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## Walk Urban

Demand, Constraints and Measurement of the Urban Pedestrian Environment

Brittany Montgomery and Peter Roberts



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Brittany Montgomery and Peter Roberts



THE WORLD BANK  
WASHINGTON, D.C.



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## EXECUTIVE SUMMARY

Walking is nature's mode of transport. For many people in the developing world, it is the *only* form of transport. The globe's rapid urbanization, particularly in low-to-middle income countries, stimulates a high demand for low cost, sustainable urban transport. A well-designed and maintained walking network can satisfy this demand, while contributing to poverty reduction, health benefits, and saved lives. However, the complexities associated with the pedestrian environment often prevent interventions that benefit walkers.

In order to identify needed walkability improvements, an urban area must be evaluated by some standard of measurement. Since walking trips are highly variable and pedestrian activity is not conducive to measurement, this mode is often neglected. By identifying macro-level indicators that appraise the urban provision for pedestrians, municipalities can begin to implement positive changes. The following five dimensions of the walking environment and their associated indicators can help cities make a top-level survey of their pedestrian conditions.

<b>Accessibility/Mobility</b>	<i>Average walking trip time</i>
<b>Safety</b>	<i>Pedestrian fatalities/population</i>
<b>Security</b>	<i>Pedestrian - targeted crime rate; perception surveys</i>
<b>Legal Provision</b>	<i>Pedestrian rights</i>
<b>Public Expenditure</b>	<i>Percent of total urban infrastructure and maintenance funds spent on walking mode</i>

While a few projects in various regions throughout the world have recently initiated pedestrian projects, there is a severe need to give more attention to the urban pedestrian environment. These indicators can assist development agencies, as well as municipal leaders, in understanding the extent of the need to address the walking mode. Further study in data collection methods for the five dimensions can make the establishment of these indicators a reality. Finally, investigating successful projects for the pedestrian environment and forging partnerships with multiple development networks can catalyze interest and effective action in the urban walking environment.



# WALK URBAN

## Demand, Constraints and Measurement of the Urban Pedestrian Environment

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### 1 INTRODUCTION

“Overall support for the pedestrian environment,”<sup>1</sup> or *walkability*, has grown increasingly important as the world urbanizes and motorized modes threaten to displace or constrain travel on foot. This concern encompasses virtually every aspect of the pedestrian experience. “Walkability takes into account the quality of pedestrian facilities, roadway conditions, land use patterns, community support, security, and comfort for walking” (Litman). Each of these facets of the pedestrian environment impacts the use of walking as a primary mode of transport.

In urban areas of developing countries, where high rates of urban growth, large poor populations, and high densities prevail, walking is the only option available to a significant portion of the population. Many people are “captive walkers,” meaning that they cannot afford an alternative; therefore, the state of the pedestrian environment is critical to allowing walkers to reach their daily needs.

The complexity of the urban pedestrian environment naturally lends itself to micro-level analysis to locate the need for improvements; however, to gain an overview of a city, it is necessary to develop macro-level indicators that can identify the general state of the pedestrian environment. While these indicators cannot diagnose all walkability problems, they can give a sense of how one urban area compares to another in similar circumstances and they have the potential for becoming an influential aspect of World Bank urban infrastructure diagnosis. Urban Transport indicators are being reviewed as one component of the current Transport Results Initiative<sup>2</sup> which is led by the World Bank’s central Transport Unit.

### 2 DEMAND FOR PEDESTRIAN-ORIENTED CITIES

Why is the pedestrian environment a growing concern in developing cities? If cities are truly developing, then why focus on pedestrians instead of private automobiles? The reasons for giving attention to the ‘walkability’ of cities extend beyond leisurely Sunday strolls and sidewalk cafes.

#### 2.1 Captive Walking Demand

“Within a generation the majority of the developing world’s population will live in urban areas and the number of urban residents in developing countries will double, increasing by over 2 billion inhabitants.”<sup>3</sup> Cities are booming with huge population increases at low incomes. “When urbanization in Latin America was roughly 30 years behind that in North America, its average per capita income approximated that of the United States 120 years ago” (Cities in Transition). Increasing urban density,

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<sup>1</sup> Litman, Todd. 2004. *Economic Value of Walkability*. Victoria Transport Policy Institute, BC, Canada.

<sup>2</sup> <<http://www.worldbank.org/transport/transportresults/home.html>>

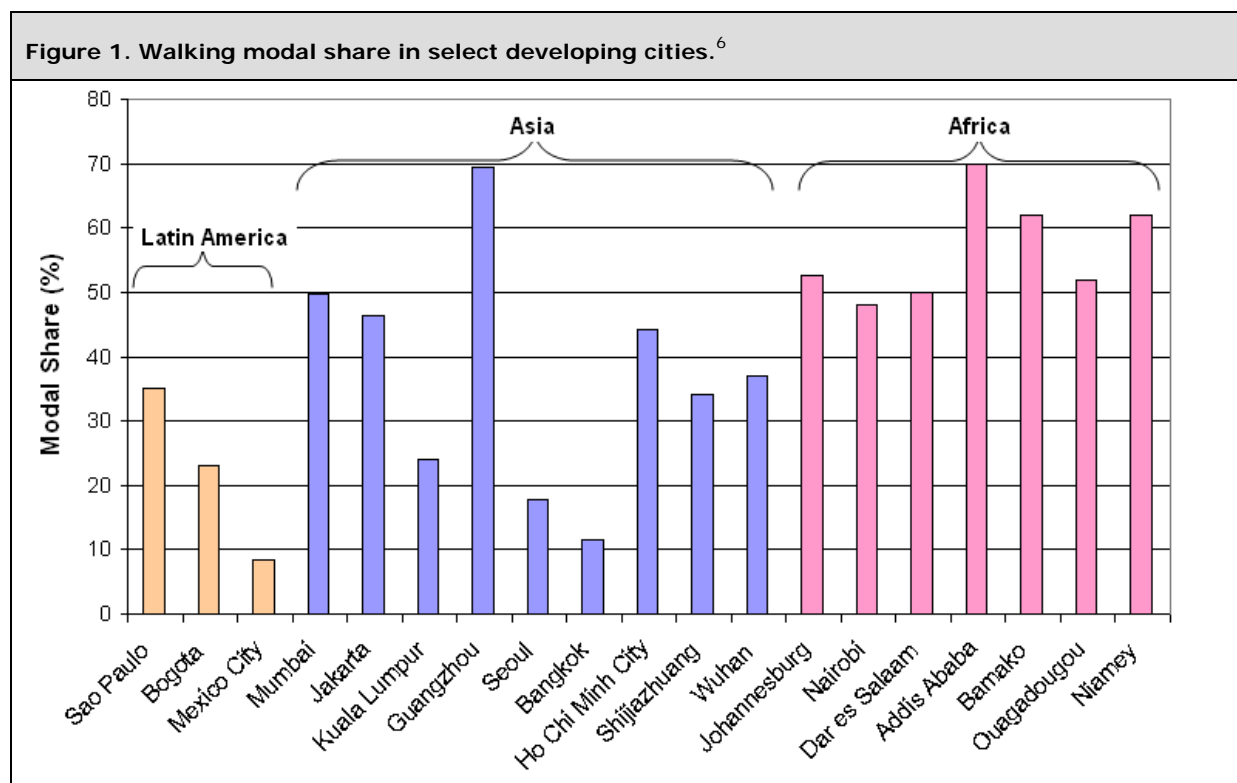
<sup>3</sup> World Bank. 2000. *Cities in Transition*. Urban and Local Government Strategy. Washington, D.C., USA

rapid growth rates, and large poor population stimulate a huge demand for high quality pedestrian environments.

