Bicycle and Pedestrian Data: *Sources, Needs, & Gaps*

U.S. Department of Transportation

BUREAU OF TRANSPORTATION STATISTICS

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Our mission: To lead in developing transportation data and information of high quality and to advance their effective use in both public and private transportation decisionmaking.

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Executive Summary

The potential of pedestrian and bicycle travel to provide mobility, reduce congestion, improve environmental quality, and promote public health has received increasing attention in recent years. Research, planning, and policymaking efforts to improve conditions for pedestrian and bicycle travel require data such as travel and facility characteristics, crash and safety information, and user preferences. However, deficiencies and limitations in existing sources for these data often hamper these efforts.

As an initial step towards enhancing bicycle and pedestrian data quality and filling data gaps, the Bureau of Transportation Statistics (BTS) has undertaken this assessment of bicycle and pedestrian data needs. The study has the following objectives:

- First, to provide an inventory of existing sources of bicycle and pedestrian-related data, including the extent, quality, and limitations of these sources;
- Second, to identify and prioritize areas in which additional or improved data are needed; and
- Third, to identify and recommend opportunities for improving the quality of bicycle and pedestrian data.

This review of existing data and data needs was based on outreach to user groups that included planners, advocates, and researchers at federal, state, and local government agencies, universities, and nonprofit organizations. Published materials and information from other recent assessments of transportation data needs were also reviewed. Primary data sources were classified by four types: 1) usage, trip, and user characteristics; 2) user preferences; 3) facilities; and 4) crash and safety data. Key types of secondary data (data that are based on analysis of primary data) were also identified, including research-study results and manuals of practice.

Based on this review, priorities for data needs were identified based on the following criteria:

- *Importance* of the data for its intended application(s) and audience(s);
- Quality of *existing* data; and
- Usefulness of the data for a *range* of applications (facility design, trend analysis, etc.), audiences (researchers, planners, policymakers, etc.), and geographic scales (local, state, national).

The identified priorities are shown in table 1.

The study also identified a number of opportunities for improving the quality of bicycle and pedestrian data. Emerging information technology, including intelligent transportation systems (ITS) for data collection as well as information management tools such as geographic information systems (GIS), have the potential to make data collection, management, and analysis cheaper and easier. Greater coordination of efforts, however, is required to fully exploit the potential of these technologies to improve pedestrian and bicycle data. Also, certain types of data, such as numbers of trips by facility and user type, are potentially useful to a wide range of user groups; but coordination among these groups is required to establish standardized, mutually beneficial data collection procedures.

Some of the key recommendations emerging from this study are identified below. These are areas in which federal involvement-through coordination of efforts, provision of technical assistance, or sponsorship of research and development activities-could greatly assist in benefiting a broad range of user groups.

Table 1
Assessment of Data Priorities

Type of data and description	Quality of existing data	Priority for better data
Usage, trip, and user characteristics		
Number of bicyclists and pedestrians by facility or geographic area	Poor	High
User and trip characteristics by geographic area or facility	Fair	Medium/high
User preferences		
Relative preferences for facility design characteristics and other supporting factors	Fair	Medium
Facilities data		
Characteristics relating to quality for bicycle or pedestrian travel	Fair	Medium
Crash and safety data		
Specific bicycle- and pedestrian-relevant crash variables	Fair	Medium/high
Data regarding crashes that do not involve a motor vehicle	Poor	Medium
Secondary data		
Safety and demand impacts of design features	Fair	High
Safety and demand impacts of policies, programs	Fair	Medium

General/Cross-Cutting Recommendations:

- Bring together the full range of users of bicycle and pedestrian data to discuss how specific data collection efforts could benefit the broadest number of users.

- Include in this discussion those who collect all types of transportation data; for example, representatives of the U.S. Department of Transportation (DOT), state DOTs, metropolitan planning organizations, and city and county transportation agencies.

- Opportunities for improving bicycle and pedestrian data should be viewed in conjunction with current opportunities and constraints for improving related types of general transportation data.

Recommendations on Usage, Trip, and User Characteristics:

- Evaluate and promote new bicycle- and pedestrian-counting technologies (i.e., video imaging, infrared sensors) by synthesizing the results of current pilot-testing efforts, sponsoring additional pilot tests and methodological development, and conducting outreach efforts to disseminate successful technologies.

- Develop a "handbook" or manual on basic pedestrian and bicycle characteristics such as trip-length distributions and typical socioeconomic and demographic characteristics.

- Develop and widely disseminate sampling and other methodologies for conducting pedestrian and bicycle counts and travel surveys.

- Continue to develop and promote methodological improvements to household travel surveys, such as metropolitan surveys, the Nationwide Personal Transportation Survey (NPTS), and other federally sponsored surveys, to better capture short walk trips, access to transit trips, children's trips, and purely recreational walk and bicycle trips.

Recommendations on Preferences, Needs, and Attitudes:

- Synthesize and disseminate existing knowledge on preferences, needs, and attitudes, and update this information on a regular basis.

- Develop survey questions regarding conditions and preferences for bicycling and walking that could be added to existing metropolitan household travel surveys, the NPTS, or other surveys.

- Develop surveys and sampling methodologies that can be applied locally across the nation.

Recommendations on Facilities:

- Assist in standardizing data formats and definitions of bicycle and pedestrian facilities where appropriate, in order to facilitate use in other applications (crash analysis, network models, etc.) and to promote data comparability among jurisdictions and geographic areas.

- Facilitate discussions among various data user groups to identify key network characteristics relevant to bicycle and pedestrian planning and design, and provide guidance to state and local agencies responsible for collecting and maintaining transportation data.

- Investigate new technologies for data collection, such as aerial photography and satellite imagery, and disseminate successful applications.

Recommendations on Crashes and Safety:

- Build consensus on characteristics that are most important to record in reporting of crashes involving bicyclists and pedestrians; include these characteristics in developing standards for computer-based reporting systems.

- Investigate opportunities provided by GIS and global positioning systems (GPS) for identifying and documenting the precise location of crashes; investigate any potential implications of these technologies for how crash and facilities data should be reported and managed.

- Investigate methods to achieve more thorough reporting of injury crashes as well as reporting of nonmotor vehicle crashes and incidents.

- Investigate the potential of utilizing existing linked crash and medical record databases for pedestrian and bicycle crash research.

Recommendations on Secondary Data:

- Continue to improve the availability of existing research by summarizing existing studies and by making resources available via the Internet.

- Prioritize, fund, and promote research to fill in key gaps in knowledge related to bicycle and pedestrian travel.

Introduction

CHAPTER 1

The importance of pedestrian and bicycle travel has received increasing attention in recent years as planners and policymakers recognize the benefits to communities, public health, economic development, and the environment of improving nonmotorized travel options. The Transportation Equity Act for the 21st Century (TEA-21), passed by Congress in 1998, requires the consideration of bicycle and pedestrian needs in transportation planning and increases funding opportunities for bicycle and pedestrian projects. TEA-21 also directs the Bureau of Transportation Statistics (BTS) to develop data on bicycles and pedestrians.

Efforts to plan for bicycle and pedestrian travel are frequently hampered, however, by deficiencies in data on travel characteristics, facilities, safety, and user preferences. As a step toward improving the quality of bicycle and pedestrian data, BTS has undertaken this assessment of bicycle and pedestrian data needs. The study has the following objectives:

- First, to provide an inventory of existing sources of bicycle and pedestrian-related data, including the extent, quality, and limitations of these sources;
- Second, to identify and prioritize areas in which additional or improved data are needed; and
- Third, to identify and recommend opportunities for improving the quality of bicycle and pedestrian data.

STUDY APPROACH

The following methods were used to identify existing sources of bicycle and pedestrian data, data needs and priorities, and opportunities for improving data collection:

- Interviews and discussions with key people involved with pedestrian and/or bicycle issues at a national level;
- An email questionnaire sent to numerous individuals and groups, including national, state, and local pedestrian and bicycle planners, advocates, and researchers;
- Various written sources of information, both published and unpublished;
- Experience gained from previous pedestrian and bicycle projects undertaken by the authors of the report.

Appendix A provides an overview of the email survey methodology and results. Appendix B contains a brief review of other recent assessments of data needs.

WHY COLLECT BICYCLE AND PEDESTRIAN DATA?

A perspective on the various uses of bicycle and pedestrian data is helpful in assessing needs and opportunities. Bicycle and pedestrian data are commonly applied to at least three general uses:

- Research studies and recommended practices;
- Planning and design of facilities, project selection decisions, policies, and programs; and
- Analysis of conditions and trends to inform policymaking.

Consideration of the various uses of data can help shape data collection programs to benefit the greatest number of users. In many cases, programs to collect and manage data can be designed to benefit a broad range of users. In other cases, research and planning studies will require data collection efforts geared toward the specific needs of the study. Even in cases where data needs are specific to the study context, however, improvements in data collection technologies and methods are still of general value. Some requirements and needs for the various uses of data are discussed in more detail below.

Research

Research studies may rely wholly or in part on data collected specifically for the study being conducted. National or local data sources may also be utilized,

depending on the scope of the study and the quality of available sources. Bicycle and pedestrian research studies fall into at least three major categories:

- Studies on basic operational characteristics (e.g., bicyclist riding speeds, shared-path "level-of-service" characteristics, or pedestrian gap acceptance at intersections). These studies usually rely on specific data-collection efforts.
- Studies of factors influencing crashes and safety. These studies rely on at least two types of data: 1) crash characteristics, describing the people and vehicles involved, location, environmental conditions, contributing factors, injury outcomes, etc.; and 2) usage data, including flows by location, user characteristics, etc., from which measures of exposure and therefore risk can be derived.
- User preference and demand studies, which analyze the effects of facility design and other policies on user preferences and demand (usage). These studies frequently rely on surveys of existing and potential pedestrians and bicyclists. Quantitative models of behavior can also be used to develop information on user preferences. These models may be based either on "stated preference" survey data, in which people are asked to make choices among various alternatives, or on "revealed preference" data, i.e., observations of people's actual behavior from travel surveys and counts. These studies may also utilize trend data on usage, which is analyzed to determine the impacts of facility or policy changes.
- As researchers synthesize and analyze raw data from research studies, the results yield secondary data, such as evidence on the impacts of facility design and other policies on safety, user satisfaction, demand, medical costs, and other factors. The results may be in the form of direct statements of impact, or they may take the form of coefficients, factors, etc. that can be used in modeling the joint impacts of multiple actions.

Research results are also used to develop manuals of practice. These secondary forms of data include design manuals, policies, and programs that, based on the results of a variety of research studies as well as other factors, can be defined as "recommended practices."

Planning and Design

Planning and design for pedestrian and bicycle travel involves at least the following aspects:

- The siting and design of facilities for travel (e.g., roads, signals, paths, and lanes);

- Development and implementation of operational policies (e.g., traffic rules and enforcement);
- Provision of other incentives (e.g., bicycle parking, shower and locker facilities for bicyclists) or disincentives (e.g., tolls and parking pricing) to travel by various modes;
- Education and outreach efforts (e.g., to provide information and training and to influence attitudes and beliefs).

Planning is supported by primary data collected locally, such as user and trip characteristics, traffic counts, facility characteristics, and crash data. Primary data can help identify the specific treatments that should be applied locally, where they should be applied, and what the specific benefits or impacts are likely to be. Uses of primary, locally collected data in planning often include the following:

- Identifying and addressing deficiencies: Data on crashes (or incidents) and facility characteristics are used to identify trouble spots in bicycle or pedestrian travel networks and to identify solutions that address these deficiencies.
- Forecasting demand: Data on facilities, counts, travel patterns, and market and user characteristics are used in conjunction with modeling techniques to forecast travel patterns and demand under assumed future conditions. Travel forecasts can be used for planning the location of routes to create a travel network, developing lists of projects for funding, and providing background for policy decisions.
- Prioritizing projects: Counts and/or demand forecasts are used in conjunction with known deficiencies to identify and prioritize improvements.
- Designing education and outreach programs: Data on crash characteristics and causes as well as counts or survey data (e.g., bicyclists against traffic flow) can assist in designing education and outreach programs for pedestrians, bicyclists, and motorists to promote safe travel practices. Origin-destination data can help identify current populations of bicyclists and pedestrians in order to target programs. Data on attitudes and beliefs can be used to design programs to promote walking and bicycling and to help plan and design facilities.

Planning is also supported in part by secondary data, such as research-study results and recommended practices as discussed above. Secondary data can assist in developing appropriate network plans, design treatments, operational policies, supporting policies, and outreach programs.

Policymaking

Information on existing conditions and trends in usage, crash rates, and facilities can provide important background for setting policy and for making funding and programmatic decisions. These data can help identify whether existing policies and programs are successful and whether additional or revised policies and programs are needed. For example, data indicating that walkway quality is generally poor and declining might lead to the establishment of improvement programs or funds, or the establishment of a committee to provide input into improvements. Data showing increasing crash rates may indicate the need for additional funding for efforts to improve roadway safety.

Data on forecast usage can also be important for policymaking. Demand forecasts can be used to predict potential increases in pedestrian and bicycle travel resulting from various types of improvements. These forecasts can help indicate the potential benefits and impacts of various policy and programmatic decisions.

The remainder of this document assesses the state of existing data, priorities for data needs, and opportunities for improving data collection.

CHAPTER 2

Existing Data Sources

The following sections provide an overview of existing U.S. sources of pedestrian- and bicycle-related data, including characteristics, uses, limitations, and potential enhancements of each source. While the focus is mainly on data sources available at the national level, the general existence and quality of data sources at the state and local levels are also discussed. For purposes of this report, both *primary* and *secondary* data sources are identified. Primary data sources are classified by the following types of data:

- *Usage, trip, and user characteristics,* including couts of users, trip patterns, and demographic socioeconomic characteristics;[1]
- Data on the *preferences, needs, and attitudes* of current or potential bicyclists and pedestrians;
- *Facility characteristics,* including the locations and attributes of pedestrian and bicycle facilities;

[1] A separate category could be established on traffic flow characteristics that would include pedestrian and bicycle volumes, speeds, and traffic densities on individual facilities. Traffic flow data are routinely collected for motor vehicles to characterize system performance and congestion, but with the exception of specific research studies, only volume (count) data are collected for bicycle and pedestrian traffic. In this report, counts are discussed in conjunction with related survey data on usage, since both are collected with similar objectives.

- *Crash and safety data*, including crashes and other data related to the safety and security of bicycle and pedestrian travel; and
- *Expenditures on* and *capital stocks of* vehicles and facilities.

While only primary data sources are treated in detail, a number of secondary data sources are also discussed briefly because these were identified in the course of the study as being important to practitioners. These secondary sources include:

- Results of research studies,
- Manuals of practice, and
- Other sources.

A summary of existing data sources is provided in table 2-1.

USAGE, TRIP, AND USER CHARACTERISTICS

This broad category of data answers the questions of who is traveling, how, where, when, and why. Usage data may take the form of number of travelers by facility, time of day, geographic area, etc. Data on trips include items such as origin and destination, trip length, mode, route, purpose, and time of day. Characteristics of the trip maker or "system user" may include demographic and socioeconomic factors such as age, gender, income, household structure, and other information that describes the person and his or her situation in life.

