

Driving Forces in Developing Cities' Transportation Systems: Insights from Selected Cases

December 2006

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ABSTRACT

In this paper, we examine basic transportation and land use characteristics from a selection of cities in Africa, China, Latin America, and South Asia. By definition, poorer than their industrialized country counterparts, developing cities are in a stage of rapid dynamism. From a mobility perspective, perhaps the single most influencing factor is motorization – the growth in motor vehicle ownership. While income drives motorization, national industrial policy, trade liberalization and the influx of used vehicles, and income distribution all play roles. In many cities, motorized two-wheelers serve as a mobility equalizer, extending mobility for many residents, increasing the overall motorization level, and, possibly accelerating the path towards automobile ownership. They also pose a host of traffic safety, pollution, and traffic management challenges. While public transportation continues to serve as the primary transportation mode for the majority of developing country residents, the systems are hampered factors such as low purchasing power of users, often large presence of “informal” para-transit operators, and a difficulty in managing private sector operators. While some cities lean towards high profile, high cost public transportation projects, bus rapid transit interventions are also spreading rapidly. In terms of land development patterns, urban expansion is ubiquitous in the form of high and low income residential suburbanization, globalization-related real estate megaprojects, and continuous pressures to provide affordable housing. Finally, these and other transportation-related dynamics present particular institutional challenges, as the rates of change often exceed institutions' capabilities to adapt, in part due to jurisdictional and sectoral boundaries.

INTRODUCTION

Much of the developing world's residents suffer from a lack of quality accessibility – that is, the ability to reach the daily needs and wants necessary to survive and thrive.

Mobility – the movement from place to place – plays a critical role in enhancing accessibility. Quite simply, some form of mobility is almost always necessary to get to work or school, visit friends, receive health care, etc. Increasing mobility reflects a desire to increase accessibility, which itself represents a more basic desire to improve the quality of life.

We can expect increasing income levels to fuel increases in accessibility demand and, thus, mobility demand. Other key, and often inter-related, drivers of mobility demand worldwide include urban decentralization (that is, suburbanization), increasing labor force participation, and declining household size (which will lead to higher motorization rates and some increasing per capita trip rates as people realize more out of home socializing). The basic results are more trips, longer trips, and more trips by private motorized transport modes.

Without doubt, considerable variation exists within this broad-brushed global dynamic. Cultural factors may influence, for example, bicycle use and legacy systems (e.g., built urban form and densities, public transport systems) will influence public transport patronage. In general, however, we can expect to see an important increase in the demand for private motorized travel, especially in the developing countries. For example, according to estimates by the International Energy Agency (IEA, 2004), over the next 50 years per capita light duty vehicle distances traveled (VDT) in the OECD countries will increase in the range of 0.2 to 0.8 percent per year, as compared to nearly 6 percent in China, 5 percent in India, and almost 3 percent in Latin America. As the great share of developing countries' population growth will occur in urban areas, most of this travel demand increase will also be in cities.

This projected urban mobility growth in the developing world reflects the fundamental benefit of accessibility – increased mobility increases development possibilities (enhanced accessibility), while increased development and income growth further increases the demand for accessibility. Increased mobility and its enabling of accessibility provide undeniable benefits. These benefits, however, come at a cost: the wide-ranging short- and long-term negative impacts that modern transportation systems impose on us, our ecosystems, and future generations. Most of these impacts have been widely detailed elsewhere (e.g., Zegras, 1996; World Bank, 1996; WBCSD, 2001) and include local air pollution, death and injuries from traffic accidents, settlement disruption and other negative effects (aesthetic and otherwise) from large-scale transportation infrastructures, greenhouse gas emissions and climate change risk, other destructive effects associated with petroleum extraction/production/distribution, and so on.

So, on the one hand, we need our urban mobility systems to continue to contribute to economic development and human welfare. On the other hand, we need to avoid or mitigate transportation's negative effects, both current and future. Evidence suggests that some of transportation's negative impacts, or at least their "rates of production," decline with development – this follows the idea of the "environmental Kuznets curve," where certain problems display an inverted U-shape trend, increasing up to a certain income point before decreasing. For example, death rates (fatalities per person) from traffic

accidents tend to decline as income grows, due to improved vehicle technologies, adapted social norms (to vehicular traffic), improved enforcement, health care improvements, etc. For the developing countries, however, the point at which the declining fatality rate occurs may be well off into the future; international statistical analysis suggests, for example, that the fatality rate for India will not begin declining until 2042 (Kopitz and Cropper, 2003). Whether the developing world cities more generally will follow the industrialized world in terms of responses to the challenges accompanying growing travel demand and motorization will ultimately depend on the timing, speed and sequencing of the relevant developments (see, e.g., Marcotullio, 2005).

Comparing Across Developing Cities

Any effort to characterize the mobility demand in the urbanizing developing world faces several major analytical challenges, related to the rapid pace of change in land development patterns and transportation characteristics (e.g., vehicle ownership) and the lack of data (because they are not collected, quickly obsolete due to rapidly changing conditions, and/or not easily collected for important segments of the population). Attempts to compare among and generalize about the so-called developing world face further challenges of data comparability (e.g., trip definition in surveys) and the enormous range of cultural, regional, economic and other factors that make for as much variation among developing countries as between the developed and developing countries.

Despite these challenges, comparative analyses can help identify regularities in trends, behaviors, and conditions and possible reference points on development trajectories. Cameron et al (2003), for example, using aggregate data from 45 cities, including from five developing Asian cities, derive a generalized model to predict aggregate private motorized distances traveled for cities based on urban area. Schafer (2000) uses data from over 30 travel surveys in 16 countries (including five developing countries) to support the hypotheses of stable average travel budgets (share of time and income persons seem willing to dedicate to mobility). Hyodo et al (2005) compare trip characteristics revealed through Japanese government-sponsored household origin destination studies for 11 different developing country cities, showing the wide ranges in vehicle ownership, trip generation rates by age and gender, mode shares, trip times, etc. Pucher and Buehler (2005) review national-level transportation trends and policies in Eastern and Central European countries, including the impacts from European Union accession requirements.