In developing cities across the globe, walkers comprise over a third of the modal share of all trips made. Sub-Saharan African cities hold the largest numbers of walkers, where many of the cities have greater than 50 percent of all trips made on foot.<sup>4</sup>

Inaccessibility to transit, along with its high price leaves a large portion of the population bound solely to the walking mode. Analogous to the concept of “captive riders” in public transport, these urban dwellers have no alternative choice but to walk. In Buenos Aires, for example, although families in the bottom income quintile walking for over half of their work journeys, they spent 32 percent of their family income on public transport journeys to work.<sup>5</sup>

The importance of walking in the journey to work for lower income households has been confirmed in a substantial study in Mumbai, India. Figure 2 shows (with a couple of very minor exceptions) that a higher proportion of the households in each income category walk to work than is the case for those in the next higher income group. In practice households in the lowest income quintile account for between twice and five times as many walkers as do those in the highest quintile.



<sup>4</sup> Pendakur, Setty. 2005. *Non-Motorized Transport in Africa: Lessons from Experience in Kenya and Tanzania*. SSATP Working Paper No. 80. World Bank, Washington, D.C., USA.

<sup>5</sup> Carruthers, Robin et al. 2005. TP-3 - *Affordability of Public Transport in Developing Countries*. World Bank, Washington, D.C., USA.

<sup>6</sup> Data from *UITP Millennium Cities Database*, *SSATP Working Paper No. 80*. and *Urban Poverty and Transport: The Case of Mumbai*.

Figure 2. Walking commute distance by income in Mumbai. The lowest income bracket has the highest share of walking trips in every distance category.<sup>7</sup>

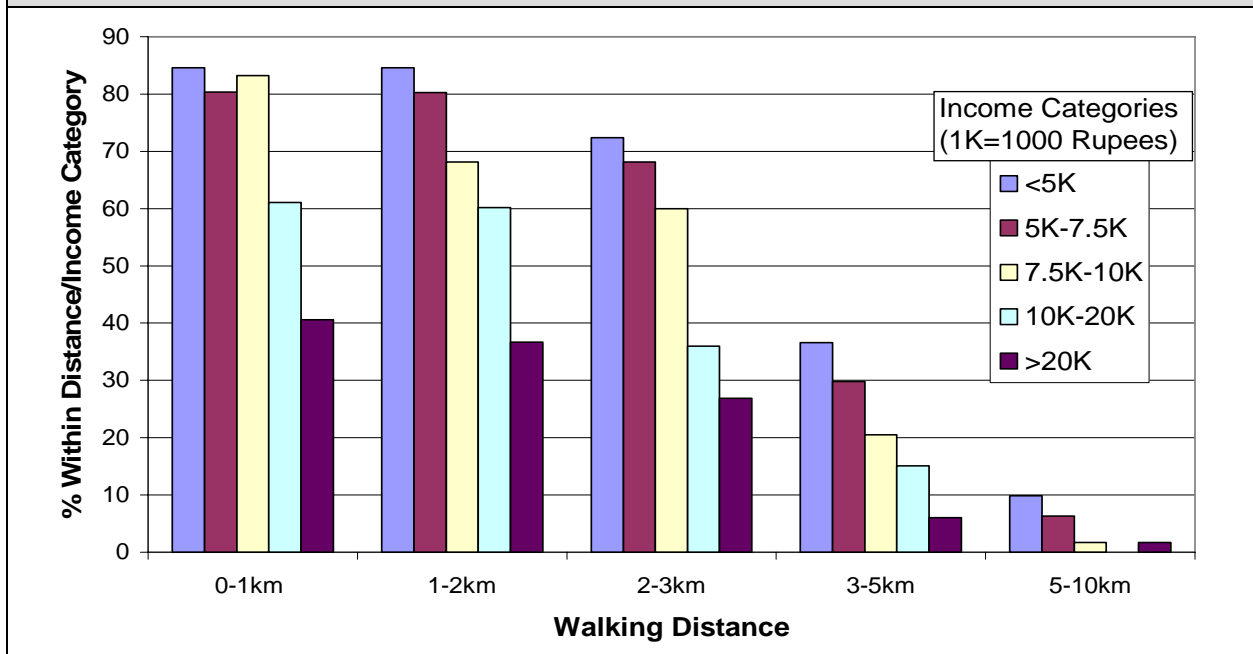
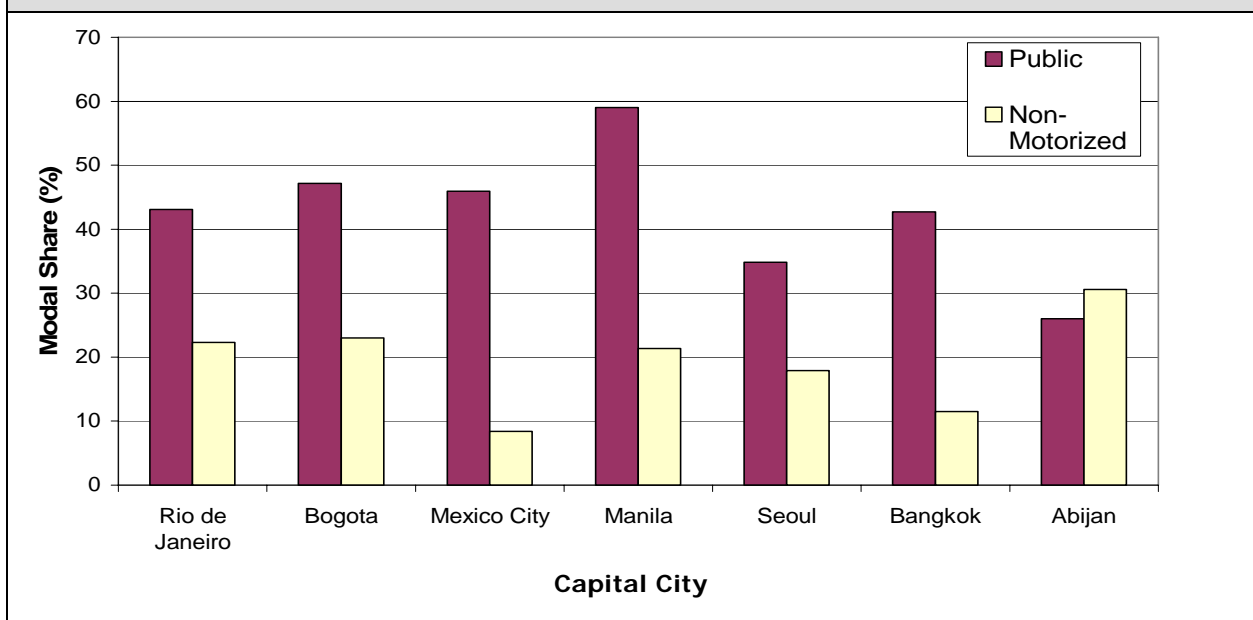


Figure 3. Many developing cities with less than one third walking modal share have high transit ridership.<sup>8</sup> Urban walkability, particularly around stops and stations, affects transit ridership.



<sup>7</sup> Baker, Judy et al. 2004. *Urban Poverty and Transport: The Case of Mumbai*. World Bank Working Paper. World Bank, Washington, D.C., USA.