Data may be reported either in aggregate or disaggregate form. Aggregated data show statistics such as mode split or average income for all persons living in a census tract. Disaggregated data include records of the characteristics and trip patterns of individual people or households. Disaggregated data can be analyzed directly for modeling purposes. Data on usage, trip, and user characteristics are initially collected at a disaggregated level but are frequently reported or available for analysis only at some level of aggregation. In the aggregate, personal and trip variables may be cross-classified, e.g., trip length distributions by mode, purpose, and/or age.

Data sources for usage, trip, and user characteristics include:

- Counts of bicyclists or pedestrians,
- The U.S. decennial census,
- Metropolitan household travel surveys,
- The Nationwide Personal Travel Survey (NPTS),
- Other surveys conducted sporadically at a national level, and
- Various local surveys and market studies.

Table 2-1
Existing Sources of Bicycle and Pedestrian Data (includes national and multistate-level sources only)

USAGE, TRIP, AND USER CHARACTERISTICS; PREFERENCES, NEEDS, AND ATTITUDES

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
U.S. Census: Summary Tape Files, Census Transportation Planning Package	U.S. Census Bureau	National	10 years	U.S. population (entire)	Aggregate (by metropolitan area, civil division, block group)-socio-economic data, journey-to-work mode share	* Journey-to-work mode shares/trends *Journey-to-work correlation with aggregate-level socioeconomic data	* CD-ROM * Web query * Summary tables: www.census.gov
U.S. Census: Public Use Microsample	U.S. Census Bureau	National	10 years	U.S. population (5% at county level, 1% at metropolitan level)	Disaggregate-household and individual socioeconomic data, journey-to-work mode share	Possible applications in bike/pedestrian analysis	Purchase CD-ROM for $100 to $450
Metropolitan Area Household Travel Surveys	Metropolitan planning organizations (MPOs)	Metropolitan area	10-20 years	Metropolitan area population (random sample of 1,000 to 10,000 households)	Disaggregate-household and individual socioeconomic data, trip patterns	* Mode shares/trends * Socioeconomic data characteristics * Trip characteristics * Behavior modeling	From individual MPOs
Nationwide Personal Transportation Survey	U.S. DOT, Federal Highway Administration	National	5 years	U.S. population (random sample of 22,000 households)	Disaggregate-household and individual socioeconomic data, trip patterns	* Mode shares/trends * Socioeconomic data characteristics * Trip characteristics * Behavior modeling	* CD-ROM * Web query * Summary tables: www-cta.ornl.gov/npts
National Sporting Goods Association	National Sporting Goods Association	National	Annual	U.S. population (random sample)	Cycling participation (6+ times in previous year) by age, gender	Conditions and trends analysis	Published in *Statistical Abstract of the United States,* www.census.gov/statab/www

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Table 2-1 *(Continued)*

USAGE, TRIP, AND USER CHARACTERISTICS; PREFERENCES, NEEDS, AND ATTITUDES

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
National Bike Helmet Use Survey	Consumer Product Safety Commission (CPSC)	National	1991 1998	U.S. population (1,000+ sample)	User and usage characteristics	* Helmet usage * Bicyclist characteristics * Crash analysis (exposure)	Published www.cpsc.gov/library/helmet.html
Adult Bicyclist Survey (Moritz)	University of Washington	National	1995	Adults (2,300+ sample)	Characteristics, exposure	Bicyclist characteristics	Published
Rodale Press Surveys	Rodale Press	National	Varies	Adults (1,000+ sample)	Cycle, walk, run-participation, user characteristics, purpose, incentives, facility availability	* Conditions and trends analysis * User preferences	Published
National Health Interview Survey	Centers for Disease Control and Prevention (CDC)	National	Annual	Sample of U.S. population	Frequency of physical activity; demographic information	Conditions and trends analysis	Summary tables: www.cdc.gov/nchs
Behavioral Risk Factor Surveillance System	CDC	National/state	Continuous	Monthly random sample	Optional module on exercise: distance and frequency of jog/walk; optional state questions may include bike helmet use	* Conditions and trends analysis * Pedestrian characteristics (recreation only) from exercise module	* CD-ROM * Summary tables: www.cdc.gov/nccdphp/brfss
Survey on Public Beliefs and Awareness About Pedestrian and Bike Safety Problems	U.S. DOT, National Highway Traffic Safety Administration (NHTSA)	National	1999	U.S. population (random sample of 4,000)	Socioeconomic data characteristics; accident exposure; driving, walking, biking exposure; willingness to walk/bike; attitudes and knowledge of road users and usage	* Developing educational efforts, incident countermeasures	Forthcoming

Facilities

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
Census TIGER/ Line files	U.S. Census Bureau	National	Continuous	Entire road network in U.S.	Location, name, address, ranges	Conditions analysis-street topographic measures (connectivity, route density, etc.)	CD-ROM www.census.gov
National Transportation Atlas Databases	U.S. DOT, Bureau of Transportation Statistics	National	Continuous	Nationally significant roads	Location, name, capacity, classification, traffic volume	Attributes of major roads	CD-ROM www.bts.gov
Rail Trail Database	Rails-to-Trails Conservancy	National	Continuous	All rail trails in U.S.	Location, length, surface, cost, contacts	Conditions and trends analysis	Summary tables: www.railtrails.org
State road databases	State DOTs	State	Continuous	Federal, state highways	Road characteristics, traffic volume, crashes	Facilities inventory, needs identification, crash studies	Varies

Crashes and Safety

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
Fatality Analysis Reporting System	U.S. DOT, NHTSA	National	Continuous	All fatal crashes involving motor vehicles on public roads	Attributes of crash, vehicle, person, driver (100+ attributes)	Fatal crash analysis	* Web query * CD-ROM * Summary tables: www.nhtsa.dot.gov/people/ncsa
National Automotive Sampling System-General Estimates System	U.S. DOT, NHTSA	National	Continuous	Sample of police accident reports for motor vehicle crashes	Attributes of crash, vehicle, person, driver, (approx. 90 attributes)	Crash analysis	* CD-ROM * Summary tables: www.nhtsa.dot.gov/people/ncsa
National Transportation Statistics	U.S. DOT, Bureau of Transportation Statistics	National	Annual	Summary statistics based on General Estimates System	Motor vehicle accidents by type; costs; trends	Conditions and trends analysis	Published www.bts.gov

Continued on next page

Table 2-1 *(Continued)*

CRASHES AND SAFETY

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
National Vital Statistics System	CDC, National Center for Health Statistics	National	Annual	All deaths in United States	Cause, circumstances	Conditions and trends analysis	Data and summary tables: www.cdc.gov/nchs
National Hospital Ambulatory Medical Care Survey	CDC, National Center for Health Statistics	National	Annual	Sample of injuries in United States	Cause (including motor vehicle)	Conditions and trends analysis	Data and summary tables: www.cdc.gov/nchs
Accident Facts	National Safety Council	National	Annual	Based on General Estimates System, National Center for Health Statistics data	Summary statistics on pedestrian, bicyclist, motor vehicle injuries	Conditions and trends analysis	www.nsc.org
National Electronic Injury Surveillance System	CPSC	National	Annual	Sample of injuries associated with consumer products	Injury characteristics and circumstances	Bicycle injury analysis	Request from CPSC
State Data System	U.S. DOT, NHTSA	17 states		Data from police accident reports for motor vehicle crashes	Varies by state	* Crash analysis * Conditions and trends analysis	* Data files available with state permission and fee * Summary information: www.nhtsa.dot.gov/people/ncsa
Crash Outcome Data Evaluation System	U.S. DOT, NHTSA	States (19 currently)	Continuous/ annual		Links highway crash data to medical and financial outcome data	Cost, cost burden analysis	Contact individual states
State-level crash databases	State DOTs	State	Continuous	Federal, state highways	Crashes (location, characteristics)	* Deficiency and needs identification * Crash analysis	Varies

CRASHES AND SAFETY *(Continued)*

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
Police accident reports	State, local police agencies	Local	Continuous	All crashes with minimum damage value	Crashes (location, characteristics)	Crash analysis	Varies
Safety Management Information Statistics	U.S. DOT, Federal Transit Administration	National	Continuous/ annual	Incidents on transit property	Incident characteristics	Pedestrian incidents involving transit vehicles, property	transit.safety.volpe.dot.gov
Federal Railroad Administration	U.S. DOT, Federal Railroad Administration	National	Continuous/ annual	Incidents on railroad property/ right-of-way	Incident characteristics	Pedestrian incidents involving railroad vehicles, property	safetydata.fra.dot.gov

EXPENDITURES AND CAPITAL STOCKS

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
Bicycle Manufacturers Association	Bicycle Manufacturers Association	National	5 years	Bicycles sold in United States	Sales of bicycles with 20+ inch wheels	Conditions and trends analysis	Reported in *National Transportation Statistics*
Consumer Expenditure Survey	Bureau of Labor Statistics	National	Continuous/ annual	U.S. population (random sample)	Expenditures on bicycles by personal and household characteristics	Conditions and trends analysis	Purchase CD-ROM from Bureau of Labor Statistics www.bls.gov/csxhome.htm
Rodale Press Surveys	Rodale Press	National	Varies (last 1990)	Sample of new bike purchasers	Bicycle expenditures purchase; user characteristics	Conditions and trends analysis	

GENERAL SOURCES

Data source	Agency	Scale	Frequency	Coverage	Contents	Uses	Availability
National Transportation Statistics	U.S. DOT, Bureau of Transportation Statistics	National	Annual	Not applicable	Various summary statistics	Conditions and trends analysis	Published www.bts.gov

Counts

Counts indicate how many people or vehicles are using the system at any given location. Counts may be differentiated by user characteristics, time of day, or day of week. In addition, if an appropriate sample is conducted, counts can be summarized to provide estimates of overall facility or system usage by time, geographic area, facility type, or user type. Counts have a variety of uses, including:

- Tracking trends in usage,
- Developing exposure measures for crash analysis,
- Evaluating level of service on a facility by comparing volumes to capacity,
- Identifying and prioritizing improvements, and
- Calibrating travel demand models.

Motor vehicle traffic volumes are monitored through the Highway Performance Monitoring System (HPMS). The HPMS is a national system for tracking motor vehicle traffic volumes by vehicle type, facility type, and geographic area based on counts at a carefully selected sample of locations. No equivalent of the HPMS exists for monitoring pedestrian and bicycle volumes or distance traveled. While a few cities and metropolitan planning organizations routinely conduct pedestrian and bicycle counts, most collect them only sporadically for specific studies or do not collect them at all.

Existing local count data also vary in quality. When designing a study, consideration must be given to choosing sampling times and collecting enough samples to account for daily, weekly, and seasonal variations, as well as for random variations resulting from weather, special events, and other causes. If counts are to be used to estimate traffic in a larger geographic area, a representative set of locations must also be sampled. A national compendium of local counts was published in 1994 by the Federal Highway Administration (FHWA) as a supplement to the National Bicycling and Walking Study, although such a compendium is not updated on a regular basis (USDOT FHWA 1994).

Census

The decennial census represents a nearly 100-percent enumeration of the U.S. population, although some variables are collected only for a sample of the population. Data are publicly available in aggregate form, with most variables available at the geographic level of the census tract (roughly 4,000 to 5,000 people) and some available at the block or block-group level. Data of interest to bicycle and pedestrian planning include work-trip characteristics-notably mode, travel time, time leaving for work, time leaving from work, and

origin/destination areas. Various personal and household characteristics, including number of automobiles available to the household, are also relevant. Some cross-classifications are available in the Census Transportation Planning Package (CTPP), such as travel time by mode and mode use by gender, at the geographic level of the city or minor civil division. The CTPP is also available at the census tract or traffic analysis zone (TAZ) level for many urban areas. The Census Public Use Microdata Sample (PUMS) contains disaggregated data for a sample of the population, five percent at the county level and one percent at the metropolitan area level.

Census data are widely used in transportation planning. Major advantages of census data include public availability, ease of use, and reliability due to the large sample size. Also, uniform data are available for the entire country at a fine level of geographic detail. For pedestrian and bicycle planning, the census is generally used for comparing journey-to-work mode shares among different areas. Some aggregate-level studies have used census data to relate journey-to-work bicycle or walk mode shares to other variables such as average income, population density, and zero-vehicle households. These studies have used data at the level of the census tract, city, and metropolitan area (e.g., Ashley 1989 and Nelson 1997).

Some commonly recognized limitations of census data for pedestrian and bicycle analysis are listed here:

- Only work trips are included. Thus, if census data are used to represent overall levels of walking and bicycling, these must be assumed to be in some proportion to work-trip use. Work trips make up less than one-quarter of all trips, so nonwork trip-making patterns are not captured by the census.
- The data may not represent "normal" pedestrian and bicycle work-trip mode use. The census is conducted the first week in April, and respondents are asked to report their most frequently used mode in the past week. Mode use may fluctuate depending on weather conditions, and occasional bicyclists or walkers would not be included. Also, trips by multiple modes (e.g., a walk to the subway) cannot be determined.
- Data are not available at both the disaggregate level and a high level of geographic detail. PUMS disaggregated data are only available for small samples at the level of the city or county, and the application of PUMS data to pedestrian and bicycle analysis has been very limited.
- The census is collected only once every 10 years, so it is not useful for tracking short-term trends or changes. In the future, the Census Bureau plans to use the new American Community Survey to provide updated data every year instead of once in 10 years.

Because of the large amount of data that must be collected in the census and the need to obtain a high level of response, it is unlikely that the census can be modified to collect more comprehensive data related to pedestrian and bicycle travel. It is possible, however, that further detailed analyses of the existing disaggregated census data-performed confidentially and released in aggregate or summary form for public use-could help relate journey-to-work characteristics to personal characteristics, household characteristics, and any relevant tract-level data such as population density.

Metropolitan Household Travel Surveys

Household travel surveys are conducted in most larger metropolitan areas by the metropolitan planning organization (MPO) on a 5- to 20-year basis. These surveys are usually administered to a sample of 1,000 or more area households whose members then record their trip patterns (time, origin, destination, mode, purpose, cost, etc.) over the course of one or two days. Characteristics of the traveler and of the household are also recorded.

Household surveys are used in travel forecasting to develop and calibrate models of travel behavior. These models are used in transportation planning to predict future travel patterns, assess transportation needs, and examine the effects of various transportation investments or other policy decisions. For example, surveys conducted by the Metropolitan Service District in Portland, OR (Portland Metro); the Chicago Area Transportation Authority; and the Capital District Transportation Commission in Albany, NY, have been used to develop mode choice models that predict walk mode shares as a function of the quality of the pedestrian environment. Household surveys can also can be used to develop descriptive statistics about trip and traveler characteristics. The data sets can generally be obtained from the local MPO for further analysis.

The information gathered in household travel surveys is, in theory, useful for assessing characteristics of pedestrian and bicycle travel. In practice, the surveys suffer from a number of limitations:

- Many MPOs cannot afford to conduct expensive travel surveys. For those that do conduct regular surveys, the sample size and trip reporting are often too small to provide useful information for detailed bicycle and pedestrian planning. A survey of 3,000 people with a 2 percent bicycle mode share yields 60 bicycle travelers. This is too small a sample to yield statistically significant information for any subset of the sample, for example, to examine how characteristics vary by geographic area or trip purpose.
- Trips solely for the purpose of recreation, such as a stroll or bicycle ride, are not included.