In this paper, we examine basic transportation and land use characteristics from a selection of cities in Africa, China, Latin America, and South Asia. In this work, we do not aim to develop a model of individual transportation demand nor even a generalizable theory of mobility demand in the developing world. Instead, we aim to use the selected cities to illustrate commonalities and differences in developing city mobility and accessibility. The cases suggest at least five forces of relevance upon which we have chosen to elaborate:

1. Motorization. Does a foreseeable motorization “ceiling” exist for cities of increasing personal income?

2. Motorized two-wheelers. What role do the two-wheeled motor vehicles play in the motorization process?
3. Public transport. What are the issues and solutions related to the poor transit performance in most developing cities?
4. Land development and decentralization. How does increased travel demand interact with land development in the cities? How do the resultant urban structures and designs respond to the above forces?
5. Institutions. Can institutions effectively react to these dynamic conditions?

These five forces do not represent all, nor necessarily the most important, forces of relevance. They do, nonetheless, represent important forces, and the cases help illustrate their variation.

BACKGROUND TO THE CASE CITIES

When initiating this research, we originally intended to select a manageable number (given time and resource constraints) of cities from around the developing world that could serve as “archetypes” – individual examples of more general conditions common to a group of developing country city types. Ultimately, however, we could not find a satisfactory means of grouping city types across the range of relevant characteristics – the necessary data were unavailable and the number of dimensions simply too high. Ultimately, we opted for a “convenience sampling” approach, selecting cases based on data availability, contacts, and our own local knowledge and experience.¹ We sought to present cases that span the main continental regions of the world and incorporate widely different cultures, economies, and forms of governance.² We have included some megacities, where magnitudes of phenomena and problems have already attracted world attention, as well as some “non-celebrity” cities.

The developing country city cases provide snapshots – with a modest degree of resolution – of the large variations in the magnitudes of selected traits (see **Table 1**). For example, between some cities, GDP per capita and population differ by a factor of 10 (Kuala Lumpur to Chennai; Mexico City to Dakar), population growth rate differs by a factor of eight (Shanghai to Dakar), and public transport mode share by a factor of three and a half (Shanghai to Belo Horizonte). Some cities have populations with very high shares of residents under 15 years-old (Dakar at 43%), while others have age profiles similar to industrialized nations (Shanghai). Two of the Asian cities exhibit perhaps the greatest possible extremes in private automobile motorization rate: Wuhan with approximately 5 autos per 1000 residents and Kuala Lumpur with 300.

Even within these wide differences and the even greater differences between these and developed cities, we are often inclined to begin with an assumption that accessibility

¹ The unpublished cases are available from the authors upon request.

² You will note that absent from the cases are the “economies in transition” – those countries, primarily of Central and Eastern Europe, that often fall through the simplified world division of “developed” and “developing.”

and mobility problems are categorically similar for all cities (congestion, traffic safety, air pollution, inadequate infrastructure, insufficient rolling stock capacity, high transportation costs, etc.), and that the problems differ only in magnitude. But we must be cautious in making such an assumption. The politics of public transportation in developing countries are very different. The reach of useful technologies is different. The significance of land use decentralization is different. Issues surrounding fare levels are different. The on-street relationships between modes – including cars and non-motorized vehicles – are different. And so on. Relative to the developed cities, three critical characteristics stand out: income levels, rapid rates of change, and urban densities.

Poverty

The developing countries, by definition, are poorer than their industrial counterparts, meaning that substantial populations cannot afford adequate transport. The World Bank (2002) characterizes the transport condition of the poor in multiple dimensions: ‘accessibility poor,’ that is, being restricted to whatever is nearby; ‘time poor,’ since they suffer the slow modes; ‘safety poor,’ since they are exposed to accidents and personal security risks; and finally ‘energy poor,’ since they have to expend a lot of energy (physical and mental) for their travel drudgery. Distribution of income further complicates this reality, typically dividing cities into two groups: those who can easily afford high quality transportation – and whose cars congest the streets – and those, typically a very large group, whose transport needs must be met with a very low budget. This reality contrasts with the cities of the North where the market for mobility can, to a greater extent, be considered something of a single market. For much of the developing world, improved accessibility comes in the form of the change from a walking trip to a public transport trip.

A number of interacting forces play a role in exacerbating the mobility and accessibility conditions of the poor. Peripheral settlements, a product of cheap land and housing pressures, often imply isolated developments with few nearby amenities and long work trips (to jobs often located in high income areas). Gender issues can pose major problems in developing cities, particularly among the poor. Women generally have less access to private vehicles (even if there is one in the house) and their travel habits – often related to household maintenance – will not be conducive to convenient public transport itineraries. They further suffer possible personal dangers on public transport.

Rapid change

Most developing cities find themselves in a condition of rapid change. In China, for example, urban land has only recently acquired a priced value, introducing revolutionary changes in land development patterns and location decisions of firms and households. In Mexico City, the changing political situation and ongoing decentralization of authority introduces vexing managerial challenges and political competition that manifests itself in, for example, bus services that are prohibited from crossing state boundaries. In Dakar, the population growth rate of greater than 3 percent – shared by cities in, for example, the Middle East – means that the city’s population will double over the next 20 years, introducing special stress on transportation systems but also offering the possibility, in principle, for adapting future urban growth to better match transportation needs. And, of course, rapid motorization (accompanying a welcome growth in income) makes for a

specialized environment because dependent urban systems cannot easily keep abreast of this change rate. Many of these changes make future requirements extremely difficult to forecast. For example, in China, most women work outside the home; in India most women do not. What will the picture of work trips per person look like 10 years from now?

Densities

In most cases, developing cities are denser (in residential population and other measures) than cities of the North. Though difficult to estimate accurately, density figures from developing cities show average and peak figures orders of magnitude greater than Northern cities. In Mexico City, for example, estimates put the overall Metropolitan Area density – covering some 1,500 square kilometers – at a higher level than that of Manhattan (New York), the most densely populated slice of urban life in the United States. Central areas of Shanghai have population densities five times greater than Manhattan. Such densities carry two important implications. First, high densities facilitate the viability of high volume public transport, while making individual transport more difficult. Secondly, historically high densities, in environments of higher incomes and increasing motorization (such as Shanghai), eventually explode into decentralization with considerable force. The patterns, forms and urban designs of that future decentralization will, in turn, have important influences on mobility patterns.

