Sustainable Transportation Strategies for Third-World Development

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Current transportation policies in developing countries, forces shaping these policies, and the implications of current policies for low-income people, the environment, and economic development are discussed. Current policies favor rapid motorization of transport to the detriment of modal diversity and nonmotorized modes, such as bicycles, cycle-rickshaws, and pedestrians. Such policies, rather than fostering real development, accelerate global climate change, increase air pollution, and weaken petroleum-importing economies, while often increasing inequality, social conflict, and poverty. Economic efficiency is diminished by decreased diversity in urban transportation systems, forcing people to conform to the few higher-cost ways of traveling offered rather than allow these movements to be made by the most appropriate and affordable means. The concept of sustainable transportation calls for a more holistic approach to policy and investment planning to achieve a diverse and balanced mix of transport modes and a sensible arrangement of land use that enables conservative use of energy and capital to fulfill mobility needs. Sustainable transportation strategies are those that can meet the basic mobility needs of all and be sustained into the foreseeable future without destruction of the planetary resource base. An overview of some of the key issues related to sustainable transportation is provided.

A large number of different transportation modes are in use around the world today, meeting in various ways and with varying success the mobility needs of human communities. The World Bank (*1*) estimates that 600 million person-trips per day were made by bus in Third-World cities in 1980. Rail trips and rural bus trips account for a modest increment of several hundred million more daily trips across the Third World. The 50 million automobiles in the Third World (*2*) account for roughly a quarter billion automobile person-trips daily. In contrast, with a half billion bicycles in the Third World, there are several billion bicycle trips per day. Daily pedestrian trips likely number as many as 10 billion per day.

MODAL DIVERSITY

Variations in the level of use of different motorized and nonmotorized transportation modes are a function of many forces. These forces include investment, subsidy, and tax and tariff policies, infrastructure design and planning, regulatory actions, topography, climate, cultural tendencies and habits, income levels and distributions, and land use patterns that evolve in response to long-term transportation system evolution. Many of these forces are strongly influenced by technocrats and social elites who shape investment policies and who direct government planning and policy formation.

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Transportation engineers, planners, and policy makers have tended to focus most of their attention on the higher-cost motorized transportation modes when studying transportation systems, identifying policy options, and offering investment plans. Traditional nonmotorized and low-cost transportation modes—such as bicycles, carts, trishaws, small locally produced boats, and oxcarts—have generally been ignored or dismissed without study as backward and inefficient. Few data have been collected about these modes, reinforcing the impression among many that they are of little consequence. The most basic mode, walking, is similarly neglected.

However, the majority of all trips made in the world are made by foot. In developing countries, most people rely on nonmotorized transportation, occasionally or regularly supplemented by public transportation, often provided by the informal sector of the economy. In most cities, the number of people affected by inadequate facilities for pedestrians and bicycles and by slow and overcrowded public transportation vastly exceeds the number affected by traffic congestion and parking problems.

Many developing countries cannot provide sufficient investment in public transportation even to keep up with population growth. Many of the poor cannot afford even low-cost public transportation and must simply walk. In rural areas, appropriate vehicles and transport services are frequently not available or affordable for the majority of people.

As a United Nations study (*3*) notes, the rural poor are

> locked into a vicious circle involving lack of money, inadequate equipment, time-consuming and health-impairing methods of transport, lack of production flexibility and exploitation by transporters and middlemen. Inadequate transportation in rural areas. . .hampers productivity, limits access to services such as education and health services, and isolates much of the population from political and social life.

The distributional impacts of both rural and urban transport system investments continue to be ignored at huge social and human costs. Even when transport investments are made with an intent to help alleviate poverty, those who are better off in the first place are far better able to capture the benefits of these investments, because the poor often cannot afford to purchase or use available vehicles. The net effect of much current transportation investment in developing countries is to increase social and economic stratification at the expense of the poor while boosting import requirements, foreign debt, and environmental problems.

Reduction in the diversity of transportation modal options within societies often reduces economic efficiency by forcing movements of people or goods to conform to the few higher-cost modes offered rather than enable these movements to

be made by the most appropriate and affordable means. More people end up walking long distances or waiting for buses that sometimes never come, or they abandon the idea of moving themselves or their goods to places that they might have been able to reach by an affordable but unavailable mode of transport.