- Walk trips (particularly short trips such as from work to a cash machine) are commonly underreported. Also, walk trips to access other modes, notably transit, are often not tracked separately in travel surveys.
- The surveys provide only limited information on the travel patterns of children. The parent completing the survey is generally asked to report trips for children from age five to somewhere in the teens. As a result of this proxy reporting, not all trips may be noted.

MPOs are developing more sophisticated travel survey methods as they search both for better data and cheaper data-collection methods, but significant limitations still exist. Some potential enhancements to address the above limitations for pedestrian and bicycle analysis include:

- The survey sample size can be increased to obtain data on more bicycle and walk trips for analysis. The costs of obtaining a sufficient sample size for detailed analysis, however, may be prohibitive. As an alternative, areas with high levels of pedestrian and bicycle travel may be oversampled, or these groups may be targeted in other ways similar to obtaining sufficient samples of transit riders through on-board surveys. Portland Metro, for example, collected additional surveys in densely populated urban neighborhoods that were likely to have higher numbers of pedestrian trips. Effective means of obtaining larger, representative samples of bicycle and pedestrian travelers is an area in which further research and implementation experience is needed.
- Proper survey design and interviewer training can greatly reduce the underreporting of short-walk trips and transit-access trips.
- A few areas are testing "time-use" surveys, in which all daily activities rather than just trips are recorded. Time-use surveys, if designed properly, could identify the time and length (although not the route taken) for purely recreational walk and bicycle trips. Portland, OR, has adopted this methodology and it is being tested in Seattle, WA.
- Underreporting of short trips, walk trips, and trips by children may be reduced or eliminated through the use of global positioning system (GPS) receivers to record travel patterns. GPS could also be used to identify specific routes taken for walk and bicycle trips. The use of GPS in travel surveys is currently being explored in Atlanta, GA, Phoenix, AZ, and Lexington, KY. The first two are multimodal surveys, including bicycle and pedestrian modes.
- In addition to collecting trip data, household surveys may include a stated-preference component that can be used to assess travelers' preferences for various hypothetical mode and route choices. Stated-preference components have been added to surveys in areas such as Portland, OR,

and Dallas, TX, to assess factors such as road pricing and residential location choice. Questions could also be developed that focus on bicycle and pedestrian travel incentives and options. Conducting stated preference surveys in conjunction with travel surveys provides compatible data sets and thus, potentially, more useful information than conducting these surveys independently. On the other hand, creating longer surveys increases the cost of the survey and also has the potential to reduce the quality and rate of responses.

Nationwide Personal Travel Survey

The Nationwide Personal Travel Survey (NPTS) is a household travel survey administered on a national level. Recent surveys took place in 1983, 1990, and 1995, and the next is planned for 2000-2001 with results available in early 2002. In 1995, the national survey included approximately 21,000 randomly selected households. Additional households were sampled in specific areas (metropolitan areas or states) that elected to use the NPTS as a supplement or replacement for their metropolitan household travel survey.

The NPTS is used to analyze the nature and amount of personal travel, the relationship between socioeconomic characteristics and travel patterns, and trends in passenger travel. The NPTS sample is large enough to provide meaningful information for pedestrian and bicycle trips at the aggregate level by trip purpose and trip rates by mode, and social, economic, and demographic characteristics of the respondents. The NPTS is publicly available for analysis through the Oak Ridge National Laboratory's website, which also has publications and summary data from the 1995 survey. The Bureau of Transportation Statistics's (BTS's) NPTS CD-ROM (BTS-CD-09) contains publications and data for the 1983 and 1990 surveys.

Although the NPTS is a nationally representative survey with a relatively large sample size, it suffers from some of the same limitations as metropolitan households surveys, discussed above. The NPTS is not detailed enough to identify bicycle and pedestrian trip and traveler characteristics for specific geographic areas, such as a metropolitan area. Increasing the sample size to allow for more geographic specificity presents significant cost implications, just as it does with metropolitan household surveys. Modifications similar to those noted above could be made for metropolitan household travel surveys, including oversampling areas with high levels of pedestrian and bicycle travel, and improving the questionnaire and providing better interviewer training to reduce underreporting of short-walk trips and transit-access trips. However, longer surveys can suffer from a reduction in quality and a lower rate of response, all of which must be considered along with cost implications when designing the survey.

Box 2-1
U.S. Consumer Product Safety Commission Study

In 1990 and 1991, the U.S. Consumer Product Safety Commission (CPSC) undertook a major national study of bicycle use and hazard patterns. CPSC conducted two surveys: an injury survey utilizing National Electronic Injury Surveillance System (NEISS) data and a national random-digit-dial telephone survey to obtain exposure data. The results were combined to evaluate bicycle usage and risk factors.

The exposure survey estimated that there are about 67 million bicyclists who ride a total of about 15 billion hours annually. Most bicycling is for recreational purposes, but almost 9 percent of riders use their bicycles primarily for commuting to work or school. The survey confirms the importance of children's travel and recreation, which is not measured in many surveys: about 22 percent of bicyclists are under age 10 and 40 percent are under age 15. The survey also noted a higher risk of injury among children, with injury rates per million hours of use roughly double those of most other age groups.

Questions about riding habits showed that most bicyclists (64 percent) ride a substantial proportion of the time on neighborhood streets with low traffic volumes. This compares with 29 percent on sidewalks and playgrounds, 17 percent on bike paths, 18 percent on unpaved roads, 7 percent on major thoroughfares, and 11 percent on unpaved surfaces or trails. The survey also noted that collisions or near-collisions with moving motor vehicles accounted for only about 10 percent of injuries. The remainder resulted from a variety of other factors, such as collisions with other bicyclists, pedestrians, or stationary objects; stunts; and falls on rough or slippery riding surfaces.

SOURCE: Gregory B. Rodgers et al., Bicycle Use and Hazard Patterns in the United States, prepared for the U.S. Consumer Product Safety Commission, 1994.

Other National Surveys

Various other national-level surveys are occasionally conducted to obtain characteristics of pedestrian and bicycle travelers. Recently, these have included the following:

- **Consumer Product Safety Commission (CPSC).** In the early 1990s, the CPSC undertook a study of bicycle use and hazard patterns (see box 2-1). A nationwide telephone survey was conducted of over 1,200 bicyclists to obtain data on exposure (usage patterns) to complement a survey of bicycle-related injuries reported in hospital emergency rooms. The exposure survey provided information on rider characteristics, such as age and gender, as well as use patterns, such as trip purpose and type of facilities used (Rodgers 1994).
- **National adult bicyclist survey.** A survey of over 2,300 adult bicycle commuters was conducted in 1995 to determine characteristics and experience of bicyclists (Moritz 1997). The survey provides information on bicycle commuter personal characteristics, trip length and frequency, facilities available, equipment, motivation for commuting, crashes, and

perceived safety. The survey was distributed over the Internet and via mailed responses to advertisements and, therefore, does not represent a random sample of commuters.

- **Recreational surveys.** The National Sporting Goods Association conducts an annual national survey to determine participation (six or more times in the previous year) in a variety of sporting activities, including bicycling, by age and gender. Results are published in the Census Bureau's annual *Statistical Abstract of the United States*. Rodale Press occasionally conducts surveys of 1,000 or more adults to identify participation in bicycling, walking, or running activities according to personal characteristics, incentives, and availability of facilities. These surveys may be most useful for tracking national trends in recreational bicycling and walking. Survey results are published in aggregate format, but this study did not find any instances where disaggregated data were made publicly available for analysis.

- **Health and physical activity surveys.** The Behavioral Risk Factor Surveillance System (BRFSS) is an annual survey designed to assess health-related risk factors including physical activity. The BRFSS is designed by the Centers for Disease Control and Prevention (CDC) and is administered at the state level by State Departments of Health via monthly random samples. The survey is designed with a number of optional modules that states can implement, including a module on exercise that includes the frequency and distance of jogging and walking, bicycle helmet use, and other information. Survey results could be used to analyze trends in recreational activity, including analysis by demographic characteristics. Annual sample sizes usually fall within the range of 1,000 to 4,000 per state, allowing some amount of disaggregation within each state. The modular design of the survey also means that uniform data can be collected in all states that choose to apply the optional modules. To date, however, it does not appear that any states have applied the exercise module. BRFSS survey data can be obtained on CD-ROM from the Government Printing Office and summary statistics are also available on the Internet.

  Another annual health-related survey is the National Health Interview Survey (NHIS), which includes the frequency of physical activity as one of its data items. This survey could also be used for trend analysis. The survey does not currently ask for type of physical activity, however, and does not yield data at the level of the local community or metropolitan area.

- **NHTSA Survey on Public Beliefs.** During 1999, the National Highway Traffic Safety Administration (NHTSA) conducted a national telephone survey of 4,000 people on beliefs and awareness about pedestrian and

bicycle safety and accommodation. The survey included demographic and socioeconomic characteristics; involvement in accidents; participation in driving, walking, and bicycling; willingness to walk or bicycle; and attitudes and knowledge regarding road users and usage. The results of the survey will be used to develop educational efforts and incident countermeasures.

Local Surveys

In some areas local surveys have been conducted of bicyclists and/or pedestrians to assess personal and trip characteristics. University researchers, city or metropolitan planners, or other interested groups may conduct such surveys. The content, scope, and quality of these surveys varies considerably according to the specific purpose, budget, and level of knowledge of those responsible for the survey. Nevertheless, these surveys can yield useful information for local planning. Surveys of bicyclists to determine usage patterns and personal preferences have been conducted by city or regional transportation planning agencies in areas such as Boulder, CO, Madison, WI, San Diego, CA, and Seattle, WA.

In many cities with rail transit systems, transit agencies routinely conduct passenger surveys that include mode of access to the station. For example, surveys conducted by the Massachusetts Bay Transportation Authority (MBTA) in Boston; the Chicago Transit Authority and METRA commuter rail in Chicago; and the Bay Area Rapid Transit District (BART) in San Francisco have identified the numbers and percentages of transit accessing each station by walking, bicycling, or other modes of travel.

Local survey results might in some cases be useful to planners in other areas. Carefully performed surveys can yield valid and transferable information on traveler characteristics, trip patterns, and preferences. Some local surveys have been publicized nationally, for example through FHWA's National Bicycling and Walking Study, which published a synthesis of survey findings in 1991 (USDOT FHWA 1992). There is no ongoing effort to identify and disseminate local survey results, however, and such an undertaking would probably prove difficult. Furthermore, even if local results could be made available on a widespread basis, it is important to recognize the specific situation and limitations of each survey before generalizing to other areas.

PREFERENCES, NEEDS, AND ATTITUDES

Data on bicyclist and pedestrian preferences, needs, and attitudes attempt to answer such questions as, how well is the existing transportation system meeting people's need or desire to bicycle or walk? What improvements would be most important in increasing the convenience, safety, and enjoyability of

people's travel experience? What improvements would most effectively induce more people to walk or bike?

These data may be collected through attitudinal surveys of existing and potential bicyclists and pedestrians. Quantitative models of behavior can also be used to develop information on user preferences. These models may be based either on "stated preference" survey data, in which people are asked to make choices among various alternatives, or on "revealed preference" data, based on observations of people's actual behavior as measured by travel surveys and counts.

Attitudinal Surveys

Attitudinal and preference data are often collected in conjunction with surveys to determine other data, such as usage patterns, personal characteristics, and crash experience. National survey efforts that investigate preferences, needs, and attitudes are described above and include the recent national adult bicyclist survey (Moritz 1997), the 1999 NHTSA Survey on Public Beliefs, and opinion polls such as the 1991 Harris Poll. Also, as identified above, local surveys have been conducted in some areas to assess user preferences, needs, and attitudes. These surveys can be useful for identifying specific concerns and needs in a community or region.

Modeling

Choice or demand models have been developed by some researchers and planners to predict bicycle or pedestrian mode or route choice based on characteristics of the mode or route (e.g., travel time, facilities available). These efforts have produced some quantitative information on relative preferences, for example, for bicycle lanes versus off-street trails. The Regional Transportation Authority in Chicago, for example, recently developed a model to predict mode of access to transit as a function of sidewalks, pathways, intersection improvements, and bicycle parking facilities in station areas (Wilbur Smith Associates 1996).

A recent FHWA guidebook identifies a range of demand modeling efforts and summarizes the state of the practice in modeling methodologies (Cambridge Systematics and BFA 1999). The success of these efforts has been limited, however, both by a lack of data and limitations in methodologies. To date, no comprehensive effort has been made to compare the preferences data developed by various models and to assess their validity for widespread use in demand forecasting.

FACILITIES

Data on pedestrian and bicycle facilities may describe the type of facility (sidewalk, shared-use path, on-road bike lane, pedestrian bridge, etc.), location, length, width, physical condition, topography, intersection characteristics, and other relevant features. Data on road facilities, such as number of lanes, lane width, pavement quality, and intersection characteristics, can also be relevant to analysis of bicycle and pedestrian travel.

Data on individual facilities need to be geographically referenced in some way to be meaningful. This referencing may occur in a format as simple as a paper map or a list of roads by jurisdiction. Increasingly, however, Geographic Information Systems (GIS) are being used to maintain facility databases. GIS can include databases in the form of lines (e.g., route segments) or points (e.g., intersections or bridges). GIS software packages provide a variety of analysis and visual display capabilities that take advantage of the geographic nature of the data.

Data on facilities can also be reported in summary formats. These might include, for example, percentage of a city's street network with continuous sidewalks, or miles of bike route by type and pavement condition within a city. An example of aggregate reporting on road and highway facilities is the Federal Highway Administration's annual *Highway Statistics* (USDOT FHWA 2000).

Potential sources of data on bicycle and pedestrian facilities include:

- The U.S. Census Bureau's Topologically Integrated Geographic Encoding and Reference (TIGER) files,
- The National Transportation Atlas,
- The Rails-to-Trails Conservancy's recreational trails database,
- State road databases, and
- Local road information.

Census TIGER Files

The U.S. Census Bureau maintains its TIGER database, a digital database of geographic features, including roads, covering the entire United States. The database contains information about these features, such as location in latitude and longitude, name, type of feature, address ranges for most streets, geographic relationship to other features, and other related information. TIGER/Line files are publicly available and can be imported into most GIS software packages.

The TIGER/Line street network is comprehensive. It has been used in pedestrian analysis to analyze the connectivity of local street networks and, thus, the directness of pedestrian pathways (Hsaio 1997). Its usefulness for pedestrian and bicycle analysis is somewhat limited because it does not contain any facility attributes such as street widths, number of lanes, presence of sidewalks, etc. In addition, it does not contain pedestrian and bicycle connections that are not part of the street network, such as alleys, walkways, or pathways. It can, however, serve as a base map for additional mapping of facilities and characteristics at the local level.

National Transportation Atlas

The National Transportation Atlas Databases (NTAD) are a collection of geospatial databases, developed by the U.S. Department of Transportation and other federal agencies, depicting transportation facilities, networks, and services of national significance. The databases are designed to be used with GIS software. Elements of the NTAD can be downloaded or ordered through the Bureau of Transportation Statistics (BTS) website.

One element of the NTAD is the National Highway Planning Network, a network database representing approximately 400,000 miles of federal-aid roads in the 50 states and Puerto Rico. It is a topologically connected line database depicting the locations and centerline alignments of nationally significant roads. Attributes include route names or numbers, capacity measures, various network classifications, and traffic volumes.