Table 1 Overview of Main Traits of Developing Country City Cases

Traits	Belo Horizonte¹	Chennai²	Dakar³	Kuala Lumpur⁴	Mexico City⁵	Mumbai⁶	Shanghai⁷	Wuhan⁸
Region	Latin America	South Asia	Africa	South East Asia	Latin America	South Asia	Asia	Asia
GDP per Cap (US\$)	6,000	800	1,500	8,000	7,500	1,200	4,200 (2000)	2,000
Population (millions) & Avg. Annual Growth Rate	4.2 1.5%	7 2.4%	2.5 3.2%	4 2%	18-23 2%	18 3%	13-17 0.42%	7.5-8.5 1%
Density (pop/ha)	4-63	59-288	35	10-58	50-120	120-460	14-460	160
Age Distribution	26% < 15	26% < 15	43% < 15	27% < 15	30% < 15	26% < 15	12% < 15	
Trip Rate	4% > 65 1.43 (1995)	8% > 60 1.24 (1993)	5% > 55 2.3 (1998)	4% > 65 2.4 (1997)	5% > 65 1.2-1.4 (1994)	6% > 60 1.26	12% > 65 1.95 (1996)	2.25
Personal Veh/1000	225 4Ws 22 2Ws	40 4Ws 171 2Ws	42	300 4Ws 170 2Ws	110 8 2Ws	27 4 Ws 25 2 Ws	4-20 4Ws 35 2Ws	5 4Ws 20 2Ws
Rail Transit (Fare US\$)	1 Line Metro (\$0.30)	1 line Metro (\$0.10) 3 suburban rail	1 suburban rail line	3 lines LRT (\$0.20-0.60) 2 suburban rail	11 line Metro (\$0.20)	2 suburban rail services 3 lines		
NMT %	5-7% (1995)	44%	44%	NA	NA (possibly 15%)	22%	72%	61%
Public Transport %	69% (1995)	47%	45%	20% (of motorized)	70% (of motorized)	60%	17%	22%

Notes:

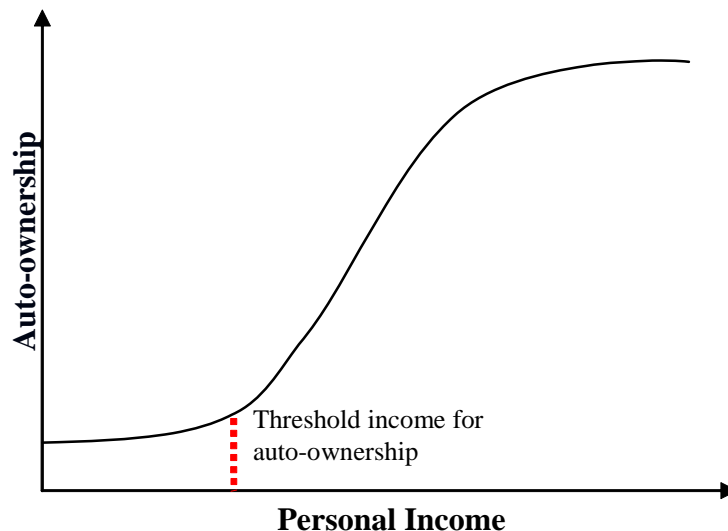
1. Except for population and density, the figures given are only for the Municipality of Belo Horizonte; the density range: 4 is average for the entire metropolitan area, 63 is for the Municipality
2. Population, trip rate and mode shares are for the metropolitan area; GDP per capita for the state of Tamil Nadu was US\$ 480 in 2000, the Chennai figure is an estimate based on the state's; density range: 59 is average for the entire metropolitan area, 288 is for Chennai City; age distribution is for the State of Tamil Nadu; public transport mode share includes auto-rickshaw (5%).
3. GDP per capita is for the country, no data for Dakar was available.
4. GDP per capita and age distribution are for the city of Kuala Lumpur; density range: 10 is average for the entire metropolitan area, 58 is for the city of Kuala Lumpur; motorization rate is for the entire metropolitan area; mode share for non-motorized trips unavailable.
5. Density range: 50 is for new fringe developments, 120 is average for the metropolitan area; trip rate in 1994 did not include walk trips, 1.4 is an upward estimate, assuming 15% of all trips in city are walk trips; 2-wheelers per 1000 is for the Federal District only, reliable data for State of Mexico was unavailable.
6. GDP per capita based on World Bank estimate that 5% of India GDP is produced in Mumbai; density range: 120 is average for entire metropolitan area, 460 is for island city; motorization rate (vehicles per 1000) is for Mumbai City, rate may be higher if less dense suburban areas are included, but data unavailable. Mode share for 2002.
7. Shanghai population range: 13 mn is "official" estimate; 17 million includes "floating" population; density range: 14 average density in new developments; 460 average density in central city. Mode shares are for 1995.

MOTORIZATION

Motorization – the growth in the motor vehicle fleet – arguably poses as the single most important factor influencing developing countries’ mobility and accessibility. Most persons want the convenience, status, and comfort of private motorized travel, but in aggregate these desires translate into well-documented problems. Does a foreseeable ceiling exist for motorization (vehicles per capita) in cities of the developing world? Will resource constraints or the accumulation of externalities attenuate motorization? Several factors play a role.

International comparative evidence shows a strong relationship between income and motorization (e.g., Ingram and Liu, 1998). This relationship exists within a given country or city as well, but at this finer resolution the influences of more nuanced local factors appear. Theoretically, motorization follows a stylized S-curve relationship, as shown in Figure 1. A basic income threshold for vehicle ownership exists; ownership increases very slowly with income until it approaches a threshold level, when a sudden sharp increase takes place. As income further grows, the increase of auto ownership levels off – a point that most of the developed world currently approaches (although forecasts of where this leveling off occurs have been notoriously premature; e.g., Ingram and Liu, 1999).

Figure 1: The Stylized Auto Ownership Curve



In much of the developing world, the vast majority of the population is still at income levels well below the rising portion of the S-curve. Even in places with high average GDP per capita, average motorization levels may be lower than predicted, due to highly skewed income distributions (Gakenheimer, 1999). Thus, continuing or worsening disparities in income distribution and/or general economic stagnation keep all developing country cities far from any theoretical motorization saturation point as suggested by the S-curve.

