PEDESTRIAN AND BICYCLE DATA COLLECTION

TASK 2 - ASSESSMENT

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SUMMARY

This document contains the results of a literature review and series of stakeholder conversations via webinar and individual calls undertaken for DTFH61-11-F-00031, "Pedestrian and Bicycle Data Collection." This document contains two sections:

(1) Pedestrian Data Collection, and
(2) Bicycle Data Collection.

Each section contains a summary of the state-of-the-practice as it existed in Fall 2011 based on available literature and practitioner input.

The literature review focused on papers written in English. The review emphasized research conducted during the past decade to ensure that emerging technologies and methods were properly identified. Included in the search was literature discussing how various counting programs are conducted by local governments, metropolitan planning organizations (MPOs), state Departments of transportation (DOTs), and national and international transportation agencies.

A presentation containing information on both pedestrian and bicycle data collection practices was disseminated via webinar. Questions aimed at documenting current practice from the practitioners' viewpoint were included. The webinar was conducted four times. Twenty-five state agencies, eight planning agencies and twenty-one other entities active in collecting, using and or analyzing pedestrian and or bicycle data participated. Subsequent to the webinars, in-depth conversations were held with eight individuals identified as being heavily involved in the collection and or use of pedestrian and bicycle data.

The top two reasons for collecting pedestrian counts are

(1) Safety analyses, and
(2) Project specific needs (most commonly before and after studies).

The two project specific topics which received nearly the same number of votes were: project design and evaluation with before and after studies ranked slightly higher than design. These are the same reasons, along with project selection, that are anticipated to need pedestrian data in the future. There are no generally accepted sampling or factoring processes. The data are typically stored in project specific formats. Pedestrian volumes have been documented to vary by both time of day and day of week. Equipment for counting pedestrians is capable of working under all weather conditions and in both on-road and off-road locations. An area of needed equipment improvement is better identification of numbers of individuals when in groups.

The top two reasons for collecting bicycle counts are:

(1) Project evaluation (before and after studies), and
(2) Safety analyses.

Other project specific uses (selection and design) both ranked lower than safety analyses. These are also anticipated to be the principal future needs (and ranking) for bicycle counts. There are

no generally accepted sampling or factoring processes. Bicycle volumes have been documented to vary by weather, route conditions, day of week and time of day. Equipment for counting bicycles is capable of collecting information under all weather conditions and in both on-road and off-road locations. Areas of needed equipment improvement include the ability to sort out clusters of bicyclists and to capture composite material frames. Bicycles made from composite materials (primarily carbon fiber) are not detectable by inductive loops, a common type of bicycle count technology.

From the limited sample of detailed discussions with researchers and practitioners several broad conclusions and recommendations were drawn. These include the following:

- A variety of bicycle and pedestrian count technologies are used nationwide. The most appropriate technologies for a given agency are dependent on the agency's particular setting and needs.
- All count technologies, including manual counts, are subject to error. Adjustment factors may be appropriate for many applications, but would necessarily vary based on the source of the error.
- Infrared detectors should be situated in locations where pedestrian traffic is on the move, as opposed to milling about.
- By its very nature, active data collection, in which those being counted are aware of their participation, is inherently not well suited for traffic monitoring purposes. That said, the increasingly ubiquitous nature of global positioning system (GPS) trip data suggests that it should be continually monitored for potential applications.
- In addition to the many uses discussed frequently in the Task 1 literature review, bicycle and pedestrian count data can and is regularly used to assist in safety analyses and in securing funding (or justifying expenditures) for new facilities. Use of count data for facility design exists but is less common.
- The common practice of conducting short-term counts and extrapolating them, while understood for practical reasons, is often insufficient and has the potential to produce skewed interpretations of the level of bicycling and or walking occurring in a community. At a minimum, multiple 24-hour counts should be conducted or select permanent counters should also be installed to provide validation of factoring and sampling processes. While some national level estimates are available for hourly to daily bicycle and pedestrian volume estimates (K_d factors), local variations in travel patterns require location specific sampling.
- The selection of local bicycle and pedestrian count sites should be representative of the types of facilities for which they serve as a sample (e.g. urban bike lanes used predominantly by commuters, recreational trails in rural areas).
- At a national level, it may be appropriate for the Federal government to manage a database and or clearinghouse for bicycle and pedestrian count data.
- The extrapolation of limited count locations to larger geographic areas is a common struggle and no known reliable solutions exist at this time.

INTRODUCTION

Non-motorized (i.e., bicycle and pedestrian) travel monitoring has become an important element in numerous agencies' planning efforts. However, there is no standardized technology for conducting counts. Most bicycle and pedestrian monitoring programs use periodic manual counts. Continuous monitoring programs are becoming more commonplace with infrared counters being the most popular technology, but video and laser counting technology appear to be promising. Pneumatic tubes and inductive loops, while not practical for pedestrian traffic, have been used effectively on bicycle facilities. Each of these methods has its best applications for given specific operational, geometric, and weather-related factors. Information collected during the course of this project is summarized in Table 1. However, limited guidance is currently available to agencies on best practices to implement a non-motorized counting program. Widely available documents include the following:

- The AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*
- The AASHTO *Guide for the Development of Bicycle Facilities*

Neither of these two documents contains more than a handful of sentences addressing count collection, utilization or storage. Updates are underway to the AASHTO pedestrian guide that are expected to result in more information on creating pedestrian counting programs.

This project was conducted to provide a summary of the state-of-the-practice for counting programs which collect data on non-motorized travel. The methods, equipment, factoring, storage, and reporting were all of interest. The first task of the project was a literature review. The material resulting from the literature review was used to develop a set of webinars, which functioned as a two-way exchange of information. The results of the literature review were presented during the webinars. Unpublished information on current practice and activities was requested via a series of polls as the webinar proceeded. In addition, discussions with eight individuals active in various aspects of pedestrian and or bicycle data collection have been documented in this report. The summary of both activities will support the current *Traffic Monitoring Guide* (TMG) update, including potentially suggesting record formats which could be adopted nationwide to simplify data exchange between organizations.

The literature review began with the identification and prioritization of sources including the Pedestrian and Bicycle Information Center (PBIC) online libraries, TRIS, ITRD (the database of the OECD's Joint Transportation Research Center), the ITE Journal, the APTA Journal and the TRR database. The literature search focused on papers written in English, but looked at both U.S. and foreign practices. The review also emphasized, but was not limited to, research from the past decade to ensure that emerging technologies and methods were properly identified. A second phase of the literature review looked at implementing jurisdictions (local governments, MPOs, state DOTs, and national transportation agencies) for application of the techniques. The literature review is included as Appendix A – Literature Review in this report.

To gather additional information, a webinar, repeated four times, and a series of discussions with practitioners were conducted. The webinar had both targeted attendees from states and metropolitan planning organizations (MPOs) and a generally broadcast invitation to the transportation community. The list of practitioners was developed based on personal contacts, FHWA input and the sources found in the Task 1 literature review.

The webinars were formulated to both provide information on the state-of-the-practice to participants and to obtain information on their experience. A set of slides summarizing the literature review, focusing on both practice and gaps, was developed for presentation during the webinar. A set of questions to accompany the webinar focusing on who the participants were, their thoughts on current and anticipated uses, and their experience (with equipment), data processing practices and data sharing by means of a commonly accepted record format was created. The slides and the question list were available for download by all participants via the library on the webinar site. The materials were also forwarded by e-mail to individuals who requested them. The materials are included in this report as Appendix B – Webinar Content.

This project was intended to get participation from all 50 states and at least 10 Metropolitan planning organizations (MPOs.) At least one contact was identified in all fifty states, the District of Columbia, and Puerto Rico, with invitations accepted by forty-one states and the District of Columbia. Twenty-four states and the District of Columbia actually had one or more personnel attend. Appendix C – Webinar Attendees discusses participation and the invitation process.

During the course of the four webinars, data were collected in three formats: screenshots of poll results as broadcasted during the webinars, CSV files downloaded from the software used for polling, and answers provided via the chat box. All three data forms were combined to provide the summary of results for each question. The details of the analysis are included as Appendix D – Webinar Poll Results.

Following the four webinars a dozen individuals were contacted and their input solicited for the project. Appendix E – Follow up Areas and Appendix F – Summary of Discussions with Practitioners provide details on the questions which framed each discussion and the results of the discussions with the eight practitioners who participated.

CURRENTLY AVAILABLE TECHONOLGIES

One of the outcomes of the project was identifying the types of equipment currently available for automated data collection and potential advantages, disadvantages and potential error rates. This information is summarized in Table 1. The "Data Collection Equipment and Technology" sections include additional information and detail. The error sources are technology specific and are in addition to the failure to follow good practice in installation, validation and maintenance of equipment.

Table 1. Existing Technology Options and Implementation Implications

Technology	Data Type	Advantages	Cautions	Error Source and or Reported Range
Manual Counts	Bicycle & Pedestrian	Minimal equipment needs; Accuracy (assuming proper training and supervision); Ability to gather extra user data	High labor cost; Not suitable for long-term/permanent counts; Inability to verify data	Observer inattention; Ulterior motives
Video Counts (Manual)	Bicycle & Pedestrian	High accuracy; Verifiable data	Equipment acquisition, installation, and maintenance costs; Not suited for low-light conditions	Equipment malfunction; Improper vantage points; 92-98% accuracy
Computer Visioning	Bicycle & Pedestrian	Data verification; Automated processes; Ideal for crowded environments	Development complexity; Non-standard and non-transferable approaches	Visual occlusion; 85-100% accuracy
Active Infrared	Bicycle & Pedestrian	Portability; Relatively low cost	Subject to interference in outdoor settings	False positives from unintended objects
Passive Infrared	Bicycle & Pedestrian	Widely available; Thoroughly tested; Relatively low cost	Tendency to undercount groups or side-by-side travelers	Side-by-side or group travel; 72-98% accuracy
Piezometric Pads	Pedestrian (strips for bicycle mode)	Permanent; Low post-installation cost	High installation cost	Nearly stationary pedestrians
Inductive Loops	Bicycle	Permanent	Cannot count pedestrians; Difficulty detecting some bicycle types; Difficult to apply in shared lane environments	Undercounting of bicyclists that do not conduct electricity; False positives from motor vehicles; Degradation over time; 83-98% accuracy
Pneumatic Tubes	Bicycle	Readily available devices; Familiar data formats	Cannot count pedestrians; safety hazard for some facility users	Low-speed travel; 73-100% accuracy

CONCLUSIONS

Several broad conclusions can be drawn from the limited sample of detailed discussions with researchers and practitioners. These include the following:

- A variety of bicycle and pedestrian count technologies are used nationwide. The most appropriate technologies for a given agency are dependent on the agency's particular setting and needs.
- All count technologies, including manual counts, are subject to error. Adjustment factors may be appropriate for many applications, but would necessarily vary based on the source of the error.
- Infrared detectors should be situated in locations where pedestrian traffic is on the move, as opposed to milling about.
- By its very nature, active data collection, in which those being counted are aware of their participation, is inherently not well suited for traffic monitoring purposes. That said, the increasingly ubiquitous nature of GPS trip data suggests that it should be continually monitored for potential applications.
- In addition to the many uses discussed frequently in the Task 1 literature review, bicycle and pedestrian count data can be used and is regularly used to assist in safety analyses and in securing funding (or justifying expenditures) for new facilities. Use of count data for facility design exists but is less common.
- The common practice of conducting short-term counts and extrapolating them, while understood for practical reasons, is often insufficient and has the potential to produce skewed interpretations of the level of bicycling and or walking occurring in a community. At a minimum, select permanent counters should also be installed to provide validation. The information to design an effective program remains an area for further study.
- At a national level, it may be appropriate for the Federal government to manage a database and or clearinghouse for bicycle and pedestrian count data.
- The extrapolation of limited count locations to larger geographic areas is a common struggle and no known reliable solutions exist at this time.

RECOMMENDATIONS

Based on the information available through this project, the following recommendations are made:

- Identify national and regional pedestrian and bicycle data collection needs beyond safety analyses that require the data obtained from permanent automated data collection. Establish a methodology for site selection that permits transferability of data and development of national a regional statistics for these multiple needs.
- A standard record format for automated bicycle data collection should be established which includes:
    - Location information suitable for geocoding and data exchange between agencies
    - Date
    - Start time (HR:MM:SS)
    - End time (HR:MM:SS)
    - Collection method (code for technology)
    - Classification scheme (more than one is anticipated depending on anticipated data use)

    - Interval for volume (zero being used for individual vehicle records, with increments that are consistent with other volume collection such as 5 or 15 min, hourly or daily values)
    - Direction
    - Lane (anticipating use of bike lanes or shoulders in addition to traffic lanes being counted)
    - Volume bins for up to 8 classes
    - Station ID or other unique identifier for a site by lane for geometric and other site-specific but invariant data)
    - Weather (coded for sun, cloudy, rain, snow, windy and the like)
    - Low speed (optional)
    - Average speed (optional)
    - High speed (optional)
- A standard record format for automated pedestrian data collection should be established which includes:
    - Location information suitable for geocoding and data exchange between agencies
    - Date
    - Start time (HR:MM:SS)
    - End time (HR:MM:SS)
    - Collection method (code for technology)
    - Classification scheme (more than one is anticipated depending on anticipated data use)
    - Interval for volume (zero being used for individual vehicle records, with increments that are consistent with other volume collection such as 5 or 15 min, hourly or daily values)
    - Direction
    - Lane (anticipating use of roadways and shoulders as well as sidewalks being counted)
    - Volume bins for up to 8 classes
    - Station ID or other unique identifier for a site by lane for geometric and other site-specific but invariant data)
    - Weather
- Additional factoring approaches should be investigated. The process associated with the National Pedestrian and Bicycle Data Collection project to expand two hour manual counts has limitations.
- A recommended counting period should be developed for automated pedestrian and bicycle volume data collection which reflects the anticipated the use of the collected data and the technologies used.
- A recommended practice on how to locate permanent automated data collection for pedestrians and bicycle counts should be established which reflects the needs to establish reference information for safety analyses and factoring.

PEDESTRIAN DATA COLLECTION

FIELD EQUIPMENT

This project focused on continuous count practices. However, the majority of the experience claimed by the webinar participants was in the area of manual counts. For those who used automated methods, the most common ones were manual reduction of video and either active or passive infrared sensors. Details on experience can be found in APPENDIX D – WEBINAR POLL RESULTS -

Equipment Experience:

Question 8 - Pedestrian count methods used:

Question 9- Which of the following automated technologies has your agency employed for pedestrian counts?

Impact Sensors

Common impact sensors such as loops and tubes are not suitable for pedestrian counting. The only identified impact sensor for pedestrian data collection was the piezometric pad. Use of this device was reported by less than five percent of the participants.

Video

Video data collection may involve manual interpretation of the data or computer visioning techniques. Manual interpretation of video is the most common "automated" process of pedestrian data collection. Nearly thirty percent of equipment users reported application of this technology. Computer visioning (described below) is generally focused on a specific counting project.

Permanent Counters

All of the technologies identified, other than video, are usable for permanent counting. Active infrared is more suitable for indoor use. Computer visioning is generally not transferrable between counting projects. Most of the webinar attendees have fewer than five permanent bicycle or pedestrian count locations. (Question 15 - How many permanent bike and or pedestrian counters do you operate on an ongoing basis?)

Portable Counters

The infrared and video technologies can be used for portable counts.

Special Counts

Active data collection technologies (typically GPS enabled devices) are not currently considered suitable to conduct long-term count data collection for pedestrians although Bluetooth monitoring may have potential.

DATA COLLECTION EQUIPMENT AND TECHNOLOGY

The Task 1 literature review indicated that a wide variety of techniques and equipment types are currently used to count pedestrians on trails and within the roadway environment. The equipment types included in this section of the literature review were presented during the webinars and most were reported by the webinar participants to be in widespread use. The majority of techniques can be applied to both modes, while some are mode-specific by nature. This section identifies and briefly describes the primary counting equipment types, as well as their key inherent advantages and disadvantages for pedestrian counts.