The NTAD is currently of very limited usefulness for bicycle and pedestrian planning since it does not include local roads or bicycle and pedestrian facilities. However, it does contain a few attributes (e.g., capacity and traffic volumes) that may be relevant to bicycle and pedestrian planning. It also demonstrates the potential of GIS technology to make information on transportation facilities readily available and usable on a national scale.

National-level inventories of pedestrian and bicycle facilities, similar to those maintained for roads and highways, have not been developed.

Recreational Trails Database

The Rails-to-Trails Conservancy maintains a database of trails in the United States that utilize former railway alignments. The database currently includes information on the location, mileage, type of surface, contacts, and other information as available for specific trails. Summary data on total trails and mileage, both existing and projected, are available by state. The database may be useful for tracking trends in the provision of off-road travel/recreation facilities. It is

also a potential repository for other relevant information, such as the number, characteristics, and trip patterns of trail users by trail as well as characteristics of trail access and the surrounding area. If enough data of reasonable quality could be assembled, this might provide the basis for analysis of factors influencing both recreational and utilitarian nonmotorized travel.

State Road Databases

State departments of transportation maintain road databases for the purposes of statewide transportation planning and programming as well as maintenance activities. These databases generally include U.S. and state highways. Attributes may include facility type, number of lanes, capacity, traffic volume, pavement quality, crashes by type, whether the road is an established bike route, and other information. The types, quality, and format of the data vary from state to state. In many states, these data have been incorporated or expanded into statewide management systems established by Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).[2] Many states also have developed, or are developing, statewide road databases in GIS format.

State road databases have been used for statewide bicycle route planning in a number of states, including Illinois, Maine, and North Carolina. Bicycle suitability inventories and route maps have been developed that rate highways for suitability according to facility type, traffic volume, shoulder width, pavement quality, and other characteristics. The specific variables and methods for determining suitability vary from state to state and are summarized in a recent report by the Texas Transportation Institute (Turner 1997) (see box 2-2). Also, in some states such as California, the data have been used as a basis for crash studies because pedestrian and bicycle crashes can be tied to various facility and locational features.

State databases suffer from the obvious drawback that they do not include local roads. They also may not include some of the most important characteristics relevant to bicycle and pedestrian planning and analysis (e.g., not all states include shoulder width in their inventories). Relevant characteristics could be added, however, given sufficient resources for data collection. Also, updates may only be performed every five-to-eight years. State road databases may be most useful for bicycle route planning and crash analysis in areas where state and federal highways make up a significant proportion of through routes. The databases could also be used to report the mileage or percentage of state and federal roads, by area, considered suitable for bicycling.

[2] ISTEA required states to develop six management systems to track transportation assets and system performance. Three-pavement, bridge, and public transportation-are asset management systems. The other three-congestion, safety, and intermodal-relate to system performance. The requirement to develop management systems has since been dropped, although many states have continued with their development.

Box 2-2
Statewide Bicycle Suitability Criteria

The Texas Transportation Institute (TTI) recently undertook a survey to determine the extent to which state Departments of Transportation (DOTs) have developed bicycle suitability criteria for use in state roadway planning. The survey revealed that 70 percent (11 of 16 sampled states) had bicycle suitability criteria in place. The two most common criteria (one or both were used in every case) were the traffic volume and the width of outside lanes or shoulders. Thirty-five percent of the states with suitability criteria also indicated that they looked at heavy vehicles when considering traffic volume, 25 percent considered pavement conditions, and 15 percent included traffic speed or speed limit criteria.

The conclusions from the survey indicate that, with some exceptions, state implementation of various bicycle suitability criteria is still in its inception. The majority of those states that had bicycle suitability criteria in place had done so to meet state legislation that mandated their formation and use as a part of a multimodal transportation plan. It appeared that the use of traffic volume and lane width as primary suitability criteria was closely related to the fact that this information was available in state DOT databases. In addition to surveying current practice, the TTI report also makes recommendations for developing and adopting bicycle suitability criteria.

SOURCE: S.M. Turner, C.S. Schafer, and W.P. Stewart, Bicycle Suitability Criteria: Literature Review and State-of-the-Practice Survey, Research Report 3988-1, prepared by the Texas Transportation Institute, College Station, TX, 1997, Internet: tti.tamu.edu.

Local Road Information

Cities, counties, or MPOs also maintain records of transportation facilities within their jurisdiction. Increasingly, this information is being stored in electronic format, primarily with GIS databases. At one end of the electronic spectrum, one can find basic mapping tools showing the location of public roads. As the databases are enhanced, one can find information on roadway geometry, including width of pavement, pavement condition, traffic volumes, presence of sidewalks, etc. At the other end of the spectrum one might find geo-coded information describing the compatibility of each facility with bicycling and/or walking. Portland, OR, for example, has used GIS databases to develop factors that describe the quality of an area for walking based on sidewalk continuity, ease of street crossings, and street connectivity.

These more sophisticated tools are typically used in areas that have well-developed networks of bicycle facilities or pedestrian activity, or in areas that have well-developed city or regional pedestrian or bicycle programs. While useful for local planning and system management functions, the data are not typically organized in a way that can be easily shared with others.

CRASHES AND SAFETY

Increasingly, the word "crash" rather than "accident" is used to refer to incidents that result in property damage, injury, or fatalities to road users. In the case of pedestrians and bicycles, falls can also result in injuries and property damage and should be included in safety nomenclature. Data on crashes and falls can include the location of the incident; number and attributes of vehicles and people involved; damage and injuries; characteristics of the incident location; and contributing factors. Also related to safety, data on personal security or crime is often relevant to bicycle and pedestrian travelers.

Crash and other safety data can be used:

- To identify trends by geographic area, facility type, severity, contributing factors, etc.;
- To identify potential hazardous locations;
- To identify contributing factors to crashes and severity, including characteristics of the individuals involved, vehicles, and environment;
- To identify potential countermeasures to reduce crashes;
- To evaluate the safety of various facility designs and operational policies;
- To identify crash costs; and
- To prioritize safety improvements.

Crash and other safety data are most useful when they can be related to exposure data, a measure of the number of people at risk for a crash. Absolute numbers of crashes on a facility, for example, are not very meaningful unless they can be related to the number of users of the facility. Dividing total crashes by an exposure measure indicates the risk or likelihood of a crash per trip or distance traveled. A road with a high number of bicycle accidents and high bicycle volumes may be safer (as measured by crashes per mile of travel) than a road with a low number of bicycle accidents and low bicycle volumes.

The ability to associate crash data with facility data, such as shoulder width or intersection characteristics, and with performance data for other modes, such as traffic volumes and speeds, is also useful in crash investigation and safety studies.

Sources of pedestrian and bicycle crash and safety data include:

- National crash and incident databases,
- National mortality and injury databases,

- State crash databases, and
- Police accident reports.

National Crash and Incident Databases

NHTSA maintains two national crash databases for public use: the Fatality Analysis Reporting System (FARS) and the National Automotive Sampling System General Estimates System (NASS GES). The FARS is a database of all fatal crashes involving motor vehicles on public roads. It contains over 100 attributes of the crash, vehicle, and people involved. GES data come from a nationally representative sample of police-reported motor vehicle crashes of all types, from minor to fatal. Approximately 90 data elements, collected from police accident reports, are coded into a common format.

Both the FARS and GES databases are available from NHTSA, and the FARS can be queried online. NHTSA also produces an annual summary report of crash data entitled Traffic Safety Facts. This document includes summary statistics for pedestrian and bicycle crashes, such as fatalities and injuries by age, gender, location (intersection or nonintersection), time of day, and related factors. NHTSA also produces a related series of traffic safety briefs, including literature on bicycling and pedestrians. BTS and the National Safety Council also produce annual summary reports that include some data from the FARS and GES (USDOT BTS 1998; NSC 1999).

Together, FARS and the GES have proven to be useful databases for tracking trends and for national studies of crash characteristics, causes, and potential countermeasures. Both databases can be used for research on pedestrian and bicycle crashes that involve motor vehicles. Although FARS provides a comprehensive inventory of fatalities, deaths make up only a small proportion of crashes. Data on nonfatal crashes are less comprehensive and reliable. The GES suffers from potential sampling errors, and minor-injury and property-damage-only crashes are typically underreported. Also, the GES data are limited by the content and accuracy of the police reports from which they are obtained (see section on police accident reports).

FARS and the GES also suffer from some specific limitations for pedestrian and bicycle crash analysis. Neither database includes crashes that do not involve a motor vehicle.[3] Also, the databases do not include a number of variables that may be important specifically in bicycle or pedestrian crash analysis. Examples include whether the bicyclist was wearing a helmet, or whether objects were present that might have obscured visibility. A lack of both appropriate crash

[3] According to a study by the Consumer Product Safety Commission, 10 percent of fatalities and 90 percent of injuries to bicyclists did not involve a motor vehicle (Rodgers et al. 1994).

variables and consistent reporting of relevant variables is a general problem with police accident reports. Specific crash data needs and mechanisms to improve reporting are discussed in more detail in chapter 4.

There are at least two potential national-level sources of pedestrian and bicycle incidents involving transit and railroads. The Federal Transit Administration's Safety Management Information Statistics (SAMIS) tracks incidents on transit property. The Federal Railroad Administration maintains a record of incidents on railroad property and rights-of-way.

National Mortality and Injury Databases

The National Center for Health Statistics (NCHS), run by the Centers for Disease Control and Prevention, maintains databases that may be useful for tracking pedestrian and bicycle injury trends. The National Vital Statistics System (NVSS) includes annual reporting of all deaths in the United States, classified by cause (e.g., motor vehicle) and circumstance (collision with motor vehicle, animal, bicycle, pedestrian, or fixed object, or fall). The National Hospital Ambulatory Medical Care Survey (NHAMCS) includes a sample of injuries in the United States classified by cause. Some summaries of NCHS data on pedestrian and bicyclist injuries are published in the National Safety Council's annual *Injury Facts* (formerly *Accident Facts*).

One advantage of these sources over motor vehicle crash databases is that they allow tracking of pedestrian and bicycle injuries and fatalities that do not involve motor vehicles. Depending on the geographic resolution at which the data can be analyzed, they could be used to develop local measures of risk (e.g., pedestrian injuries per capita). Also, the NHAMCS could potentially allow a better analysis of injury characteristics and the resulting costs than is provided by police accident reports. On the other hand, without linkages to specific crash or location data the usefulness of these databases for crash investigation is limited or nonexistent. The authors are unaware of applications of these data to pedestrian and bicycle injury analysis.

Another source of data on bicyclist injuries is the National Electronic Injury Surveillance System (NEISS), maintained by the Consumer Product Safety Commission. NEISS is based on a sample of hospitals that are statistically representative of hospital emergency rooms nationwide. From the data collected, estimates can be made of the numbers of injuries associated with consumer products (including bicycles and bicycle helmets) and injuries treated in hospital emergency departments. Data are collected on a broad range of injury-related issues, covering hundreds of product categories, and provide national estimates of the number and severity of product-related injuries. The NEISS data have been used in at least one study on bicycle-related injuries (Rodgers et

al. 1994; Tinsworth 1993). NEISS information can be obtained by contacting the Consumer Product Safety Commission.

State Crash Databases

Most states maintain, in varying forms, their own crash databases. NHTSA has recently undertaken efforts to make state-level information more widely available and useful. One product of these efforts is the State Data System (SDS). The SDS includes crash files from 17 participating states. The data are taken from police accident reports and the specific data collected vary by state. Data files are available from the individual states with state permission and a fee. NHTSA has also produced a report from these data, *State Data System: A Summary of Motor Vehicle Traffic Crashes from State Crash Data Files*, which is available on its website. The summary report includes pedestrian fatalities and injuries by age, location, and state.

Another NHTSA effort to make better use of existing state databases is the Crash Outcome Data Evaluation System (CODES) project. CODES is a project to link highway crash data to medical and financial outcome data. The linked data were originally used to demonstrate the effectiveness of safety belts and motorcycle helmets on death, disability, and costs. While linked data have not been used specifically for bicycle and pedestrian crash analysis, linkage represents a potentially useful tool to conduct better crash analysis without collecting additional data. By linking crash data to medical and financial records, specific factors in bicycle and pedestrian crashes (helmet use, type of crash, location, etc.) could be more closely linked to injury outcomes and the resulting costs. This may assist with targeting resources for prevention and designing appropriate countermeasures.

A similar effort is FHWA's Highway Safety Information System (HSIS), which currently contains state crash data for eight states-California, Illinois, Maine, Michigan, Minnesota, North Carolina, Utah, and Washington. These crash data are linked to roadway inventory files and traffic volume data. HSIS allows users to analyze a large number of safety-related problems that can range from basic "problem identification" issues to modeling efforts that attempt to predict future accidents from roadway and traffic characteristics. HSIS is limited to state roads, however, and does not cover local streets.

State-level databases can potentially provide a more complete sample of crashes than contained in the GES. As described above, they can be linked with data in state road databases, such as facility type and traffic volumes. As a result, they are generally more useful for local analysis and planning than national crash databases. Not all state databases include crashes on local roads, however, and often do not provide enough detail for needed analyses. Also, as with

the GES, the data are based on police accident reports and suffer from the same limitations in reporting.

Police Accident Reports[4]

Police accident reports (PARs) serve as the basis for most local, state, and national crash databases. Although many incidents are unreported, the majority of these involve only minor property damage and no significant personal injury. PARs include specific categories of information on the crash location and characteristics, as well as crash diagrams and narratives (compiled from witness reports and follow-up investigation) describing what happened. The quality and level of information collected varies locally.

PARs can provide a rich source of data for anyone with the resources to analyze them individually. However, they suffer from a number of limitations and are frequently inadequate for remediation studies. These limitations include:

- Reporting formats and information vary from state to state (usually, each state has a standard accident reporting form).
- Important variables are often not collected, and in particular many variables relevant to pedestrian and bicycle crash analysis may not be reported.
- Police officers may not be well trained in crash reporting and reports are often filled out by civilians. As a result, the quality of reporting may vary. In particular, injury severity is often estimated incorrectly.
- The reports are often available only in hard copy, although many departments are starting to adopt computerized reporting systems.

The widespread adoption of computer-based reporting systems has the potential to overcome many of these limitations and provide better and more useable crash data. These opportunities are discussed in chapter 4.

Security and Crime

In addition to crashes and falls, crime can represent a safety hazard for pedestrians and bicyclists. Actual and perceived risks to personal security may in some cases be a strong deterrent to pedestrian or bicycle travel. Data on the locations and characteristics of criminal incidents, such as muggings, can help local authorities improve enforcement in needed areas and reduce risks to travelers. While some aspects of crime prevention are beyond the purview of trans-

[4] This section is based on personal communication with Richard Blomberg, Dunlap & Associates, Stamford, CT.

portation planning agencies, in many cases, site and facility design can influence the safety of bicyclists and pedestrians. Examples of important design features include lighting, placement of vegetation, sightlines, and orientation of buildings.

Data on incidents of crime are primarily maintained at the city level in police crime logs. Many of the same statements that apply to local crash reporting apply to the reporting and management of crime data. For example, cities are developing-to varying degrees-GIS-based systems that can display the locations of incidents as well as store the various attributes of these incidents. In this outreach effort, no particularly outstanding issues regarding security-related data for bicycle and pedestrian analysis were identified, but nonetheless this is an area that should not be overlooked. Perceptions of safety are also important, but may not correlate to the reported level of crime.

