turn toward technology fixes, because they generally require less coordination and less behavioral and institutional change.

Leapfrog technologies--advanced technologies that allow developing countries to go beyond what is now typically used in industrial nations--are the highest-order technical fix. Why not skip over the relatively dirty and inefficient internal combustion engine, the large fuel production and distribution infrastructure associated with petroleum, and the chaos of "unintelligent" roads and transit systems? In the telecommunications industry, cellular phones are replacing wires as the physical equipment needed for communication all over the world. In developing countries, this is making it easier than ever for people to connect to each other and to the rest of the world, leapfrogging past the need for telephone lines.

Some advanced transportation technologies are already being pursued in developing nations. Electric bicycles and scooters are being used in China and a number of other countries to reduce urban air pollution. Some cities are switching buses, taxis, and other vehicles to natural gas. Still others are about to experiment with fuel cells. Shanghai is building a maglev train from the airport to downtown, employing German technology that failed for 25 years to find a market in developed countries. Information technologies are being used to control roadway congestion and collect tolls in many developing-country cities. And some small innovations such as inexpensive emission-control devices are being developed using local materials.

In the end, though, the case for a leapfrog approach is far less compelling in transportation than it has been in telecommunications. Advanced transportation technology does not harbor any solutions that will revolutionize the way people and goods get around. Some fuel, propulsion, and information technology (known as intelligent transportation system, or ITS) options are currently available, and their deployment could be accelerated, generating modest emissions or energy savings. But generally speaking, they tend to be more costly than conventional petroleum combustion technologies and, in the case of ITS technologies, require huge financial and institutional investments. Advanced transportation technologies are clearly an attractive option in developing countries, but great care must be given to adapt to the setting, anticipate unexpected costs, and provide the expertise and institutional investments to implement these technologies successfully.

Perhaps the most talked-about leapfrog technology is fuel cells. They are more energy efficient and less polluting than internal combustion engines, and potentially cost-competitive. But they illustrate well the leapfrog challenge. They are far from cost-competitive today. So any country seriously contemplating a leap to fuel cells would need to invest many billions of dollars in its domestic automotive industry, or await investments from foreign companies. Fuel cell vehicles are not expected to be mass-marketed before 2010 in affluent industrial countries and thus could not leapfrog to developing countries for at least 15 years.

The temptation to embrace leapfrog technologies is seen in the experience of the Global Environment Facility (GEF). Established as a multilateral trust fund by the United Nations and World Bank, the GEF for many years shied away from transport, uncertain how to proceed. That changed in the late 1990s with an allocation of \$60 million to a fuel cell bus initiative, funding pilot projects in Mexico City, São Paulo, Cairo, New Delhi, Shanghai, and Beijing. Delivery of about 50 buses was scheduled to begin in 2002. Such projects have consumed most of the resources allocated to transportation. The GEF is now exploring other strategies more seriously.

Take the bus

Novel policies, investments, and technologies are not needed. There are plenty of examples of effective initiatives around the world, many of them pioneered in developing countries (see box). What is missing in most cities are commitment and public resources.

Bus rapid transit is viewed as perhaps the most important transportation initiative today, not only in Asia and Latin America but also in the United States. It involves a variety of measures that enhance bus performance. The primary characteristics of bus rapid transit systems include some

combination of segregated bus lanes, techniques to hasten boarding and alighting, priority given to buses at intersections, and effective coordination at stations and terminals. The motivation is to emulate rail transit without the high cost. Indeed, a few bus rapid transit operations have been able to move almost as many passengers in one bus lane as on one rail line (about 35,000 passengers in each direction), and at a fraction of the cost. Rail lines in urban areas typically cost over \$100 million per mile in developing countries, whereas bus rapid transit costs less than one-tenth as much.