Just as an ecological system is healthiest when it displays great diversity and differentiation, so too is a transportation system healthiest and most robust when diverse modal options are available to those moving people or goods. A transportation system dependent on only one or two modes of transport is far more susceptible to inefficiency, disruption, and system failure than is one in which numerous different modes are allowed to operate within a competitive market environment, regulated to the extent necessary to ensure safety and fair allocation of street space and other infrastructure among the modes serving different market niches.

NONMOTORIZED TRANSPORTATION

Walking is the most fundamental form of human transportation, something most of us do both in developed and developing countries. Many billions of trips are made by foot every day. Walking accounts for two-thirds of total trips in large African cities such as Kinshasa and Dar es Salaam. In relatively prosperous Malaysia, a recent study found that 70 percent of all on-farm trips and 50 percent of shopping trips are made on foot. A survey of one district in India found that nearly 40 percent of rural households spend no money on transport, being totally dependent on walking. In Kenya, surveys have found that more than 90 percent of rural trips were on foot, 4 percent by bicycle, 2 percent by paratransit (small informal public transportation vehicles), and only 0.5 percent by bus (*4*, p.130).

In many parts of Asia, the bicycle is a predominant means of short-distance vehicular transport. In China there are over 270 million bicycles and the urban bicycle ownership rate is about 0.5 bicycle per person and growing. In most Chinese cities, 50 to 90 percent of vehicular passenger movements is by bicycle, with most of the remainder by bus (*5*). In India there are 25 times as many bicycles as motor vehicles (*6*). In Madras one-third of vehicles entering the central business district is bicycles, as is 25 percent of vehicles passing a cordon line 10 mi out from the center. Pedal-powered trishaws constitute a predominant element in the street traffic of cities like Dhaka, Bangladesh, and account for the majority of all goods movements. In Thailand, Indonesia, Pakistan, and many other countries in this region, bicycles and tricycles have attained similar importance.

In many parts of Latin America, the Caribbean, and Africa, however, bicycles and tricycles are far less common. However, opportunities for the transfer of bicycle and tricycle technologies between Asia and these regions appear to be great, especially in the many countries with large low-income populations and inadequate public transportation systems and those undergoing structural adjustment in response to debt problems that have been exacerbated by unsustainable levels of petroleum and motor vehicle imports.

MOTORIZED TRANSPORTATION

Public Transportation

A wide variety of motorized public transportation services operated by both the private and public sectors is found throughout developing countries. The vehicles used include motorized trishaws built on extended motorcycle frames; small trucks; buses; vans, larger buses, and trucks outfitted for passenger hauling; and many types of rail vehicles.

Motorized public transportation in developing countries has been the subject of much research and discussion by transportation professionals. It has an important role in moving people around urban and rural areas with only modest impact on the environment and modest demands on scarce energy and capital resources. However, even if public transportation is relatively inexpensive and efficient, many people still cannot afford it and will seek alternative means to move themselves or their goods.

In many countries, public transport services have failed to keep up with population growth, widening the gap between transport system supply and demand. Levels of investment in public transport have been restrained in many countries in the past decade by capital shortages, especially in nations with severe debt problems.

Private Transportation

Around the world, people dream of owning automobiles and covet their speed, privacy, comfort, and convenience. People everywhere seek access to automobiles for themselves and their societies whenever this goal appears attainable. Achieving an automotive society, however, is well beyond the means of most of the world, at least for the foreseeable future. Worldwide petroleum, capital, and infrastructure are insufficient for this condition to be a near-term global goal. Motorization is a pleasure attainable only by a minority of the world's people.

Motorization is retarding development for the majority of Third-World people. Imports of petroleum and motor vehicles consume one-third to one-half of the foreign exchange earnings of many developing countries, for example, Haiti, Honduras, Kenya, and Thailand. Instead of providing affordable mass transportation, these imports often simply increase debt burdens and budding automobile cultures irrespective of the needs of the majority.