EXPENDITURES AND CAPITAL STOCKS[5]

The Transportation Equity Act for the 21st Century (TEA-21) calls for "a national accounting of expenditures and capital stocks (facilities and vehicles) on each mode of transportation and intermodal combination." Ideally, this would include estimates of the current value of sidewalks, shared-use paths, pedestrian bridges, etc., but the data currently do not exist.

Tracking of bicycle stocks is one way of tracking trends in bicycle usage. The following sources on bicycle expenditures and stocks are known:

- The Bicycle Manufacturer's Association has data on bicycles sold from 1970 to the present in five-year increments. These data are available in the BTS report, *National Transportation Statistics,* which is produced annually (USDOT BTS 1999).
- The Bureau of Labor Statistics' (BLS's) Consumer Expenditure Survey includes data on personal expenditures on bicycles. These expenditures can be tabulated by age, education, income, household composition, occupation, region of residence, and other variables. Microdata CD-ROMs that include bicycle expenditure information can be purchased from BLS.
- Purchasing data are available from industry surveys, such as a 1990 survey by Rodale Press of 3,200 new bicycle purchasers. These data are not currently reported on a regular basis.
- The Federal Transit Administration's (FTA) grant management system is a potential source for FTA funding of bicycle-transit links. However, for

[5] This section is partially based on unpublished information from Paul Schimek, Cambridge, MA.

most grants that include funds for bicycle improvements, such as for the purchase of racks and lockers, the system does not separately identify this information. Likewise, FHWA tracks bicycle and pedestrian funding for stand-alone projects-that is, where the funding is not part of a larger transportation project. The information covers projects that use federal transportation money (i.e., ISTEA, TEA-21), and does not show spending categories.

SECONDARY DATA

Secondary data include research-study results, manuals of practice, summary statistics, and other reports, manuals, or findings that can help practitioners in planning for bicycle and pedestrian travel. Secondary data are often based on analysis and synthesis of data from the primary sources discussed above. Specific types of secondary data might include the safety effects of design features; demand impacts of design features, education programs, and other policies to promote bicycling or walking; and recommended street or sidewalk design practices.

This report does not include a comprehensive inventory of secondary data sources by type. However, the outreach effort conducted for this report revealed both a strong interest in secondary data sources and significant gaps in what is currently available. The survey revealed a particular need for better dissemination of existing data and knowledge and for additional research in a number of key areas. Two of the most commonly requested secondary sources, research study results and manuals of practice, are discussed here.

Research Study Results

Various research studies have been conducted on factors such as the safety effects of design features and the demand impacts of various design features and other policies. Results are frequently disseminated through publication of reports and conference proceedings, and may be used to inform the development of design manuals. Local planners and advocates, however, often do not have the time or the resources available to locate published studies. Also, many design features-particularly recent innovations, or those that have seen little implementation-have not been thoroughly studied. A further complication, in the case of demand impacts, is that the relative impacts of various policies and actions may work together in ways that are difficult to untangle. As a result, applying the results of demand studies to local situations can be very difficult.

The U.S. Department of Transportation's National Bicycling and Walking Study produced a series of reports in the 1990s, some of which included references to research results on various topics. A forthcoming publication by NHTSA will

help disseminate existing safety-related research results. This Bicycle Research Compendium, to be published by the end of 1999, will provide a synthesis of NHTSA's bicycle research program from the 1960s through the 1990s. The compendium will include a synopsis of each study as well as a subject and author index.

Manuals of Practice

Manuals of practice assist local planners and engineers by providing standards they can use, instead of having to "reinvent the wheel" in every situation. Relevant manuals cover such topics as engineering guidelines for facility design and traffic engineering. The manuals are based on research studies and implementation experience concerning safety effects, user preferences, and costs. In the parallel field of traffic engineering, guidelines have been adopted to the point of having strong legal implications if not followed.

While it may or may not be desirable to establish certain design practices as "mandatory" from a legal standpoint, manuals of practice nevertheless provide important useful guidance to practitioners. In the past few years, the American Association of State Highway and Transportation Officials (AASHTO) and other organizations have been actively involved in the development of improved guidance for bicycle and pedestrian design. AASHTO's *Guide for the Development of Bicycle Facilities* was updated in 1999. This document represents a significant enhancement of the prior edition. Because it is focused on design and not planning, however, it does not represent a source of data.

Several recent efforts to enhance pedestrian design are also notable. In 1998, the Institute of Transportation Engineers published *Design and Safety of Pedestrian Facilities,* which provides an excellent basis for good planning practice. The document also provides some overview data on crash-related trends. In 1999, the Transportation Research Board, through AASHTO and its National Cooperative Highway Research Program, initiated Project 15-20, Planning, Design, and Operation of Pedestrian Facilities. The first objective of this project is to compile the most relevant existing information related to the planning, design, and operation of pedestrian facilities, including the accommodation of pedestrians with disabilities. The second objective is to develop a guide for the planning, design, and operation of pedestrian facilities. Again, this effort is not focused on data needs, but will include strategies and recommendations for filling information gaps.

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Data Needs

CHAPTER 3

SUMMARY OF DATA NEEDS AND PRIORITIES

The following section identifies needs for new or improved data as expressed by practitioners. The section also identifies priorities for improving data, based on the potential usefulness of the data and on the quality of existing data. In some cases, these needs can be met by enhancing existing data collection or data management efforts. In other cases, new data collection efforts are required.

The outreach effort conducted for this project serves as the primary basis for this assessment. For this, an email survey was conducted to help identify bicycle and pedestrian data needs. A brief questionnaire was emailed to over 60 people active in the fields of planning, research, or advocacy for bicycles and/or pedestrians. The assessment is also based on the results of other recent evaluations of data needs for transportation in general, and for pedestrian and bicycle planning in particular. These efforts include:

- A conference on information needs for state and local transportation decisions, cosponsored by the Bureau of Transportation Statistics (BTS), the Transportation Research Board, the Federal Highway Administration (FHWA), the Federal Transit Administration, and the American Association of State Highway and Transportation Officials (NAS TRB 1997);

- A BTS assessment of needs for transportation statistics (USDOT BTS 1998); and
- An FHWA-sponsored guidebook on methods of forecasting bicycle and pedestrian travel (Cambridge Systematics and BFA 1999).

The appendices provide more detail about the outreach effort and other assessments as well as their results.

Table 3-1 summarizes the identified data needs and provides a rough assessment of priorities, listed by data type. These priorities are based on the following criteria:

- Quality of existing data,
- Importance of the data for its intended application(s) and audience(s), and
- Usefulness of the data for a range of applications (facility design, trend analysis, etc.), audiences (researchers, planners, designers, policymakers, etc.), and geographic scales (local, state, national).

The strength of priorities, of course, must be compared with the level of effort needed to collect the desired data. Nevertheless, the results indicate areas in which effort should be directed into developing improved data collection, analysis, and reporting methods. The remainder of chapter 3 discusses the various needs identified for each type of data and describes the reasoning behind this prioritization in greater detail.

USAGE, TRIP, AND USER CHARACTERISTICS

Perhaps of highest priority, there is a strong need for comprehensive and systematic data on usage, including potential usage. Even basic information, such as total travelers, trips, and distance traveled by bicycle or foot, does not exist in most areas. Nearly 40 percent of respondents to the outreach effort identified a need for better data of this type. In particular, respondents expressed three related but distinct needs:

- Overall indicators of usage and trends in usage, such as numbers of people who bicycle or walk; total numbers of bicycle or walk trips; mode shares; and miles of travel by nonmotorized modes. The need for such indicators was expressed primarily at the local level but also at the state and national levels.
- Counts (traffic volumes) on specific facilities, in some cases by characteristics such as time of day, day of week, or type (e.g., work, shopping, recreational).

Table 3-1
Assessment of Data Priorities

Data type	Description	Primary uses	Quality of existing data	Priority for better data
Usage, trip, and user characteristics	Number of bicyclists and pedestrians by facility or geographic area	Conditions and trend analysis Network planning (prioritize improvements) Crash analysis (develop exposure measures) Demand forecasting (calibrate models)	Poor	High
Usage, trip, and user characteristics	User and trip characteristics by geographic area or facility	Conditions and trend analysis Crash analysis (exposure measures, contributing factors) Demand forecasting (develop models)	Fair	Medium/ high
User preferences	Relative preferences for facility design characteristics and other supporting factors	Facility design Network planning (prioritize improvements) Demand forecasting (determine demand impacts)	Fair	Medium
Facilities data	Characteristics relating to quality for bicycle or pedestrian travel (facility-specific; or areawide summary)	Conditions and trend analysis Facility design and network planning (identify deficiencies, prioritize improvements) Crash analysis (identify hazardous locations, designs) Demand forecasting (include factors in models)	Fair	Medium
Crash and safety data	Specific bicycle and pedestrian-relevant crash variables	Crash analysis (contributing factors, countermeasure development)	Fair	Medium/ high
Crash and safety data	Nonmotor-vehicle crash data	Crash analysis (contributing factors, countermeasure development)	Poor	Medium
Secondary data	Safety and demand impacts of design features	Facilty design	Fair	High
Secondary data	Safety and demand impacts of policies, programs	Policy and program design	Fair	Medium

- Better data on characteristics of pedestrian and bicycle trips and trip-makers, including distributions of trips by distance, purpose, and time of day; distributions of travelers and trips according to demographic and socioeconomic characteristics; and various cross-classifications of these variables.

More comprehensive and systematic data on usage would assist a wide variety of data users for many purposes. At the local level, it would aid planners and advocates in determining current travel patterns, prioritizing improvements, and tracking the effectiveness of policies, programs, and facility improvements. It would assist in safety analysis and crash prevention at all levels by providing safety researchers and local planners with measures of exposure. This is particularly important since crash data must be combined with exposure data (e.g., pedestrian traffic volumes) to determine the hazards or risks posed by various designs, environmental factors, etc. It would assist efforts to model and forecast demand and to determine preferences for and demand impacts of various improvements. At all levels of policymaking, from local through national, better data on system usage would assist policymakers by illustrating overall trends in usage as well as differences in trends among geographic areas, user characteristics, and so forth.

Field counts and travel surveys both provide a basis for estimating usage, and each has advantages and disadvantages as discussed in chapter 4. Regardless of the technique used, an ideal system of usage data collection and reporting would have the following characteristics:

- The data collection would permit tracking of usage patterns on individual facilities as well as aggregation of data across an area (e.g., total bicycle-miles of travel in a city);
- Data would be collected systematically-that is, on an ongoing basis in a manner in which patterns can be compared over time;
- Data would be collected in a consistent manner across cities, metropolitan areas, etc., so that the data could be aggregated to larger geographic areas, including nationwide; and
- Data could be broken out by specific factors, such as user characteristics (age, sex, disabilities, etc.), trip purpose and length, time of day, type of facility, etc.

While usage data is an overall high priority, the importance of these specific aspects varies according to the intended use of the data. For some uses, specific variables or compatibility among areas may be required; for other uses, it may be more important simply to know overall levels of travel in a particular geographic area.

PREFERENCES, NEEDS, AND ATTITUDES

Data on user preferences, attitudes, and expressed needs of existing and potential bicyclists and pedestrians appear to be a secondary but still important priority.[1] Fourteen percent of respondents expressed a desire for better data in this area. Respondents specifically requested data on relative preferences for facility types, to assist with both facility design and travel modeling; reasons why people do not bicycle or walk and what would encourage them to do so; and perceptions of safety and the influence of safety concerns on bicycling or walking.

A fair amount of information on expressed preferences-as gathered from various local and national surveys-already exists, and has to some extent been summarized through the National Bicycling and Walking Study. These data provide a general sense of what factors are important in a person's decision to walk or bicycle. Recent research to establish a Bicycle Compatibility Index is also helping establish relative preferences for specific design features (USDOT FHWA 1998). Knowledge of user preferences falls short, however, when it comes to modeling the impacts of specific policies and facility design characteristics on travel choices. This is because there are many factors that influence these decisions, and they can interact in complicated ways. Advances in demand modeling as well as better data to support this modeling are therefore required to further quantify relative preferences.

Fortunately, a systematic and comprehensive data collection effort on user preferences, similar to a system of tracking usage and crash data, is probably not necessary. There is strong evidence from travel modeling experience that preferences are to a large extent "transferable" from one area to the next, and that it is therefore not necessary to perform preference surveys in every city or metropolitan area.

Current challenges are:

- To further disseminate results (including recent surveys and studies) on a national basis,
- To compare results across geographic areas to determine their transferability,
- To synthesize results in a manner that is most useful to local practitioners, and
- To identify additional research efforts that are required to support specific purposes such as demand modeling and facility design.

[1] Note that it is important to know preferences for *potential* as well as actual bicyclists and pedestrians, therefore the term "user" is applied loosely to indicate all people for whom bicycle and pedestrian-related policies could potentially impact travel choices.

Targeted research and methodological development is required to quantify the tradeoffs that people make among various factors in a format that is useful for behavior modeling across geographic areas. Note that while research studies in this area may require their own specific data collection, they will also strongly benefit from the improvement of other pedestrian and bicycle data, including facility characteristics, travel survey results, and counts.

FACILITIES

Better data on the location, characteristics, and extent of bicycle and pedestrian facilities was identified as a need by 15 percent of respondents to the outreach effort. As with preferences data, improved data of this type would be useful but are probably not as high a priority as basic usage data. For local planning purposes, even if a comprehensive inventory of facilities does not exist (and therefore total mileage by type, condition, etc., cannot be quantified), anyone familiar with an area has a general sense of what conditions are like and where specific problems might exist. It is easier to assess existing facility conditions through observation than to obtain "hard" data such as user counts and surveys. Local jurisdictions, for example, frequently conduct inventories of bicycle facilities for the purpose of developing bicycle plans.

Nevertheless, both needs and opportunities exist for improving facilities data. Better facilities data would appear most useful for local planning efforts. A number of respondents identified a desire for databases indicating locations and characteristics of specific facilities. Potential uses include developing compatibility ratings and recommended routes, identifying deficiencies, and identifying and prioritizing improvements. Local data on facility characteristics would also assist in crash studies and in forecasting travel demand.

A few respondents also identified a desire for aggregate-level reporting of facilities data (e.g., miles of bicycle paths per capita in a city, county, or metropolitan area). Tracking the extent of facilities at the metropolitan, state, and national levels would be useful in helping planners and policymakers assess the extent to which adequate facilities are provided.

Particular needs for improving facilities data include:

- Incorporating attributes relevant to bicycle and pedestrian travel (e.g., sidewalk and crosswalk locations) into roadway databases;
- Expanding roadway databases to include bicycle- and pedestrian-specific links, such as off-road trails;
- Incorporating other environmental and land use variables that relate to the quality of an area for bicycling and/or walking; and

- Incorporating data into a geographic information system-based format so that it can be more easily analyzed, displayed, and linked with other relevant data for analysis.

CRASHES AND SAFETY

Approximately 30 percent of outreach respondents indicated a need for better data related to crashes and safety, and this appears to be a relatively high priority. Three specific needs were identified:

- More complete and consistent information on locations and characteristics of reported crashes,
- More comprehensive reporting of nonfatal crashes and nonmotor-vehicle crashes, and
- Geographic linkage of crash data to facility and usage data.