Bus rapid transit achieves high speed by operating on exclusive rights-of-way and giving signalization priority to buses when they intersect other traffic (using onboard transponders). In the more sophisticated systems, buses move in convoys through city centers. These systems achieve fast loading and unloading by elevating platforms to the same level as the bus floor and by collecting fares off board in order to allow simultaneous and rapid entry and exit from extra-wide bus doors.

For almost two decades, the only successful example of bus rapid transit was in Curitiba, Brazil, though many elements of that system were also found elsewhere. Europe had many exclusive busways and tram and bus signal prioritization, but other features were missing. By the 1990s, however, major bus rapid transit systems in Quito, São Paulo, Nagoya, Ottawa, Pittsburgh, and a growing number of cities around the world were using bus rapid transit. By providing high capacity and high speed, these systems attract more riders and provide service more efficiently than conventional bus services operating in mixed traffic.

Steering away from trouble

As motorization overwhelms cities of the developing world, the challenge for public authorities is twofold: enhance the attractiveness of collective and nonmotorized modes and reduce the impact of personal vehicles. The United States can assist developing countries in forging and implementing sustainable transportation strategies in a variety of ways, emphasizing approaches that recognize and align with local needs and priorities. These efforts should engage many institutions and elements of U.S. society. Enhanced efforts are needed in the following areas:

Private investment and technology transfer. The vast majority of resource flows from industrial to developing countries comes through private investment. Efforts should be undertaken to encourage stronger investment in efficient and environmentally beneficial technologies, including production of clean transportation fuels and vehicle technologies. Apart from broader concerns about investment risk in developing countries, innovative transportation strategies face additional

barriers, such as high initial capital costs. One potential mechanism to help overcome perceived investment risks would be a public-private investment fund established by the Overseas Private Investment Corporation, targeted specifically to transportation needs in developing countries. A transitory fund that uses government funding to leverage private capital could mitigate financing risk and serve as a bridge to longer-term financing through private or multilateral lenders. Also, small programs at the California Energy Commission and U.S. Department of Energy to assist private companies investing in energy-efficient technologies in developing countries could be expanded.

Multilateral and bilateral government support. Working through existing institutions, the United States should increase government lending and assistance for sustainable transportation strategies. For instance, it should work with multilateral lenders to increase financing for such projects and should support these efforts by making technical and planning expertise within federal agencies available. The government also should commit adequate and sustained funding for the GEF, which serves as the funding vehicle for various multilateral environmental agreements. Priority should be given to projects that enhance nonmotorized travel, transit services (such as bus rapid transit), and vehicle technology (such as facilitating pollution reduction by eliminating lead and reducing sulfur in fuels).

Capacity building. Perhaps the most important outreach from the United States could be to help strengthen the capacity of developing countries to analyze and implement transportation strategies and to integrate them with land use and broader sustainable development strategies. These efforts need not be undertaken exclusively or even primarily by government entities. The private Energy Foundation and the Packard Foundation, for instance, fund U.S. experts to work with government officials and nongovernmental organizations in China to develop energy standards and test protocols for various products, including motor vehicles.

Training of professionals and researchers by U.S. universities also plays an important role in capacity building and technology transfer. Historically, U.S. universities drained the top students from developing countries, but that is becoming less true. Many students are returning permanently or through various collaborative ventures. Increasingly, U.S. universities are forming alliances with those in developing countries and participating in various cross-training and technology transfer programs. More could be highly beneficial, with funding from private foundations.

Other potential partners in capacity building could include large automakers or other major international companies. Many companies have the resources to assign and fund technical staff to assist in traffic management and in environmental, energy, and safety regulation. Because these companies have a significant stake in these newly emerging markets, safeguards against undue conflicts of interest would be necessary.

The U.S. ability to encourage change in developing countries is being compromised by its stance on greenhouse gas emissions.