Manual Counts

Manual counts, in which a person situated in the field counts pedestrians as they pass the count station, likely remains the most prevalent type of data collection technique because equipment is not required. The observer merely counts facility users using pen and paper or a clicker-type device. Manual counts have the potential to be the most accurate type of count, but the observers must be well-trained and, in some cases, well-supervised. Furthermore, field observers can easily gather other user characteristics (e.g. direction of travel, gender, group size, strollers) with relative ease. Despite not requiring equipment and the potential for high accuracy, manual counts are frequently not conducted because of several inherent drawbacks. These drawbacks include the significant labor cost, the associated impracticality of conducting long-term or permanent counts, and an inability to verify data, which is particularly important if volunteer staff are used.

Video Counts (Manual)

Another common variation on manual counts is to videotape the facility and have an observer count users while watching the resulting video. Video-based counts offer some advantages over other manual counts. Specifically, the ability to re-watch footage improves accuracy and allows for data verification while the ability to bypass periods of inactivity can reduce labor costs and thereby increase the span of data collection. However, the camera setups can be expensive to acquire, install, and maintain.

Computer Visioning

Computer visioning refers to any type of video-based data collection that counts and classifies users through a computer model or algorithm rather than through a manual process. Computer visioning applications have proliferated in recent years because of the inherent advantages they offer (e.g., data verification, labor reduction, and success in crowded settings) and improvements in technology. However, each computer visioning process tends to be different because of its complex nature and the lack of a standardized approach.

The processes documented in the research and discussed during the subsequent interviews were developed by researchers to test algorithms that can be used to detect individual pedestrians, determine their direction and speeds, and in some cases map their movements. The algorithms developed are specific to the equipment used, its orientation and the environment in which it is deployed. As a result, there are no “off-the-shelf” products to implement the computer visioning methods documented in the research and the technology remains largely non-transferable.

Active Infrared

Active infrared detectors sense and count pedestrians when an infrared beam is broken. Active infrared detectors are often used because they are highly portable for counting at different locations, they allow for longer-term counts, and they are relatively low-cost compared to other automated count equipment. Active infrared detectors remain more appropriate for indoor use because of their sensitivity to interference from objects that are not intended to be counted such as rain, leaves, and animals. While this drawback is reported to be lessening as technology improves, it remains less practical for installation along outdoor transportation facilities than other devices.

Passive Infrared

Passive infrared detectors produce an image of heat that indicates the presence of a pedestrian or bicyclist. The literature review suggests that passive infrared detectors are the most widely tested and perhaps the most widely used of the automated count technologies. These devices are viewed favorably by many researchers and practitioners because they are widely available, relatively low-cost, have been thoroughly tested, and have generally been shown to produce good accuracy rates. There is a range of error rates, however, which is usually related to passive infrared detectors' frequent inability to distinguish distinct users when they are traveling side by side or in groups.

Piezometric Pads

Piezometric pads are devices embedded within the walking surface used to detect pressure that is applied as pedestrians traverse them. This is another equipment type that provides a permanent source of count data and it has the added benefit of low maintenance costs following installation. That installation, however, can be expensive unless performed in conjunction with an ongoing construction project. It is worth noting that similar devices, sometimes referred to as piezometric strips, can be used to count bicycles using a similar technique.

PROCESSING DATA

Very little information was obtained on data processing activities both through the webinars and the practitioner discussions. This can be traced to the large number of participants with little or no experience in the area and the limited numbers of counts conducted. Almost half the webinar attendees reported fewer than 10 pedestrian counts a year. (Question 13 - How many pedestrian counts do you do a year?) The Traffic Monitoring guide update is working to improve procedures in this area.

Factoring Methods

Select practitioners indicated that various factoring methods exist and are appropriate for use. The National Bicycle and Pedestrian Documentation Project provides a series of tables to extrapolate hourly volume counts to annual volumes. Numerous practitioners have recognized that the NBPDP adjustment factors are based upon a significant amount of data. However, they also note that travel volume distributions vary greatly from location to location and should be confirmed at local (and frequently site specific) long term count sites. They also suggest that such factors were more likely location-specific than regionally or nationally transferable.

Variance of Data

Information on data variance was limited. Several practitioners in discussing their count programs mentioned sources of error, as outlined in Table 1.

Minimum Counts and Sampling

There is no documented information on how to determine the minimum number of counts or a sampling procedure. Ideally, multiple counts would be conducted over similar time periods and checked for consistency and confidence level. The sample size and number of counts required to obtain a desirable level of confidence is dependent upon the variation in the sample and the level of confidence one wants to attain. For hour of day counts, the distribution would need to be evaluated to determine the confidence of level of hourly-to-daily factors.

The fourth webinar had a vigorous participant discussion on some of the recommended practices for sampling periods. Some of the practitioners had comments on use of portable counters and short period counts in their counting programs.

REPORTING INFORMATION

Colorado DOT is the only agency that identified a standard reporting format based on the traffic data software package they use for processing other traffic data. An example of Colorado DOT's online output format (December 8, 2011) follows.

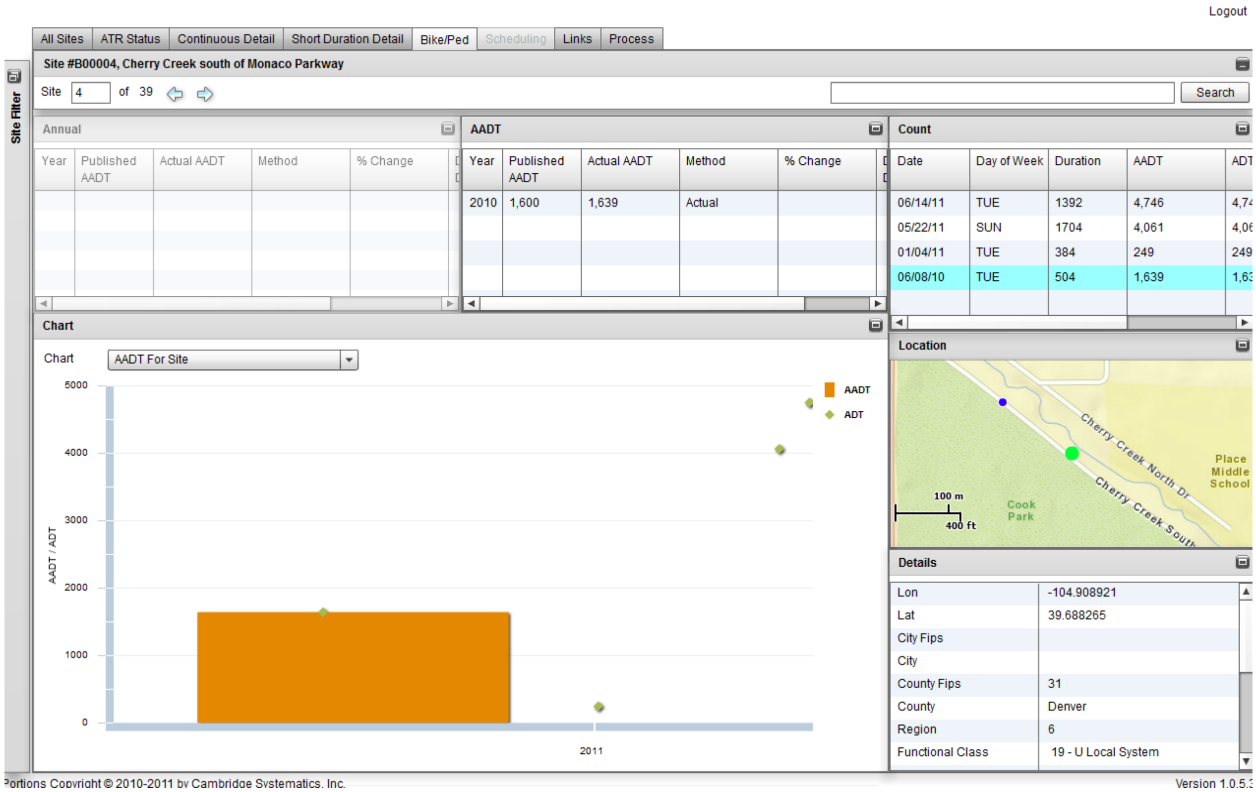

Figure 1. Sample On-line Statistics Output - Colorado DOT

UTILIZING DIFFERENT SOURCES

Active data collection with devices worn or carried by pedestrians is thought to have potential applications by several of the researchers. It is not, however, in common use for pure counting or monitoring programs. The individuals used for data collection purposes are self-selecting limiting the population and coverage areas. These biases cannot be satisfactorily addressed without use of significant supplemental data collection activities to obtaining data for factoring and other purposes that need to include the entire population.

FORMATS

A series of questions was asked to see what types of information webinar attendees considered relevant to a pedestrian count record:

Question 21 - Which of the following should be MANDATORY in a national pedestrian data record?

Question 22 - Which of the following would be nice to have in a national pedestrian data record?

Question 23 - Which of the following should be OMITTED from a national pedestrian data record?

Responses recommended as mandatory by sixty-five percent of poll participants are included in the “should” category. Responses selected by at least fifty percent of the respondents as either mandatory or nice are identified as “could be included”.

Based on the input of the attendees, a standard pedestrian count record should include the following items:

- Station ID (67%),
- Location information that permits geocoding (75% latitude/longitude),
- Date (100%),
- Time (100%),
- The interval over which the data was collected (88%), and
- Weather (75%).

Additional potential record items that could be included are:

- Direction (53%),
- Collection method (59% mandatory),
- Location*(51% street address),
- Classification scheme (53%), and
- Weather* (53%).

The fact that weather and location show up twice may reflect some uncertainty on how that variable would be quantified.

The purpose of the count was not recommended for inclusion in the record.

The distribution of responses from the webinar attendees by record item can be seen in Table 2.

Table 2. Pedestrian Data Record Field Options

Pedestrian Data Record – Candidates for Data Fields	Mandatory	Nice	Omitted
Station ID	**67%**	25%	8%
Location (latitude/longitude)	**75%**	33%	4%
Location (route/milepost)	35%	37%	4%
Location (street name/address)	**65%**	**51%**	6%
Date	**100%**	39%	2%
Time	**100%**	41%	2%
Direction	59%	**53%**	8%
Classifications	39%	**53%**	10%
Collection Method	59%	45%*	4%
Interval for volume (i.e. hour, 15 minutes)	**88**%	33%	2%
Purpose	14%	41%	**51%**
Group size	12%	41%	43%
Weather	**75%**	**53%**	6%

*Exceeded 50% for mandatory

REASONS FOR COLLECTION

The most common reasons for pedestrian counts according to the webinar attendees are:

- Safety analyses,
- Trends analyses,
- Before and after studies, and
- Project design.

Before and after studies are anticipated to increase the need for pedestrian counts as reported in APPENDIX D – WEBINAR POLL RESULTS, Current and Anticipated Data Uses, Question 4- Pedestrian counts are collected for: and Question 5 - Pedestrian counts are anticipated to be needed for:

BICYCLE DATA COLLECTION

FIELD EQUIPMENT

As noted in the previous chapter, this project focused on continuous count practices. However, the majority of the experience claimed by the webinar participants was in the area of manual counts. For those who used automated methods, the most common ones were pneumatic tubes followed by manual video and inductive loops. Details on experience can be found in APPENDIX D – WEBINAR POLL RESULTS.

Equipment Experience:

> Question 10 - Bicycle count methods used:
>
> Question 11- Which of the following technologies has your agency employed for bicycle counts?

Impact Sensors

Impact sensors can be used for bicycle data collection. However, sensors such as tubes which protrude above the surface can pose a tripping hazard to other users of the facility (rollerbladers, individuals with canes or other mobility assistance devices, strollers.)

Video

Video data collection may involve manual interpretation of the data or computer visioning techniques. Manual interpretation of video is the most common "automated" process of bicycle data collection. Nearly thirty percent of equipment users reported application of this technology. Computer visioning is generally focused on a specific counting project.

Permanent Counters

All of the technologies identified are usable for permanent counting. Active infrared is more suitable for indoor use. Computer visioning is generally not transferrable between counting projects. Most of the webinar attendees have fewer than five permanent bicycle or pedestrian count locations. (Question 15 - How many permanent bike and or pedestrian counters do you operate on an ongoing basis?)

Portable Counters

The tube sensor, infrared and video technologies can be used for portable counts.

Special Counts

Active data collection technologies are not currently considered suitable to do long-term count data collection for bicyclists although Bluetooth monitoring may have potential.

DATA COLLECTION EQUIPMENT AND TECHNOLOGY

The Task 1 literature review indicated that a wide variety of techniques and equipment types are currently used to count bicycles and pedestrians on trails and within the roadway environment. The equipment types included in this section of the literature review were presented during the practitioner webinars and most were reported by the webinar participants to be in widespread use. The majority of techniques can be applied to both modes, while some are mode-specific by nature. This section identifies and briefly describes the primary counting equipment types, as well as their key inherent advantages and disadvantages for bicycle counts.

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Manual counts, in which a person situated in the field counts bicyclists as they pass the count station, likely remains the most prevalent type of data collection because equipment is not required. The observer merely counts facility users using pen and paper or a clicker-type device. Manual counts have the potential to be the most accurate type of count, but the observers must be well-trained and in some cases well-supervised. Furthermore, field observers can easily gather other user characteristics (e.g. direction of travel, helmet use, gender) with relative ease. Despite not requiring equipment and the potential for high accuracy, manual counts are frequently not conducted because of several inherent drawbacks. These drawbacks include the significant labor cost, the associated impracticality of conducting long-term or permanent counts, and an inability to verify data, which is particularly important if volunteer staff is used.

Video Counts (Manual)

Another common variation on manual counts is to videotape the facility and have an observer count users while watching the resulting video. Video-based counts offer some advantages over other manual counts. Specifically, the ability to re-watch footage improves accuracy and allows for data verification while the ability to bypass periods of inactivity can reduce labor costs and thereby increase the span of data collection. However, the camera setups can be expensive to acquire, install, and maintain.

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Inductive Loops

Inductive loops are specific to the bicycle mode. As with similar devices that are in widespread use to detect and count motor vehicles, bicycle loops are embedded within the pavement and use electricity to detect when metal objects (i.e. bicycles) pass over them. The primary advantage of inductive loops is that they provide a permanent bicycle count station. They can be susceptible to undercounting bicycles made of certain materials and they can be difficult to apply in shared lane environments (counting nearby motor vehicles in addition to the intended bicyclists). However, recent technological advances are mitigating both of these drawbacks.

Bicycles made from composite materials (primarily carbon fiber) are not detectable by inductive loops, a common type of bicycle count technology. Fortunately, only a small percentage of bicycles are carbon fiber thus this error source is minimal. On roadways frequented by high end road cyclists, an adjustment factor based upon could be obtained through observational counts. Observers would need to be very carefully trained to identify carbon fiber bicycles. Assuming a 1% or 2% carbon fiber mix, would probably provide an acceptable level of accuracy for count adjustment.

Pneumatic Tubes

Pneumatic tubes are another device used to count bicyclists but not pedestrians. Rubber tubes are placed over the facility and triggered when a bicycle applies pressure to the tube as it is crossed. The fact that many transportation agencies already use such tubes to count motor vehicles offers a couple of key advantages: readily available devices and the output of automated data in familiar formats. Among the potential drawbacks of pneumatic tubes are the hazard they pose to certain users on shared use paths and the need for trained individuals to install and monitor the devices.

WEATHER EFFECTS

The only information provided during the webinars on weather effects on bicycle counts provided was anecdotal in nature.

PROCESSING DATA

Very little information was obtained on data processing activities both through the webinars and the practitioner discussions. This can be traced to the large number of participants with little or no experience in the area and the limited numbers of counts conducted. Nearly sixty percent of the webinar attendees reported fewer than 10 bicycle counts a year. (Question 14 - How many bicycle counts do you do a year?)

Factoring Methods

No information was obtained on factoring techniques for bicycle data that might be reproducible by others.

Variance of Data

Information on data variance was limited. Several practitioners, in discussing their count programs, mentioned sources of error.

Minimum Counts and Sampling

There is no documented information on how to determine the minimum number of counts or a sampling procedure.

REPORTING INFORMATION

Colorado DOT is the only agency that identified a standard reporting format based on the traffic data software package they use for processing other traffic data. An example of Colorado DOT's online output format is included in the Pedestrian Data Collection section of this report.