Automobile ownership levels remain low in much of the world. Of every 1,000 people, fewer than 5 are car owners in Haiti, Pakistan, India, and China; fewer than 7 in Indonesia, Ecuador, Zaire, and Honduras; fewer than 12 in Africa as a whole; and fewer than 15 in Thailand and Nicaragua. In Brazil and Mexico, 75 out of 1,000 people own cars compared with 370 in the Western European countries of the Organization for Economic Cooperation and Development (OECD) and 570 in the United States.

Automobile ownership in the Third World increased at an average annual growth rate of 11 percent in the first half of the 1970s and 8 percent in the second half of the 1970s. Decreasing commodity prices and increasing debt burdens lim-

ited the annual market growth rate to 5 percent in the 1980s. China and India together own over 600 million bicycles and scarcely 0.5 percent of the world's cars. Recently, however, both countries have changed their priorities to embark on policies to stimulate automobile production and use, with help from some Western transportation experts and corporations (*2*).

Spreading Culture of Motorization

Current trends favor growth in motorization. The automobile has become a central icon of the emerging global culture of the late 20th century. Motorization has proponents, especially among the social elite, in nearly every nation on earth. A variety of institutional structures have been established to defend the interests of motor vehicle users and producers.

International lending institutions, corporations, and Third-World elite groups largely favor transportation policies similar to those that led to the motorization of North America. These policies emphasize maximizing subsidies and government spending to benefit motorization through effective control of transportation investment policies; expanding the formal transport sector while restricting, regulating, or eliminating informal transport sector activities; reallocating street space and infrastructure to restrict nonmotorized transportation; and encouraging the decapitalization of modes that offer an alternative to motor vehicles.

For example, though bicycles provide the primary means of rural and urban mobility in China, the World Bank recently issued a 400-page report (*7*) on China's transportation sector that did not even mention the bicycle. Rather than identifying means for better integrating land use controls, traffic management systems, and the current bicycle-based transport system with more and better public transportation, some Chinese planners, such as Min Fengkui, now call for bicycle traffic to be strictly controlled with the ultimate intent of reducing it to an auxiliary means of short-range transportation. Writing about the bicycle problem in China, Fengkui (*5*) reflects the attitude of many Third-World professionals:

> As has been shown in the developed countries, the traffic role of bicycles will gradually phase out when urban transportation becomes modernized. . . . Their functions there have already been reduced to being tools of sports, recreation and tourism. Such examples should serve as our reference in the planning of our future urban development. Currently efforts should be focused on speeding up road construction, improving public transportation and traffic control and restraining volume of bicycle traffic in the cities, so as to prevent further worsening of urban traffic congestion. . . . Steps should be taken now to restrict overproduction of bicycles. . . . Control on urban bicycle traffic should be tightened by strictly restricting licensing and enforcing safety inspection of bicycles. Bicycles should not be allowed to travel on certain vital or busy urban streets, but be gradually diverted to specially built bicycle lanes in different urban districts. . . . A full-scale development of urban road, public transportation and traffic control systems should be carried out with the ultimate aim of completely modernizing the urban traffic system in the Chinese cities.

Although many transportation decision makers view the United States as a model and equate the modernization of transportation systems with total motorization, other potential models, such as the Netherlands, Switzerland, and Japan, clearly demonstrate the important role that nonmotorized transportation can play in modern transport systems, especially for short trips and for access to public transport services (*8*).

Transportation investments closely reflect systems of power in the world. Former Philippine senator José Diokno understood how transportation investment limited development of local economies in his country while fostering dependency on raw material exports.

> Look at the expressways. Most of the cars that go through are private cars. Who owns the private cars in this country? The elite. And did you notice one more thing? All of these expressways converged in Manila when we should have been building roads connecting the different barrios to the poplacion (town) and one barrio to another so that the flow of goods would not all go in one direction, which is towards an outgoing port, but would have been circulating internally.

Transportation system development is not market driven. Technocratic control is usually in the hands of engineers and economists wealthy enough to own cars, trained in American-style policy solutions, and subject to political control from those who profit from oil import deals, automobile dealerships, construction contracts, or other aspects of motorization. Most transportation investments and subsidies benefit the formal transport sector of motor cars, trucks, aviation, railways, and motorbuses. The prime criteria for most transportation investments in developing countries are the potential benefits to corporations and military security interests, not the potential benefits to communities or informal economic sectors.