The cases offer further glimpses into local-level phenomena influencing motorization rates. For example, local industrial and trade policies play an important role in nearly every case: in Brazil and Malaysia, government promotion of the motor industry has further stimulated motor vehicle ownership, evidenced particularly in the high vehicle ownership levels in Kuala Lumpur. In Dakar, the Senegalese liberalization of trade and the opening of the borders to used car imports increased vehicle ownership levels, a phenomenon seen in parts of Latin America (such as Perú) as well as Central and Eastern Europe. Shanghai's motorization rate is lower than what might be expected given the city's relatively high income; a function, in part, of historically high vehicle ownership fees. The Chinese government's industrial policy, with an emphasis on the motor vehicle industry as a pillar of the national economy, may soon change that reality.

Other local policies, not originally aimed at affecting vehicle ownership per se, also play a role. For example, Mexico City's "*Hoy No Circula*" program, a restriction on driving by certain vehicles (based on license plate numbers) during high pollution days, created the perverse impact of promoting the purchase of second hand vehicles (apparently imported from other parts of the country) by many families – increasing the motorization rate (Eskeland and Feyzioglu, 1997). The government has more recently adapted the ban to create an incentive for purchasing cleaner vehicles, an approach also adapted in the case of Santiago (Chile), which uses a similar restriction policy. In these cases, the related externalities – and government efforts to deal with them – have not produced any discernible effects on increasing motorization tendencies.

In fact, increasing motorization and its attendant impacts may actually further induce motorization. For example, motorization fuels spatial decentralization, which then further drives motorization. Further, while motorization exacerbates congestion, congestion may then create the perverse incentive of increasing automobile ownership and use. Since increasing congestion further encumbers main arteries and slows buses and other surface transit, there is increasing advantage to using a car because it enables substitution with a route that avoids traffic and/or a destination in a less congested direction.

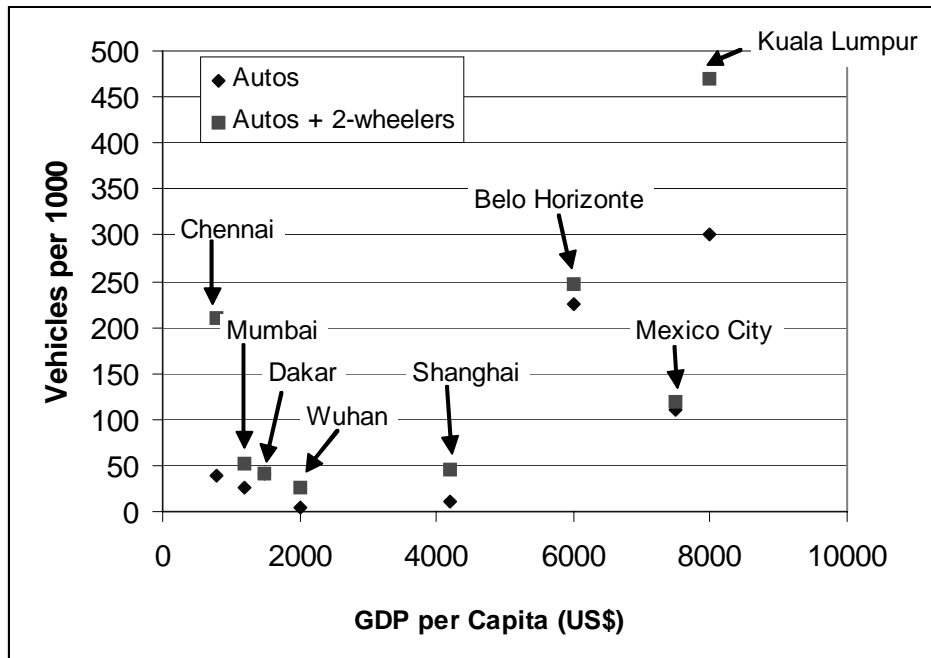
Ultimately, concerns about motorization relate not only to the overall magnitude – that is, a city's total motor vehicle fleet size – but also the rate of increase, as this rate tends to outpace relevant physical and institutional capabilities. Motorization is a fundamental driving force behind increases in transportation greenhouse gas emissions, pressures for land conversion to urban uses, dependency on petroleum, and demands for infrastructure expansion. To help mitigate these (and other) problems, and in reference back to the stylized S-curve (Figure 1), we will need to find ways to push out the motorization threshold point, flatten the slope of increase and/or lower the ultimate motorization saturation point. What country or city in the developing world will be willing, however, to impose the necessary controls, becoming the world's next Singapore (see, e.g., Willoughby, 2000)?

THE ROLE OF TWO-WHEELERS IN MOTORIZATION

The role of motorized two-wheelers (motorcycles and scooters) cannot be ignored in the developing world's motorization patterns. Asia and the Pacific region accounts for more than 70 percent of the world's fleet of motorized two-wheelers, of which China and India account for roughly 20 percent each (IEA, 2004). Among the cities represented by our

case studies, two-wheelers account for 80 percent of the total (autos and two-wheelers) vehicle ownership rates in Chennai, Shanghai, and Wuhan; 50 percent in Mumbai; and 40 percent in Kuala Lumpur. In the Latin American cities, two-wheelers are much less prevalent, accounting for less than 10 percent of the ownership rate in both Belo Horizonte and Mexico City (see Figure 2). There are many cases in which the consideration of two-wheeled motor vehicles in cities in “two-wheeler regions” brings their motorization levels up to the same level as cities of much higher incomes. In fact, based on available data, Mexico City has a GDP per capita 10 times higher than Chennai, but a lower car plus two-wheeler vehicle ownership rate than Chennai (Figure 2). Two-wheelers serve as an individual motorized mobility equalizer.