UTILIZING DIFFERENT SOURCES

Active data collection using GPS enable devices carried or worn by bicyclists is thought to have potential by several of the researchers. It is not, however, in common use. The sole exception is the San Francisco County Transportation Authority CycleTracks activity, which is used for modeling travel patterns rather than counting users.

FORMATS

A series of question was asked to see what types of information webinar attendees considered relevant to a bicycle count record:

> Question 24 - Which of the following should be MANDATORY in a national bicycle data record?
>
> Question 25 - Which of the following would be nice to have in a national bicycle data record?
>
> Question 26 - Which of the following should be OMITTED from a national bicycle data record?

Responses recommended as mandatory by sixty-five percent of the poll participants are included in the "should" category. Responses selected by at least fifty percent of the respondents as either mandatory or nice to have are identified as "could be included."

Based on the input of the attendees, a standard pedestrian count record should include the following items:

- Station ID (66%),
- Location information that permits geocoding (64% - latitude/longitude),
- Date (100%),
- Time (96%), and
- Collection method (66%).

Additional potential items that could be included in the record are:

- Classification (53% mandatory),
- Interval for volume (60% mandatory), and
- Direction (51%).

Speed is not recommended for inclusion in the record.

The distribution of responses from the webinar attendees by record item is summarized in Table 3.

Table 3. Bicycle Data Record Data Field Options

Bicycle Data Record – Candidates for Data Fields	Mandatory	Nice	Omitted
Station ID	**66%**	19%	9%
Location (latitude/longitude)	**64%**	30%	2%
Location (route/milepost)	34%	28%	6%
Location (street name/address)	47%	38%	2%
Date	**100%**	30%	0%
Time	**96%**	28%	0%
Direction	28%	**51%**	15%
Classifications	53%	<u>28%*</u>	0%
Collection Method	**66%**	9%	4%
Interval for volume (i.e. hour, 15 minutes)	60%	<u>38%*</u>	9%
Weather	4%	40%	34%
Speed	4%	36%	**70%**
Purpose	12%	9%	43%

*Exceeded 50% in mandatory.

REASONS FOR COLLECTION

The most common reasons for bicycle counts according to the webinar attendees are:

- Before and after studies,
- Trends analyses, and
- Safety analyses

No changes are expected in the categories where more counting will be done as reported in APPENDIX D – WEBINAR POLL RESULTS, Current and Anticipated Data Uses, Question 6 - Bicycle counts are collected for: and Question 7 - Bicycle counts are anticipated to be needed for:

APPENDIX A – LITERATURE REVIEW

PEDESTRIAN AND BICYCLE DATA COLLECTION

Contract No. DTFH61-11-F-00031

TASK 1 – LITERATURE REVIEW

August 29, 2011

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For:

Federal Highway Administration, HPPI-30

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SUMMARY

This document contains the literature review undertaken for DTFH61-11-F-00031, “Pedestrian and Bicycle Data Collection”. This document contains seven sections: Summary, Introduction, Equipment, Data Collection Programs, Data Processing and Storage, Data Use and Reporting. Each section contains a summary of the materials found, the potential gaps relating to conducting a bicycle and pedestrian counting program and an annotated bibliography organized by sub-topics.

The sources used included the Pedestrian and Bicycle Information Center (PBIC) online libraries, TRIS, ITRD (the database of the OECD’s Joint Transportation Research Center), the ITE Journal, the APTA Journal and the TRR on-line database. The literature search focused on papers written in English. The review emphasized on research from the past decade to ensure that emerging technologies and methods are properly identified. Included in the search was literature discussing how various counting programs are conducted by local governments, MPOs, state DOTs, national, and international transportation agencies.

Information on bicycle and pedestrian data collection equipment and data collection programs is significant. Research papers and case studies describe a variety of manual and automatic counting methods. Additionally, new technologies such as GPS devices and smartphones are making bicycle and pedestrian data collection more dynamic.

The literature review also revealed that it is common to mix data and analysis methods to analyze data or extrapolate trends for planning purposes. From the review of data collection programs, it is common to combine manual count data, automatic count data and survey data to analyze bicycle and pedestrian activity.

Areas where information is lacking and in need of expansion include data processing and storage, data use, and reporting. Related to data processing and storage, the main information gaps are related to record formats and file structures. While it is clear from the literature that standards have been established through several programs, such as the National Bicycle and Pedestrian Documentation Project, information on the specifics of these topics was not found in the literature. The same information issues are related to reporting as well. Some agencies have developed standards for reporting. Other agencies either lack standards or have standards that are very different from those generally used.

While data use is documented in the literature, it is still clear that uniform standards for its processing and application are needed. Typically, data is used to analyze a local facility, is project specific or applies only to a specific geography. More information is needed on how bicycle and pedestrian data collection can be used to address safety, funding or legislative mandates, facility design and quality of service.

INTRODUCTION

Nonmotorized monitoring has become highly relevant to numerous agencies' planning efforts. However, there is no standardized technology for automated counts. Most bicycle and pedestrian monitoring programs use periodic manual counts. Continuous monitoring programs are becoming more commonplace with infrared counters as the most popular technology. Video and laser counting technology is promising. Pneumatic tubes, while not practical for pedestrian traffic, have been used effectively on cycle tracks. Each of these methods has its best applications given specific operational, geometric, and weather related factors. Currently limited information is available to agencies for standardization of non-motorized counting programs. Widely available documents on non-motorized facilities include the following:

- The AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*
- The AASHTO *Guide for the Development of Bicycle Facilities*

Neither document contains more than a handful of sentences addressing count collection, utilization or storage.

This project is intended to provide a summary of the state of the practice for counting programs which collect data on non-motorized vehicles and pedestrians. The collection methods, equipment, factoring, storage, and reporting are all of interest. This material is being used to develop a set of webinars and provide input to the update of the Traffic Monitoring Guide (TMG). The webinars are intended to be a two-way exchange of information. A summary of this review will be presented to individuals involved in non-motorized data collection to increase awareness of the state of the practice. As a part of the webinars, unpublished information on current practice and activities will be sought. The summary of both activities will be available to update the TMG, including potential record formats which the community could adopt to simplify data exchange between organizations.

The review began with the identification and prioritization of sources including the Pedestrian and Bicycle Information Center (PBIC) online libraries, TRIS, ITRD (the database of the OECD's Joint Transportation Research Center), the ITE Journal, the APTA Journal and the TRR database. The literature search focused on papers written in English but looked at both U.S. and foreign practices. The review emphasized, but was not limited to, research from the past decade to ensure that emerging technologies and methods were properly identified. A second phase of the literature review looked at implementing jurisdictions' (local governments, MPOs, state DOTs, national and international transportation agencies) for application of the techniques. Listings were generated for both U.S. and international literature and then trimmed to those most likely to contain implementation rather than academic outcomes.

The following chapters are generally organized with an overview of the content, materials that only reference pedestrians, materials that only reference bicycles and then materials that either reference both or for which the difference in modes is not applicable. Not all chapters contain all subsections. Within each subsection the relevant sources are cited. Following the citation is a table indicating the relevant project topics for the material and a short summary of the material.

A major and not unexpected consistency found throughout the literature is that there is a lack of generally accepted standards for bicycle and pedestrian data collection. Several programs and case studies, such as the National Bicycle and Pedestrian Counting Project, have served as de facto standards. Substantive and vetted standards for bicycle and pedestrian data collection are still needed to provide consistent, multi-use/multi-user data of known quality and adequate quantity.

There is a demand for bicycle and pedestrian count data. The data is needed to inform policy, to support modeling and to assist with project design and implementation. However, a lack of resources is a barrier to meeting bicycle and pedestrian data collection needs.

In terms of equipment and methods, manual counts are still the predominant bicycle and pedestrian data collection method. Much of this can be attributed to the low capital costs required for manual counting and the fact that additional data, such as user characteristics, can be collected in addition to volume data. That being said, programs are increasingly using a blend of automatic and manual counting methods to collect data, with the method varying depending on the site context and information needed.

Beyond the common themes found in the literature, there are also several gaps in information and research that need to be filled. Notably, more comprehensive testing of automatic counting equipment is needed. The technology available today is analyzed sporadically and typically as part of a case study. A test method or other means to validate counting technology that practitioners can use to select the tools would be useful.

Another major gap in information is documentation of any widely accepted methods for data collection, storage and analysis. Data collection at all levels of government varies considerably from agency to agency. Some agencies have robust programs while others do not have a bicycle and pedestrian data collection program at all. This variance in the quality and quantity of data makes it difficult to transfer or compare bicycle and pedestrian data by geography, facility type, user, etc.

EQUIPMENT

Equipment may be divided into two categories: point-based and individual based. Point-based equipment covers sensors installed in, along or above the path for which volume counts are to be collected. Individual based equipment moves with the user to capture a series of locations in time and space from which trips may be inferred.

From the literature review, manual counting appears to be the baseline standard for bicycle and pedestrian data collection. It has a low level of technological sophistication and is labor intensive. Additionally, manual counts allow for data collection of multiple user types, user behaviors and characteristics in addition to volume.

However, automatic counting technology is increasing in use as equipment costs come down and effectiveness of technology improves. Automatic counting technology has higher up-front equipment costs but potential for long-term savings because of reduced labor costs. Additionally, automatic counting technology is useful for long-term counting to establish temporal standards (daily, weekly, yearly volumes and behaviors). Downsides of automatic counting include the need for users to pass a specific point and that the majority of technologies cannot distinguish between bicyclists and pedestrians.

Automatic counting equipment typically falls into one of five categories that include passive infrared, active infrared, video imaging (pixel change analysis or analysis by a person), piezometric (strip or pad), or in-pavement magnetic loop (Jones, 2010, pg. 68). New technology that is being tested for data collection includes GPS devices and GPS-enabled smartphones.

Equipment selection typically includes consideration of a variety of factors such as (Ozbay, 2010, pg. 18):

- Commercial availability
- Capability to satisfy minimum counting requirements required for needed traffic parameters
- Level of technical support provided by vendor
- Ease of installation and calibration
- Ability to be installed in different positions or heights without impacting performance
- Reliability and ability to continuously work in different weather and traffic conditions
- Compatibility
- Cost-effectiveness of equipment, maintenance and staff labor required for use

SENSOR TECHNOLOGIES

Table 1 provides a summary of the technologies found for each of the modes in doing the review. Table 2 breaks out the types of counters in the row labeled "Permanent Counters" as they were named by the authors. Following Table 1 are technology descriptions.

Table 1 Sensor Technologies by Type and Reference

Technology	Pedestrian Counting References	Page	Bicycle Counting References	Page
Impact Sensors/ Tubes	Somasundaram (2010)	38	Somasundaram (2010)	38
	Ozbay (2010)	18		
	Jones (2010)	68	Jones (2010)	68
			Hunter (2009)	
Video	Greene-Roesel (2008)	15		
	Ismail (2009)	16		
	Ozbay (2010)	18		
	Somasundaram (2010)	38	Somasundaram (2010)	38
			SRF (2003)	39
Permanent Counters	Montufar (2011)	17		
	Hudson (2010)	74		
	Somasundaram (2010)	38		
	Ozbay (2010)	18		
	Jones (2010)	68	Jones (2010)	68
	Schneider (2009, "Pilot")	63		
	Schneider (2009, "Methodology")	62		
	SRF (2003)	39	SRF (2010)	39
	Greene-Roesel (2008)	15		
			Nordback (2010)	27
Portable (Manual)	Jones (2010)	68	Jones (2010)	68
	Jones (2006)	48	Jones (2006)	48
	Metropolitan Transportation Commission (2003)	50	Metropolitan Transportation Commission (2003)	50
Intercept Surveys			Jones (2006)	48
			Jones (2010)	68
GPS			Casello (2011)	73
			Dill (2008)	30
			Harvey (2008)	31
Smartphone Apps			Charlton (2011)	29
Other			Moskovitz (2011)	81[1]
			Lovejoy (2011)	80[2]

[1] Time Series photography (parking racks)
[2] Police records (thefts); counts at bike racks, On-line travel survey by invitation to stratified sample

Table 2 Types of Permanent Counters Discussed

Sensor	Pedestrian Counts	Bicycle Counts
Break-beam with target	Hudson (74)	
Computer vision	Green-Roessel (15)	Somasundaram (38)
Electronic piezo		Somasundaram (38)
Hydro acoustic		Somasundaram (38)
Inductive loop	SRF (39)	Nordback (27) Somasundaram (38) SRF (39)
Infrared	Hudson (74) Somasundaram (38)SRF (39)	Somasundaram (38) SRF (39)
Infrared beam	Green-Roessel (15)	
Infrared, active	Jones (68)	
Infrared, dual	Schneider (63, 62) Hudson (74)	
Infrared, passive	Ozbay (18) Jones (68)	
Infrared, passive array	Green-Roessel (15)	
Infrared, passive dual beam	Green-Roessel (15)	
Laser scanner	Green-Roessel (15)	
Magnetic loop	Jones (68)	Jones (68)
Mechano acoustic		Somasundaram (38)
Microwave	Montufar (17)	
Passive infra-red	Montufar (17)	
Peizometric tube	Jones (68)	Jones (68)
Piezo metric pad	Jones (68)	Jones (68)
Piezo-electric pad	Green-Roessel (15)	
Pneumatic tube		Somasundaram (38)
Pneumatic/piezo electric/tube counters	SRF (39)	SRF (39)
Pyroelectric	Montufar (17) Somasundaram (38)	Somasundaram (38)
Radio beam	SRF (39)	SRF (39)
Radio beam metal		Somasundaram (38)
Radio beam reflective	Somasundaram (38)	Somasundaram (38)
Stereo-vision curbside detector	Montufar (17)	
Thermal	Ozbay (18)	Ozbay (18)
Video imaging	Jones (68)	Jones (68)

Impact Sensors/Tubes

Impact, or piezometric, sensors or tubes use a change in pressure to detect a pedestrian or a person riding a bike. Sensors are fixed at a particular location while tubes can be easily moved. Sensors are more commonly used for pedestrian and bicycle data collection, while tubes are primarily used for bicycle data collection. Impact sensors are best used on a sidewalk or path. Tubes are best used on a path or a street.

Video

Video data collection can be analyzed using computers to detect pixel change or by a person. Computer-based video processing requires significant calibration and is primarily intended for indoor use. However, outdoor applications are being tested with case studies. Manual video processing by a person is effective in collecting volume data as well as user characteristics. It has also been used to analyze the variance of manual counts and other automatic counting equipment because it can be reviewed several times or slowed down to allow a technician time to accurately document data.

Four references address video data collection for pedestrians and two for bikes.

Permanent Counters

Permanent counters require installations at a fixed location and are either not able to be moved once installed or are not easily moved.

For the purpose of this literature review, passive infrared, active infrared and laser scanners are considered permanent pedestrian counters. Passive infrared equipment is best used for counting pedestrian volume along a sidewalk or at intersections. Active infrared can distinguish between bicycles and pedestrians, so it can be used in multiple location including sidewalks and shared paths. Laser scanners can be used along a sidewalk or path but require an open, unobstructed detection area.

For the purpose of this literatures review, active infrared and in-pavement magnetic loop detectors are considered permanent bicycle counters. In-pavement magnetic loop detectors sense a change in magnetic field as metal passes, such as a bike frame, and are appropriate for paths or streets.

Table 2 named twenty-nine technologies including variants that could be considered for permanent count locations. Twenty-four were identified for pedestrian counts and seventeen for bicycle counts. Not all technologies identified were considered to be satisfactory for the specific application tested.

Portable Counters

For the purpose of this literature review, manual pedestrian counts are considered portable counts. Manual counts are a common data collection method. Equipment requirements typically include clip boards, pre-made paper forms, pens or pencils and a hand-held counter. Manual counts are labor intensive as they require a staff person or volunteer to spend time in the field. Standard methods for manual counts have been developed.

Intercept Surveys

Intercept surveys, or surveys of users at a specific site, can be used to collect additional bicycle data beyond volume. Surveys allow data to be collection for user characteristics, behaviors, and preferences.

GPS

GPS devises are typically used to support studies that analyze a sample of a population. GPS devices can be used to collect trip data, such as trip length and duration, and user characteristics, such as demographics and travel behavior. GPS devises are often combined with user surveys to enhance data with additional information about the users.