International development organizations influence policies adopted by local elite groups. Current World Bank lending for 18 road projects is U.S. $1 billion. The major share of $100 million in annual World Bank spending for urban transport is related to automobile transportation promotion. Between 1972 and 1985, the World Bank spent more than a half-billion dollars on urban road construction, improvement, and maintenance, with about $120 million devoted to urban traffic management and road safety. Of the $2.1 billion spent by the World Bank in 1985 on transportation, minuscule amounts were expended to benefit the nonmotorized informal transportation sector.

The long-term effect of World Bank programs has been to encourage capital and energy-intensive transport systems. In Pakistan, for instance, the World Bank is investing hundreds of millions of dollars to develop a local automobile industry, although less than 1 percent of Pakistanis own cars and walking and cycling account for 60 percent of total trips and 40 percent of work-related trips, even in its former capital city of Karachi.

Little investment has gone into research and development of those modes that are of greatest use to the poor. As an Indian development professional, Hoda (*9*) has noted,

> Our research programs do not have even a remote relationship with the problems of poor people and rural areas of India. We consider research on aeroplanes, aerospace, and automobiles as the real science, whereas research on Indian modes of transport like bullock carts, horse carts, and rickshaws is considered substandard and below dignity. . . . The transport problems

> of the bulk of people in this country can be solved by working on these indigenous vehicles and not by working on airplanes, rockets and automobiles.

The leading global lending institutions frequently help reinforce these attitudes. The World Bank's recently updated report on urban transport policy (*1*) refers appropriately to helping "developing countries find inexpensive ways of increasing transport capacity and improving transport flows, with particular attention to the transport needs of the urban poor," but nonmotorized transport is viewed solely as a congestion generator rather than as a part of the solution to urban mobility problems. The report ignores extensive recommendations published in other recent World Bank studies that call for a reorientation to favor such low-cost transportation to meet basic needs (*10,11*), as well as the similar recommendations of the United Nations Center for Human Settlements (*3*) and other experts (*4,12*).

For urban areas in developing countries, the World Bank and many others have advocated better transportation system management (TSM), including restrictions on urban automobile use, and more investment in motorized public transportation services. TSM offers many excellent ideas for more cost-effective and environmentally sound transportation, and buses offer a sound means for low-cost public transport in most circumstances (*13*). However, the effectiveness of many TSM strategies has been limited by political resistance to serious urban automobile restraints. In most cities, shortages of financing have kept the growth rate of public transportation services below population growth rates, leading to low service quality.

In many countries, TSM has been used to reduce the availability of low-cost transport, forcing people to walk, to use already overcrowded public transport, or to defer travel. Too often, the concepts of TSM have been applied solely to improve motor vehicle traffic flow. With this objective, TSM has often focused on getting rid of or displacing in time or space existing pedestrian and pedal-powered traffic. This policy has pushed more people into dependence on motorized transportation, in the end leading to more traffic and a loss of the original improvement in transportation efficiency. Motor-vehicle-biased TSM has been encouraged by policies of the World Bank, which have been generally hostile to human-powered transportation modes. The sole use of the word "bicycle" in the World Bank's 1986 transport policy report (*1*) is in the following statement: "Congestion is often exacerbated when the road network must cope with a mixture of motorized vehicles, other modes of transport (such as bicycles and pedal carts), and pedestrians."

BANNING SLOW TRAFFIC

Following the inference of such statements, many cities have imposed constraints on nonmotorized modes of travel, such as cycle rickshaws, bicycles, and pedestrians, claiming that these cause congestion. This claim is despite the fact that bikeways offer capacities that are far higher than typical automobile freeways and close to the capacities of buses in mixed traffic (*3*).

Transportation policy makers in a number of developing countries have destroyed valuable nonmotorized transportation resources because they see them as symbols of backwardness and hold them accountable for motor vehicle traffic congestion and safety problems. In Kuala Lumpur, Malaysia, and Jakarta, Indonesia, many thousands of cycle rickshaws have been thrown into the sea in the past several years (*14*). In April 1987, the government of Dacca, Bangladesh, announced plans to completely ban pedicabs from the city on safety grounds, although they employed more than 100,000 people (*15*).