Figure 2 Motorization and Income in the Cases



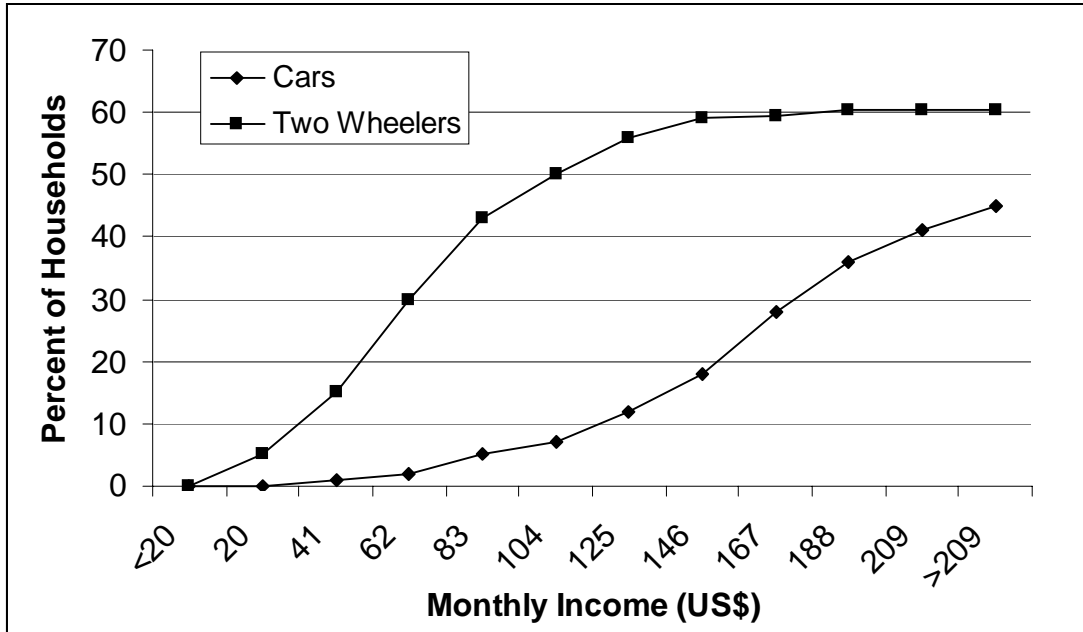
The inclusion of two-wheelers changes the perception of the motorization phenomenon. Returning to the stylized motorization S-curve and including two-wheelers, we can see, not surprisingly perhaps, that two such curves exist – one for two wheelers and one for cars. The Chennai case (Figure 3) exemplifies this. In India, one can buy inexpensive two-wheelers for as low as US\$200. The two-wheeler demand curve crosses the income level of a much larger part of the population. Two-wheelers apparently accelerate the motorization process, particularly since households that “move up” to four wheeled vehicles likely keep their two-wheelers thereby becoming multi-vehicle families.

In detail, these are not necessarily neatly separate curves. Higher priced two-wheelers cost more than lower priced cars, and choice may depend on factors other than price, such as details of social role, age, or gender. Motorized two- (and three-) wheelers are also emerging as “new” public transportation modes in places like Nigeria (Fasakin, 2002).

The question remains, however, as to why two-wheeled motor vehicles are so prevalent in some regions of the world, while they are virtually insignificant in others,

even those of roughly the same income levels? Thoroughly answering this question requires more detailed analysis, but at first glance, the answer seems to lie in the fact that two-wheelers dominate in regions where bicycles were previously numerous. In other words, two-wheelers have fairly directly replaced bicycles. In regions where bicycles appeared in substantial numbers before or during the early motorization movement, they established a place for themselves in traffic on busy streets – a place readily taken over by motorized two-wheelers.

Figure 3 Relationship of Income to Vehicle Ownership in Chennai, 1993



Source: RITES, 1995.

Motorized two-wheelers decrease the physical burden associated with bicycle use, reduce travel times, and offer the opportunity to more effectively maneuver in (or at least keep up with) the higher-speed motorized traffic. Motorized two-wheelers then supersede the bicycles, the latter being endangered by their faster and heavier motorized cousins. This dynamic is dramatically evident in metropolitan Taipei, for example. Ironically, in a city where millions of bicycles are made for export all over the world, bicycles are very seldom used on the streets of Taipei. The rights of way are fully crowded with motor vehicles traveling at high speeds, including the side lanes reserved for all two-wheeled vehicles.

The result is that bicyclists are forced up the “ladder of mobility” to motorized two-wheelers if they can afford them because bicycles are no longer viable in traffic. This transition will be extremely important in China, where bicycles are much more prevalent than any other vehicle (e.g., there are about 1.8 bicycles per family in all income levels). In fact, in some Asian cities, attempts have been made – explicit or otherwise – to discourage bicycle or non-motorized three-wheeler use, with the justification that such vehicles disrupt traffic, occupy too much road space, and dilute the market for public transport (lest this argument seem strange to Western readers, note that

in the late 1800s in US cities, bicycles were considered to be the principal threat to adequate passenger volumes for the new electric streetcar).

All of the above suggests something of a “ladder of mobility improvement” – it is a small jump from two wheels without a motor to two wheels with a motor. A somewhat similar small jump takes one from an independent motor vehicle on two wheels to four wheels. If we believe this ladder of mobility, then motorized two-wheelers offer a stop on the route to auto ownership. The concurrent decentralization and de-densification of cities only further fuels the transition, with additional space opened up for automobile maneuverability.

The two-wheeler picture enlightened by the case studies suggests answers to several questions:

- Do two-wheelers extend individual mobility in regions where they are used? Answer: They do so, probably dramatically.
- Do two-wheelers accelerate the overall growth of motorization? Answer: They definitely do.
- Are two-wheelers a stage toward auto ownership? Answer: We believe they are, as a point in a procession of modal adoption brought on, in part, by traffic pressures.

The above responses do not represent our normative judgment regarding the motorized two-wheeler phenomenon. These vehicles present a range of problems. Not only do motorcycles tend to have higher local pollutant emission rates than other motorized modes, they also tend to be extremely dangerous. The latter challenge (safety) has no obvious technological solution. Users have a penchant for taking advantage of the vehicles’ narrow profile to dart in and out of traffic, which disturbs (and, in the case of human-powered transport, poses as a serious risk to) pedestrians, cyclists, auto drivers, bus service, and law enforcement. If the right of way is divided between cars and bicycles, motorized two-wheelers prove disruptive because they don’t fit either facility. Some governments have taken steps to suppress motorized two- (and three-) wheelers, whether as a form of public transport or as private vehicles. From an environmental and equity perspective, major concerns exist regarding the motorized two-wheelers replacing their human-powered cousins. Yet, at the same time, we must likely find an adequate spot in the mobility panorama for the motorized two-wheelers, as their low prices and maneuverability suggest they have a valuable role to play in a well-managed a multimodal system. Finding this role will remain a challenge; indeed, some have characterized the motorcycle as likely the “most challenging” transport problem that Asia will face in the next decade (Gwilliam, 2003).

PUBLIC TRANSPORT PERFORMANCE

The poor performance of public transport may be the single condition that perhaps most hampers mobility and accessibility in the cities of the developing world.