<sup>8</sup> 2000. *UITP Millennium Cities Database for Sustainable Transport*. Urban Transport, Land Use, Infrastructure, Economic, and Environment Indicators for 100 International Cities. UITP.

Even those who can afford transit rely on walkable environments to access bus stops and metro stations. Some cities, such as Bangkok for the Skytrain system (see photograph on front cover), have spent millions on high-profile mass transit systems without considering the walking environment surrounding these systems.<sup>9</sup> A transit trip actually consists of the transit mode trip + two walking trips; hence, designing for pedestrians is integral to transit service usability.

## **2.2 Sustainable transport**

Yellow-gray haze obscures the skylines of Shanghai and Bidonville alike, as they face the effects of industrialization and rapid motorization. Replacing walking and public transit trips with those made by the private automobile significantly contributes to the deteriorating air quality in both developed and developing cities. Walking does not burn fossil fuels, cause congestion, or detrimentally affect air quality. Therefore, it is a transport mode which responds to the longer-term needs for less dependence on non-renewable energy, the land-use or spatial need for efficient travel, and the biological need for clean air. Self-propulsion is the most resource-efficient way of making many urban trips, particularly short trips. Retaining these short trips in the walking mode significantly reduces dependence on motorized vehicles in those locations which are most prone to congestion and where the negative effects of pollution and other environmental impacts will be suffered by large numbers of people.

In the longer-term walking also contributes to sustainability through its characteristic impact on land-use. Pedestrians use limited space efficiently and effective foot travel depends on dense urban areas, rather than vast sprawling urban agglomerations. This trend is further reinforced since the walking mode enables public transit, contributing to more beneficial uses of urban space and further lowering demands on non-renewable energy sources.

## **3 IMPACT OF THE WALKING ENVIRONMENT**

The walking environment has the potential to dramatically change the urban fabric. It is important for contributing to the inclusiveness of a transport system and does much to determine whether children can go to school, if women have pre-natal care, and if the elderly and disabled can function independently in society. Safe, secure, and serviceable walking environments are in high demand and can contribute to poverty reduction, saved lives, and healthy citizens.

### **3.1 Better walkability contributes to poverty reduction**

According to the World Bank's *Sourcebook for Poverty Reduction Strategies*, "Good transport policy can help reduce poverty in all its dimensions while stimulating economic and social development and inclusion, by: creating opportunity, facilitating empowerment, and enhancing security."<sup>10</sup> Walking, since it is the least expensive form of transport (in terms of monetary cost), is often the only form of transport available to the poor. Improvements in the walkability of urban areas can address each of these poverty reduction goals and contribute to achieving Millennium Development Goals Nos. 2, 3, 4, and 5, thereby improving the quality of life for all potential users, not just for those of privileged income groups.

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<sup>9</sup> Conversation with Sam Zimmerman, World Bank, TUDTR. July 2006.

<sup>10</sup> Klugman, Jeni ed. 2002. *A Sourcebook for Poverty Reduction Strategies, Volume 2: Macroeconomic and Sectoral Approaches, Chapter 22-Transport*. World Bank, Washington, D.C., USA.

## ***Opportunity***

Ensuring that there is a foot-network to connect the entire urban area can facilitate the ability of the urban poor to reach essential destinations, such as employment centers, medical facilities, and schools. Public and private transport services are often out of reach for the poor, due to un-affordability and non-availability. For example, in Mumbai the poorest income group has a walking mode share of 17 percent above average but makes fewer trips overall than do the non-poor.<sup>11</sup> In many metropolises, development has occurred in such an uncoordinated manner that transport networks for medical services, etc. has not accompanied the construction of housing settlements. Therefore, the only access to these areas is often by foot and the ability to reach essential services is entirely dependent on safeguarding key pedestrian routes. So adequate pedestrian facilities can grant not only the opportunity to survive physically, but also the opportunity to access basic services such as education. Getting to school can be a huge obstacle for children and teachers in developing countries, and dependence on expensive public transport hampers access to schools, especially for girls.<sup>12</sup>

## ***Empowerment***

Empowerment is closely linked to the idea of opportunity, and it embodies the idea of enabling people to reach beyond their current capacities. Well-designed walking environments can give freedom of mobility to the disabled, thus giving them social and political access. "Improved access and mobility are critical for reducing isolation, vulnerability, and dependency of elderly and/or people with disability, particularly in developing countries where individuals with disabilities and the old are likely to be among the poor and most vulnerable sections of the population."<sup>13</sup> In addition to meeting needs of the disabled, a walkable city can improve independent travel for women, whose transport needs are often distinct from, and less well served than, those of men ("Social Analysis in Transportation Projects").

## ***Enhanced security***

Having "eyes on the street" is possibly the most effective urban crime prevention measure, as noted by Jane Jacobs in her groundbreaking work, *The Death and Life of Great American Cities*.<sup>14</sup> An environment that encourages walking at all times of day and by various user groups will help to promote eyes on the street, thereby improving the security of vulnerable users, particularly women and children. Crimes are less likely to occur in well-lit, frequently traversed areas (i.e. areas which promote foot traffic). Therefore, enhancing the urban pedestrian environment may have a direct impact on city crime and perception of security – contributing to a 'virtual cycle' which further encourages walking.

### **3.2 Walkable cities save lives**

Inadequate treatment of the pedestrian environment in relation to motor traffic reaps grim consequences, and in many developing cities a high number of walkers corresponds to many

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<sup>11</sup> Baker, Judy et al. 2004. *Urban Poverty and Transport: The Case of Mumbai*. World Bank Working Paper. World Bank, Washington, D.C., USA.

<sup>12</sup> Porter, Gina and Kathrin Blaufuss. 2006. *Getting to School: Achieving universal primary education*. id21 insights #63. <[www.id21.org](http://www.id21.org)>

<sup>13</sup> Social Development Department. 2006. *Social Analysis in Transportation Projects*. World Bank, Washington, D.C., USA.

<sup>14</sup> Jacobs, Jane. 1961. *The Death and Life of Great American Cities*. Random House, Inc. New York, NY, USA.

pedestrian deaths. Road safety and the global effort to reduce traffic fatalities, the tenth leading cause of death in low-and-middle income countries,<sup>15</sup> have primarily focused on vehicle and driver safety. However, in developing countries, pedestrians are the most common victims of vehicle crashes. According to the World Report on Road Traffic Injury Prevention, “a review of 38 studies found that pedestrian fatalities were highest in 75 percent of the studies, accounting for between 41 percent and 72 percent of all fatalities.”<sup>16</sup> To counter the trend of rising road fatalities in developing countries it will be necessary to not only address driver-related issues, but also to improve the design of the pedestrian environment.

In the United States, “three-quarters of pedestrian crashes occur where there are no traffic controls.” Attention to pedestrian facilities can dramatically reduce these tragedies. For example, over the past ten years in London the number of children seriously injured or killed on London’s streets has fallen by 62 percent due to the “record levels of investment” in London’s safety improvements.<sup>17</sup> Walkable cities can save pedestrian lives.

### 3.3 Healthy living

A good walking environment can provide access to several components of a healthy lifestyle. If the walking network increases access to healthcare centers, it can be a factor in improving pre-natal and other health care. The ability better to reach health services on foot can improve the willingness to seek medical attention, thereby increasing the frequency of this care. In South Africa more than 40 percent of trips to health care facilities are made on foot<sup>18</sup>. Additionally, a well-connected walking network links “captive walkers” to a greater variety of market choices and food-source options, which could impact their capacity to consume a more nutritious diet.