The wholesale assault on trishaws and bicycles on safety grounds is simply an expression of the political power of automobile users and motorized public transport interests who resent sharing road space with slow nonmotorized modes used by the poor. This situation has its structural parallel in the removal of slums and squatter settlements by elite groups who wish to displace the poor to favor their own interests. In urban housing policies, slum clearance has been largely discredited in the international development community and replaced by sites and services approaches to community development, in recognition of the lack of resources to provide every household in squatter settlements in the developing world with adequate housing. Similar changes in thinking are needed in transport policy, in recognition of the lack of resources to provide every person in the world with motorized transport. The banning of trishaws is nothing less than slum clearance on Third-World streets. Just as slum clearances destroy real housing resources for the poor, so too do current transport policies destroy real transportation resources, harming millions of people who lack the political power to defend their mobility systems.

NEW DIRECTIONS AT WORLD BANK

The World Bank plays an important role in setting the direction of global development policies. It has begun to respond to criticism that its policies have damaged the environment and harmed low-income people. The Bank's reorganization in 1987 led to shifts in personnel, some decentralization, and possibilities for policy innovation at the project level.

In 1988, the U.S. Congress passed legislation requiring the U.S. representatives to the multilateral lending institutions to press for more attention to low-cost, nonmotorized transportation in development lending. The Congress also requested that the Agency for International Development undertake initiatives in this area. Further legislation is awaiting Congressional action. Concern over global warming and the debt crisis is leading to a changing political climate for transport policy reform.

The World Bank is now funding a project in Ghana that includes a small but important component to build low-cost (U.S. $4,300 per kilometer) feeder village-to-market paths, to provide nonmotorized vehicles to villages served by these paths, and to strengthen a local workshop producing nonmotorized vehicles (*16*). A World Bank–funded project in Mozambique will provide a slow traffic lane as part of a road rehabilitation project in Beira. Transport policy in the Sub-Saharan Africa is undergoing reassessment with potential for greater recognition of the vital role nonmotorized transport must play in economic development. These small elements

are indicative of positive changes in World Bank transport policy at the project level. However, whether these changes will result in serious funding for and high-level policies supportive of nonmotorized and sustainable transport strategies remains to be seen.

ALTERNATIVE POLICIES FOR SUSTAINABLE DEVELOPMENT

Infrastructure and Land Use

The safety and congestion problems associated with automobiles and pedal-powered modes have much in common when situations are compared in which one or the other of these has clear local dominance in traffic. Different problems occur when there is a more even mixture of automobiles and nonmotorized traffic.

In the developed world, the response to automobile-induced traffic congestion has been to control land development staging, institute better traffic management, and program additional infrastructure and transit services. In cities where bicycle traffic congestion is a major problem, similar solutions should be adopted. Better traffic management and design might include improved traffic signal systems that are explicitly designed for slow traffic, as in the Netherlands; creation of one-way modally segregated street systems; and where extremely high volumes of bicycle traffic clog intersections—such as in some Chinese cities where up to 50,000 bicycles per hour have been counted passing through a single intersection—grade separation through use of underpasses (*17*).

Transportation investment policies need to be reordered to place more emphasis on making roads and trails suitable for low-cost vehicles. In urban areas, street space needs to be reallocated to enhance the safety and usefulness of nonmotorized modes. Sidewalks, footpaths, and pedestrian and bicycle under- and overpasses crossing congested arterial roads need to be incorporated as standard elements of urban transportation planning. Automobiles should be subject to far greater restrictions and higher user fees in dense central city areas. Area licensing schemes, as used successfully in Singapore, should be more widely adopted, along with more widespread automobile-free zones and strict parking law enforcement. Area licensing requires all private motor vehicles entering an area to either maintain a minimum occupancy level (such as four persons per automobile) or to display an area license that can be purchased on a daily or monthly basis for one to several dollars per day.