Smartphone Apps

Smartphone apps can be used to collect trip data, such as route length and duration, and user information, such as demographics and travel behavior. Smartphone apps require the use of a smartphone, development of an app (often for multiple operating systems) and server space for data collection. Since smartphones cannot pick up signals everywhere not all areas can be monitored with this method.

Special Counts

Time series photography can be used to collect data on bicycle parking facilities. Data for volume over time, trip duration and parking behavior was collected as part of a study conducted by Moskovitz (2011, pg. 81).

Another unique source for bicycle data is police reports and hospital records. A study done by Lovejoy (2011, pg. 80) used these sources to collect data on bicycle theft, volume of bicycle injuries and bicycle accidents. A benefit of this data is that it is often standardized, objective and readily available. However, a disadvantage of this data is that incidents are often under-reported.

Pedestrian Counting Equipment

Pedestrian counting equipment needs to be selected based on count location and the purpose of the data collection. If manual counts are used, training and field equipment (such as forms, clip boards, pens, hand counters, etc.) are needed. If automatic count technology is used, field installation, calibration and data retrieval (either remotely or in the field) needs to be considered. The automatic pedestrian counting technology found in the literature includes passive infrared, active infrared, video imaging, piezometric pads and laser scanners.

Information on the use of GPS devices, smartphones and pedometers for pedestrian data collection was not found. Neither was information found on how pedestrian counting equipment can be integrated with motorized vehicle counting equipment. This is particularly important in urban areas where motorized and non-motorized traffic volumes are high and modes are mixed. Additional information is also needed to understand the environmental impacts and constraints on equipment, such as weather, site conditions, traffic modes, traffic volumes, etc.

Fixed Location

Information on fixed location equipment for pedestrian data collection includes impact sensors, video, passive infrared, active infrared, laser scanners and manual counts. Additionally, intercept surveys have been used to supplement data collection at fixed locations.

Among fixed location counting equipment types, video-based technologies are the most commonly cited within the international literature. There are ten citations in this report which used some type of vision technology. There are six discussions of video technology evaluation and four that discuss applications which are listed in the following paragraph.

Video can be augmented by image processing techniques that classify objects and track their paths through the use of algorithms (Li, 2010, pg. 36). Research from Austria (Brandle, 2009, pg. 33) analyzed three different video-based analysis techniques (embedded 3D sensors, motion path modeling, and optical flow) and compared their advantages and disadvantages, finding all three to be largely accurate but also in need of refinement. In Zurich, lasers were used to count pedestrians and map pedestrian movements (Schweizer, 2005, pg. 19). While the counts were accurate and provided useful data in the mapping of movements, off- the-shelf software was not available to interpret the data. EcoCounter (Rheault, 2008, pg. 37) employs acoustic slabs to monitor pedestrian activity. Queensland, Australia employed a matrix of its pedestrian count program needs to determine the most appropriate technology and, perhaps tellingly, constructed a hybrid device taking advantage of multiple components (Davies, 2008, pg. 35).

Citation:
Greene-Roesel, R., M.C. Diogenes, D.R. Ragland. and L.A. Lindau. Effectiveness of a Commercially Available Automated Pedestrian Counting Device in Urban Environments: Comparison with Manual Counts. Presented at the 87th Annual Meeting of the Transportation Research Board 87th Annual Meeting, Washington, D.C., 2008.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts	X	Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed	X	Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This contains an analysis of the effectiveness of commercially available automatic pedestrian counting devices compared to manual counts. Several automated pedestrian counting devices were considered for use in the analysis, but <u>the dual sensor passive infrared counter was ultimately selected for its cost and ease of deployment</u>. The conclusion was that the device can be used to obtain reasonable estimates of pedestrian volumes in outdoor environments. Additionally, the study found that field observations and manual counts from video-recordings provide relatively accurate counts, but accuracy is dependent on the complexity of the counting task and the level of observer motivation.

Citation:
Ismail, K.A., T.A. Sayed and N. Saunier. Automated Collection of Pedestrian Data Using Computer Vision Techniques. Presented at the 88th Annual Meeting of the Transportation Research Board, Washington, D.C., 2009.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts	X	Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This material presents a technique for automated pedestrian data collection using video cameras. Several conclusions are presented including that the accuracy of data is sensitive to camera calibration, environmental conditions can significantly influence data accuracy, and there are limited systematic procedures for evaluating video for pedestrian data collection.

Citation:
Montufar, J. and J. Foord. Field Evaluation of Automatic Pedestrian Detectors in Cold Temperatures. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, D.C., 2011.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts	X	Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts	X	Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed	X	Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This contains the results of conducting a field performance analysis of three commercially available curb-side automatic pedestrian detectors to assess their performance during winter months. A pole-mounted passive infrared and stereovision curb-side detector, a pole-mounted passive infrared curb-side detector and a pole-mounted microwave detector were tested. <u>Initial findings show the passive infrared and microwave detectors perform better at warmer temperatures and the infrared/video detector performs better at colder temperatures.</u>

Citation:
Ozbay, K., B. Bartin, H. Yang, R. Walla and R. Williams. *Automatic Pedestrian Counter*. Publication FHWA-NJ-2010-001. NJDOT, FHWA, New Jersey Department of Transportation, Federal Highway Administration. 2010.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This is a review of existing pedestrian data collection methods and selection of two commercially available automatic counters to test in the field. The methods of pedestrian data collection reviewed include manual counting as well as the following automatic counting technologies: infrared beam counters, passive infrared counters, piezoelectric pads, laser scanners, and computer vision. The pedestrian counters selected for field testing include a double pyroelectric sensor and a thermal sensor. The counters were selected based on criteria that included the availability, capability, vendor support, ease of deployment, adjustability, reliability, compatibility and cost-effectiveness of a device. To test the devices, the evaluation methodology included test site criteria, data collection methods, and data evaluation procedures. Included are appendices containing interview questions and summaries for professionals currently managing automatic pedestrian counting programs, a summary of case studies of automatic pedestrian counters, general recommendations for an automatic pedestrian counting program, and guidelines for the sensors tested.

Citation:
Schweizer, T. Methods for Counting Pedestrians. Zürich, Switzerland, Presented 6th International Conference on Walking in the 21st Century, Zürich, Switzerland, 2005.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed	X	Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	

Summary:
The paper addressed the use of laser detectors for counting pedestrians. The main disadvantage of this method is the lack of off-the-shelf software for interpreting the data. The article did discuss the required number of data points to ensure reasonable accuracy and the potential for extrapolating daily volume from 15-minute or 30-minute counts. Bar and whisker graphs illustrated variances in the data and predicted pedestrian volumes.

Individual-based

No information was found for individual-based equipment for pedestrian data collection in the U.S. However, information on GPS and smartphone apps applied to bicycle data collection was found and may provide cross-over application to pedestrian data collection.

The international literature frequently notes the ability of GPS, smartphone apps and other individual-based technologies to provide detailed information about pedestrian travel routes, speeds, etc. However, such techniques are not applicable to passive counting of pedestrians because they require the subject pedestrians to deploy a particular device in order to be observed.

There is also abundant pedestrian safety research that aims to reduce pedestrian-motor vehicle conflicts through the use of individual vehicle and pedestrian technologies. For example, pedestrians equipped with an electronic tag can send signals to nearby motorists when they enter a particular area such as an intersection that has a magnetic field (Oda, pg. 40). While these examples also currently require the pedestrian to be an active participant, there may be future applications for performing pedestrian counts.

Bicycle Counting Equipment

Bicycle counting equipment needs to be selected based on count location and the purpose of the data collection. If manual counts are used, training and field equipment (such as forms, clip boards, pens, hand counters, etc.) are needed. If automatic count technology is used, field installation, calibration and data retrieval (either remotely or in the field) needs to be considered. The automatic bicycle counting technology found in the literature includes active infrared, video imaging, piezometric, in-pavement magnetic loop, GPS and smartphone apps.

Information was not found on how bicycle counting equipment can be integrated with motorized vehicle counting equipment.

Fixed Location

Information on fixed location equipment for bicycle data collection includes impact sensors, video, active infrared, in-pavement magnetic loop detectors and manual counts. Additionally, intercept surveys have been used to supplement data collection at fixed locations.

Many of the fixed count location equipment types available for the pedestrian mode are also applicable to the bicycle mode, but the research indicates that additional techniques are unique to counting bicyclists such as pneumatic tubes and in-ground inductive loops. There are eleven citations associated with evaluation of fixed location equipment including five in the international literature discussed here.

The City of Hamilton, New Zealand conducted extensive research and testing of a wide variety of bicycle count equipment types (infrared, radar, video, pneumatic tubes, magnetic field detection, and inductive loops) before determining that the in-ground loops would be the most appropriate and cost-effective technology for its own count program (Lieswyn, 2010, pg. 25). Similarly, the Norwegian government tested inductive loop, pneumatic tube, and infrared technologies from multiple companies to determine their respective accuracy levels (Hjelkrem, 2009, pg 24). It is worth noting that while there was some variability amongst the various equipment types and sources, all were found to have an accuracy level of above 83%.

Among more specific tests, a video-based data collection method applicable to both modes, also reports high levels of accuracy (Brandle, 2010, pg. 34). In New Zealand pneumatic tube counters were found to be 100% accurate in an environment exclusive to bicyclists while they were 92% accurate in mixed environments. Speed of the bicyclists was found to be a factor as well as the length of the pneumatic tubes (Macbeth, 2002, pg. 26). VicRoads uses inductive loop counters to obtain 24-hour, 365-day counts at 21 locations in Melbourne, Australia (VicRoads, 2011, pg. 23). Vienna uses radar counters to obtain automated counts (Berger, 2007, pg. 22). These are validated using video surveillance and are reported to be “operating flawlessly.”

Citation:
Berger, Thomas, *Workshop: Strategies in a Metropolis Velo Monitoring Vienna*, Vienna, Austria. 2007.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	X
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
The City of Vienna (Austria) has a traffic count program which includes manual counts, automated counters, and cyclist interviews. They use radar counters retrofit onto existing poles. Data are checked using video surveillance and counts. The eight counting posts are reported as "operating flawlessly."

The City also maintains a website http://www.snizek.at/radverkehr/dauerzaehlung2.php on which they publish numerous graphs showing counts by time of day, day of week, and month. Annual summaries and analyses are also provided.

The City is using the data to develop methods for projecting traffic volumes based upon 7-hour counts, correction of traffic due to rainfall, creating daily and seasonal adjustment factors, and identifying trip purpose trends.

Citation:
Cycling Data and Statistics. VicRoads, Melbourne, Australia. http://www.vicroads.vic.gov.au/Home/Moreinfoandservices/Bicycles/StrategicDirectionsForCycling/CyclingDataAndStatistics.htm. Accessed June 17, 2011.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	X
Special Counts	X	Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
VicRoads has installed permanent inductive loop counters in various locations across Melbourne. Seventeen are off road on pathways and another four are located on road. Each site records cycling flows in two directions. The counters record bicycle volumes 24 hours per day, every day of the year. This is useful for monitoring changes in bicycle use over the seasons but also year to year.

The state government survey "Victorian Integrated Survey of Travel and Activity" (VISTA) took place in 2007 and 2009 and included data on bicycle and pedestrian trips. This data can be accessed at http://www.transport.vic.gov.au/vista .

Local communities also perform manual counts. One regional manual count is held on the first Tuesday in March between 7:00 and 9:00 A.M.

Citation:
Hjelkrem, O.A. and T. Giaever. A Comparative Study of Bicycle Detection Methods and Equipment. Presented at 16th ITS World Congress and Exhibition on Intelligent Transport Systems and Services, Stockholm, Sweden, 2009.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This documents a study of the accuracy of several types and manufacturers of bicycle counting equipment. The research was undertaken by the Norwegian Public Roads Administration because of reported inadequacies in its current bicycle counting program.

Seven pieces of equipment were tested for accuracy and compared against parallel manual counts: several models of inductive loop equipment (94.0% and 96.4% and one not reported), pneumatic tubes (98.1%), inductive loops for bicycles only (97.5%), inductive loops for bicycles, pedestrians, and motorized vehicles (83.5%), and infrared (84.5%). Numbers of observations among the tests ranged from 100 to several thousand. Common observed reasons for inaccuracies included difficulty separating bicycles passing the equipment at nearly the same time and bicycles passing near the edge of inductive loops.

While not the focus of the research, the paper does include data showing variations in bicycle use by time of day and day of week. In the study location (Trondheim, Norway), counts are much higher on weekdays than on weekends and during the AM and PM peak hours, suggesting that the vast majority of bicycle traffic there is commute-related.

Citation:
Lieswyn, J., A. Wilke and S. Taylor. Automatic Cycle Counting Programme Development in Hamilton. IPENZ Transportation Group Technical Transportation Conference, New Zealand, 2011.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
The City of Hamilton, New Zealand recently introduced a citywide bicycle count program. This paper includes both a summary of existing literature (used to guide the City's decisions) and the process employed to determine the appropriate characteristics of the implemented program.

A need is stated for bicycle count programs to quantify the effectiveness of infrastructure investments, but generally describe a vacuum of reliable guidance on the subject. The literature review uncovered a variety of automatic count types including infrared, ultrasonic, radar, video imaging, piezometric pressure sensitive, and inductive magnetic field loops (the last of which is the most common type employed in North America). Other highlights of the reviewed literature included the importance of control sites, the need for non-manual counts, and the general finding that "there is no standard method of determining the required number and placement of cycle counters for a cycle counting programme." Regarding appropriate duration, there is evidence that non-permanent counters can be used to indicate yearly volumes. While durations as short as part of a day can be used, a minimum of two week durations for temporary sites are recommended.

Based on the research findings, a network of twelve count sites was established, with two of the locations hosting permanent counts (some existing manual count locations were also retained for calibration purposes). A cost analysis indicated that in-ground inductive loops would be the most effective equipment type for the City's use. Detailed site investigations were conducted to study the technical aspects of implementation and to determine precise counter locations. The Hamilton count program is expected to be fully operational in 2011.

Citation:
Macbeth, A. G. Automatic Bicycle Counting. IPENZ Transportation Group Technical Transportation Conference, New Zealand, 2002.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	

Summary:
This covers an evaluation of the effectiveness and accuracy of two pneumatic tube counters for the purpose of counting bicycles: a bicycle classifier and a vehicle classifier.

The bicycle classifier was found to be 100% accurate in an exclusive bicycle environment and more than 92% accurate in a mixed environment (roadway).The researchers noted it is possible that the classifier was 100% accurate in the roadway environment and the manual counts were inaccurate.

The vehicle classifier was found to be 100% accurate counting bicycles travelling at more than 10 km/h (6 mph) in a mixed environment until tube lengths exceeded 10 meters.

The researchers noted that the vehicle classification systems used in New Zealand do not include exclusive classes for bicycles. Bicycles are either not classified or grouped with motorcycles.

Citation:
Nordback, K. and B.N. Janson. Automated Bicycle Counts: Lessons from Boulder, Colorado. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2190, Transportation Research Board of the National Academies, Washington, D.C., 2010, pp. 11-18.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	X
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This presents the analysis of the accuracy of inductive loop detectors over a period of several years. The equipment is part of the City of Boulder's (Colorado) permanent count system for its multiuse path network. It was found that inductive loop detectors are proven, low-maintenance, and low-cost technology for bicycle detection. However, the equipment needs to be periodically and properly calibrated, the software needs to be checked for proper setting, and external factors need to be minimized to provide quality, accurate data.

Individual-based

Information on individual-based equipment for bicycle data collection includes GPS and smartphone app technologies. Both allow for rich data collection of user characteristics, user behavior and trip information.

As with the pedestrian mode, GPS-based data is prevalent in the international literature for observing and characterizing bicycle activity (Menghini, 2009, pg. 32). Again, such approaches typically involve active participants and are therefore used for purposes other than pure counting.

Citation:
Charlton, B., J. Hood, E. Sall and M. Schwartz. Bicycle Route Choice Data Collection using GPS-Enabled Smartphones. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, D.C., 2011.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
An app was developed for GPS-enabled smartphones to collect bicycle data related to route choice. The use of the smartphone allowed collection of data related to sensitivity to slope, presence of bike lanes and/or bike route destinations, trip purpose and gender. The information collected is being used to inform the San Francisco regional travel model. Other potential applications of this method identified include tracking pedestrians and before and after studies of new bicycle facilities.