Although the majority of passenger trips in developing cities typically depend on public transportation, in most cities services suffer from poor financial conditions, inadequate passenger capacity, low network integration, slow operating speeds, and deteriorating physical conditions. As a result, public transport serves declining modal

shares and performs in a context of congestion, crowded vehicles, and high rates of personal injury. Our case studies cover the full spectrum of public transport problems while also displaying some glimmers of hope.

What are the obstacles? At the most basic level, poverty poses a major problem. People cannot afford to pay a fare that sustains good service. For example, a study of metro starts in the late 1980s concluded that while none of the metros in developing cities break even financially, most of them could if they were able to charge a fare of about one US dollar (Allport and Thomson, 1990), more than double the fare of most rail transit systems operating in the developing world today, nearly 15 years later (see, e.g., Table 1). Even in the case of developing cities' road-based public transport systems, many of which are operated by the private sector, fares are often too low to sustain reasonable service levels, and operators essentially cannibalize their capital through poor maintenance practices. Any improvements to the system face the equity challenge of forcing the lowest income groups to finance upgrades via fare hikes.

The share of public transport in daily trip-making varies widely among the case studies. Belo Horizonte, Mexico City, and Mumbai have the highest public transport share of all cities, at 60-65 percent. Shanghai, Wuhan, and Kuala Lumpur have low mode shares, the former two because of heavy reliance on non-motorized modes and the latter due to competition from private motorized modes. Both Dakar and Chennai have mode shares split almost evenly between public transport and non-motorized transport.

Several of the cases studied offer examples of the challenges that public transport systems in the developing world face:

- Since the eighties, Dakar's buses have experienced a 20 percent decline in ridership, despite a rapidly growing population. Fed up with public services, residents have turned to alternative transport means – privately operated minivans such as “*car rapides*.”
- Chennai's public transport mode share declined by 20 percent in the 25 years preceding 1995, largely due to a rapid rise of the number of motorized two-wheelers.
- Kuala Lumpur's transit mode share declined from 35 percent in 1985 to 20 percent transit in 1997, coinciding with efforts to promote the automobile industry through the “National Car.”
- In Mexico City, the publicly owned bus system collapsed during the eighties and the massive Metro system's ridership stagnated, due in large part to the rapid rise of the para-transit “*Colectivos*,” privately operated minivans.

These challenges shed light on the multiple institutional and operational problems underlying the public transport crisis in the developing world cities. For example:

- Public transport can prove difficult to manage as a private industry in the public service due to political challenges and institutional capabilities necessary for contract design, bidding, enforcement, etc.
- Private operators have strong political leverage (including the option of paralyzing strikes as in the case of Mexico City). As a result, officials find it hard to budge from the status quo of contractual arrangements.

- The fare is a conspicuous element of the cost of living. Political leadership therefore remains very hesitant to permit the fare increases and sometimes suffers acutely when it does so (e.g. Mumbai).
- Innovations and new services are often intentionally isolated from the existing system to avoid its historical resistance to change and accumulated political obligations. As a result, systems are un-integrated (e.g. Kuala Lumpur's light rail transit [LRT] system and Mexico City's recent bus rapid transit [BRT] corridor).
- Government agencies responsible for operations arrangements and control are often weak and isolated from the strong elements of the transportation bureaucracy that are responsible for infrastructure construction. Often, this isolation results from an effort by the government to keep the turbulence of public transport operations from affecting the stability of capital flows for infrastructure investment.
- Ambivalence towards supporting informal sector transit services has further complicated the problem. The informal sector adds significant increases in service levels (i.e., door-to-door) and serves as an employment source, but cripples government sponsored transit service and system management (e.g. Mexico City).
- Inter-jurisdictional problems within metropolitan areas sometimes impede system integration in very harmful ways (such as in the Federal District of Mexico City, where maximum age for transit vehicles is different than in the surrounding urbanized State of Mexico, and agreements to extend metro lines across the boundary have been difficult to reach).

Despite these problems, the same cases show that a remarkable capability exists for facilitating public transport and enhancing its share in absorbing trip making (e.g. Belo Horizonte's transit share of nearly 70% of trips in the face of a private vehicle ownership rate of 225 cars per thousand persons). Mumbai's publicly owned BEST (bus company) increased its daily service by around 20 percent (passengers) during the 1990s and increased its earnings in the same period by more than two and a half (Bombay First, 2003). A few cities have committed large budgets to public transport (e.g. Shanghai with 28% of its infrastructure budget going towards its rail system and Mexico City's historic emphasis on expanding its Metro). If Mexico City's ambitious Metro expansion holds lessons for Shanghai, however, it is that the Metro will not retain a high mode share unless efforts are made to curtail urban expansion, promote development near Metro stations, and curb competition from road-based modes. The Mexico City Metro currently requires nearly US\$400 million in annual operating subsidies.

Kuala Lumpur, to a certain degree, typifies the most problematic case, with incomes and motorization high enough to make it scarcely characterizable as a "developing" city, relative to the others. In this case, public management of the sector has left the service-providing companies near collapse. During the nineties, the private sector embarked on the development of three rail-based transit systems (two light rail systems [LRT] and one monorail). The LRT systems, now operational, demonstrate the difficulty in making this mode a profitable private endeavor. The two systems have recently been combined under one owner; details on the financial conditions are unavailable. The monorail system, with construction delays caused by the nineties financial crisis, finally opened in August of 2003. At present, these systems do little to

pick up the transit share of trip making or to relieve pressing street congestion in the city. While formal data since the inauguration of the rail systems does not exist, it seems unlikely that public transport mode share in the city has increased beyond 20 percent.

At the other extreme is Belo Horizonte, with, ironically, the same size metropolitan population and roughly the same residential density as Kuala Lumpur. Yet with public transit accounting for 69 percent of all trip making, Belo Horizonte features three and a half times more public transit use than Kuala Lumpur. Belo Horizonte has no “special technology” transit systems, and in general, operational bus speeds are slow. That this system manages to maintain high mode share is testament to some degree of effective regulatory structure and perhaps a persistent willingness on behalf of citizens to continue using buses, even when they might own a motor vehicle.