Urban land use planning should encourage heterogeneous land use patterns at a small scale and a mix of housing types at different cost levels. Spatial separation of economic activities and residential locations, except for heavy and hazardous industrial uses, should be minimized. Mixed land use patterns with greater decentralization of employment can reduce the need for motorized commuting and foster community integration. When cities grow ever larger, it is desirable to locate employment clusters along rail nodes and in corridors well served by rail or bus public transportation, with affordable, transit-accessible housing nearby.

The development of new roads in rural areas should be accompanied whenever possible by land redistribution and the assurance of secure land tenure to those living near the new roads. Without this, most benefits of the new roads will accrue to those who own the land or who have the capital to take advantage of increased market access. In many countries, rural road programs have simply pushed those at the bottom of the economic heap onto more marginal lands, creating injury rather than benefit as the larger landowners succeeded in driving off subsistence producers from what has often been ancestral land. Major transportation investments without development of an equitable system of land distribution inherently will increase inequality and economic stratification.

In countries where capital is insufficient to meet the basic transport development needs of the poor majority, road construction standards should be reduced to cut costs, and more labor-intensive, lighter-weight motorized and nonmotorized vehicles should be favored over heavy vehicles, except for transport of bulk commodities on selected routes. In many cases, this traffic might be well served by rail.

Road weight standards need to be set and enforced, and the costs of road maintenance should be borne by those imposing the most wear and tear on the roads. Wear and tear on roads varies by the fourth power of axle weight, so most road maintenance costs are attributable to heavy truck traffic. Frequently, only large corporations and those dependent on them (an influential and sometimes sizable minority) benefit from this traffic. It makes no sense to build roads unless they can be properly maintained.

More attention should be paid to the integration of motorized and nonmotorized modes, encouraging bicycle access to express transit services for longer-distance trips. As city size increases, average trip lengths tend to increase, and the usefulness of bicycles and walking in urban areas is diminished. In Western Europe and Japan today, the fastest-growing and predominant access mode to suburban railways is the bicycle, accounting for one-fourth to one-half of access trips to stations (*18*). In India and China, bicycles play a major role in access to commuter railways. Adequate supporting infrastructure, including secure parking at station entrances and safe access routes, is needed to enhance such intermodal integration.

Urban rail passenger transportation has an important role to play in the development of large cities. Modal diversity, as previously argued, is essential to the creation of healthy cities. However, the same forces that have promoted motorization and made use of low-cost, nonmotorized modes of transport marginal have been hostile to new investment in rail transportation systems.

The World Bank has been resistant to most proposals for highly capital-intensive metrorail system development in Third-World cities, arguing that these are not cost-effective and benefit mostly the middle class. However, many capital-intensive road projects funded by the World Bank appear to be vulnerable to the same arguments. The World Bank's aggressive promotion of urban bus alternatives to the exclusion of all forms of rail has failed to address basic needs.

Especially in larger cities, light-rail or commuter rail systems, combined with bicycle access and egress systems in moderate- to high-density suburban areas as in much of Europe and Japan, offer cost-effective investment opportunities.

Surface rail infrastructure on its own right-of-way offers far more reasonable costs than tunneled track, which can likely be justified only in extremely dense central areas.

Investments in rail infrastructure, however, should be accompanied by programs to recapture for the public sector most infrastructure and operating costs. Special real estate assessment districts, public-private joint development of land adjacent to stations, and other techniques are needed to ensure that these major investments do not simply profit a handful of already affluent landowners.

Access to Vehicles for Mobility

In Europe and America, roads are built with the reasonable expectation that users will obtain the necessary vehicles to operate on the infrastructure provided. In developing countries, this expectation persists but results in serious system failure because few can afford vehicles for the infrastructure, and many trips need to be made in places without any infrastructure. In this situation, resources need to be reallocated from infrastructure to providing the poor with better access to low-cost vehicles and efficient carrying devices. Such tools can have a major effect on the labor productivity of the poor and their access to services and local markets. The hauling of produce and collection of water and cooking fuel require many hours of labor each day for millions of people around the world, especially women.