Citation:
Dill, J. and J.P. Gliebe. *Understanding and Measuring Bicycling Behavior: A Focus on Travel Time and Route Choice*. Publication OTREC-RR-08-03. OTREC, Oregon Transportation Research and Education Consortium. 2008.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
Global positioning system (GPS) technology was used to record trip data for a sample of adults riding their bicycles in Portland, Oregon. A variety of data types were collected including surveys and trip characteristics (environmental conditions, trip length, etc.). Combined with GIS data for infrastructure, data was collected relating to type of cyclist, frequency of bicycling, age, income, overall trips and mileage, trip purposes, trip speeds, time of day and weather, route choice priorities, and routes by facility type. Based on the findings, information was provided that describes how often, why, when and where cyclists ride.

Citation:
Harvey, F., K.J. Krizek and R. Collins. Using GPS Data to Assess Bicycle Commuter Route Choice. Presented at the 87th Annual Meeting of the Transportation Research Board, Washington, D.C., 2008.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
A method to collect bicycle trip data using global positioning system (GPS) technology is presented. The data was used to analyze bicycle route choice using a combination of participant surveys, GPS device data collection, and GIS data. While the data collected provided detailed trip information (distance, time, elevation, route) and behavior characteristics (self-reporting information), challenges were found associated with GPS data, primarily with data processing. After the data was collected, the data required significant filtering and automated scripts to clean the data. However given the challenges, it was still possible to extrapolate bicyclist behavior using the GPS technology.

Citation:
Menghini, G., N. Carrasco, N. Schussler, and K.W. Axhausen. *Route Choice of Cyclists in Zurich: GPS-based Discrete Choice Models*, Zurich, Switzerland, 2009.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This presents a bicycling route choice model based on data collected in Zurich, Switzerland. The recommended models include variables related to route length, elevation change, and presence of traffic signals (the influence of traffic volume was not examined because of the unavailability of data). An existing database of 11,000 GPS-tracked bicycle trips (extracted from trips made by all modes) made by 2,435 residents was used to identify existing routes. While the research does include a component of bicycle counting in that GPS responders were used to track cyclists, its applicability is limited because it does not relate to passive detection of bicyclists.

CITATIONS ADDRESSING BOTH MODES

Fixed Location

Citation:
Brandle, N. Automatic Classification, Counting and Modeling of Non-Motorized Traffic with Video Analytics. Presented at 10th Annual International Conference on Walking and Livable Communities, New York, United States, 2009.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
This presentation highlights the Austrian Institute of Technology's experience in bicycle and pedestrian monitoring using video analysis. Three video-based analysis techniques are described: 1) an embedded visual 3D sensor, 2) path modeling based on traveler's motion paths, and 3) pedestrian path modeling based on optical flow. The first type has the advantage of real-time counting and has high reported accuracy rates. Individual path modeling is reported to break down in dense bicycle/pedestrian environments because of occlusion. That problem is partially addressed through optical flow, which models crowds as a set of interacting particles.

Citation:
Brandle, N., A.N. Belbachir, and S. Schraml. SmartCountplus – Towards Automated Counting and Modeling of Non-Motorised Traffic with a Stand-Alone Sensor Device. In *REAL CORP 2010 Proceedings*, Vienna, Austria, 2010, pp. 1261-1266.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
The authors describe a new device used for automated counts of bicyclists and pedestrians. It is a visual sensor that uses changing light intensity to determine depth and therefore object shapes. The key feature of the device is that it is designed to discriminate between pedestrians and bicyclists (and their sub-categories) in an outdoor environment while avoiding privacy issues through the use of "captured depth data." The device uses embedded clustering (grouping together objects associated with the same traveler) and classification (by mode) algorithms. At a test site with a relatively small sample of 128 facility users, there was a correct classification rate of 92% for riding cyclists and 100% for traditional pedestrians. Walking cyclists and pedestrians with umbrellas were separately analyzed; the latter group had a lower successful classification rate, suggesting the need for further investigation.

Citation:
Davies, R. Pedestrian and Cycling Counters – South East Queensland. Presented at 9th Annual International Conference on Walking and Livable Communities, Barcelona, Spain, 2008.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts	X	Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
The Active Transport Planning Unit of Queensland (Australia) Transport's Integrated Transport Planning Division sought improved bicycle and pedestrian counting techniques and recommendations to better gauge network performance and guide investment decisions. Noting the numerous count technologies, Queensland developed a set of requirements based on its needs, including the ability to count both modes directionally, producing 24-hour counts at 15-minute intervals, allowance of remote access data retrieval, and not being cost prohibitive. After employing a matrix of technologies and needs, the agency ultimately created and implemented its own prototype. The presentation concludes with a discussion of implementation at one site and the daily variation of bicycle and pedestrian volumes at that location.

Citation:
Li, J., C. Shao, W. Xu, and J. Li. Real-time System for Tracking and Classification of Pedestrians and Bicycles. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2198, Transportation Research Board of the National Academies, Washington, D.C., 2010, pp. 83-92.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
This is an evaluation of a pedestrian and bicycle tracking and classification (PBTC) system. The system uses typical video-based data collection and then incorporates image-processing technology to detect, track, and classify pedestrians and bicyclists. The algorithm approach of the PBTC system includes six modules.

Three test sites in Beijing, China were examined. An accuracy level of approximately 85% for both modes at all three test sites was observed. Inaccuracies were largely observed to be the result of inaccurate detection (such as double counting pedestrians who stop for long periods of time) and occlusion failure (including when two closely spaced pedestrians are observed as one).

The conclusion was that the PBTC system is generally effective, but that the embedded algorithms could be improved with further research.

Citation:
Rheault, J. Measuring Walking: Counting Pedestrians. Presented at 9th Annual International Conference on Walking and Livable Communities, Barcelona, Spain, 2008.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This presentation was delivered by vendor employee and describes the types and uses of the company's products, which include inductive loops and selective pneumatic tubes for bikes, acoustic slabs for pedestrians, and pyroelectric sensors for both modes. Other components of the presentation include key features, an example output showing volumes by time of day, maintenance recommendations, and data management options.

Citation:
Somasundaram, G., V. Morellas and N.P. Papanikolopoulos. *Practical Methods for Analyzing Pedestrian and Bicycle Use of a Transportation Facility*. Publication MN/RC 2010-06. MnDOT, Minnesota Department of Transportation. 2010.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	X
Factoring Methods	X	Factoring Methods	X
Variance of Data	X	Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
This document contains a review of existing technologies used to collect automatic counts for bicycles and pedestrians, and selection of a video-based system to analyze its application in the field. Several computer vision algorithms were reviewed and tested in the field to assess effectiveness in collection data. The existing technologies reviewed include buried pressure pads, pyroelectric sensor, inductive loop, pneumatic/piezo electric sensors/tube counters, radio beam sensors, infrared sensors, and vision-based sensing. The appendix provides a useful summary table for these methods and summarizes device type, ease of use, type of data collection (bicycle, pedestrian or both), cost, light conditions, accuracy, environmental sensitivity, applicable sites, whether the technology is wireless, power source, and portability. Additionally several algorithms were analyzed in the field to test different conditions and applications of the video-based system.

Citation:
SRF Consulting Group, Inc. *Bicycle and Pedestrian Detection*. Minnesota Department of Transportation, 2003.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data	X	Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
This is an early review of the application of sensor technology for non-motorized traffic detection, how the sensor technology is applied in the field and how to conduct field tests to evaluate the performance of the technology. Field applications for the sensor technology reviewed include curbside pedestrian detection, crosswalk pedestrian detection, intersection approach bicycle detection and historical data collection (volume, speed and classification data). Technology reviewed includes commercially available passive infrared/ultrasonic, infrared, microwave, video and magnetic devices. The field tests include documentation of sensor installation, the data collection systems, baseline data requirements, and data collection. The conclusion was that the type of sensor technology should be selected based on the type of data needed, such as real-time data versus historical data. The appropriate applications for each technology reviewed are also summarized.

Individual Based

Citation:
Oda, H., S. Kubota, and Y. Okamoto. *Movement-Pattern Models of Pedestrians at Intersections and the Technology to Reduce Traffic Accidents Involving Pedestrians or Cyclists*, Yokosuka, Japan. Undated.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
The intent of this research is to refine a system by which motorists are alerted to the presence of pedestrians and bicyclists at intersections. When pedestrians and bicyclists equipped with an electronic tag enter a magnetic field, a signal is sent to motorists (whose vehicles also have a receiver) who may be in a position to conflict with the non-motorized user. The authors describe a matrix-based approach to determining the speed and direction of pedestrians and bicyclists.

The research is aimed at reducing crashes, and because users are required to be equipped with a device, the system is not well-suited for passive bicycle/pedestrian counts.

DATA COLLECTION PROGRAMS

Data collection programs cover any type of program that performs a regularly scheduled survey or volume collection activity. Regularly scheduled surveys as the label implies do not necessarily use equipment except as an adjunct to the individual collecting the data. More emphasis has been placed on volume collection programs that do not require on-site manual activities to generate volumes. Both are included as input to creation of possible standard record formats for storing and sharing data.

A case study of state, regional and local agencies was conducted in 2005 to identify bicycle and pedestrian data collection trends in the United States. The results of the study identified several reasons for having a program including (Schneider, 2005, pg. 44):

- Documenting conditions and conducting trend analysis
- Bicycle and pedestrian network planning
- Pedestrian vehicle crash analysis
- Forecasting demand for walking trips
- Pedestrian facility design
- Traffic law enforcement impact studies
- Policy and program design

In addition to the reasons for having a bicycle and pedestrian data collection program, several reasons for not having a program – or a more robust program - were identified as well and include (Schneider, 2005, pg. 44):

- Lack of knowledge on how pedestrian data can be integrated with motor vehicle data
- Costs for counting equipment and labor for processing and managing data
- Funding frameworks for programs
- Lack of guidance on pedestrian behavior and demand characteristics
- Lack of guidance on data application approaches
- Lack of guidance on data gathering procedures
- Lack of understanding of the data types needed
- Data management
- Lack of dissemination standards or platforms for sharing data with users

Table 3 contains the materials identified that specifically reference design or surveys of data collection programs. Programs mentioned in the literature reviewed as a data source are also mentioned in this chapter.

Table 3 Information on Data Programs by Jurisdictional Level

Organization	Pedestrian	Page	Bicycle	Page
National	Jones (2006)	48	Jones (2006) Richardson (2006)	48 54
State	Schneider (2005) Cottrell (2003)	44 46	Schneider (2005)	44
Regional	Schneider (2005) Cottrell (2003) Metropolitan Transportation Commission (2003)	44 46 50	Schneider (2005) Metropolitan Transportation Commission (2003)	44 50
County	Schneider (2005) Cottrell (2003)	44 46	Schneider (2005)	44
City	Schneider (2005) Cottrell (2003) Little (2008) VicRoads (2011)	44 46 52 23	Schneider (2005)	44

Citation:
Bicycle and Pedestrian Data: Sources, Needs and Gaps. Publication BTS00-02. US DOT, BTS, U.S. Department of Transportation, Bureau of Transportation Statistics, 2000.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
Included (circa 2000) are existing data sources, data needs, and options for improving bicycle and pedestrian data. Related to counting, there is an outline of the then current state of practice for counting data collection, how different counting data is used for analysis, and the priorities for data improvement. Recommendations are provided on how to improve data collection programs and standards.

Citation:
Schneider, R.J., R.S. Patten and J.L. Toole. Case Study Analysis of Pedestrian and Bicycle Data Collection in U.S. Communities. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 1939, Transportation Research Board of the National Academies, Washington, D.C., 2005, pp. 77-90.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data	X	Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
Twenty-nine communities were surveyed to profile bicycle and pedestrian data collection programs and how they are managed. They also identified the geographic size of agencies collecting data, the scale of data collection programs, data collection methods employed by the different agencies, and frameworks for bicycle and pedestrian data collection programs. A variety of different agencies were surveyed include cities, counties, regional councils, metropolitan planning organizations and state agencies. Methods of data collection varied and included surveys of users, manual counts, automatic counts, and facilities inventories. Data program elements identified include benefits of pedestrian and bicycle data collection, reasons communities do not collect pedestrian and bicycle data, efficiency of data collection processes, scope of data collection efforts, data collection processes, and institutionalization of data collection programs.

PEDESTRIAN PROGRAMS

Pedestrian data collection can be found at all levels of government, although data collection is tailored to local needs (Cottrell, 2003, pg. 46). Programs typically include at least one, and most often several, of the following components:

- Manual counting, automatic counting, or both
- Surveys identifying user characteristics, behaviors and preferences
- Inventories of facilities
- Spatial analysis and documentation, often using CAD or GIS
- Data collection methods
- Data storage
- Institutionalization of program

Gaps in the research scanned include a lack of information on staffing organization and responsibilities, how programs fit within the larger agency structure, and how programs work with other agencies to share information. Additionally, there is a need for a set of uniform, national formats for non-motorized transportation data. The uniform formats would allow for local data to be aggregated up to regional, state and national levels, compare data on use and facilities between geographies, and establish, measure, and monitor benchmarks for non-motorized travel and facilities (Schneider, 2005, pg. 44).

Citation:
Cottrell, W. D. and D. Pal. Evaluation of pedestrian data needs and collection efforts. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 1828, Transportation Research Board of the National Academies, Washington, D.C., 2003, pp. 12-19.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
An early 2000s survey of several state, regional, and local transportation agencies to identify whether they have a pedestrian data collection program and, if they do, analyzed the structure of the program. The survey identified several program elements including average count duration, count duration range, most common counting times, counting methods and purpose of counts. The three common data collection methods include manual counting, recording push button use and video camera recording. Based on the findings, a pedestrian data collection framework was presented that can be used by local, regional and state planning agencies. The framework outlines the type of data to be collected and how the data can be used to address specific traffic design and planning applications.

While there are examples of pedestrian data collection programs, the quality and quantity of data is typically identified as variable and in need of improvement. Areas of improvement and need for data quality and quantity include (Bicycle and Pedestrian Data, 2000, pg. 43):

- Data collection needs to address usage patterns of individual facilities as well as total usage for geographic areas, such as for pedestrian trips for an entire city
- Data needs to be collected on a systematic and regular basis to compare patterns over time
- Data needs to be collected in consistent manner so that it can be aggregated from local location to large geographic areas, such as a city or region
- Data needs to be categorized by type to include information such as user characteristics, trip purpose and length, time of day, and type of facility.

National

The National Bicycle and Pedestrian Documentation Project is a voluntary data collection project that was created through a partnership between Alta Planning + Design and the Institute of Transportation Engineers Pedestrian and Bicycle Council. The goals of the project are to establish a consistent national bicycle and pedestrian count and survey methodology, establish a national database of bicycle and pedestrian count information generated by these consistent methods and practices, and to use the county and survey information to begin the analysis on the correlations between local demographics, climate and land-use factors and bicycle and pedestrian activity.

Citation:
Jones, M.G. and A.M. Cheng. National Bicycle And Pedestrian Documentation Project. Presented at 85th Annual Meeting of the Transportation Research Board, Washington, D.C., 2006.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts	X	Special Counts	X
Factoring Methods	X	Factoring Methods	X
Variance of Data	X	Variance of Data	X
Minimum Counts Needed	X	Minimum Counts Needed	X
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
This is a presentation of a preliminary framework for national data collection for bicycle and pedestrian counting. The structure of the project addresses the following: establish consistent survey methodology, establish national database of bicycle and pedestrian count information and use information collected to analyze social, environmental and facilities conditions that influence bicycle and pedestrian activity. The paper provides background information on the project, objectives, methodology and next steps.

Statewide

The information presented by Schneider (2005, pg. 44) documents state level programs as case studies, but no literature was found profiling state-level pedestrian data collection programs. Additionally, a comprehensive list of state data collection programs was not found during the literature review.

For information on how local research can be adopted at the state level, see resource by Jones (2010, pg. 68).