Most respondents expressed the need for more complete or usable crash databases or for more detailed data on specific crashes. Data were particularly requested on specific characteristics of crashes relevant to pedestrian and bicycle crash analysis; for example, location relative to a crosswalk or whether the bicycle was equipped with lights if traveling at night. Improved crash data and data linkages would assist in crash analysis and the design of countermeasures (i.e., steps taken to prevent crashes), both in local planning and in larger-scale research studies.

A number of respondents also expressed the need for better aggregate crash data, i.e., summary statistics by area, facility type, or crash type. This would also assist in tracking safety trends at the local, state, and national levels.

SECONDARY DATA

Better secondary data appear to be a relatively high priority for planners, engineers, consultants, and advocates at the local level. Important types of secondary data include research results on the safety, demand, and other impacts of design features and policies; recommended design practices; and model policies and programs relating to design, education, and promotion.

The safety and user-preference impacts of various design features, especially for bicycle travel, were identified by about 30 percent of outreach respondents and appear to be the highest priority need. While recent research has focused on a number of bicycle and pedestrian design issues, many issues have not been thoroughly researched, and evidence on the appropriateness of various treatments is often conflicting or nonexistent. Furthermore, existing research results may

not be readily available or known to practitioners at the local level. In the absence of such evidence, planners, engineers, and advocates often find it difficult to agree on or justify specific design treatments.

The effectiveness of many other policies and actions to support pedestrian and especially bicycle travel is also not well understood. Some of these issues include the demand impacts of shower and locker facilities at the workplace; demand impacts of bicycle parking in commercial areas, and the safety and demand impacts of educational programs. In the absence of evidence on these effects, benefits cannot be compared to costs, and planners may find it hard to justify particular programs or actions.

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CHAPTER 4

Options for Addressing Data Needs

GENERAL RECOMMENDATIONS

By viewing the overall range of data needs and opportunities in perspective, perhaps the most important finding emerging from this study is that opportunities and constraints to improved bicycle and pedestrian data collection must be investigated in a crosscutting manner.

Practitioners in a diversity of areas, such as safety research, demand forecasting, and roadway engineering, may benefit from common data collection activities. Furthermore, information-based technologies, including intelligent transportation systems (ITS) and geographic information systems (GIS), are creating opportunities to improve the state of transportation data collection and management in general. At the same time, institutional and financial constraints create barriers to capitalizing on these opportunities. Greater coordination is required among federal, state, and local transportation planning agencies to improve the quality of pedestrian and bicycle data.

An effort to identify opportunities, constraints, and needed actions might include a conference or series of workshops that bring together a variety of important groups. Some key aspects of such an effort would include:

- The full range of users of bicycle and pedestrian data would be brought together to discuss how data collection efforts could benefit the broadest number of users. For example, count or survey data could serve as a foundation for tracking usage of specific facilities, estimating overall levels of system usage, developing measures of exposure for crash analysis, and developing and calibrating network models. The potential for coordinating efforts to meet all of these needs should be investigated.
- The discussions would also include those who collect all types of transportation data; for example, representatives of the U.S. Department of Transportation (USDOT), state DOTs, metropolitan planning organizations, city and county transportation agencies, hospitals, and police. Representatives of these agencies could help identify both opportunities and constraints to improving the collection of bicycle- and pedestrian-related data.
- Opportunities for improving bicycle and pedestrian data would be viewed in conjunction with opportunities for and constraints to improving related types of general transportation data. For example, computer-based crash reporting systems have the potential for greatly improving the quality and usefulness of crash data. Local adoption of these systems is likely to be driven by their general usefulness for data management rather than by specific pedestrian and bicycle data opportunities. At the same time, however, pedestrian and bicycle data users must be involved in the design of these systems to ensure their maximum utility for pedestrian- and bicycle-crash analysis.
- Needs and opportunities for making databases compatible with each other would be discussed. For example, GIS can greatly facilitate the management and analysis of pedestrian- and bicycle-related data. If data definitions in different sources are not compatible with each other, however, GIS cannot be utilized to its maximum potential. Other opportunities for standardizing data and linking databases (e.g., medical records and crash records) should also be identified.

The outreach effort for this study resulted in additional recommendations for improving the quality of bicycle and pedestrian data. By far, the most common recommendation regarding existing data was to make all available data readily accessible via the Internet. Some respondents specifically suggested that a centralized Internet repository with a searchable database and/or links to other relevant sources would be useful. Respondents' suggestions for new data collection generally focused on new technologies, such

as video cameras and GIS, and on alternative survey methodologies. Other suggestions for better dissemination of data and for new data collection opportunities are noted in appendix A.

Respondents also provided general suggestions as to how the Bureau of Transportation Statistics (BTS) and/or other federal agencies could assist with new data collection efforts. These generally fell under the following areas:

- Technical assistance, including developing uniform data collection methods and reporting formats, demonstrating new data collection technologies, and developing case studies of successful data collection efforts;
- Financial assistance in the form of grants or other funding specifically designated for data collection;
- Requirements or mandates, such as requiring pedestrian and bicycle data collection as a part of transportation data collection or transportation planning efforts that benefit from federal funding; and
- Assistance in coordinating efforts, for example, sponsoring conferences or working groups, or maintaining contact lists of peer professionals, resource people, etc.

The remainder of this section discusses specific opportunities for each type of data, including options for addressing data needs as well as potential actions that could be taken (especially at the federal level) to advance these options.

USAGE, TRIP, AND USER CHARACTERISTICS

Basic demand or usage indicators may be developed from either systematic counts or regular travel surveys. Counts provide total numbers of users by facility, facility type, area, and time and can also be used to estimate total bicycle- or pedestrian-miles of travel if adequate samples are conducted. Surveys have the additional potential for tracking usage by characteristics of the user, trip purpose, and origin/destination. As in standard transportation practice, the ideal is probably a combination of regular field monitoring to obtain volume patterns combined with occasional surveys to collect more detailed data on origin-destination patterns, user characteristics, etc.

Currently, major barriers to gathering better demand/usage data are cost and effort. Both counts and surveys are extremely labor-intensive, and mechanical counting technology is more difficult to apply to bicycles and pedestrians than to motorized vehicles. Given limited financial resources and a general lack of priority assigned to bicycle and pedestrian data, state and local agencies are generally unwilling to allocate sufficient resources to bicycle and pedestrian data collection.

While applications of new information technology have the potential to reduce the costs of data collection, particularly for counts, an increase in both federal and/or local resources will ultimately be required to improve the quality of data in this area. In addition to simply allocating more resources, however, a number of actions may be taken at the federal level to better leverage existing data collection efforts and to increase the capacity of local agencies to collect additional data. Some recommendations include:

- Develop a "handbook" or manual on basic pedestrian and bicycle characteristics, such as trip-length distributions and typical socioeconomic and demographic characteristics.[1] In addition to the National Personal Transportation Survey (NPTS), a potentially underexploited source of such data is existing metropolitan household travel surveys, which could be analyzed and compared on a nationwide basis.
- Evaluate and promote new bicycle- and pedestrian-counting technologies (i.e., video imaging, infrared sensors) by synthesizing the results of current pilot testing efforts, sponsoring additional pilot tests and methodological development, and conducting outreach efforts to disseminate successful technologies. Further development and evaluation is required in this area, and local agencies must be provided with the know-how to adopt and utilize new technology.
- Develop and widely disseminate model surveys and sampling methodologies for collecting pedestrian- and bicycle-related data. Currently, surveys and sampling methods that are applied in practice vary significantly in their quality. Recommended methodologies should be developed and disseminated for both counts and travel surveys. For example, assuming resources are devoted to systematic bicycle and pedestrian traffic monitoring, what would an ideal temporal and spatial coverage of counts look like? What are recommended methodologies for obtaining representative pedestrian and bicycle travel survey data?
- Investigate enhancements to household travel surveys, notably inclusion of purely recreational bicycle and walk trips, as well as techniques to improve reporting of children's trips, short walk trips, and walk or bicycle access to other modes of travel. Techniques to minimize underreporting of walk trips have been developed with some success in a few metropolitan areas and should be adopted on a more widespread basis.
- Evaluate and, if successful, disseminate new technologies to collect travel survey data, such as personal monitors to measure physical activity levels. The success of pilot survey applications of global positioning system

[1] This need was identified in the development of the Guidebook on Methods to Forecast Bicycle and Pedestrian Travel (Cambridge Systematics and BFA 1999).

(GPS) units to track trips should also be monitored and potential applications to monitoring pedestrian and bicycle travel explored.

- Improve the state of the practice in bicycle and pedestrian demand forecasting. Data on forecast usage can be at least as important as data on existing usage for many planning and design applications and for supporting funding allocation decisions. Forecasts may be important in designing a trail to ensure adequate width, for example, or in planning a network of routes to maximize usage.

PREFERENCES, NEEDS, AND ATTITUDES

As noted in chapter 2, there are several ways to obtain data on preferences, needs, and attitudes. Qualitative assessments and attitudinal surveys are less resource-intensive and may, in many cases, be adequate for planning and design activities. Stated-preference or revealed-preference analysis can be used to develop more robust and quantitative information on user preferences, but these methods are limited by the expense involved in conducting and analyzing surveys, deficiencies in other data (particularly usage and network characteristics), and modeling limitations.

An additional point is that data on preferences are to a large extent transferable from one area to another and, therefore, local data collection efforts may not be required everywhere as they are for usage, facilities, and crash data. Calibration across localities for differences in socioeconomic level, land use, climate, and other factors may be necessary. With these points in mind, the following actions could be taken to improve data on preferences, needs, and attitudes:

- Synthesize existing knowledge on preferences, needs, and attitudes. Such a synthesis was written in 1991 as part of the National Bicycling and Walking Study, but regular updates would be useful. One component of this effort should investigate the potential for using existing quantitative preference data in models to predict pedestrian and bicycle travel choices.
- Develop survey questions regarding conditions and preferences for bicycling and walking that could be added to existing metropolitan household travel surveys, the NPTS, or other market surveys.
- Develop model surveys and sampling methodologies. As with travel surveys, a variety of surveys and sampling methods are applied in practice, with varying levels of quality.

Box 4-1
Portland, Oregon, Pedestrian Potential and Deficiency Indices

The city of Portland, Oregon, assembled data from a variety of sources into a common geographic information system (GIS) environment to develop and map a "Pedestrian Potential Index" and a "Deficiency Index." These indices were then combined to identify areas of both high potential and high deficiency, so that these areas could be targeted for improvements.

The Pedestrian Potential Index is based on a variety of factors, including adopted street and neighborhood classifications (e.g., pedestrian district, town center); proximity to schools, transit stops, public parks, and pedestrian-friendly commercial zoning; and the likelihood of short trips being made by walking, based on analysis of metropolitan household travel survey data.

The Deficiency Index is developed by combining rankings for six factors: sidewalk deficiency, crash locations, traffic speed, traffic volume, street width, and length of street block. Sidewalk deficiency is based on the continuity of sidewalks, as determined by field surveys. Pedestrian crash locations were determined from city accident databases. Traffic speeds and volumes were identified at available count locations. Roadway widths and segment lengths were also identified from city GIS databases of roadway facilities.

The city's analysis illustrates how GIS tools can be used to manage and display existing data from various sources, as well as newly collected data, in a common environment. The analysis further illustrates how these sources can be used to identify areas in which improvements to the pedestrian environment are required.

SOURCE: City of Portland, OR, Office of Transportation, Identifying Priorities for Pedestrian Transportation Improvements, Pedestrian Master Plan Project Development: Final Report, June 30, 1997.

FACILITIES

Emerging information technology is providing new opportunities for maintaining more useful databases on transportation facilities. Geographic information systems provide the ability to store geographically referenced data in a format that is easy to analyze, display, and link with other databases (e.g., crash records, population and land-use data) for analysis (see box 4-1). Most state and local transportation agencies have adopted or are adopting GIS to store and manage facilities-related data. Many are integrating facilities data with other transportation-related data to varying degrees, for example, through the development of Transportation Management Systems. These efforts can involve substantial initial investments, but can also have significant payoffs in the long run.

While GIS and other new technologies can make it easier to update and maintain facilities databases, it is important to note that GIS cannot collect data. Resources must still be devoted to compiling relevant data and updating it on a regular basis. Communication and coordination among agencies with varied responsibilities are also required.

Some recommendations to improve the quality of data on bicycle and pedestrian facilities include:

- Standardizing data formats and definitions where appropriate in order to facilitate use in other applications (crash analysis, network models, etc.), and promote data comparability among jurisdictions and geographic areas. Facilities data will be most

useful if they are developed in a geographically referenced format that can be easily linked with socioeconomic and demographic data and crash databases, and if they contain attributes that can be incorporated in transportation model networks for demand forecasting.

- Facilitate discussions among various data user groups to identify key network characteristics relevant to bicycle and pedestrian planning, and provide guidance to state and local agencies responsible for collecting and maintaining transportation data. Given that resources for data collection are limited, it may be helpful for users to agree on a set of common characteristics that are of interest and that can realistically be monitored within data collection budgets. In addition to incorporating attributes relevant to bicycle and pedestrian travel (e.g., presence of bike lanes or crosswalks), facilities databases should also contain bicycle- and pedestrian-specific links, such as off-road trails and pedestrian bridges, that do not appear in standard roadway databases. Coordination among state and local agencies is also important because planning practices and desired data may differ from area to area.
- Investigate new technologies for data collection and disseminate successful applications. Analysis of aerial photographs has been used in Portland, OR, for example, to develop pedestrian environment factors for individual traffic analysis zones.

CRASHES AND SAFETY

The quality of pedestrian and bicycle crash data is dependent on the quality and characteristics of local crash reporting systems as well as local, state, and national crash data management systems. Most of the limitations of existing crash databases and data management apply to all modes of transportation and are not unique to pedestrian and bicycle crashes. Highway and road safety analysis receives considerable attention, and problems such as reporting of nonfatal accidents and a lack of good injury data are widely recognized. As with other types of pedestrian and bicycle data, recommendations to improve the quality of data must take into consideration current opportunities and constraints in the broader area. See, for example, the discussion of how new technology can help overcome institutional obstacles to improved crash records processing (Miller 1997).

Also, as with other data, emerging information technology offers potential solutions to many existing problems, for example:

- Computer-based crash reporting systems have the potential to allow detailed and specialized crash reporting. These systems are in various levels of adoption by police departments across the country. They can also

permit the transfer of crash data into central databases, eliminating the need for manual data entry. As a result, data on all reported crashes can be made readily available for analysis.

- Geographic information systems are facilitating the management, display, and linkage of data. GIS will assist researchers and planners in linking data to facility and environmental databases, and will assist lay people through its capabilities of visually displaying information. GIS-based systems for maintaining crash records, facility information, and other data are in various levels of implementation by states, metropolitan agencies, and local jurisdictions.
- Global positioning systems are permitting the recording of precise crash locations.
- National Highway Traffic Safety Administration (NHTSA) is undertaking efforts to link crash and medical records databases in some states. Use of these data for bicycle and pedestrian crash analysis, however, will require funding of specific research studies.
- NHTSA is also developing crash-typing software. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) helps users create a database of their pedestrian and bicycle crashes from hardcopy accident reports, helps users capture detail on roadway and environmental conditions at the time of the crash, types/categorizes the crashes, helps users produce some basic tables and graphs, and links the crash types to some countermeasures.