A recent World Bank project design (*16*) estimated the costs of head-loading in rural Ghana at U.S. $8 per ton-mile, some 8 to 12 times more expensive than any other form of transport, and noted that

> the head-loading and foot-path economy not only constrains production and marketing, but also limits other forms of rural mobility and access to schools and health facilities, severely affecting the development of human capital and the quality of life. Extensive head-loading also causes a severe health problem (cervical spondylosis) due to constant trauma to the neck and spine and remains the most burdensome chore affecting the rural woman's life. . . . Head-porterage effectively limits the time and energy available for farm activities, particularly because the peak of transport activity coincides with the peak of farming activity in the harvest season.

This report noted that building motorable roads to reach villages by truck is not a supportable economic solution; the appropriate and recommended solution (*16*) is rather

> low cost "single blade" roads (costing about 8 % of a standard feeder road), *in combination with* the provision of low-cost non-motor transport such as bicycle-trailers and specially designed hand-propelled farm carts—both of which are relatively new to Ghana. This combination will *help mechanize*, and provide a substitute for, human transportation by head-loading.

The provision of low-cost credit for the purchase of bicycles, carts, pack animals, and similar vehicles should be a high priority to ensure that more of the poor have access to affordable mobility. In Hyderabad, India, commercial banks are encouraged to lend to rickshaw operators for the purchase of vehicles. In Santo Domingo, Dominican Republic, a credit union of tricicleros helps finance vehicle purchases and a tricycle assembly project. Such lending programs, targeted at microenterprises, can provide major stimulation to local economic activity.

Those of higher status, such as rural extension agents in health, education, and agriculture, should be afforded bicycles to enhance their productivity at low cost and to counter the low-status associations that human-powered modes have in many countries. For the cost of sending one jeep to the front office of a development project, a whole fleet of new all-terrain bicycles can be sent to provide mobility to project participants, organizers, and agents. Food distribution efforts in famines should incorporate human-powered utility vehicles where appropriate to augment other transport resources, especially where trucks cannot go.

Creation of more modally diverse vehicle fleets can enhance economic efficiency in cities, too. In Bogota, Colombia, a large bakery once used only trucks to deliver baked goods to its 600 retail outlets. Today the bakery uses semitrailer trucks to distribute inventory to six subdistribution centers, from which a fleet of cargo tricycles of 1-m^3 capacity provides final distribution to retail outlets. By recognizing the benefits of modal differentiation, the bakery cut distribution costs by over half while increasing employment (*12*).

The difference in labor and capital intensity between motorized and nonmotorized modes is vital to understanding their appropriate respective roles in low-income countries. A 100,000-rupee (U.S. $12,000) investment in a conventional bus system in Patna, India, for example, enables creation of two new direct jobs. If the same amount is invested in a motorized autorickshaw, six direct jobs are created. The same sum invested in the cycle rickshaw industry creates 75 jobs (*19*). Where capital is scarce and incomes are low, nonmotorized transportation offers far more potential for the creation of microenterprises than motorized transport systems and can thus serve as a powerful engine for sustainable and healthy economic growth at the base of such societies.

Most countries should be encouraged to develop local bicycle assembly and cart production capabilities for domestic use. This policy can create significant employment opportunities. Even if all of the bicycle parts must be imported, these imports can continue to generate productive outputs for some time, rather than being spent on a single trip, as petroleum imports are. Several countries have fostered domestic bicycle manufacturing industries with varying success. Mexico and China both have offered subsidies to their bicycle industries to enhance access of lower-income people to this mode and encourage domestic production. The attempts of Tanzania and Mozambique to establish protected domestic bicycle manufacturing were failures because of low product quality and high costs of local parts manufacture. However, by starting with small assembly workshops of low capital cost and only gradually assuming the production of selected bicycle components, countries with little or no industrial base can begin to develop appropriate domestic transportation vehicle manufacturing capabilities with low risk (*12*,*20*).

Research, Development, Demonstration, and Policy

More resources should be committed to research and demonstration related to safety of nonmotorized modes. Better traffic management, infrastructure, and vehicle design; the

encouragement of bicycle helmet use; and safety education all have a role to play in this area.