Several developments offer glimmers of hope for the future public transport in the developing world. First, the “revolution” of bus rapid transit (BRT) systems, sparked by the well-known case of Curitiba over two decades ago, is now beginning to spread across Latin America (e.g. Bogota, Mexico City, Santiago, Lima) and other parts of the world. Second, the Global Environment Facility (GEF), has initiated a number of programs (mostly directly related to BRT projects and World Bank loans) aimed at improving public transport performance (see, e.g., Graftieux, et al 2003). Finally, the private sector entrepreneurs operating systems around the developing world should be recognized for the important role they play; with the main challenge being how to capture this market power to improve the ultimate public transportation value for citizens.

LAND DEVELOPMENT TRENDS

Most of the cities in our study are decentralizing at rates faster than those in the North, although not because of any single factor. Continued urbanization and demographic pressures, population density alleviation, economic trends and globalization forces (and industrial structure changes and subsequent relocation to peripheral sites typically adjacent to upgraded highway infrastructures), social pressures and demand for cheaper land for housing, land speculation, and motorization itself all feed into this growing trend that, in turn, tends to lead to increases in travel demand and further motorization.

All of our case cities are experiencing intense urban decentralization pressures. For example, virtually all of Mumbai’s population growth has occurred in the city’s suburbs since the mid-1960s (Pacione, 2006); in Mexico City, over the past two decades population in the Federal District (the historical city proper) declined by an average 0.1% per year while in the surrounding suburban jurisdictions population increased by 3.2% per year (Molina and Molina, 2002). These trends, in part, are response to historically high urban densities. Among our cases, Wuhan shows an average density of 160 persons per hectare; Mumbai, 120; and Belo Horizonte, 63. If Shanghai’s population were distributed at the same density as the greater New York metropolitan area, Shanghai would occupy an area about 16 times its current size. Rapid suburbanization, always a force in urban evolution, has been a natural response. Suburbanization is sometimes spontaneous and “informal,” producing scattered and disorganized “sprawl” which overwhelms infrastructures and ecologies. However, even “planned” suburbanization does not always turn out as planned.

As an example, to alleviate population pressure in Mumbai, the state government created Navi Mumbai (New Mumbai), a planned suburb that would incorporate

employment elements, strict infrastructure requirements, and residential areas. Actually borne of two competing visions – a geographical extension of the existing city or a self-contained “new town” – Navi Mumbai eventually evolved with market powers superseding the planning regime (Pacione, 2006). The result is a prosperous, but sprawling suburban landscape, which has created the need for expensive new bridges and highways connecting the suburb to downtown and further intensifying pressures on Mumbai’s commuter rail network. The transport impacts have been mixed – according to Shaw (2004), for example, fully 66% of Navi Mumbai residents are employed in Navi Mumbai, which at least diminishes travel demand flows across the Thane Creek.

Many of the other cities offer examples similar in some ways to Navi Mumbai. Shanghai’s Pudong New Area literally sprang out of rice fields across the river from historical Shanghai in the early 1990s, with the original plans a product of an international urban design competition. Pudong’s new CBD already offers a soaring testament to the city’s aspirations to re-cast itself as a global financial center (and architects’ desires to bask in the celebrated limelight) – but the district more broadly displays a surprising amount of segregation of land uses (i.e., residential areas distant from commercial areas) and extremely ample roadway infrastructures which makes travel by modes other than private motorized vehicles increasingly difficult. The forces of globalization and pressures to compete on the global scene has produced similar mega-developments in Kuala Lumpur (the Kuala Lumpur City Centre Project [KLCC]; e.g., Bunnell et al, 2002) and, in Mexico City, Santa Fe, a massive office, commercial and up-scale residential development on a former landfill on the southwest periphery of the city. Santa Fe was borne as a direct response to the need for high class office space in Mexico City (due to globalizing competition) – an estimated 50% of the 335,000 square meters of Mexico City’s office space added between 1995 and 2001 was developed in Santa Fe. Interestingly, Pudong, KLCC, and Santa Fe were all initiated roughly around the same time. These all provide examples of strong inter-relations between private sector interests and public officials (KL, Santa Fe) and have been influenced, not surprisingly by transportation infrastructure expansion (especially highways).

Despite these high profile, globally-oriented real estate mega-projects, all of the case cities continue to face the dire pressure to adequately house their poorest residents. The challenges are evident in fairly wealthy Kuala Lumpur, where an important number of squatter dwelling units still exist (e.g., Bunnell et al, 2002). In Mexico City, an estimated 49% of the population lives in “irregular” settlements (Zanetta, 2003), typically consisting of low income housing lacking legal tenure and access to basic urban services, often located on land protected for ecological purposes, and continuously spreading outwards into the urban edge driven by land prices and availability. Even the “new town” suburb of Navi Mumbai is susceptible to the challenge, with an estimated 39% of the population resides in “informal settlements” (Pacione, 2006). In Shanghai, the razing and rebuilding of entire, relatively low income centrally-located neighborhoods (which are, admittedly, extremely crowded and dilapidated) to make room for upscale offices and apartments have forced lower income residents to the distant urban periphery. In Shanghai (and other Chinese cities) a peculiar fiscal condition fuels physical expansion. Since national tax reforms in 1993, local governments assumed an increasing fiscal responsibility, but were left with few revenue-raising sources. Land conveyance fees – whereby local governments receive up-front lump sum land rent payments for long-term

leasing – account for up to 60% of total local government revenues, and thereby provide a powerful incentive for local governments to convert land into urban use (Ding, 2005).

INSTITUTIONS

The ultimate challenge pervading every aspect of transportation – including planning and project preparation, operations management and regulation, and construction and maintenance – continues to be institutions. Any discussion of the institutional issues facing developing cities must begin by recognizing the challenges resulting from the need to respond to rapidly increasing travel demand in the face of limited resources. Cities in China, with a still highly centralized government structure, face these challenges, as does Mexico City, operating in a context where the Federal Government, at least two state governments, plus 50-odd Municipal governments each vie for its slice of control and political capital. Democratization and governmental and fiscal decentralization generally come hand-in-hand with development. However, as cities grow and the number of jurisdictions within their urban areas increases, the institutional problem of managing the system – transportation or otherwise – at times seems to increase exponentially.

In the developing world, these conditions are worsened by fiscal realities and subsequent problems for the bureaucracy and civil service. Governments tend to be strapped for resources. Salaries are often very low, generally attracting young professionals at the very beginning of their careers, those who can profit privately from government employment (e.g. through parallel consulting), and those who occupy key positions out of a sense of obligation to society. And each of us knows few heroic individuals in this last category who are responsible for important action.