A request for information from State Bicycle and Pedestrian Coordinators found that Washington State has implemented a Washington State Bicycle and Pedestrian Documentation Project in response to the National Documentation Project. This project uses the same methodology as the national project. Rhode Island has installed trail user counters at some of its trail crossings; they will not differentiate between bicyclists and pedestrians.

Regional

The Metropolitan Transportation Commission (MTC), which is the San Francisco region's metropolitan planning organization, created the Bicyclist and Pedestrian Data Collection and Analysis Project to provide a bicycle and pedestrian data collection standard for the local jurisdiction in the region and to provide a central collection point for data collected by local jurisdictions. As part of the project, the MTC developed the Handbook for Bicycle and Pedestrian Counts to establish data collection standards and procedures.

Citation:
Handbook for Bicyclist and Pedestrian Counts. Metropolitan Transportation Commission, (San Francisco, California) 2003.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data	X	Variance of Data	X
Minimum Counts Needed	X	Minimum Counts Needed	X
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
The handbook was developed to establish bicycle and pedestrian count standards for the Metropolitan Transportation Commission's (MTC) Bicyclist and Pedestrian Data Collection and Analysis Project. The five sections of the handbook address development of a counting calendar, staffing, equipment and forms standards, schedule of activities, data processing and management, and user survey procedures. The section that addresses development of the count calendar includes information on when counts should be conducted, summary of factors that may influence the counts, and the creation of a master count schedule. The section that addresses staffing, equipment and forms addresses staff requirements and their roles, outlines equipment options, and provides standardized forms with descriptions on how to use them. The section on schedule of activities addresses pre-planning and day of requirements. The section on data processing and management outlines how the field data should be transferred to a database and how the database should be managed. The final section on user surveys outlines procedures for administration and analysis of user surveys.

Local/City/Municipal

The information presented by Schneider (2005, pg. 44) documents local-level programs as case studies, but no literature was found profiling specific local-level pedestrian data collection programs in the U.S.

For information on how research and a data collection program can be applied at the local level, see resource by Jones (2010, pg. 68).

London, England expressed a need to better understand the extent of walking in the city (Little, 2008, pg. 52). Accordingly, the city's transportation agency tested numerous technologies to determine accuracy of pedestrian counts. Based on the findings, the city has now installed 40 video-based count locations.

Melbourne, Australia includes pedestrian trip questions within its "Victorian Integrated Survey of Travel and Activity" (VicRoads, 2011, pg. 23). The survey includes walking as a potential travel mode with respect to trip chaining and travel group size. While it asks questions about specific routes chosen for vehicular trips, it does not do so for pedestrian trips.

Citation:
Little, B. Pedestrian Monitoring. Presented at 9th Annual International Conference on Walking and Livable Communities, Barcelona, Spain, 2008.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This presentation documents the efforts of London Streets, a City of London transportation agency, to decide upon and implement a pedestrian counting/monitoring program. The City's mayor had stated that the true extent and nature of walking in London is poorly understood and stated an aim to monitor the extent of walking in order to set a baseline for walking in London.

Site selection was determined on the basis of popular destinations, cordon or screenlines, key routes, and random locations. Trials were conducted for several identified technologies including closed circuit television detectors, floor mounted laser scanners, passive infrared array detectors, and overhead laser ranging scanners. The specific platforms examined included laser, video and CCTV. Manual counts were compared against the automated counts, with error percentages ranging from 1.6% (video) to 8.1% (CCTV). On the basis of the trials, video option was awarded a three-year contract for 40 monitoring sites.

The presentation concludes by highlighting several example monitoring sites by showing a photograph of the installation and identifying associated land use, location, required permission, mounting type, processor location, and power source.

BICYCLE PROGRAMS

Similar to pedestrian data collection programs, bicycle data collection programs can be found at all levels of government. While some agencies have developed their own programs, most agencies have used the National Bicycle and Pedestrian Documentation Project to advance the systematic collection of data for bicycle use.

Additionally, data vary by geography and government agency. Some agencies have robust data collection programs that are easily applied across geographies and compared to other data collected by different agencies, some data is collected sporadically to address specific local needs and some agencies do not collect data at all. The lack of consist quantities and types of data make it difficult for data users to compare data to geographies outside of the location where the data is collected (Jones, 2010, pg. 68).

National

Outside the United States, at least one other nation has embarked on a nationwide counting project. Switzerland maintains a national bicycle route system, Veloland Schweiz, and the Swiss government undertook a study to determine the system's usage and associated economic benefits (Richardson, 2006). Because of the relatively small geographic scale of the network, counts (and associated surveying of intercepted bicyclists) were able to be performed manually. One of the most instructive components of the Swiss count program is that it included the development of count weighting factors based on weather and day of week, along with spatial weights that can be used to extrapolate point-based counts to an entire bicycle network.

Citation:
Richardson, A.J. Estimating Bicycle Usage on a National Cycle Network. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 1982, Transportation Research Board of the National Academies, Washington, D.C., 2006, pp. 166-173.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This describes a multi-year survey of bicyclists using Veloland Schweiz, a national cycling route system. The survey included basic counts as well as follow-up interviews and mail-back questionnaires. The purpose of the survey was to estimate network-wide usage and the associated bicycling-related expenditures made by users of the system.

The counts themselves were performed manually – one or two people hand-counted bicyclists as they passed each of 16 survey sites and noted basic characteristics of the cyclists. A random sample of those counted cyclists was chosen to participate in the follow-up interview.

To convert the sample counts to a total estimate of system users, several weighting factors were applied: nonresponse, nonacceptance, cycle flow, site selection, temporal expansion, and spatial expansion. Two temporal factors were considered, seasonal (weather) weights and day-of-week weights. For the former, the temperature and rainfall were recorded for each of the sixteen survey dates. These measurements were compared against cycle flow rate graphs that show the propensity of cycling (broken into several trip characteristics) by temperature and rainfall, and then scaled accordingly. The graphs, based on prior research, suggest that cycling is most prevalent at a temperature of approximately 25° C (approximately 77° F) with no rainfall. The surveys were conducted on Wednesdays and Sundays, so the day-of-week adjustments simply make the assumption that Wednesday counts are representative of other weekdays and Sunday counts are representative of Saturday as well.

Local/City/Municipal

Internationally, several municipal governments have established methods for monitoring bicycle activity. The city of Vienna, Austria uses radar counters and video surveillance to track bicycling activity and has methods for projecting short-term counts (Berger, 2007, pg. 22). Hamilton, New Zealand instituted a bicycle counting program following its own extensive review of the literature and available counting techniques (Lieswyn, 2010, pg. 25). The recently implemented program largely uses in-ground inductive loops and includes a mix of permanent and temporary count stations. Melbourne, Australia's VicRoads has installed and monitors permanent count stations at 21 locations across the city (VicRoads, 2011, pg. 23). Their website includes comprehensive reports analyzing hourly, daily, and monthly variations in bicycle traffic. The communities within Melbourne supplement these automated counts with a one-day 2-hour manual count each March.

DATA PROCESSING AND STORAGE

Data processing and storage addresses how data is handled after it is collected and what methods are used to support future retrieval.

Table 4 Sources with Information on Factoring, Sampling and Count Variance

Source	Page	Pedestrian			Bicycle		
		Factoring	Count Variance	Sampling	Factoring	Count Variance	Sampling
Berkow (2009)	72				X	X	X
Casello (2011)	73				X	X	X
Charlton (2011)	29				X	X	X
Dill (2008)	30				X	X	X
Diogenes (2007)	60	X	X				
Greene-Roesel (2008)	15	X	X				
Harvey (2008)	31				X	X	X
Hudson (2010)	74	X	X	X	X	X	X
Hunter (2010)	76				X	X	X
Ismail (2009)	16	X		X			
Jones (2006)	48	X	?	?	X	X	?
Jones (2010)	68	X	X	X	X	X	X
Lovejoy (2011)	80				X	X	X
Metropolitan Transportation Commission (2003)	50			X			
Montufar (2011)	17	X	X	X			
Moskovitz (2011)	81				X	X	X
Nordback (2010)	27				X	X	
Ozbay (2010)	18	X	X	X			
Schneider (2009, "Methodology")	62	X	X	X			
Schneider (2009, "Pilot")	63	X	X	X			
Somasundaram (2010)	38	X			X	X	X
SRF (2003)	39		X		X	X	X

PEDESTRIAN COUNTS

Information on pedestrian data processing and storage is largely found through case studies. The information for data processing and storage in these case studies generally falls into categories of factoring methods, count variance, or sampling

The international literature search did not reveal significant information on pedestrian sampling techniques, recording formats, or file structures. While researchers and practitioners whose work was reviewed for this literature search must have developed recording formats and file structures for their analyses, these were not discussed in any detail in the papers reviewed. Presumably, further exploration and follow-up correspondence with the authors would allow for the collection of format and structure information.

The major gaps in the literature are related to data formats and file structures. While additional information is needed for factoring methods, count variance, and sampling, there is very little information in the literature review that addresses record formats and file structures in detail.

Factoring Methods

Factoring methods help reduce error and variances in data. Additionally, factoring methods are used to extrapolate findings from sites to similar locations, aggregated geographies or generalize data for modeling purposes. Factoring methods typically use a baseline data set, a sample data set of field data and statistical methods to process data. Manual counts, video processing by a person, or seasonal counts are typically used to establish a baseline data set or factoring measure.

Frequently, limitations in budget or equipment lead to the conducting of temporary, short-term counts even though agencies are interested in long-term pedestrian monitoring. As a result, significant portions of the international literature are devoted to methods that can be used to factor counts over longer periods of time. Two frequently discussed factoring methods involve day-of-week and seasonal variations.

Day-of-week variability in activity depends to a significant extent on the nature of that activity (i.e. trip purpose) (Mondheim, 1998, pg. 61). In areas where pedestrian travel is predominantly utilitarian in nature, including commute trips, activity is higher on weekdays. Where recreational activity is more prevalent, the converse may be true.

Count Variance

All pedestrian data collection has some degree of error or bias. Count variance can be attributed to several factors including equipment technology, environmental factors, site conditions, seasonal, weekly or time of day factors, and human error.

Sampling

Sampling for pedestrian data collection can be applied to site selection, day and time, or participant selection for studies that track individuals. Methods for site selection range from the use of local knowledge of facilities, facility characteristic, facility volumes, geography or spatial characteristics, such as urban or rural. Selection criteria range from the use of site conditions criteria to statistical methods. Day and time selections are often made to capture peak periods for pedestrian volumes and to capture seasonal or weekday variations.

Citation:

Cullen, P. Effective Pedestrian Surveys with Everyday Equipment. Presented at 8th Annual International Conference on Walking and Livable Communities, Toronto, Canada, 2007.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts	X	Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts	X	Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:

In this conference "note," the author describes the highly variable nature of pedestrian trips and behaviors and makes the case for improved surveying techniques. With regard to measuring pedestrian flows, it is suggested that time increments need to be very short (one minute) to account for significant minute-by-minute differences. Most of the pedestrian survey techniques discussed involve self-survey using Personal Data Assistants, cell phone applications, and other personal data loggers.

Citation:
Diogenes, M. C., R. Greene-Roesel, L.S. Arnold and D.R. Ragland. Pedestrian Counting Methods at Intersections: A Comparative Study. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2002, Transportation Research Board of the National Academies, Washington, D.C., 2007, pp. 26-30.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts	X	Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This is an analysis of the effectiveness and accuracy of three pedestrian counting methods including manual counting with sheets, manual counting with a clicker and manual counting with video. The results of the analysis show pedestrian counts taken in the field were systematically lower than the pedestrian counts taken by observing video recordings. The accuracy of field counts did not appear to be strongly related to pedestrian volumes. Situations were identified when field counts and video counts are best applied. While field counts have a higher degree of error than manual video counts, field counts allow observers to easily collect additional pedestrian data such as pedestrian characteristics and behavior. It is suggested that manual video data reduction is best used in situations when the accuracy of the count is a primary goal.

Citation:
Mondheim, R., Methodological Aspects of Surveying the Volume, Structure, Activities and Perceptions of City Centre Visitors. In *GeoJournal 45*, Kluwer Academic Publishers, 1998, pp. 273-287.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed	X	Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
While the focus of this research is on using pedestrian data and opinions to determine the potential of retail locations in downtown areas, as opposed to pedestrian transportation, it does devote significant attention to pedestrian counts and associated temporal variations (time of day, day of week, and annually). It is noted that these variations are further complicated by different patterns based on the study site's physical location and the function of the adjacent street (for example, a street in an office district with prevalent pedestrian commuting versus a shopping district street with a more uniform time of day pattern). The research includes a discussion of a "representative weekday" that can be used to extrapolate daily counts to weekday counts, with a specific comparison of Tuesday counts and Saturday counts at sites worldwide. The second half of the paper includes a discussion of pedestrian interviews (i.e., surveys). Again, while the context is asking pedestrians about their opinions regarding city centers and shopping districts, there is some useful discussion regarding weighting of surveys both temporally and spatially.

Citation:
Schneider, R.J., L.S. Arnold and D.R. Ragland. Methodology for Counting Pedestrians at Intersections: Use of Automated Counters to Extrapolate Weekly Volumes from Short Manual Counts. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2140, Transportation Research Board of the National Academies, Washington, D.C., 2009, pp. 1-12.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This presents a method for using manual and automatic pedestrian counts to estimate weekly intersection pedestrian volumes. Included is an outline of the specific methods for intersection selection (to provide a variety of intersection types and environmental conditions), manual counts, automatic counts, and how to manage variances in the data associated with temporal, spatial and weather factors.

Citation:
Schneider, R. J, L.S. Arnold and D.R. Ragland. Pilot Model for Estimating Pedestrian Intersection Crossing Volumes. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2140, Transportation Research Board of the National Academies, Washington, D.C., 2009, pp. 13-26.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	
Factoring Methods	X	Factoring Methods	
Variance of Data	X	Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	
Utilizing Different Sources	X	Utilizing Different Sources	
Formats for Counts	X	Formats for Counts	
Reasons for Data Collection	X	Reasons for Data Collection	

Summary:
This presents a pilot model for using manual and automatic pedestrian counts to estimate weekly intersection pedestrian volumes. Additionally, the authors outline the specific methods for intersection selection (to provide a variety of intersection types and environmental conditions), manual counts, automatic counts, and how to manage variances in the data associated with temporal, spatial and weather factors.

BICYCLE COUNTS

Information on bicycle data processing and storage is largely found through case studies. The information for data processing and storage in these case studies generally falls into categories of factoring methods, count variance, or sampling

The major gaps in the literature are related to data formats and file structures. While additional information is needed for factoring methods, count variance, and sampling, there is very little information in the literature review that addresses record formats and file structures in detail.

The international literature search did not reveal significant information on bicycle data recording formats or file structures. While researchers and practitioners whose work was reviewed for this literature search must have developed recording formats and file structures for their analyses, these were not discussed in any detail in the papers reviewed. Presumably, further exploration and follow-up correspondence with the authors would allow for the collection of format and structure information.

Factoring Methods

Factoring methods help reduce error and variances in data. Additionally, factoring methods are used to extrapolate findings from sites to similar locations, larger geographies or generalize data for modeling purposes. Factoring methods typically use a baseline data set, a sample data set of field data and statistical methods to process data. Manual counts, video processing by a person, or seasonal counts are typically used to establish a baseline data set or factoring measure.

As with the pedestrian mode, significant portions of the international literature are devoted to methods that can be used to factor counts over longer periods of time. Two frequently discussed factoring methods involve day-of-week and seasonal variations.

Studies in Australia and Norway indicated significantly higher use of bicycle facilities on weekdays, while the Swiss national cycle network sees higher usage on weekends. The Swiss research additionally observes that ideal weather conditions, defined as a temperature of approximately 25° C (approximately 77° F) with no rainfall, lead to increased bicycling activity (Richardson, 2006). Different adjustment factors have been developed to account for these temporal variations based on local conditions, but no international standard has been cited.

Count Variance

All bicycle data collection has some degree of error or bias. Count variance can be attributed to several factors including equipment technology, environmental factors, site conditions, seasonal, weekly or time of day factors, and human error.

Sampling

Sampling for bicycle data collection can be applied to site selection, day and time, or participant selection for studies that track individuals. Methods for site selection range from the use of local knowledge of facilities, facility characteristic, facility volumes, geography or spatial characteristics, such as urban or rural. Selection criteria range from the use of site conditions criteria to statistical methods. Day and time selections are often made to capture peak periods for pedestrian volumes and to capture seasonal or weekday variations.