While obesity and inactivity are not problems faced by most developing cities, they can arise if the focus of development is on private modes. Mexico now stands in second place for the fattest nation, according to a recent OECD study, and the surge in obesity is partially attributed to rapid urbanization.<sup>19</sup> The US and the UK encourage walking as a form of exercise to prevent disease and other health issues.<sup>20 21</sup> Thus, investing in the walking mode can help to counteract health problems related to healthcare facility inaccessibility and to poor levels of physical activity.

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<sup>15</sup> Brown, David. 2006, April 3. *Saving Millions for Just a Few Dollars*. The Washington Post. Data from: “Disease Control Priorities in Developing Countries, Second Edition.” Washington, D.C., USA.

<sup>16</sup> Peden, Margie et al. 2004. *World Report on Road Traffic Injury Prevention*. World Health Organization. Geneva.

<sup>17</sup> 2006, July 14. *Child road casualties in London reduced by 62 per cent*. Transport for London. <<http://www.tfl.gov.uk/tfl/press-centre/press-releases/press-releases-content.asp?prID=844>>

<sup>18</sup> TP-12

<sup>19</sup> 2004, December 16. *Fat Mexico: Sins of the Fleshly*. The Economist.

<[http://www.economist.com/displaystory.cfm?story\\_id=3507918](http://www.economist.com/displaystory.cfm?story_id=3507918)>

<sup>20</sup> Department of the Environment, Transport, and the Regions: London. 2000. *Encouraging walking: advice to local authorities*. London, UK.

<sup>21</sup> *Making Your Community More Walkable*. National Highway Traffic Safety Administration. US Department of Transportation. Washington, D.C., USA.

<<http://www.nhtsa.dot.gov/people/injury/pedbimot/ped/walk2.html>>



## 4 CHALLENGES FACING THE WALKING MODE

Improving the pedestrian environment is replete with challenges. This facet of the urban fabric faces many obstacles to improvement, from the exposure to perilous conditions that is often inherent to urban walking to building a political constituency which is supportive of walking and which recognizes the needs of pedestrians.

Paradoxically, walking can actually place people in greater danger than does traveling in private or public motorized modes. Walking exposes pedestrians to the risk of being hit by those vehicles, as well as to the unhealthy air pollutants which they emit (see photograph on front cover).

Mitigating the environmental consequences of motorization, so as to foster a healthy walking atmosphere, is a long-term process that may take decades to achieve. However, legislation, infrastructure, and education can augment pedestrian safety.

The urban poor make up a city's "captive walkers," but since this group has the least resources, it usually has the smallest political voice. Relatively wealthy private automobile owners can easily influence infrastructure decision-makers to fund projects which facilitate automobile use, but which bring little or no benefit to the majority of the population. Transit and development specialists have usually not given the same priority to projects for pedestrians as those for new highways or transit systems. As a result, investments for pedestrians are rarely viewed by urban politicians as appropriate for building local, national or international support.

## 5 MACRO-LEVEL MEASUREMENT

Complex, unregulated, and often without pattern, foot travel naturally does not readily lend itself to measurement or data collection. For enhancements to be made to the walking environment, a city's current conditions must be assessed. Thus, the difficulty of measuring this highly variable mode can prevent improvements from being made. Suggestions for macro-level measurement of the walking environment follow.

Currently, measurement of the walkability of a city results from micro-level field surveying techniques. A host of walkability checklists, level-of-service guides, and review systems have been established in developed cities to determine specific neighborhood-level walking environment problems. Simple walkability checklists, such as one devised by the US Department of Transportation, allow parents and children to assess walking in their neighborhoods.<sup>22</sup> More comprehensive techniques examine a host of walking environment characteristics. The Pedestrian Environment Review System (PERS) created in the UK analyzes very specific facets of pedestrian infrastructure (curb gradients, tactile information, etc.) by breaking cities and neighborhoods down into links, crossings, and routes.<sup>23 24</sup> The concept of a global Walkability Index attempts to rate the walkability of an entire urban area by a combination of random and specified street evaluation, and in addition to infrastructure, it notes the policy-making capacity of cities.<sup>25</sup> Finally, some pedestrian facility improvement guides concentrate entirely on safety, thus basing infrastructure changes only on the sorts of crash types that typically occur in

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<sup>22</sup> US Department of Transportation. 1997. Walkability Checklist. Washington, D.C., USA  
<http://www.walkinginfo.org/pdf/walkingchecklist.pdf>.

<sup>23</sup> 2006, June. Conversation with Dr. Annabel Bradbury. TRL, Limited, Berkshire, UK.  
< <http://www.trl.co.uk> >.

<sup>24</sup> *PERS v 2: street and space audit tool*. TRL Handout. Berkshire, UK.

<sup>25</sup> Krambeck, Holly. 2005. "Global Walkability Index." MIT Thesis, in conjunction with World Bank ETWTR.

specified locations.<sup>26</sup> For more information on walkability studies see: *Annotated Bibliography on the Pedestrian Environment*.<sup>27</sup>

While micro-level pedestrian environment audit tools can identify specific problems that should be addressed by local agencies, their form does not permit comparison of the walking environment between cities with similar characteristics. Nor do these tools succinctly identify large-scale problems. Therefore, it is necessary to develop macro-level indicators for the walking mode that can be used for these purposes.

Macro-level indicators should identify whether a city area has exigent walking problems and could provide the opportunity for a developing city to compare its provisions for pedestrians with those of similar areas. Since the purpose of these indicators is to gain a representative view of the pedestrian environment with the least intensive data collection, the number of indicators that reflect dimensions of a walkable pedestrian environment must be limited. This requires a clear balance between the number of indicators, the intensity of data collection involved, and the knowledge gained (or omitted) from the inclusion of specific indicators. To this end, five dimensions of walkability have been identified, each with a specific indicator.

The dimensions for which indicators are proposed include:

- **Accessibility/Mobility** → Average walking trip time
- **Traffic Safety** → Pedestrian fatalities/population
- **Street Security** → Pedestrian-targeted crime rate
- **Legal Provision** → Pedestrian rights
- **Public Expenditure** → Percent of total urban infrastructure and maintenance funds spent on walking mode

Each of these is considered in more detail in the following sections. In the context of international development this needs to reflect the range of cultures and social practices. These range from unregulated diversity which mixes motorized and non-motorized traffic with pedestrians amidst street vendors and other street uses to the controlled environment of many developed cities which rigorously restrict sidewalk use and segregate pedestrians from other traffic.

## 5.1 Accessibility/Mobility

Accessibility and mobility are two concepts which are frequently differentiated in reference to motorized forms of transport; however, for the pedestrian environment, these two concepts are so intricately intertwined as to be considered the same dimension of walkability. *Accessibility* and *mobility*

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<sup>26</sup> Federal Highway Administration. 2004. "PEDSAFE: The Pedestrian Safety Guide and Countermeasure Selection System." Washington, D.C., USA.

<sup>27</sup> Montgomery, Brittany. 2006, August. *Annotated Bibliography on the Pedestrian Environment*. Prepared for World Bank ETWTR. World Bank, Washington, D.C., USA.

allow people to reach desired destinations, goods, and services (i.e. opportunities).<sup>28</sup> An accessible walking environment provides for the mobility of all pedestrians and makes appropriate use of the built environment.