Modest investments in the design of cycle rickshaws, for example, could yield substantial increases in their safety and efficiency in traffic. Most cycle rickshaws have only one gear, making them hard to start in motion, particularly at the base of an incline. Most also have only a single, often poor quality brake on the front wheel of the vehicle. A development group working in India has demonstrated that by retrofitting existing rickshaws with three-speed gearing and a three-wheel braking system, vehicle safety, efficiency in traffic, and driver working conditions can all be greatly improved with less than a 20 percent increase in vehicle cost (*9*).

There should be more funding for research on transportation problems in developing countries and more work to transfer low-cost human-powered transportation technologies from the countries where they are successful to those in need of low-cost mobility, especially to Africa and Latin America. Relatively small investments could produce significant improvements in traditional carrying devices and vehicles powered by humans, animals, wind, and sun, extending their range and utility at low cost.

Funding is needed to support demonstration projects for the transfer of emergent low-cost transportation technologies. For example, all-terrain bicycles, a recent innovation, offer much greater performance than traditional bicycles. Although multiple barriers impede the diffusion of such new technologies, demonstration projects can help identify and overcome these difficulties.

More encouragement should be extended for the creation of locally responsive appropriate technology research and training centers to study and respond to local needs, including those in transportation, and to build community leadership and skills. Transportation projects should be designed in consultation with representatives of the poor and the users of slow transportation modes to identify alternative strategies for mobility enhancement, unmet travel needs, and ways of making projects most compatible with the interests of all potential users.

Transportation professionals at all levels should be encouraged to take nonmotorized and informal modes of transport seriously in the collection and analysis of data, the design of facilities and policies, and the evaluation of alternative solutions to mobility problems. Textbooks designed for traffic planning in the United States and Europe are inappropriate for Third-World transport planning. Funding is needed to support the development of new textbooks and planning paradigms for sustainable transport system planning and development, especially for low-income countries.

Diverse programs and actions should be undertaken to influence public opinion in favor of less-resource-intensive transportation modes and to promote traffic discipline and safety in the operation of both motorized and nonmotorized modes.

Impact statements should be required for all transportation projects funded by development lending institutions to identify alternatives and anticipated impacts of projects on the environment, on alternative transportation modes, on the poor, and on long-term foreign currency requirements. Such impact statements might be required as part of legislation funding various aid programs. A process for public review and comment on these statements should be required.

Taxes on automobile purchases and operation, particularly for private use, should be increased sharply to reflect the true costs of automobile use on the urban environment. Subsidies for automobile use of urban road space should be eliminated. It is common for private motor vehicle traffic used by a minority of the population to be allocated the majority of publicly provided street space, to the detriment of public transportation, which suffers from severe congestion, and nonmotorized traffic, which often simply loses a safe place to operate. Road pricing and street space reallocation through physical separation of modes can address these problems.

Taxes and tariffs on bicycles, public transportation vehicles, and nonmotorized vehicles should be eliminated or sharply reduced to enhance their affordability by the poor and near-poor. Public transport pricing should encourage economic use of resources while maintaining basic access for the poor. Innovations in services and modes should be encouraged by allowing private-sector competition with regulation to ensure safety and fair access to street space.

CONCLUSIONS

Major changes are needed in the priorities for transportation policy in the Third World if development is to meet human needs rather than benefit only the world's current elite groups. The costs of failing to redirect transport policies today will be paid in the decades to come through a sharply reduced quality of life in the world's cities, increased conflict between the mobile elite and the mobility-restricted poor, and reduced capacity to solve the problems of capital shortages, unpayable debt burdens, toxic air pollution, and global climate change.

Changes in transport policies are needed not only in the Third World, but also in many advanced industrial and post-industrial countries. It will become increasingly difficult in coming decades for policy makers to ignore the global limits on resource consumption, particularly in the burning of fossil fuels. The planet will remain a closed atmospheric system with finite resources and potentials for absorbing man-made pollutants.

The transition to a world that recognizes the need for social as well as economic development and a world that is based on sustainable patterns of production and consumption must begin soon. Nonmotorized transportation cannot be expected to supplant the solidly entrenched motor transport sector in the developed world in the foreseeable future, but it can serve a major portion of local travel needs, as many healthy and wealthy modern communities in the Netherlands, Denmark, and Japan demonstrate.

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