London, United Kingdom’s Department for Transport has identified the number of counts required to accurately detect a change in various bicycle flows (Department for Transport, 1999, pg. 66).

Citation:
Monitoring Local Cycle Use. Department of Transport, London, Great Britain, 1999.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	X
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	

Summary:
This traffic advisory leaflet discusses methods of counting bicyclists. It also recommends specific periods to count, time of year, and the number of days. The number of counts required to accurately detect a change in flows is also discussed.

DATA USE

Data may be collected for trends analysis, projects or to fulfill a regulatory mandate which may or may not support funding for infrastructure construction, improvements or maintenance. This section contains most of the case study documentation encountered in this review.

Bicycle and pedestrian data can be applied to a variety of situations and a variety of scales. From local communities to national agencies, bicycle and pedestrian data is used to document facility performance, assess need for bicycle and pedestrian facilities, improve safety, inform design and construction projects and inform policy and funding decisions. However, there is an expressed demand and need for a higher quantity and quality of data, as well as better standards and methods, to inform the list of applications above.

Amongst the international literature, much more focus is placed upon process and techniques for collecting data as opposed to reporting and using data. Limited examples of data use are provided below in this section.

Citation:
Jones, M.G., S. Ryan, J. Donlon, L. Ledbetter, D.R. Ragland and L. Arnold. *Seamless Travel: Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type*. Publication UCB-ITS-PRR-2010-12. California PATH, ITS-Berkeley, California Partners for Advanced Transportation Technology, Institute of Transportation Studies, University of California Berkeley, 2010.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data	X	Variance of Data	X
Minimum Counts Needed	X	Minimum Counts Needed	X
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
The report summarizes an extensive research project focused on bicycle and pedestrian data collection and analysis in San Diego, CA. The report summarizes current count and survey methods, describes in detail the data collection process for the project, documents the count and survey results, and presents the results of several bicycle and pedestrian models using the data collected. The review of count and survey methodology describes manual count methods, automatic counting technologies, bicycle and pedestrian survey methods, and reviews several bicycle and pedestrian models that have been developed to use the data. The data collection section describes how manual and automatic counts for bicyclists and pedestrians can be structured to collect year round data, as well as how a survey can be used to supplement the count data. The results section presents the findings from the data collection and includes information on bicycle and walking trip purpose, frequency of bicycling and walking, destination information, reasons preventing people from bicycling or walking more often, preferred bicycle and pedestrian facilities, socio-economic data, volume data, capacity data, temporal patterns, mode split and level of service information. The final section on bicycle and pedestrian models tests several predictive models. The modeling results are compared with the data collected to identify if the models are effective in estimating and forecasting bicycling and walking. The report concludes with several additional resources including a link to the count database, a training manual for bicycle and pedestrian counting, instructions for sending future data, details about the bicycle and pedestrian model, a summary of comparison surveys, and a summary of the background data used for analysis.

PEDESTRIAN STUDIES

The primary focus of the pedestrian studies reviewed focused on how counting data can be used to identify trends, analyze facility performance or document facility capacity. Information on how data is used to inform modeling and how mixing data can be used to extrapolate information was also found.

Several data gaps were highlighted throughout the literature related to data use including:

- How to blend survey data with count data to extrapolate trends, capacity or design needs
- Information on how bicycle and pedestrian data can be used to inform policy and funding decisions
- Information on safety data collection and analysis
- Guidelines for how count data can be used to improve facility design and safety improvements
- Before and after studies related to new facilities or facility improvements for pedestrians

Recurring

Several resources examined how data collection programs can be used to analyze walking trends for a particular facility or geography. Case studies were not found that describe how pedestrian count data was used to improve safety or how data has been used to address funding or legislative mandates.

Trends

Two case studies were found that illustrate how pedestrian data can be used to analyze trends. Data typically includes a mix of manual counts, automatic counts and surveys to develop information about pedestrian trends.

The City of London, England began its pedestrian counting program simply to better understand the extent and nature of walking activity (Little, 2008, pg. 52). The initial counts were performed to get a baseline measure, presumably with the intent to monitor trends over time.

Safety

No case studies were found on pedestrian safety data collection as part of the literature search for this report.

Funding/Legislative Mandates

No U.S. case studies were found on pedestrian funding/legislative mandate data collection as part of the literature search for this report.

International transportation agencies, including state and municipal agencies in Australia and New Zealand, were found to regularly conduct bicycle counts to monitor system or facility performance and the benefits of investments in those bicycle facilities. In this sense, the count programs are used to justify government expenditure and perhaps gain funding for additional facilities. Switzerland has gone one step further by using additional surveys to determine ancillary investments made by users of the national cycle network (Richardson, 2006, pg. 54).

Project Specific

No case studies were found on project specific data collection to address facility construction or traffic warrants.

Research

Case studies were found on how pedestrian data can be applied to analyze capacity. No case studies were found that address quality of service and no special needs case studies were found either.

Capacity

Pedestrian data has been used to assess existing facility performance as well as extrapolate capacity need for facilities. Pedestrian data that addresses capacity has also been used to develop transportation models for local communities and regions.

See resources by Jones (2010, pg. 68), Schneider (2009, "Methodology", pg. 62), Schneider (2009, "Pilot", pg. 63), Schneider (2005, pg. 44), Cottrell (2003, pg. 46) and Hudson (2010, pg. 74) as well as Diogenes (2007, pg. 60).

Quality of Service

No case studies were found on pedestrian quality of service data collection, as it relates to monitoring counts or activity levels as part of the literature search for this report.

Special Needs

No case studies were found on pedestrian special needs data collection as part of the literature search for this report.

BICYCLE STUDIES

The primary focus of the bicycle studies reviewed focused on how counting data can be used to identify trends, analyze facility performance or document facility capacity. Information on how data is used to inform modeling and how mixing data can be used to extrapolate information was also found. Additionally, several studies address the collection and analysis of bicycle and pedestrian data.

Several data gaps were highlighted throughout the literature related to data use including:

- How to blend survey data with count data to extrapolate trends, capacity or design needs
- Information on how bicycle and pedestrian data can be used to inform policy and funding decisions
- Information on safety data collection and analysis

- Guidelines for how count data can be used to improve facility design and safety improvements
- Before and after studies related to new facilities or facility improvements for bicyclists

No case studies were found that documented how bicycle counting data has been used to address safety or funding/legislative mandates. However, the need for this information is a common theme throughout the literature reviewed, especially as it relates to funding and legislative mandates.

Recurring

Several resources examined how data collection programs can be used to analyze biking trends for a particular facility or geography. Case studies were not found that describe how bicycle count data was used to improve safety or how data has been used to address funding or legislative mandates.

Trends

Several case studies were found that illustrate how bicycle data can be used to analyze trends. Data typically includes a mix of manual counts, automatic counts and surveys to develop information about bicycle trends.

See resources by Jones (2010, pg. 68), Jones (2006, pg. 48), Dill (2008, pg. 30), Harvey (2008, pg. 31), Charlton (2011, pg. 29), Lovejoy (2011, pg. 80) as well as the resources by Berkow (2009, pg. 72), Casello (2011, pg. 73) and Hudson (2010, pg. 74).

Citation:
Berkow, M. Using Bicycle Count Data to Measure Use of Existing Bicycle Facilities in Portland, Oregon. Presented at the 88th Annual Meeting of the Transportation Research Board, Washington, D.C., 2009.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	X
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This is an analysis of the City of Portland's methods for bicycle count data collection and how the data is managed. The information was used to identify ways to organize and analyze data. It identified how bicycle count data can be used to assess the use of bicycle facilities, inform policies and justify investment in bicycle infrastructure. Ways that Portland can improve its data collection program and minimum requirements that are needed for municipal bicycle count programs to be effective were presented.

Citation:
Casello, J., A.O. Nour, K.C. Rewa and J. Hill. Analysis of Stated-Preference and GPS Data for Bicycle Travel Forecasting. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, D.C., 2011.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
Two data collection methods were used, an on-line survey and GPS units to collect bicycling trip data, to produce trip generation and attraction rates for cycling as a function of land use. The mixed-data analysis method was used to inform models for bicycle trip distribution, mode and path choice, as well as prioritization of infrastructure investments.

Citation:
Hudson, J. G., T.T. Qu and S. Turner. *Forecasting Bicycle and Pedestrian Usage and Research Data Collection Equipment*. Publication TTI No. P2009330. Texas Transportation Institute, Capital Area Metropolitan Planning Organization and the Federal Highway Administration, 2010.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts	X	Portable Counts	X
Permanent Counts	X	Permanent Counts	X
Special Counts	X	Special Counts	X
Factoring Methods	X	Factoring Methods	X
Variance of Data	X	Variance of Data	X
Minimum Counts Needed	X	Minimum Counts Needed	X
Reporting Information/Customer Needs	X	Reporting Information/Customer Needs	X
Utilizing Different Sources	X	Utilizing Different Sources	X
Formats for Counts	X	Formats for Counts	X
Reasons for Data Collection	X	Reasons for Data Collection	X

Summary:
This is an analysis of bicycle and pedestrian monitoring programs around the United States, testing equipment used to collect data for bicycles and pedestrians travel, identification of best practices for data collection and storage, and identification of ways bicycle and pedestrian data can be used to inform regional transportation models and project selection criteria. Included is a discussion on how bicycle and pedestrian monitoring programs can help answer questions related to whether programs are actually increasing the number of people who bike and walk.

Project Specific

A case study was found that documents the ridership volumes before and after a facility as constructed.

An Australian study was found which used bicycle data to build models to forecast use as a function of climate variables.

Facility Construction

A study in St. Petersburg, Florida documented the before and after bicycle volumes to see whether the facility supported an increase in riders.

Citation:
Hunter, W. W., R. Srinivasan and C. Martell. Change in Amount of Bicycling Associated with Installation of Bike Lanes in St. Petersburg, Florida. Presented at the 89th Annual Meeting of the Transportation Research Board, Washington, D.C., 2010.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This is a case study of how to use bicycle counts to analyze whether the installation of a bike lane influenced bicycle ridership. A method for data collection is presented that includes seasonal data collection, equipment, and equipment placement.

Citation:
Ahmed, F. and C. Jacob. Impact of weather on commuter cyclist behavior and implications for climate change adaptation. Presented at 33rd Australian Transportation Research Forum, Canberra, Australia, 2010.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This paper did not discuss methods for obtaining bicycle counts. Rather it discussed research which used the counts to develop models to explain variations in bicycle commuting as a function of weather related variables: wind speed, daily precipitation, apparent temperature, hours of sunshine, and humidity.

The modeling effort made use of Vic Roads bicycle count stations. Subsequent research obtained from the Vic Roads website is provided in a separate summary.

Research

Case studies were found on how bicycle data can be applied to analyze capacity as well as unique bicycle data applications.

Capacity

Bicycle data has been used to assess existing facility performance as well as extrapolate capacity need for facilities. Pedestrian data that addresses capacity has also been used to develop transportation models for local communities and regions.

See resources by Jones (2010, pg. 68) and Hudson (2010, pg. 74).

Special Needs

In addition to on-street and path facilities bicycle counting data, two resources presented unusual methods to collect and analyze bicycle data. One resource analyzed the use of bicycle parking facilities to extrapolate information on bicycle parking behavior, effectiveness of bicycle parking facilities and trip and origin destinations. The other study used mixed data collection methods to extrapolate bicycle use and behavior data.

Citation:
Constant, A., A. Messiah, L. Felonneau and E. Legarde. Investigating Risk Compensation Theory in Cyclists: Results from Intelligent Video System. Presented at International Conference on Safety and Mobility of Vulnerable Road Users: Pedestrians, Motorcyclists, and Bicyclists, Jerusalem, Israel, 2010.

Pedestrian Consideration	Addressed?	Bicycle Consideration	Addressed?
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
An observational study was undertaken in Bordeaux, France to determine whether helmet use among bicyclists leads to riskier bicycling behaviors (in accordance with "risk compensation theory"). An Intelligent Video Analysis System (IVAS), consisting of an Internet Protocol camera (used to detect and measure the speed of bicyclists) and a synchronized camera that takes pictures to record other characteristics including helmet use were used in the study. The study compares risky behaviors between men and women and helmeted cyclists and non-helmeted cyclists. "Risky" behaviors (including higher speed travel, on-road riding, and running of red lights) were more commonly observed among helmeted males than non-helmeted males, but no significant differences were discovered among the female population. While the IVAS may have additional applications for bicycle and pedestrian counting, it is not described in any significant detail in the research summary.

Citation:
Lovejoy, K. and S.L. Handy. Mixed Methods of Bike Counting for Better Cycling Statistics: The Example of Bicycle Use, Abandonment, and Theft on UC Davis Campus. Presented at the 90th Annual Meeting of the Transportation Research Board 90th Annual Meeting, Washington, D.C., 2011.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	X
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	X
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	X
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This documents use of three different methods of bicycle data collection to project bicycle travel behavior and total volumes of bicycle ridership at the University of California-Davis. The data sources used include police records on reported bike thefts, a bike rack count, and a travel survey. The sample results from the surveys, reports and counts were used to make projections about bicycle use for the entire campus population. The combination of measurement methods provided a more robust picture of bicycle volumes than any one method alone could.

Citation:
Moskovitz, D. A. and N. Wheeler. Bicycle Parking Analysis Using Time-Series Photography. Presented at the 90th Annual Meeting of the Transportation Research Board, Washington, D.C., 2011.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	X
Variance of Data		Variance of Data	X
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	X
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	X
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This presents a method for collecting and analyzing bicycle parking data. Digital photography was used to capture bicycle parking data over a period of time that includes arrival and departure times, parking durations and turnover rates. The data can be used to answer questions related to bicycle parking behavior, effectiveness of bicycle parking facilities, and trip and origin destinations.

Citation:

Phung, J. and G. Rose. Temporal Variations in Usage of Melbourne's Bike Paths. Presented at 30th Australasian Transport Research Forum, Melbourne, Australia, 2007.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	X

Summary:

This paper did not discuss methods for obtaining bicycle counts. Rather it discussed research which used the counts to develop models to explain variations in bicycle commuting and recreational use as a function of temporal variables: time of day, day of week, month of year. Based upon their analysis the researchers recommend hour to day, day to week, and month to year adjustment factors.

The modeling effort made use of Vic Roads bicycle count station. Subsequent research obtained from the Vic Roads website is described in a separate citation.

Citation:
Ellison, R, and S. Greaves. Travel Time Competitiveness of cycling in Sydney. Presented at 33rd Australasian Transport Research Forum, Canberra, Australia, 2010.

Pedestrian Consideration	**Addressed?**	**Bicycle Consideration**	**Addressed?**
Portable Counts		Portable Counts	
Permanent Counts		Permanent Counts	
Special Counts		Special Counts	X
Factoring Methods		Factoring Methods	
Variance of Data		Variance of Data	
Minimum Counts Needed		Minimum Counts Needed	
Reporting Information/Customer Needs		Reporting Information/Customer Needs	
Utilizing Different Sources		Utilizing Different Sources	
Formats for Counts		Formats for Counts	
Reasons for Data Collection		Reasons for Data Collection	X

Summary:
This paper did not address counting of bicyclists for use in determining volumes. Rather, GPS units were provided to cyclists and motorists accessing areas and specific destinations to compare travel times among cyclists and motorists.

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REPORTING

Reporting is an outcome of a defined need to collect information. In assigning material to this section three questions were asked: Does this material provide information on standardizing a record format for data storage? Is the method of presentation "easily" transferrable? Is there a mandate for this information that a consistent presentation of the material would simplify comparison or aggregation of the information provided.

The standards identified as part of this literature review are based on the standards established by the National Bicycle and Pedestrian Documentation Project. The project's standards have evolved over time and have also been adapted to local needs, methods and programs.

The standards include record formats for intersection counts, screenline counts and surveys. The standards allow for facilities types to be compared and data aggregated to analyze larger geographic areas.

See resources by Jones (2010, pg. 68), Jones (2006, pg. 48) and the Metropolitan Transportation Commission (2003, pg. 50).