Further problems arise from the lack of clarity of administrative responsibility among linked agencies. Since lower level agencies are often impoverished, they are likely to delay action in the hope that the national government will bail them out. For example, in many government traditions, infrastructure is a national responsibility, but its maintenance is a local responsibility. Accordingly, the local government has an incentive to allow roads to deteriorate, hoping that when deterioration reaches the level of requiring full rebuilding the national government will step in. This situation prevails in the industrialized world as well, the United States providing a perfect case in point; however, in the developing world the relatively lower level of fiscal autonomy and capability of local jurisdictions further intensifies the incentives.

Transportation agencies are often decapitated, with all principal officers replaced, when a newly elected government administration arrives, resulting in program discontinuity (this often happens even when the same party is re-elected but the personalities of leadership are changed). This poses a serious impediment to the collection of useful data for analyzing transportation problems and the ongoing development of methodological advances, often hampering transportation planning capability in relevant agencies. Transport plans are usually accomplished by a consortia of consulting firms. These plans usually advise follow-through which is not undertaken, and the plans themselves are often very limited in circulation in order to confine decision strength to a select group. Subsequently, coherent policy fails to emerge since actions are built on isolated reports from a succession of consultants. Data, if collected, are rarely collected systematically and remain guarded closely (see, e.g., Leman, 2005) –

information is power. Again, these challenges are by no means unique to the developing countries, however they are exacerbated considerably by the scarcity of resources.

In many cities throughout the developing world, public transport vehicles operate without a concession agreement, vehicle registrations are notoriously incomplete and even a significant portion of personal drivers' licenses are falsified. Solving such problems would go a long way towards improving the conditions of transport in the developing country city.

CONCLUSIONS

The developing world's transportation demand must increase. Much of the developing world remains mobility and accessibility poor and mobility will both increase development and be increased by development. The high forecasted growth in these nations' travel represents a good degree of "catching up" – for example, even after a forecast three percent average annual increase in per capita light duty vehicle kilometers traveled (VKT) over the next 50 years in Latin America and the Caribbean, North America's per capita VKT will still be three times higher (IEA, 2004).

Drawing from a limited number of cases, drawn from a wide spectrum of developing city contexts, we have identified some of the commonalities and differences among a range of the principal driving forces underlying mobility and accessibility trends today. Virtually all cities of the developing world are still in the early stages of private motor vehicle ownership, with considerable variation not only due to income levels, but also due to, for example, income distribution (e.g., Gakenheimer, 1999), as well as – as illuminated by the cases – factors such as the role of the national motor vehicle industry and trade policies regarding used vehicle imports. It remains unclear whether developing world cities will reach a near-term "saturation point" with respect to motor vehicle ownership – due to "natural" resource constraints, "artificially" imposed restrictions (à la Singapore), or perhaps cultural or other factors. The motorized two- (and three-) wheeler phenomenon plays an important role in some regions of the developing world, primarily in Asia (although spreading to Africa and parts of Latin America), apparently serving as a mobility "equalizer" and motorization accelerator and likely serving as a stepping-stone to automobile ownership (for better or worse). In the meantime, they pose a host of traffic management, air and noise pollution and safety problems – with particular problems for human-powered travel. As for public transport, the primary means of mobility for the majority of most developing cities' residents, system performance tends to be plagued by lack of priority on scarce streetspace, low purchasing power of the users, difficulty in managing private sector operators, and a tendency to focus on high-profile (high cost) solutions. The recent growth in interest in BRT may help overcome some of these problems, however it remains to be seen whether BRT revolutionizes public transportation systems or simply creates discrete "solutions" within the larger continuing chaos. Finally, the rapid physical expansion underway in most developing cities may pose the single largest long-term challenge to mobility management in these cities. The physical form of cities – the distribution of potential trip origins and destinations – provides the underlying context determining travel demand. Desires to reduce intense densities and related crowding, land speculation fueled by infrastructure development, large-scale real estate projects influenced in part by globalization forces, and continued pressures to house lower-income groups – these and other pressures

continue to push cities outwards. The resulting development patterns tend to increase travel distances and disfavor public transportation and human-powered transport modes. Effective management of urban development for improved mobility has proved to be elusive around the world, developed or developing. Finally, the rapid pace of change of these and other related forces overwhelm institutional capabilities – a problem by no means unique to the developing country context, yet one exacerbated by resource constraints.

This limited survey of a select number of cities by no means covers all of the relevant topics. Freight has been entirely ignored, for example. Furthermore, we only briefly touch on the important issue of human-powered transportation. Other relevant developments, such as private sector concessions for infrastructure delivery and operations, such as used for the original development of Kuala Lumpur's urban railway infrastructure expansions (eventually taken over by the government; e.g., Bunnell et al, 2002), have not been discussed here. We have chosen the main drivers as we see them. Others might see others as more relevant. The drivers themselves suggest potential solutions to some of the challenges. For example, might the interest in BRT capture land development in effective ways, as the "streetcar suburbs" developed cities at the beginning of the last Century? Can the vigor of the private sector transit entrepreneurs be tapped? How about finding the effective role and management of motorized two-wheelers? These drivers suggest where developing cities might be going; though we would not be so bold as to suggest that the anecdotal evidence from these few cities can be generalized to the "developing world." It would be interesting to expand the analysis to look at a range of cities and to see whether it would be possible (and useful) to select archetype cities which could allow to generalize potential futures from city types. Ultimately, the future possible trajectories are likely at least as wide as the differences between the cities of Northern Europe and North America. But the quality of life of a much greater number of persons ultimately depends on where those trajectories take us....

ACKNOWLEDGMENTS

We would like to acknowledge the following co-authorships of the cases from which this paper is drawn: Mark Emmert (Belo Horizonte and Dakar); Anjali Mahendra (Mumbai and Chennai); Apiwat Ratanawaraha (Kuala Lumpur); and Jinhau Zhao (Shanghai and Wuhan) – all current or former graduate students in the Department of Urban Studies and Planning, Massachusetts Institute of Technology. We received data gathering assistance from the Municipality of Wuhan and the Malaysia University of Science and Technology, Program on Transportation and Logistics. The original research was financially supported by the Sustainable Mobility Project of the World Business Council for Sustainable Development. Finally, we sincerely thank Holly Krambeck, currently of PBCConsult, for her writing and editing contributions to an earlier version of this paper.

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