In implementing new technologies for crash reporting, analysis, and data management, consideration should be given to specific needs for bicycle and pedestrian crash reporting. The potential of computer-based crash reporting systems, for example, should be leveraged for bicycle and pedestrian crash analysis through the development of expert systems to guide data entry. Expert systems can request specific information keyed to the nature of the crash. For example, if a bicyclist were involved, the computer would prompt to determine whether or not the bicyclist was wearing a helmet.

Some specific recommendations to improve pedestrian and bicycle crash data include:

- Build a consensus on characteristics that are important to record in reporting crashes involving bicyclists and pedestrians; incorporate these characteristics in standards for computer-based reporting systems. Crash reporting systems should be designed with input from bicycle and pedestrian safety researchers to include important information relevant to bicycle and pedestrian crash analysis. To maximize its usefulness, a standard

system should be adopted throughout the country so that comparable data are available on crashes in all areas.[2]

- Investigate opportunities provided by GIS and GPS for identifying and documenting the precise location of crashes, and investigate how this data should be reported and managed.
- Investigate methods to achieve more thorough reporting of injury crashes as well as reporting of nonmotor vehicle crashes and incidents. While there is no known way of assuring the comprehensive and systematic reporting of crashes that fall beneath state-specified damage value thresholds, opportunities may exist for obtaining better samples of data. Examples may include examination of medical records or self-reporting of incidents on surveys of bicyclists or pedestrians.[3] (Moritz 1997)
- Investigate the potential of utilizing existing linked crash and medical record databases for pedestrian and bicycle crash research.
- Continue to include safety researchers in initiatives to improve usage-data collection, so that usage data provide the most useful measures of exposure for crash investigation. Aggregate exposure statistics should be compatible with aggregate crash statistics; for example, facility types or user characteristics should have consistent definitions. Facility definitions for both exposure and crash data on specific facilities should also be compatible (e.g., for pedestrian crash analysis, pedestrian volumes on a specific crosswalk may be important.)

SECONDARY DATA

Needs for secondary data may be addressed through more widespread dissemination of existing research results; through additional research on design features, policies, etc. that have not been fully studied; and through the development and dissemination of recommended practices as well as case studies of successful programs and applications. Some specific recommendations include:

- Continue to improve the availability of existing research. The National Transportation Library, the National Bicycling and Walking Study, and the Bicycle and Pedestrian Clearinghouse have all made strides in this direction and the Internet provides excellent new opportunities in this

[2] Richard Blomberg of the Transportation Research Board Pedestrian Committee has been investigating opportunities and constraints to the adoption of new reporting systems. Involvement by the NHTSA may be helpful in promoting widespread agreement on and adoption of such systems.

[3] Self-reporting through surveys has previously been used to estimate the frequency and types of nonmotor-vehicle crashes and incidents (Moritz 1997).

area. A forthcoming NHTSA bibliography on bicycle safety research will help. Additional bibliographies on other bicycle and pedestrian research topics-for example, international safety research-would also be useful.

- Prioritize, fund, and promote research to fill in knowledge gaps. It is beyond the scope of this assessment to make a comprehensive inventory of bicycle- and pedestrian-related research needs, although some priorities (particularly for bicycle-related research) emerged from the outreach effort. Some recent assessments of research needs, however, have come from the following sources:

  The Transportation Research Board Bicycle and Pedestrian Committees regularly solicit and prioritize research problem statements, although there is no dedicated funding source to carry out this research;

  NHTSA is currently producing a compendium of the agency's bicycle-related research that will help identify areas in which research is lacking; and

  A recent Federal Highway Administration report on bicycle and pedestrian demand forecasting methods identified research needs to support forecasting.

- Continue to assess research findings and inpractice experience to update recommended practices. The need for recommended practices is being addressed to some extent through the American Association of State Highway and Transportation Officials' recently released revision of its design guidelines for bicycle facilities. It is important in the future, however, to update these recommended practices on a regular basis to ensure that new research is considered and that new techniques are included. A few cities in the United States, for example, are experimenting with bicycle facility design techniques borrowed from Europe; to the extent that these prove successful, it may be desirable to include them as recommended practices for certain situations.

REFERENCES

Cambridge Systematics and Bicycle Federation of America (BFA). 1999. *Guidebook on Methods to Estimate Non-Motorized Travel*, FHWA-RD-98-165. Produced for the U.S. Department of Transportation, Federal Highway Administration. Washington, DC.

Miller, J.S. 1997. Using Technology to Help Overcome Institutional Obstacles to Improved Crash Records Processing. *Transportation Research Record 1581*.

Moritz, W.E. 1997. A Survey of North American Bicycle Commuters: Design and Aggregate Results, presented at the Transportation Research Board Annual Meeting, Paper No. 970979. Washington, DC.

Results of Outreach Effort

APPENDIX A

METHODOLOGY

To help identify bicycle and pedestrian data needs, a brief questionnaire was emailed to over 60 people identified as active in the fields of planning, research, or advocacy for bicyclists and/or pedestrians. In particular, those targeted were:

- Representatives of key federal organizations and national advocacy groups;
- University researchers and consultants who recently conducted research related to bicycle and pedestrian planning or safety; and
- Local planners and advocates active in professional activities, such as conferences and committees, at a national level.

Names were identified through:

- Transportation Research Board bicycle and pedestrian committee lists;
- Published research and literature;
- Contacts made at conferences;
- Contacts made through previous research by the report authors; and
- Suggestions from others.

Table A-1
Email Listservs Contacted

Listserv name	Listserv address
Department of Transportation Listserv	dot@listserv.nodak.edu
Institute of Transportation Engineers Discussion	itetraffic@lists.io.com
ITE Transportation Planning Discussion	ite_trans_planning@lists.io.com
ITE Safety Discussion	itesafety@lists.io.com
Travel Model Improvement Program (TMIP) Listserv	tmip@list.bts.gov
Transportation Infrastructure Affecting Cycling	facilities-n-planning@cycling.org
Pedestrian Discussion Group	pednet@flora.ottawa.on.ca
State Bicycle & Pedestrian Coordinators	bfa-stcoords@igc.org
Association of Pedestrian & Bicycle Professionals	apbp@smoke.suba.com
Physical Activity Listserv	phys-act@vm.sc.edu

In addition, to obtain broad coverage (in particular of local planners and advocates), the questionnaire was sent to 10 email listservs (see table A-1).

The questionnaire was not intended to yield a random or representative sample of responses. Rather, it was viewed as a low-cost means of giving as many people as possible the opportunity to respond and provide feedback. In conjunction with the other sources used for this study, it helps provide a picture of the most pressing data needs for various types of activities.

RESPONSES

Responses were obtained from 78 individuals. Most responses were received by email, although a few were sent as hard copy and a few were obtained through telephone conversations. The responses were entered into a Microsoft Access database and tabulated. Responses were received from a nonrandom cross-section of national, state, metropolitan, and local sources (figure A-1). Over two-thirds represented either government agencies or advocacy groups, while most of the rest represented universities or consulting firms (figure A-2). Responses by type of respondent are shown in table A-2. The groups most commonly represented included:

- State bicycle and pedestrian coordinators (8);
- Metropolitan planning organizations (MPOs), city planners, and county planners (16);
- Local advocacy groups or individual advocates (17);

- Researchers (10); and
- Public health and physical activity planners (10).

EXISTING DATA

The phrasing of the question, "What data sources do you rely upon?" left it to the respondent to interpret what was meant by "data source." As a result, some people cited specific types of data (travel survey, counts, etc.) while others cited sources of data (Department of Transportation (DOT) publication, state agency, and so forth).

Figure A-1
Responses by Scope of Activity

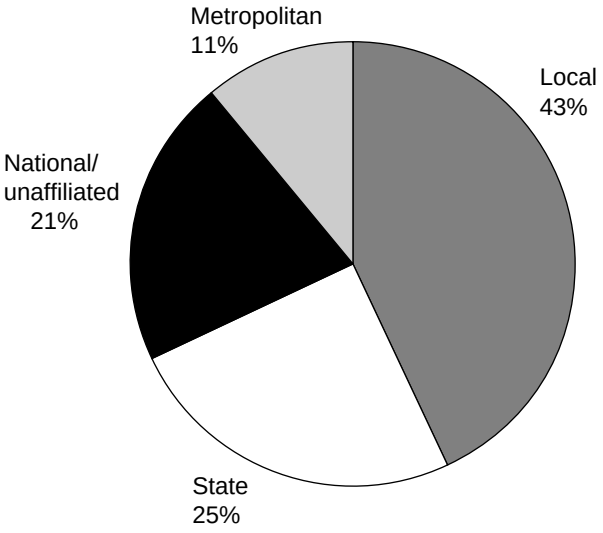

Table A-3 identifies the most commonly cited types of data. For information on user and trip characteristics, the U.S. Census Bureau was the most commonly cited source (seven citations); the Nationwide Personal Transportation Survey (NPTS) and metropolitan household travel surveys also received four citations each. Frequently cited local sources included bicycle and/or pedestrian counts (seven) and user surveys of attitudes, preferences, habits, etc. (five). For facilities data, six respondents cited state or local facility inventories or traffic counts. For crash data, a number of respondents cited state or local crash databases (12), with a few (3) citing national crash databases maintained by National Highway Traffic Safety Administration (NHTSA).

Figure A-2
Responses by Type of Organization

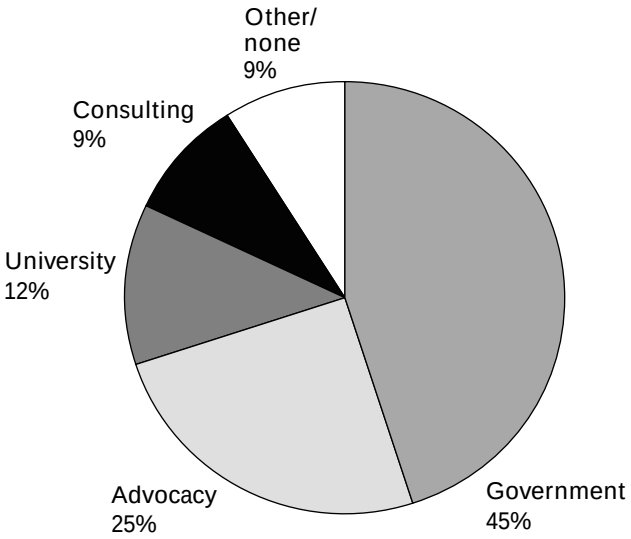

Table A-4 identifies sources of data cited by respondents. The most commonly cited sources included a state agency, usually a state DOT (13); U.S. DOT publications (10); primary data collection (10); published research (6); national public health agencies (6); and engineering manuals of practice (5). A number of respondents (11) also cited a variety of informal sources, such as magazines, newsletters, Internet discussion groups, and personal communication.

Table A-2
Survey Responses by Type of Respondent

Type of respondent	Responses
Project/system planning	
State (bike/pedestrian coordinator)	8
Metro (metropolitan planning organization)	8
Local government	8
Consulting	5
Subtotal	**29**
Advocacy	
National	3
State/local	17
Subtotal	**20**
Research	
Safety/design	6
System planning/demand analysis	3
Health/physical activity	1
Subtotal	**10**
Health/physical activity	
State department of health	7
Other	3
Subtotal	**10**
Other/unknown	**9**
Total	**78**

DATA NEEDS

The outreach effort conducted for this project asked the following questions to ascertain data needs:

- What types of data would be most useful to you but are not available?
- How would these data be useful?

Responses were categorized according to the type of data mentioned. Response frequencies are shown in table A-5. Since the responses do not represent a random sample of bicycle and pedestrian planners, researchers, and advocates, the frequency of responses should not be viewed as a prioritization. In particular, most responses came from planners and advocates at the state and local level. The results are generally consistent, however, with data needs identified through other forums by researchers and by national-level planners, policymakers, and advocates. Results are discussed according to the major categories of identified data needs as shown in table A-5.

Usage, Trip, and User Characteristics

Nearly 40 percent of survey respondents identified a need for better data on system usage and user characteristics. As discussed above, the most widely accessed sources of these data are the decennial census, the NPTS, and metropolitan household travel surveys. Other counts and surveys are conducted sporadically in particular areas or nationwide. The most frequently mentioned needs include:

- **Demand/usage indicators.** Sixteen respondents expressed the need for better indicators of system usage. Such indicators might include total bicycling or walking trips, numbers of people who bicycle or walk, mode shares, and miles of travel by nonmotorized modes. The need for such indicators was expressed primarily at a local level (city, county, or metropolitan area) but also at the state and national geographic scales. Reasons for wanting these data include tracking trends, determining the effective-

ness of policies and programs, and justifying programs and funding by demonstrating system use. This is an "aggregate" or summary-level category of data, although it may be developed from the same disaggregate sources as described below.

Table A-3
Types of Existing Data Cited

Type of data	Responses
Census	7
Nationwide Personal Transportation Survey	4
Local household travel surveys	4
Local attitude/use surveys	5
Local bike/pedestrian counts	7
State/local facility inventories	4
National crash databases	3
State, local crash databases	12
National Center for Health Statistics	6

- **Trip and user characteristics.** Fourteen respondents indicated a desire for better profiles of bicycle and pedestrian trips and travelers. These include distributions of trips by distance, purpose, and time of day; distributions of travelers and trips according to demographic and socioeconomic characteristics; and various cross-classifications of these variables. In other words, people want to know "who is traveling where, when, why, and how." This type of data is traditionally collected through household travel surveys, but as discussed above, most travel surveys contain inadequate data on bicycle and pedestrian trips. Most of these respondents expressed a desire for profile (i.e., aggregate-level) data on trips and travelers at the community or metropolitan area level. Such data might be obtained through improvements to standard household travel surveys or through travel surveys targeted specifically at bicyclists and pedestrians. A few respondents also identified a desire for better national-level profiles, as might be obtained through refinements to the NPTS or a national survey targeted specifically at bicyclists or pedestrians.

  Four respondents in this category specifically expressed a need for better travel survey data to support demand modeling. The improvements needed to make survey data more useful for modeling would be similar to those required to develop better summary statistics on travel characteristics. Finally, five respondents specifically expressed a need for better data on travel patterns of children and/or school trips.

Table A-4
Sources of Existing Data Cited

Sources of data	Responses
State agency (DOT, DOH, other)	13
Magazines, newsletters, Internet discussion	11
U.S. DOT publications	10
Primary data collection	10
CDC, NIH	6
Published research	6
Engineering manuals of practice	5
Local recreation or advocacy groups	4
MPO or city staff	3

KEY: CDC = Centers for Disease Control and Prevention; DOH = Department of Health; DOT = Department of Transportation; MPO = metropolitan planning organization; NIH = National Institutes of Health.