Design with accessibility in mind will consider the form and composition of the urban area in order to simplify transport between common origins and destinations. It ensures that walkers have the ability to make efficient, uninterrupted, non-circuitous trips by focusing on the continuity of the pedestrian network. Including all physical components of walking infrastructure support, such as dropped curbs and zebra crossings, the *access/mobility* category relates to the safe movement of pedestrians. Adequate *accessibility* also grants pedestrians the widest opportunity to participate in society by giving them modal choice; thus, an accessible pedestrian network should be *inclusive* (or *universal*) and connect all types of users (women, children, and disabled) to all modes of transport, especially public transit.<sup>29</sup>

Several European cities have given much attention to improving pedestrian access and mobility. In the UK, the Department for Transport promotes the concept of “accessibility planning” as an avenue to bolster social inclusion.<sup>30</sup> In developing countries various cities and governments have begun to place priority on mobility and accessibility planning for pedestrians. For example, the Kenya and Tanzania Non-Motorized Transport Program emphasizes “mobility planning” with its primary goal being to “improve mobility and accessibility at a lower overall cost, catering to non-motorized traffic.”<sup>31</sup> The program seeks to balance the needs of motorized and non-motorized traffic, thereby meeting the needs of all sections of the population.

#### ***Indicator: Average walking time per trip***

Not only do the urban poor suffer from lack of monetary resources, the time they spend on the only mode of transport they can afford, walking, also makes them “time poor.” According to a SSATP study in Morogoro, 49 percent of walkers spend between 30 and 75 minutes on average per walking trip.<sup>32</sup> Thus, the only resources the poor have: time and physical energy are depleted.

Lack of accessibility and mobility due to inappropriate pedestrian infrastructure, circuitous routes, and disconnected origins and destinations can add substantial travel time to pedestrian journeys. In the Temeke area of Nairobi “Some pedestrian routes are greatly extended by detours. These may be due to the lack of footbridges across rivers and swamps, obstructing buildings, or access prohibitions across government or private land.”<sup>33</sup> When pedestrians lack designated rights of way, they must

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<sup>28</sup> *Measuring Transport: Traffic Mobility and Accessibility*. 2006. TDM Online Encyclopedia. Victoria Transport Policy Institute.

<[http://www.vtpi.org/tdm/tdm55.htm#\\_Toc38358384](http://www.vtpi.org/tdm/tdm55.htm#_Toc38358384)>

<sup>29</sup> Roberts, Peter and Julie Babinard. 2006. TP-12 - Maternal and Child Mortality Development Goals: What Can the Transport Sector Do? World Bank, Washington, D.C., USA

<sup>30</sup> UK Department for Transport. 2006. *What is accessibility planning?* London, UK.

<[http://www.dft.gov.uk/stellent/groups/dft\\_localtrans/documents/page/dft\\_localtrans\\_023937.hcsp](http://www.dft.gov.uk/stellent/groups/dft_localtrans/documents/page/dft_localtrans_023937.hcsp)>

<sup>31</sup> Wilson, Scott. 2002, November. *Assessment of the Non-Motorized Transport Program in Kenya and Tanzania*. Sub-Saharan Africa Transport Policy Program. World Bank, Washington, D.C., USA.

<sup>32</sup> Pendakur, Setty. 2005. *Non-Motorized Transport in African Cities: Lessons from Experience in Kenya and Tanzania*. Sub-Saharan Africa Transport Policy Program Working Paper No. 80. World Bank, Washington, D.C., USA.

<sup>33</sup> Howe, John. 2000. *Poverty and Urban Transport in East Africa: Review of Research and Dutch Donor Experience*. World Bank, Washington, D.C. USA.

contend with faster, more dangerous competing modes, increasing the time needed to make walking trips. Limited access to public transport can also add to travel time, and one of the primary factors in evaluating public transport is walking accessibility.<sup>34</sup> Each of the factors contributing to increased walking travel time is dramatically magnified for people with disabilities, especially in cities that have little or no dedicated pedestrian space.

Measuring the average walking time per trip (including access to/from public transport) can indicate severe concerns in the accessibility/mobility dimension of the pedestrian environment. For example, cities with relatively low motorization and a very high walking mode share also have a host of accessibility/mobility problems (for example, Nairobi and Dar es Salaam).<sup>35</sup> Lower average walking trip times indicate higher degrees of accessibility/mobility, but the modal split of a city will impact this indicator. A developing city with a relatively low average walking trip time could simply have a very low walking modal share.

Obtaining average walking trip time through household surveys is a time and resource intensive process. This type of data may only be available on a five to ten year basis; however, if it is combined with routine census or other survey measures, the additional data collection may be manageable in terms of additional resources.

## 5.2 Traffic safety

Loss of life has both high economic and social costs, and in the case of pedestrian fatalities, it should be a high priority to be prevented. According to the Road Safety Initiative appraisal in five African cities, pedestrians and public transport passengers make up the greatest percentage of urban transport fatalities, accounting for 30-40 percent *each*.<sup>36</sup> The highest traffic crash death rate occurs in the age range of 15-24 years for almost every country in the world, thus impacting a city's next generation of productive and innovative capacity.<sup>37</sup> From another SSATP study, fear of injury was shown to affect walking trips. "Fear of fatal road accidents has curtailed walking along the major corridors because of difficulties associated with crossing the road at various intersections."<sup>38</sup> Therefore, it is imperative to include the dimension of safety from traffic hazards in any assessment of a city's pedestrian environment.

### ***Indicator: Pedestrian fatalities/population***

The number of serious injuries together with fatalities which are suffered by pedestrians as a result of traffic accidents should be a good basis to judge the 'traffic safety' of the pedestrian environment. However, data accuracy is a function of the level of reporting; therefore, while pedestrian injury and fatality data would provide the best indication of safety, reliable reports of injuries are rarely available at the national level, let alone for specific city in a developing country.

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<sup>34</sup> Gomide Alexandre et al. 2005. *Public Transport and Urban Poverty: A Synthetic Index of Adequate Service*. World Bank, Washington, D.C. USA.

<sup>35</sup> Pendakur, Setty. 2005. *Non-Motorized Transport in African Cities: Lessons from Experience in Kenya and Tanzania*. Sub-Saharan Africa Transport Policy Program Working Paper No. 80. World Bank.

<sup>36</sup> Bultynck, Patrick. 1998, September. *The Urban Transport 1998-2002 Strategic Development Plan*. Sub-Saharan Africa Transport Policy Program. Africa Region. World Bank, Washington, D.C. USA.

<sup>37</sup> Cropper, Maureen and Elizabeth Kopits. *Why Have Traffic Fatalities Declined in Industrialized Countries? Implications for Pedestrians and Vehicle Occupants*. World Bank, Washington, D.C., USA.

<sup>38</sup> Pendakur, Setty. 2005. *Non-Motorized Transport in African Cities: Lessons from Experience in Kenya and Tanzania*. Sub-Saharan Africa Transport Policy Program Working Paper No. 80. World Bank.