In the end, the United States, as the world's largest economy, energy user, and GHG emitter, has a responsibility to show some leadership. Its ability to encourage sustainable development elsewhere will remain seriously compromised until it demonstrates a genuine commitment to addressing its own GHG emissions. Through the 1992 Framework Convention on Climate Change (to which the United States is a party) and the subsequent Kyoto Protocol, industrial countries have committed to the global promise that, having generated the bulk of GHG emissions to date, they must take the first steps toward emission reduction. The U.S. withdrawal from Kyoto and the Bush administration's adoption of a climate strategy that allows substantial continued growth in U.S. emissions underscore the perception in developing countries that industrial countries have yet to deliver on that promise.

With or without the Kyoto Protocol, the United States can pursue a suite of well-known policy options for curbing transportation-related emissions in the United States, including improving vehicle efficiency through standards, taxes, and tax credits; promoting low-carbon and renewable fuels; creating innovative transit services suited to prevailing suburban land development patterns; using information technologies and other innovations to encourage intermodal connections with conventional bus and rail transit; and discouraging single-occupant driving.

Ultimately, the most cost-effective tool for reducing emissions is likely to be a trading system that caps emissions, either by sector or economy-wide, and allows companies to buy and sell GHG credits. The United States should create the domestic framework for such a system, making it as compatible as possible with other national trading systems and the international trading system established under Kyoto. An effective trading system could prove to be one of the most powerful means of facilitating private investment in sustainable transportation in developing countries.

A related opportunity is the Clean Development Mechanism (CDM) established under Kyoto, which allows developing countries that are

hosting emission reduction projects to market the resulting emission credits. One promising approach would be to recognize sector-based efforts. For instance, a comprehensive program to reduce transportation-related emissions in a given city or country could be recognized for crediting purposes through CDM or a CDM-type mechanism linked to a domestic U.S. trading system. Such an approach would provide a strong incentive to both U.S. companies and developing countries to support more sustainable transportation choices.

The United States can do a great deal to support sustainable transportation in developing countries. Fortunately, many strategies and policies aimed at solving problems there can at the same time address global concerns about climate change and petroleum dependence. It is unlikely, though, that such assistance alone could ever be sufficient to the need.

The United States can in the long run be far more influential by launching credible efforts at home--to reduce transportation oil use and emissions and to tackle climate change more broadly--and by creating strong incentives to engage the private sector in these efforts. As the world's largest market for motor vehicles and other transportation services, the United States to a large degree drives the pace and direction of transportation technology development worldwide. Policies that reduce greenhouse gas emissions from the U.S. transportation sector will have a significant spillover effect in the developing world, both in generating cleaner technology and in shifting the orientation of multinational auto manufacturers.

Recommended reading

Daniel Sperling and Deborah Salon, *Transportation in Developing Countries: An Overview of Greenhouse Gas Reduction Strategies* (Arlington, Va.: Pew Center on Global Climate Change, 2002) (this report summarizes a series of four case study reports published by Pew).

National Research Council, *Transportation Options for Megacities of the Developing World* (Washington, D.C.: National Academy Press, 1996).

Mobility 2001: World Mobility at the End of the Twentieth Century and its Sustainability (prepared by MIT and Charles River Associated for the World Business Council for Sustainable Development, 2001) (available at www.wbcsmobility.org).

Lew Fulton, Jeffrey Hardy, Lee Schipper, and Aaron Golub, *Bus Systems for the Future: Achieving Sustainable Transport Worldwide* (Paris: International Energy Agency, Paris, 2002).

Daniel Sperling (dsperling@ucdavis.edu) is director of the Institute of Transportation Studies and professor of Engineering and Environmental Science and Policy at the

Transport Success Stories in Developing Countries

Singapore

Singapore is a small, relatively affluent country with low car ownership and extensive, high-quality transit service. In the 1950s, Singapore had a high motorization rate for its income, a relationship its leaders explicitly set out to reverse. Singapore restrained vehicle ownership and use, invested aggressively in public transit, and controlled land use development.