- **Facility counts/volumes.** Eight respondents mentioned a need for more and better bicycle and/or pedestrian count data. This type of data is similar to "demand/usage

Table A-5
Outreach Effort: Summary of Identified Data Needs

Type of data	Total	Percent
Primary data		
Usage, trip, and user characteristics	**34**	**43**
Demand/usage indicators (total, mode shares)	16	20
Trip and user characteristics (frequency, distance, destination, purpose, age, gender, etc.)	14	18
Counts/volumes on specific facilities	8	10
Exposure data (to relate to crash data)	7	9
Travel patterns of children, school trips	5	6
Trip generation rates	5	6
Household survey data/inputs to forecasting models	4	5
Bicycles in use/owned	3	4
Helmet usage	3	4
Preferences, needs, and attitudes	**11**	**14**
Descriptive data	8	10
For input to forecasting models	3	4
Facilities	**12**	**15**
Databases/inventories	8	10
Summary statistics/benchmarks	4	5
Ancillary facilities (showers, parking, etc.)	3	4
Crashes	**23**	**29**
Crash databases:	*17*	*22*
Location, characteristics, contributing factors	14	18
Nonmotor vehicle crashes	4	5
Nonfatality crashes/injury data	3	4
Links to other data (facilities, exposure, injury)	3	4
Summary crash data:	*7*	*9*
Contributing factors/causes	3	4
General crash data (crashes, crash rates)	2	3
Nonfatality crashes	1	1
Nonmotor-vehicle crashes	1	1
Bicyclist violations of motor vehicle code	1	1
Crime on trails	1	1
Secondary data		
Facility design	**22**	**28**
Safety impacts	13	16
Demand impacts	7	9
Recommended practices	4	5
Costing data for planning	2	3
Effects on motorist behavior and attitudes	1	1
Policies and programs	**10**	**13**
Recommended/model practices	6	8
Benefits of various policies/programs	3	4
Safety impacts	3	4
Demand impacts	1	1

indicators," but with the difference that the data are desired for specific facilities rather than for an area as a whole. Counts, if performed in a systematic manner at an adequate sample of locations, can provide a basis for estimating aggregate usage and tracking trends in usage; developing exposure measures for crash analysis; and calibrating travel models. They can also directly assist planning activities such as designing adequate facilities to accommodate traffic and prioritizing facilities for improvement.

- **Exposure data.** Seven respondents specifically indicated a need for "exposure" data. Exposure data are similar to usage indicators in that they quantify trips, miles of travel, etc. An additional purpose of exposure data, however, is to develop crash rates or risk measures (e.g., crashes per bicycle-mile of travel). As a result, data used to develop exposure measures may have more specific requirements than data that are collected just to determine levels and trends in system usage. It may be desirable, for example, to collect exposure data by facility type, time of day, bicyclist experience level, or any other measure that is important in classifying and analyzing crashes.
- **Trip generation data.** Five respondents (all consultants) identified the need for bicycle trip generation data by type of land use. Automobile trip generation rates, expressed in terms of trips per thousand square feet or another measure of the size of development, are widely used in transportation planning. They are developed by regressing traffic counts against size of development and other related measures, based on surveys at various locations, and are reported in the Institute of Transportation Engineers' Trip Generation. Consultants who work with such data would clearly appreciate similar data for bicyclists.
- **Other usage-related data.** Other desired data related to system usage include bicycles in use or owned (three respondents) and helmet usage (three respondents).

Preferences, Needs, and Attitudes

A total of 11 respondents expressed a desire for better data on preferences, expressed needs, and attitudes of existing and potential bicyclists and pedestrians. Preference data can assist in designing facilities, policies, and programs to have the greatest benefit to users and the greatest impact on attracting new bicyclists and pedestrian trips. Respondents specifically requested data on relative preferences for facility types, to assist with both facility design and travel modeling; reasons why people do not bicycle or walk and what would encourage them to do so; and perceptions of safety and the influence of safety concerns on bicycling or walking. Three of these respondents specifically indicated a need for preference data that could be used in demand modeling.

Facilities

Twelve respondents identified a need for better data on bicycle and pedestrian facilities. Two-thirds of these identified a need for databases indicating locations and characteristics of specific facilities, that is, "disaggregate" facility data. Desired data include not only the presence and characteristics of bicycle and pedestrian facilities, but other relevant characteristics such as roadway lane widths and traffic volumes. A number of respondents noted that having these data in Geographic Information System (GIS) format would be of great help in planning and analysis.

Better facilities data would primarily be useful in local planning activities, including developing compatibility ratings and recommended routes, identifying deficiencies, and identifying and prioritizing improvements. Some respondents also expressed a desire for facilities data in a format that can be related to other datasets, such as travel volumes and crashes.

In addition to facility databases, four respondents noted that it would be useful to have summary statistics of miles of bicycle lanes, sidewalks, etc. The purpose of having these data would be to measure progress in providing facilities and to set "benchmarks," for example, an actual versus desired ratio of bike lane-miles per capita or per road-mile.

Three respondents noted that it would also be useful to have either general inventories or know the specific locations of ancillary facilities, including bicycle parking and shower/locker facilities at workplaces.

Crashes

A total of 23 respondents indicated the need for better data on crashes. Seventeen of these respondents expressed the need for more complete or usable crash databases or for more detailed data on specific crashes. These disaggregate crash data (databases of individual crash records) are used by researchers in crash analysis as well as by planners in identifying hazard locations, crash causes, and countermeasures. In addition, seven of the respondents expressed the need for better aggregate crash data, that is, summary statistics by area, facility type, or crash type. Aggregate data can be useful both for tracking trends and for identifying areas in which improvement is needed. Some specific needs for improved crash data include:

- **Locations and causes of crashes.** A number of respondents were interested in knowing the locations and causes of crashes for planning purposes, and indicated that data in GIS format would be particularly useful for matching with facilities data. The quality of data on crash locations varies locally and by state, so some respondents might have access to high-

quality data while others might not. Some jurisdictions, for example, have developed GIS-based crash databases, but this technology has not yet been adopted throughout the country. The ease with which crash data can be obtained from the responsible agency can also vary locally.

- **Crash characteristics and contributing factors.** A number of respondents also indicated a need for additional and better quality data collection on crash characteristics and contributing factors. These data would help inform crash analysis and countermeasure development. Specific areas in which better data are needed include environmental variables such as roadway geometrics and visibility impairments; characteristics of those involved such as demographics, helmet use, light use, and bicyclist skill level; and other potential causal or contributing factors.
- **Specific types of crashes.** Some respondents also noted specific types of crashes for which data are particularly lacking. While the Fatal Accident Reporting System (FARS) provides a comprehensive inventory of fatalities, injury databases may not be comprehensive, and as the severity of the crash decreases the quality of the data and likelihood of reporting also decreases. Furthermore, a general lack of data on crashes or incidents that do not involve motor vehicles was noted. These might include, for example, bicycle-pedestrian collisions or single-bicycle incidents. Data of this type, in addition to tracking trends, would be useful in analyzing the safety impacts of various facility designs or specific facilities.
- **Injuries and outcomes.** Two respondents noted the need for better data on injuries and medical outcomes of crashes. Currently, injury severity is coded by an often untrained crash witness. Better data on injury types, severity, and costs can assist in analyzing the full costs of various types of crashes, designing appropriate countermeasures, and prioritizing specific sites or crash types for countermeasures.
- **Summary data.** Seven respondents indicated a desire for better summary-level data on crashes. Specific requests were for better reporting of contributing factors and causes of bicycle and pedestrian crashes; more complete reporting of nonfatality and nonmotor-vehicle crashes; bicyclist violations of the motor vehicle code; and crime on trails.

Secondary Data

The data needs discussed above all involve the collection, dissemination, and/or summary analysis of primary data. Over one-third of survey respondents, however, also interpreted "data" to mean secondary data sources, such as results of research studies and recommended practices. Respondents involved in local planning and facility design rely heavily on these data to assist in choosing

appropriate design treatments and recommending policy actions. The results are summarized here under two categories: 1) facility design and 2) policies and programs.

- **Facility design.** Twenty-two respondents indicated a desire for data and recommendations to help inform the design of facilities. Over half requested evidence on the safety impacts of various design features, while one-third wanted data on the demand impacts of design features. Similarly, four requested recommended practices (such as would be found in a design manual), while two requested costing data for various facility types, for planning purposes.

  The most frequently mentioned design issue of interest was the demand and safety effects of various bicycle facility designs (bike paths, bike lanes, wide curb lanes, lane widths, and other design alternatives). Other specific design features for which better information was requested include contra-flow lanes, intersection treatments, rumble strips, angled parking, mid-block pedestrian crossings, pedestrian overpasses, traffic calming, and mixed-use and "pedestrian-friendly" neighborhoods.

- **Policies and programs.** Ten respondents requested information to support the development of policies and programs, including education programs, promotional efforts, and city-wide "bicycle-friendly" or "pedestrian-friendly" policies. As with facility design, some respondents were interested in the safety, demand, and other impacts of these programs. Others were interested in learning about recommended or "model" programs that have been demonstrated to be effective in other areas.

OPTIONS FOR ADDRESSING DATA NEEDS

In addition to asking about existing sources and data needs, the outreach effort conducted for this project also asked respondents whether they had any suggestions for:

- More effective dissemination and utilization of existing data sources,
- Cost-effective ways of collecting new data (enhancement of existing surveys, use of advanced surveillance technologies, etc.), and
- Assistance activities that would help encourage and facilitate the collection of local data.

Responses are summarized below.

Better Use of Existing Data

Half of the survey respondents provided suggestions for making better use of existing data. Not surprisingly for a survey conducted primarily by email, the vast majority of these respondents commented that all available data should be made readily accessible via the Internet. (While use of the Internet is not yet ubiquitous, one respondent commented that "Almost all of us who do bike planning for a living are online and in contact with each other.") A few respondents specifically suggested that a centralized, searchable database would be useful, as would links to related sites with relevant data such as NHTSA and the Centers for Disease Control and Prevention (CDC). A few respondents also noted existing good examples of data dissemination, including the Bureau of Transportation Statistics' (BTS') National Transportation Library and the Federal Highway Administration (FHWA) Bicycle/Pedestrian Clearinghouse, and suggested expanding these applications.

Five respondents noted a general need for better awareness of existing data, where to obtain it, and how to use it.

Other suggestions for collecting and disseminating existing data included:

1. Use of existing publications, such as American Planning Association newsletters and the Institute of Transportation Engineer's Trip Generation;
2. Collection and dissemination of local data and survey results through state bicycle and pedestrian coordinators or other state-level staff;
3. Dissemination through other groups, such as the National Bicycle Safety Network and state departments of health;
4. Additional analysis and publication of summary-level bicycle- and pedestrian-related crash data, using existing national and state databases;
5. More widespread publication and presentation of bicycle- and pedestrian-related research;
6. Maintaining contact lists of local governments and advocacy groups who are working to improve bicycle and pedestrian conditions; and
7. Sponsorship of a conference on bicycle and pedestrian site design issues, including case studies, in conjunction with developers.

Collection of New Data

A number of respondents also provided suggested methods for collecting additional data. Suggestions generally fell into two categories: 1) use of new tech-

nologies and 2) improved surveying and sampling methods. Suggestions for use of new technologies included:

- Video monitoring for bicycle and pedestrian counts-including both new monitoring systems and use of existing systems established for traffic or street security monitoring;
- Infrared sensors;
- Dataloggers that are placed on a person and measure physical and environmental variables;
- Use of GPS for pedestrian trip tracking; and
- Laptop-based crash reporting systems.

Suggestions for conducting or expanding surveys included:

- Addition of questions to the NPTS;
- Addition of questions to health surveys, including the Behavioral Risk Factor Surveillance System and the Youth Risk Factor Survey;
- Distribution of surveys at bicycle shops and pedestrian trip generators, such as schools and shopping malls;
- Surveys of people accessing mass transit;
- Surveys using the Internet or newspapers; and
- Use of local bicycle groups to identify problem areas.

Assistance with Data Collection

Respondents' suggestions for how the BTS or other federal agencies could assist with data collection generally fell into three categories: technical assistance, financial assistance, and regulations/ mandates.

- *Technical assistance.* Seven respondents identified the need for technical assistance, specifically:
  - Developing uniform data collection methodology, reporting formats, and analysis methods;
  - Demonstrating, evaluating, and testing new data collection technologies; and
  - Developing case studies of successsful data collection efforts.
- *Financial assistance.* Eleven respondents noted a shortage of local resources for data collection and suggested that financial assistance would

be helpful in the form of grants or other funding specifically designated for data collection. One respondent also suggested funding bicycle and pedestrian *research studies* at the local level. Another suggested enlisting local advocacy, religious, and community groups to provide volunteer assistance with counts.

- *Requirements/mandates.* Seven respondents suggested that bicycle and pedestrian data collection be required as a part of transportation data collection or transportation planning efforts that benefit from federal funding. One respondent suggested that state DOTs be required to work with state departments of health.
- *Assistance in coordinating efforts.* Suggestions in this area included maintaining a database of bicycle advocates and planners, and assisting in coordination among groups (e.g., between local government staff and a university to coordinate research).

APPENDIX B
Other Recent Assessments of Data Needs

This project also reviewed the results of other recent assessments of bicycle and pedestrian data needs. These include:

- A 1997 conference sponsored by the Bureau of Transportation Statistics (BTS) in Irvine, California, to identify transportation-related information needs, including bicycle and pedestrian data;
- The BTS' *Transportation Statistics Beyond ISTEA: Critical Gaps and Strategic Responses,* an assessment of needs for transportation statistics; and
- A Federal Highway Administration (FHWA)-sponsored guidebook on methods for forecasting bicycle and pedestrian travel.

To a large extent, the recommendations from these efforts corroborate the results of the outreach effort conducted for this project. Key findings are summarized below.

IRVINE CONFERENCE

In March 1997, the BTS cosponsored a conference in Irvine, California, entitled "Information Needs to Support State and Local Transportation Decisionmaking into the 21st Century." The conference resulted in a number of recommendations relevant to bicycle and pedestrian data, notably:

- Development of a nationwide transportation facility and service database, including bicycle and pedestrian facilities, with accuracy to scale maps of 1:100,000 or less;
- Better trip data, including origin-destination data at a greater level of temporal and spatial detail; trip chaining; and multiple modes;
- Better information on user behavior and characteristics;
- Linkage of system data with data on system use and surroundings;
- Effects of transportation systems management (TSM) and travel demand management (TDM) strategies on system use and characteristics; and
- Customer satisfaction and user perceptions of performance.

BUREAU OF TRANSPORTATION STATISTICS ASSESSMENT

In 1998, the Bureau of Transportation Statistics published an assessment of needs for transportation statistics (USDOT BTS 1998). While the focus was not specifically on bicycle and pedestrian data, the document did identify a number of bicycle- and pedestrian-related data needs. These include:

- Passenger travel for disadvantaged people, including low-income families without cars;
- Exposure measures for bicycling and walking, especially for children and the elderly;
- Underreporting of bicycle and walk trips in national travel surveys;
- Locations and attributes of crashes, especially nonfatal crashes;
- Incidents not involving motor vehicles; and
- Standardization and integration of geographically based data.

BICYCLE AND PEDESTRIAN DEMAND FORECASTING GUIDEBOOK

FHWA recently developed a guidebook on methods of forecasting bicycle and pedestrian travel (Cambridge Systematics and BFA 1999). While the focus of the guidebook is on methodologies, a number of critical data gaps were identified that inhibit demand forecasting. These include:

- Data on bicycle and pedestrian trip patterns at the local level (nonmotorized sample sizes in household travel surveys are generally insufficient for forecasting purposes);

- Facility-level data-for example, the locations and characteristics of bicycle and pedestrian facilities-for use in transportation network databases used for modeling;
- Environmental data in land use databases; for example, descriptors of the quality of the pedestrian environment or the mix of land uses in an area; and
- Preferences for various mode, route, etc. attributes in a format that can be used in demand modeling.

REFERENCES

Cambridge Systematics and Bicycle Federation of America (BFA). 1999. *Guidebook on Methods to Estimate Non-Motorized Travel*, FHWA-RD-98-165. Produced for the U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

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