Data on pedestrian fatalities are more readily available and are an explicit indication of a lack of safety for the walking mode. A high incidence of pedestrian fatalities reveals significant flaws in the pedestrian environment, particularly in relation to managing the interface and conflicts with motorized transport modes, traffic management, and pedestrian infrastructure. In theory the key source of data on traffic accidents in cities would be the municipal police service. However, police records of injuries and even fatalities continue to be very unreliable in most developing countries. Several experts in road safety have noted the best source for obtaining fatality data as emergency medical service and hospital records.<sup>39</sup>

### **5.3 Street security**

Urban walking without fear of intimidation or physical harm influences the life of the city, particularly at nighttime and for vulnerable users, such as women, children, and the elderly. An urban transport study in Wuhan (the capital of Hubei Province, China) revealed that “women were keenly aware of security issues; they feel vulnerable to theft and assault, especially at night because street lighting is poor.”<sup>40</sup> Other walkers in a neighborhood contribute to the security of a place, and without eyes on the street, the walking environment becomes treacherous for everyone, even men.<sup>41</sup>

#### ***Indicator: Pedestrian-targeted crime rates***

Street muggings, pick-pocketing, and other forms of pedestrian-directed crime can influence the ability and willingness to walk. Security is particularly relevant to women and children who may choose alternate modes (use a taxi to cross the street, rather than walk)<sup>42</sup> or may be forced to eliminate trips due to a perception of dangerous pedestrian conditions.

Obtaining reliable, consistent data for pedestrian-related crimes in a large number of developing countries would probably prove very difficult, if not impossible, due to widespread legal corruption and underreporting of these types of crimes. If the data are available, targeting specific high-crime areas with law enforcement measures and police presence could indirectly help to increase walkability.

#### ***Alternative Indicator: Perception of crime***

Although survey data indicating the public perception of security requires more intensive data collection and probably has a higher degree of subjectivity than reported crime numbers, only altered perceptions of security will actually impact the amount of walking in certain locations of a city or during particular hours. Therefore, surveying the public perception of security during walking could better identify the state of the pedestrian environment. While subjectivity of perception surveys could increase the difficulty of city comparison, consistent surveying techniques could reduce reporting variability.

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<sup>39</sup> Conversations with Anthony Bliss (World Bank ETWTR) and Michael King (Nelson\Nygaard).

<sup>40</sup> McNeil, Lucie et al. 2003. *A Lifetime of Walking: Poverty and Transportation in Wuhan*. Wuhan Urban Transport Project. Economic Research Institute, Wuhan University in conjunction with the World Bank. World Bank, Washington, D.C., USA.

<sup>41</sup> Conversation with Bernice Van Bronkhorst, Urban Specialist. Latin American and Caribbean Region. World Bank, Washington, D.C., USA.

<sup>42</sup> Conversation with Shomik Menhdiratta, Senior Transport Specialist. July 2006. World Bank, Washington, D.C., USA.

Such perception surveys are a relatively cost-effective way to gain information from travelers on particular sections of the transit system. They would serve well for determining the perceptions of current pedestrians in specific locations. However, it would be somewhat more difficult to design a survey which revealed the perceptions of people who had opted for an alternative form of travel on account of their perceptions of an unsafe street environment.

#### **5.4 Legal provision for pedestrians**

Establishment of road safety laws that reflect pedestrian needs in using the streets and sidewalks is a key step forward in the effort to reduce urban traffic casualties. Rapid motorization has brought inexperienced and careless drivers to urban streets, jeopardizing pedestrians and non-motorized transport. It has created situations with which both of the latter are unfamiliar and by which they are increasingly threatened. Cities can improve the quality of the pedestrian environment by strictly regulating vehicle operators and levying consequences for poor motorist behavior, defining rights and responsibilities at points of unavoidable interaction or conflict.

##### ***Indicator: Pedestrian rights/traffic management***

Allowing pedestrians to be the highest-ranking urban street users by enacting laws that force motorists to stop at crosswalks for pedestrians and consistently give pedestrians the right-of-way shows progress in providing for pedestrians. Traffic laws can serve as the first step in creating a “functional road hierarchy,”<sup>43</sup> that places pedestrians at the top of the traffic priority list on local urban streets. They can also set standards for providing universal access to all pedestrians. By designating slower vehicle speeds on local streets and ensuring that these routes receive proper administration, cities will be improving the quality of life walkers, which often make up the largest mode share in developing countries. China, for example, recently enacted traffic management legislation that benefits pedestrians by regulating motorists. The 2004 national Road Traffic Safety Law holds motorists responsible for any traffic accident involving pedestrians, regardless of the party in fault. Furthermore, the State can require drivers to obtain third party insurance, which, if priced by driver accident rate, can dramatically improve traffic behavior.

#### **5.5 Public expenditure**

The poor suburban or peri-urban areas of many cities in developing countries have made little or no investment to develop pedestrian facilities. At best these are usually adjuncts to constructing or upgrading routes for motor vehicles. Consequently such construction generally tends to increase constraints on pedestrian activity, contributing significantly to a spiral of increased imbalance which favors motorized traffic at the expense of pedestrian and non-motorized modes. Commonly this poor provision for pedestrians has been compounded by subsequent neglect of even those sidewalks and other facilities which have been introduced. This neglect is manifest in the form of encroachment into the pedestrian space and failure to maintain its condition, both of which severely reduce its capacity and utility.

Without routine maintenance, sidewalk conditions can deteriorate quickly. Although many developing cities have pavements in the central areas, frequently their disrepair endangers walkers, particularly those with disabilities. “It’s really dangerous when manhole covers go missing for a long time. This spring, another blind person I know went out to buy vegetables and fell into the open hole – he broke

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<sup>43</sup> Frame, Gladys. 2006. *Traffic Management Main Report. China Urban Transport AAA FY 06*. World Bank, Washington, D.C., USA.

a leg and ended up in a cast for 2 or 3 months.”<sup>44</sup> Construction materials and equipment, parked cars, and unregulated street vendors plague urban sidewalks and often block the clear passage of walkers, forcing them to share road space with fast moving motor vehicles. While funding for pedestrian environment maintenance would probably not directly include enforcement of sidewalk regulations, a systematic maintenance program would identify obstructed zones, thereby encouraging resolution of, and sometimes helping to clear these problems.

***Indicator: Percent of total transport funds spent on walking mode***

Public expenditure for pedestrians as a measure of the percentage of total transport funds (where possible distinguishing between capital and maintenance investment) can serve as a proxy for the effort being made by the municipal government to serve pedestrians, as well as a measure of the state of the pedestrian environment. Despite the fact that walking captures a much larger mode share than motorized vehicles in many developing cities, investment in facilities for pedestrians is comparatively low. Simple solutions, such as well constructed sidewalks and crossings which are designed to relevant inclusive standards with clear markings, dropped curbs, and properly covered drainage systems can have dramatic impacts on the walking population, which makes as many as 80 percent of all trips in some developing cities.<sup>45</sup>

Inclusion of maintenance in this indicator is essential to reflect the ongoing care of pedestrian facilities. Large infrastructure investments could indicate progressive walking environment attention; however, poorly maintained facilities are perhaps even more harmful to pedestrians than a sheer absence of walking paths. Since these two funding allocations represent very different uses, it might be more practical to separate them into two different indicators.