Investment in bus and rail transit has been substantial. The rail transit network was carefully designed in coordination with land use development plans. Stations are located near 40 percent of all businesses and within walking distance of 30 percent of all Singaporeans. The government also strongly discouraged car ownership and use. A very high additional registration fee (ARF) was imposed on vehicle purchases until 1990, when it was replaced by an auction system. At its height, the ARF reached 150 percent of the vehicle's market value; the bid price for the right to purchase a vehicle under the current system is similarly high. In parallel, vehicle usage has been restrained with high road taxes and parking fees. Until 1998, drivers entering certain areas of the city were required to purchase an expensive license, which was then replaced by electronic road pricing. Singapore emerged from poverty in the 1950s to be one of the most affluent countries in the world, with among the highest quality-of-life ratings and with very low transportation energy use and GHG emissions for a country with its income level.

Shanghai, China

Shanghai most closely reflects Singapore, but at an earlier stage of development and on a much larger scale (16 million versus 4 million people). Shanghai has a sophisticated planning organization that coordinates transportation decisions with other land use and city planning policies. The municipal government has considerable control over land use and can coordinate housing and transit investments in a way that is impossible in many other parts of the world. It has built grade-separated lanes for bicycles and slow-moving scooters along most major roads and separate sidewalks for pedestrian traffic, and is building an extensive rapid transit rail system to serve new satellite cities. Shanghai is executing an ambitious plan to decentralize the extremely crowded city, with coordinated investments in rail transit and major highways. From 1991 to 1996, Shanghai spent approximately \$10 billion on transport infrastructure, including two major bridges, a tunnel, an inner ring road, and the first line of its new subway system. It has also adopted strong disincentives for car ownership, including high taxes on vehicles and registration caps.

Curitiba, Brazil

Curitiba is a superb example of policy coordination, in this case between land use planning and public transit investments. This is one of the few cities in the world that has implemented a linear pattern of development together with an efficient transportation system. Buses efficiently serve the entire city with a hierarchy of routes, including feeder routes and a limited number of dedicated routes for

double-articulated buses (extra-long buses that bend). Development was strongly encouraged along the dedicated routes. At the same time, much of the city center was converted to pedestrian-only streets that are most easily accessed by public transit. From the mid-1970s to the mid-1990s, bus ridership increased more than 2 percent a year . During that time, every other Brazilian city and most cities elsewhere in the world experienced significant declines.

Chile

Unlike many developing countries, Chile has already made radical structural changes in its transportation system. It has one of the most sophisticated efforts to transfer transportation infrastructure and services provision to the private sector. In 1990, in response to long periods of deferred investment, the government launched an ambitious franchising program for roadways and freight railways. Today, all the main highways in Chile are built, financed, and operated by private companies. In the future, smaller roadways and even urban streets may be privatized as well. Freight railways or the right to use the tracks have been sold to private operators, resulting in greatly increased business on the affected lines. The overall effect has been far greater investment in transportation facilities than could have been provided by cash-strapped government agencies.

Bogotá, Colombia

In the 1990s, Bogotá implemented effective programs to simultaneously restrain vehicle ownership, improve conditions for walking and biking, and enhance bus transit. In the late 1990s, the government opened two lines of a planned 22-corridor bus rapid transit system (modeled after Curitiba's), built 200 kilometers of a planned 300-kilometer network of bike lanes, expanded numerous sidewalks, added a 17-kilometer pedestrian zone, and implemented a number of demand management measures. Cars with license plates ending with one of four numbers were not allowed to operate within Bogotá during the morning and evening peak, parking fees doubled, gasoline taxes were increased 20 percent, and bollards were built on sidewalks to prevent people from parking illegally. All these measures were boosted by occasional car-free days, car-free Sundays, and other promotional efforts. In the first four years, the percentage of trips made by private cars and taxis dropped from 19.7 percent to 17.5 percent, and bike trips increased from 0.5 percent to 4 percent of all trips.