## **6 DIMENSION AND INDICATOR SUMMARY**

These five dimensions of walkable pedestrian environments have been identified as being the most applicable to the assessment of developing cities. In order to understand the nature of the pedestrian environment, these dimensions must be considered together, rather than in isolation. Failure to embrace all five of these dimensions can result in “solutions” to pedestrian issues that actually increase the potential for pedestrian crashes, decrease security, and hamper pedestrian accessibility/mobility. For example, Chinese cities that have focused only on safety have separated modes by constructing pedestrian bridges that restrict mobility and accessibility due to the lengthy walking routes which they impose and to the poor provision for disabled users (such as unclear signs and markings; curbs and stairs; steep ramps, etc.). “While physical segregation can provide safe facilities for pedestrians to cross, it also results in severance and inconvenience for them, particularly elderly or disabled pedestrians.”<sup>46</sup> Equally crossing provisions can become locations of conflict and increased danger if the laws and customs of behavior which are necessary for them to function properly are not recognized and respected. A balanced approach to traffic management which incorporates traffic calming measures and pedestrianization of certain streets, complemented by well integrated public transport services, helps to preclude physical segregation. This illustrates the

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<sup>44</sup> McNeill, Lucie. 2003. *A Lifetime of Walking. Poverty and Transportation in Wuhan*. Wuhan Urban Transport Project. World Bank, Washington, D.C., USA.

<sup>45</sup> Pendakur, Setty. 2005. *Non-Motorized Transport in African Cities: Lessons from Experience in Kenya and Tanzania*. Sub-Saharan Africa Transport Policy Program Working Paper No. 80. World Bank, Washington, D.C., USA.

<sup>46</sup> Frame, Gladys. 2006, June. *Traffic Management Main Report*. China Urban Transport AAA FY 06. World Bank, Washington, D.C. USA.

interconnectivity of pedestrian issues and highlights the need for holistic treatment of the walking environment.

**Table 1: Summary of pedestrian environment dimensions, indicators, etc. Currently, city data is not readily available for any of these dimensions.**

Walkability Dimension	Potential Indicator	Simplicity of Measurement	Data Accuracy	Collection Frequency
<b>Accessibility/Mobility</b>	Mean and 90 percent walking trip times	Difficult	Fair / under-reported	Medium to long-term plans: 3, 5, or 10 years
<b>Traffic Safety</b>	Pedestrian fatalities/ population	Simple	Fair / under-reported	Annual
<b>Street Security</b>	Pedestrian crimes/ population	Moderate	Poor / under-reported	Annual
<b>Legal Provision</b>	Pedestrian Rights	Simple	High	Annual
<b>Public Expenditure</b>	Percent infra. and maint. funds spent on pedestrians	Moderate	Fair	Medium term infrastructure plans: Annual maintenance disbursement

It is expected that four of the indicators will be quantified, whilst ‘legal provision’ will be process indicator. The occurrence of fatal accidents and street crimes need to be related to the population of the city or neighborhood in question. The walking time and public expenditure statistics are already normalized. The population figures will be more informative if they are complemented by information on pedestrian activity, such as the average number of walking trips per person.

In principle the measures required to calculate the indicators are rather basic and should generally be available. However, in practice, the regular compilation and publication of such data is not yet well established in many low income, or even some middle income countries.

## 6.1 City comparison

### *Additional data needed*

Comparing the walking environments of cities that have dramatically different cultural uses of urban streets, populations, or urban densities provides little insight. In order to complete a meaningful analysis, demographic, geographic, and travel-demand data needs to be considered to set the context. Basic urban data, including population and metropolitan land area would help classify cities



with similar general properties. Disaggregated travel-related data, such as modal split and motorization (number of vehicles/population), that shows the relationship between income, gender, and other population characteristics would permit more insightful analysis.

### **Potential use of macro level indicators**

Indicators for the five dimensions of walkability discussed in this paper have potential to inform governments and development institutions in several capacities. Data reflecting each of these dimensions will contribute an important dimension to a global development knowledge base for urban areas, which in the next generation will hold over half of the world's population.<sup>47</sup> More importantly, this information can be used to benchmark cities in similar regions or with similar population characteristics, creating an influential policy-making tool. Whilst massive resources are being invested in urban ring roads and other facilities to accommodate motorization which will serve a minority of the population, very limited funds are being allocated and spent on facilities for pedestrians. These indicators would give planners and decision takers the tools to appreciate the importance of the pedestrian environment and to encourage municipal authorities to fund walking projects by comparing their cities to others with similar characteristics. Furthermore, they could help transport engineers to consider walking as an essential component of the urban transport system to be incorporated in all urban infrastructure projects.

## **7 PEDESTRIAN ENVIRONMENT PROJECTS IN DEVELOPING COUNTRIES**

Few World Bank projects have focused entirely on pedestrian access and movement. Considerations of the urban pedestrian environment are usually the result of larger-scale infrastructure projects, particularly those related to access to mass transport. The pedestrian environment has only recently begun to receive special attention. The following are some of the projects which highlight current pedestrian-focused work at the World Bank (not a comprehensive list):

### **7.1 Latin America**

#### ***Bogotá Urban Services Project***<sup>48</sup>

Pedestrian access and mobility is covered under the first subproject, "Improved mobility," and includes pedestrian access to the TransMilenio system, sidewalk construction, and pedestrian safety studies. The "Urban upgrading" subproject of the loan does not explicitly mention pedestrian movement, but it included construction and rehabilitation of public space and community services, as well as improved sidewalks and stair-streets. Included in this project is a study of pedestrian movement that aims to comprehensively understand factors associated with pedestrian accidents, including accident circumstances, demographics, infrastructure, specific corridor characteristics, and the economic impact of crashes.

#### ***Lima Transport Project***<sup>49</sup>

In this Bus Rapid Transit project one of the subcomponents, "improvements to pedestrian and vehicular circulation," targets public space improvements and interface between the busways, pedestrians, and passengers at five specific areas along the busway.

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<sup>47</sup> 2000. *Cities in Transition*. World Bank Urban and Local Government Strategy. International Bank for Reconstruction and Development. Washington, D.C., USA.

<sup>48</sup> PAD Report # 24941-CO. February 2003. World Bank, Washington, D.C., USA.

<sup>49</sup> PAD Report # 27253-PE. November 2003. World Bank, Washington, D.C., USA.

## 7.2 Asia

### ***Liaoning Medium Cities Infrastructure Project***<sup>50</sup>

Several components of this loan address pedestrian issues. The *Secondary Road Rehabilitation and Road Maintenance Equipment Component* will enhance last-mile pedestrian access, and the *Traffic Safety and Traffic Management Component* includes signaling and traffic management tools to improve safety. Walking travel times will be used, together with panel discussions for pedestrians, to provide results indicators for this project.

## 7.3 Sub-Saharan Africa

### ***Sub-Saharan Africa Transport Policy Program Non-Motorized Transport Pilot Project Program***<sup>51</sup>

This program was designed to test practical non-motorized transport (NMT) policies and measures by implementing infrastructure and policy solutions in four East African cities (Nairobi, Dar es Salaam, Morogoro, and Eldoret). The NMT modal share in these cities is particularly high (greater than 50 percent). Thus, trying a variety of pedestrian and cyclist interventions gave many insights to the viability of NMT designs.

## 8 FURTHER STUDY

Recognition that the urban pedestrian environment is a facet of the city which requires careful attention and can dramatically change the livability of a city is relatively recent. High income countries in Europe (such as the UK, the Netherlands, Germany and Scandinavia), Australia, and US have taken the lead in identifying and solving the problems of walkability in many urban centers. However, developing countries, which have much higher numbers of 'captive walkers' have done little to ameliorate their appalling pedestrian conditions. The World Bank can play an important part in raising the awareness of the short and long-term benefits for these municipalities from encouraging and supporting walking in their transport systems. Gaining a better understanding of the extent of urban walkability issues from a macro-level is an important step in an urban development paradigm shift that values pedestrians in the street hierarchy. This recognizes that an accessible, safe, and secure pedestrian environment is essential for a large portion of the population and a priority for all. The following suggested areas of research can further the goal of establishing walking alongside the main urban transport modes.

### 8.1 Accessibility

The average walking trip time is not readily available for most cities; however, by working with existing urban household studies and modifying the way questions are asked, it may be possible to obtain this and related important data with relatively small marginal cost. It would be helpful to examine selected municipal surveys as case studies to determine the type of data currently available. It would also be instructive to assess the urban data that can be gleaned from available national household surveys.

- How do current surveys inquire about the walking activity of household members?

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<sup>50</sup> PAD Report # 35588-CN. May 2006, World Bank, Washington, D.C., USA.

<sup>51</sup> Pendakur, Setty. *Non-Motorized Transport in African Cities: Lessons from Experience in Kenya and Tanzania*. SSATP Working Paper No. 80. World Bank, Washington, D.C., USA.

- Can these surveys easily be adapted to gain more information about walking trips and the time they take?
- Which questions should be used to garner the most accurate responses? (Reference: UK Department for Transport National Travel Survey)<sup>52</sup>

## 8.2 Safety

Road safety specialists<sup>53</sup> at the World Bank have recently begun to examine pedestrian safety and the infrastructure design that increases safety for vulnerable road users.

Attention is being paid to the European development of a safety rating quality assurance system for road infrastructure, known as the European Road Assessment Programme (EuroRAP). An international component is now being created – the International Road Assessment Programme (iRAP) – to develop tools and indicators that might be applied consistently anywhere in the world. Key questions being addressed include:

- How many lives could be saved and injuries avoided with safer infrastructure provision for pedestrians in low and middle-income countries?
- How relevant are the European safety rating tools and indicators to low and middle-income countries?
- Can safety rating tools and indicators – and related infrastructure safety programs – be developed to assure the safety of pedestrians in low and middle-income countries?

## 8.3 Security

Perception survey responses are being considered as an alternative type of measure on which to base indicators for pedestrian security, but more research into the types of questions that would need to be asked to reflect personal security when walking should be undertaken to inform further work on such measures. The aspects to be considered include:

- What are the main aspects of individual concerns which constrain pedestrian activity?
- What questions need to be asked to address these aspects?
- Could these sorts of questions be easily added to a current city-wide survey?
- What would a modular survey of the perception of pedestrian security entail?

Considerable work has been done on safe/secure urban design and perception surveying in Latin American cities by a crime/violence specialist<sup>54</sup>. Rather than creating projects specifically for crime prevention, the approach has woven security design measures into urban renewal projects, etc. and it seems likely that this approach may be most effective for pedestrian environment improvements.

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<sup>52</sup> *National Travel Survey*. 2005. Department for Transport. UK.

<[http://www.dft.gov.uk/stellent/groups/dft\\_transstats/documents/page/dft\\_transstats\\_610054.hcsp](http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/page/dft_transstats_610054.hcsp)>

<sup>53</sup> Tony Bliss and Said Dahdah, Transport Unit (ETWTR), World Bank, Washington, D.C., USA.

<sup>54</sup> Bernice Van Bronkhorst. LAC Region, World Bank, Washington, D.C., USA.

#### **8.4 Pedestrian legal rights**

Case studies on the types of legal rights given to pedestrians, as well as the penalties or repercussions for drivers that cause crashes involving pedestrian (resulting in fatalities and/or injuries), would provide a policy-based frame of reference for the Bank. Key questions to be answered include:

- What sorts of legal rights do pedestrians have in cities/countries that have concentrated on the walking mode (Scandinavia, the Netherlands, UK, US, etc.)?
- What are the progressive examples of pedestrian legal rights in developing cities/countries?
- What is the relationship and balance between pedestrian-related laws which stem from the federal government and city-specific regulations?
- What are the responsibilities and repercussions for any motorist involved in an accident (for example, payment of compensation to victims, fines, loss of licensure to drive, insurance rate hikes, etc.)?
- Are there meaningful arrangements for pedestrian priority at conflicts with motor traffic which are supported by legislation?
- Is there evidence that a correlation between cities that have legal provisions for pedestrians and fatality rates?

#### **8.5 Public expenditure on pedestrians**

Funding for the pedestrian environment gives an indication of the priority that a city is setting on upgrading conditions for walking. However, this data is often difficult to access even in developed countries. Operational task team leaders could do more to encourage transport officials in client countries to begin to document this information, particularly as it relates to urban transport projects financed by the Bank. It is desirable that, this type of information should be provided by a city to the appraisal team before project approval, to ensure that funds are truly being allocated to appropriate priorities.

#### **8.6 Developing the political will to support and fund pedestrian projects**

While indicators and the good intentions of urban and transport planners may point to the walking environment as a top investment priority, changes to the pedestrian environment ultimately lie within the hands of urban leaders and politicians. To make walking a priority requires strong political will and a substantial constituent backing because it does not have the private enterprise support and glamour of the automobile. Thus, to persuade mayors and the municipal government of the value of pedestrian-oriented investments, details of case studies of successful pedestrian projects must be readily available. It would be helpful to have a summary of the walking environment improvements (and the associated political circumstances) made in at least one 'typical' city in each region to illustrate the benefits of this type of investment.

#### **8.7 Survey of successful policy and infrastructure projects**

Since pedestrian interventions are frequently incorporated into much larger funding packages, they can easily become lost in project appraisal documents and reports. A comprehensive survey of the

types of infrastructure and policies implemented throughout the regions could usefully contribute to the regions' reference, community-driven-development ideas, and as success stories / proof of the viability of solutions to municipal politicians. According to Ronald MacLean-Abaroa, former mayor of La Paz, a tool highlighting implemented solutions would be helpful in their decisions to invest in the pedestrian environment.<sup>55</sup>

## **8.8 Partnerships**

In pressing forward with the work on walkability and the urban pedestrian environment, partnerships with World Bank units outside the transport sector could be helpful in acquiring necessary data and in designing appropriate walking projects.

### ***Cities Alliance***

Cities Alliance has chosen 120 cities on which to focus their data collection efforts, as related to urban expansion, etc. (see "The Dynamics of Global Urban Expansion"<sup>56</sup>). Since they have already selected case-study cities and are obtaining information relevant to walking, such as city size, population, etc. it is possible that the Transport Unit might be able to use this data to identify good practice, as well as suggesting other city data directly pertaining to walkability that should be collected.

### ***Environment and Socially Sustainable Development (now merged in the Socially Sustainable Network)***

Sustainable urban transport relies on energy-efficient, non-polluting modes, and walking is a key factor in creating sustainable cities. Partnering with ESSD urban development, social development and air quality specialists on urban projects may provide opportunities for more effectively implementing pedestrian environment improvements.

### ***Community-Driven Development***

This is an important theme managed within the Sustainable Development Network. Since pedestrian environment improvements are often small-scale, easily implemented projects, they may be well-suited for communities to manage within a municipality. By targeting walking improvements through community-driven-development initiatives, the most critical problems with local footways can be addressed with the range of key stakeholders. This type of project would provide local ownership of the project, as well as opportunities for community employment.

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<sup>55</sup> Conversation with Ronald MacLean-Abaroa, World Bank Institute. World Bank, Washington, D.C., USA.

<sup>56</sup> Angel, Shlomo. 2005. *The Dynamics of Global Urban Expansion*. Transport and Urban Development Department. World Bank, Washington, D.C., USA.