Reporting standards for safety, funding/legislative mandates, facility construction and traffic warrants were not found.

Amongst the international literature, much more focus is placed upon process and techniques for collecting data as opposed to reporting and using data.

VicRoads (Melbourne, Australia) maintains a website which includes data collected. Bicycle count information is reported by time of day, day of week, and month of year. Each year a narrative analysis is prepared of the bicycle count data. These analyses present hypothesis to explain some variations from the norm in annual data (e.g. a particular month was particularly rainy).

APPENDIX B – WEBINAR CONTENT

This appendix includes the slides from the webinar with the poll questions embedded at the appropriate locations. The figures of a pedestrian and a bicyclist indicate the slides following which poll questions were asked.

The slides and the questions were available for download by all participants via the library on the webinar site. The materials were also forwarded by e-mail to those individuals who requested them. Where questions were not visible to the participants because of software technical difficulties, copies of the poll were furnished on request. No responses were received following the e-mail of the questions.

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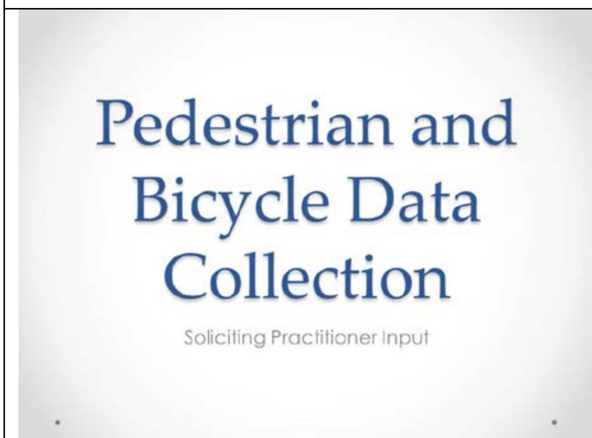
<tr><td>
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<tr><td></td><td>What do You Want the Data for? (chat box)
Open ended question with response via chat box</td></tr>
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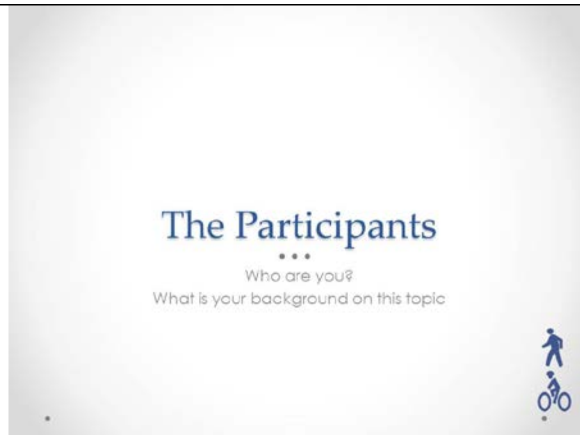
Presentation materials with poll questions inserted



For which type of agency do you work?

a. State
b. Regional/MPO
c. County
d. Municipal/City/Town
e. Federal
f. Research/Educational Institution
g. Advocacy Group
h. Consultant/Vendor
i. Other (enter in chat box)
j. Tribal Agency

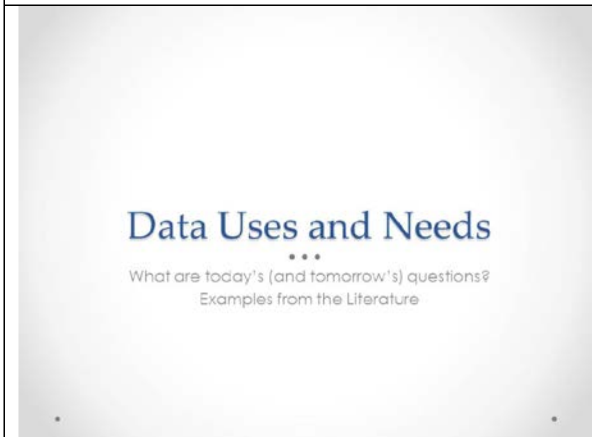
For how many years have you/ your agency been collecting bicycle and or pedestrian count data?

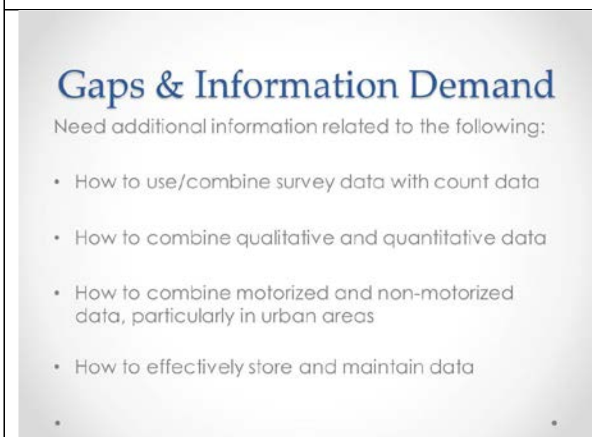
a. Not yet
b. 1-3 years
c. 4-7 years
d. 8-10 years
e. 11 + years

Is your pedestrian/bicycle data collection program -

a. Continuous counts
b. Periodic scheduled counts
c. On demand counts
d. Recurring (continuous and periodic) only
e. Recurring and on demand
f. Do not count [Reason? Please use chat box]

Presentation materials with poll questions inserted





Presentation materials with poll questions inserted

Pedestrian counts are collected for -

a. Safety analyses
b. Project selection (preliminary planning)
c. Project design
d. Project evaluation (before and after studies)
e. Modeling – long range planning
f. Modeling – simulation
g. Trends analysis

Pedestrian counts are anticipated to be needed for -

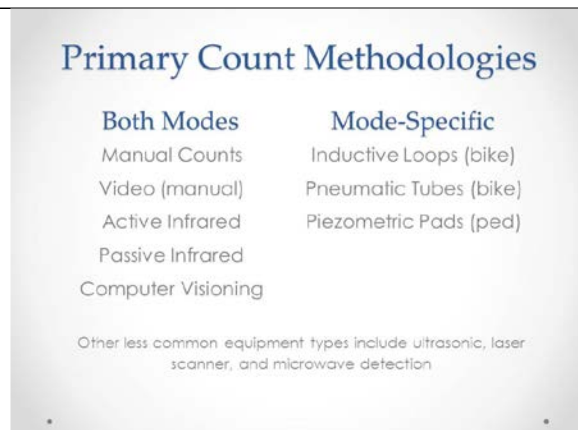
a. Safety analyses
b. Project selection (preliminary planning)
c. Project design
d. Project evaluation (before and after studies)
e. Modeling – long range planning
f. Modeling – simulation
g. Trends analysis

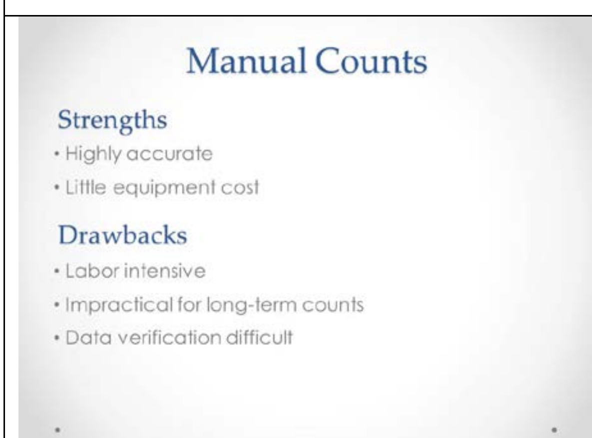
Bicycle counts are collected for -

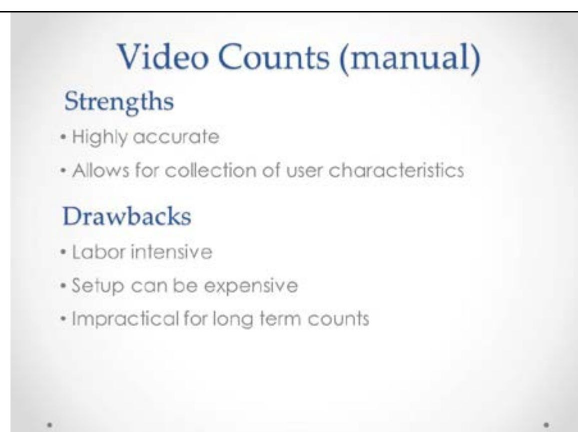
a. Safety analyses
b. Project selection (preliminary planning)
c. Project design
d. Project evaluation (before and after studies)
e. Modeling – long range planning
f. Modeling – simulation
g. Trends analysis
h. Other (enter in chat box)

Bicycle counts are anticipated to be needed for -

a. Safety analyses
b. Project selection (preliminary planning)
c. Project design
d. Project evaluation (before and after studies)
e. Modeling – long range planning
f. Modeling – simulation
g. Trends analysis
h. Other (enter in chat box)







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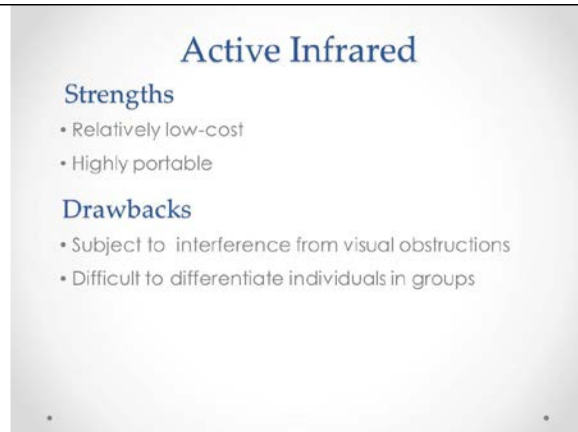
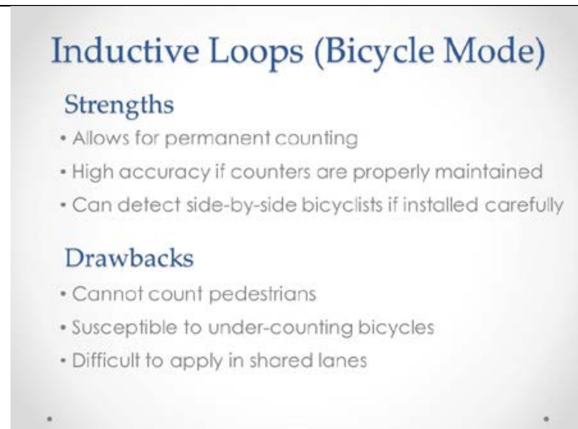
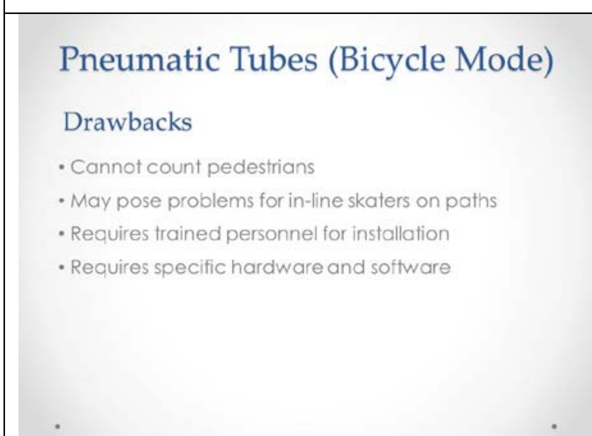
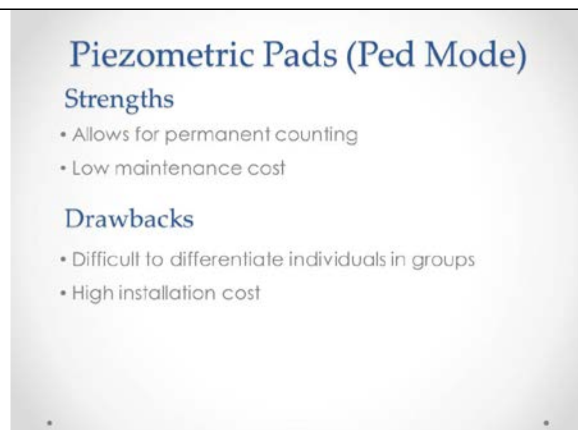








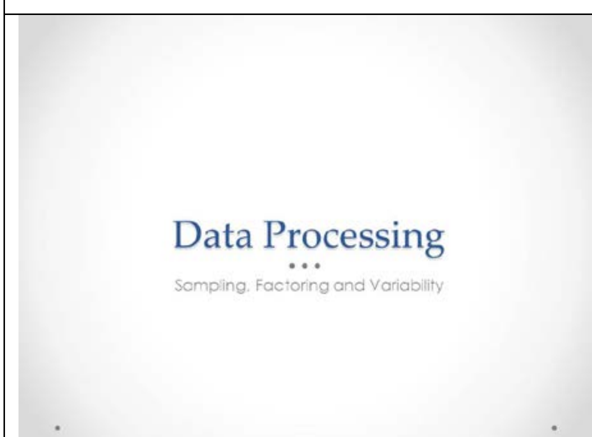
Presentation materials with poll questions inserted

Pedestrian count methods used

a. Manual
b. Automated fixed location
c. Active collection (GPS, Smartphone)
d. None

Which of the following automated technologies has your agency employed for pedestrian counts?

a. Piezoelectric Pad
b. Active Infrared
c. Passive Infrared
d. Computer Visioning
e. Manual Video
f. Not certain/Other (identify technology or equipment in chat box)
g. None

Presentation materials with poll questions inserted	
Bicycle count methods used a. Manual b. Automated fixed location c. Active collection (GPS, Smartphone) d. None	Which of the following technologies has your agency employed for bicycle counts? a. Inductive Loops b. Pneumatic Tubes c. Active Infrared d. Passive Infrared e. Computer Visioning f. Manual Video g. Not certain/Other (identify technology or equipment in chat box) h. None
Has your agency independently evaluated the effectiveness of any automated count equipment types? a. Yes (please tell us how we can find the information) b. No	How many pedestrian counts do you do a year? a. Under 10 b. 10 to 20 c. 21 to 50 d. 51 to 100 e. 100 plus
How many bicycle counts do you do a year? a. Under 10 b. 10 to 20 c. 21 to 50 d. 51 to 100 e. 100 plus	How many permanent bike and or pedestrian counters do you operate on an ongoing basis? a. Under 5 b. 5 to 10 c. 11 to 20 d. 21 to 30 e. 31 or more
	

Presentation materials with poll questions inserted

Handling Short Counts: Sampling, Factoring, and Extrapolation
Potential error sources

There are three potential sources of significant error associated with extrapolating counts.

- Errors associated with creating adjustment factors based upon low volume counts
- Errors associated with applying adjustment factors to low volume counts
- Errors associated with utilitarian/recreational mix

Handling Short Counts: Sampling, Factoring, and Extrapolation
How do you address these concerns?

Many agencies cannot conduct permanent counts

- How can short term counts be used to gauge overall usage of a facility?
- How are these methods applied to small sample sizes?

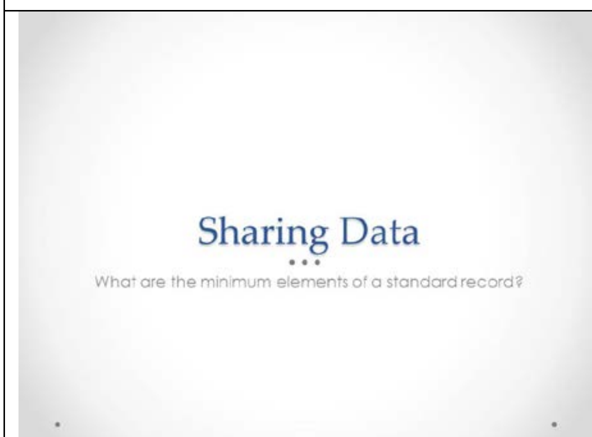
Handling Short Counts: Sampling, Factoring, and Extrapolation
(Sources)

- Primary sources:
  - National Pedestrian and Bicycle Documentation Project– interactive spreadsheet extrapolates two-hour counts
  - Schneider, Arnold, and Ragland, 2009 (ped intersections)
  - International research from the United Kingdom, Australia, and Switzerland

Additional Data Factoring & Storage Considerations

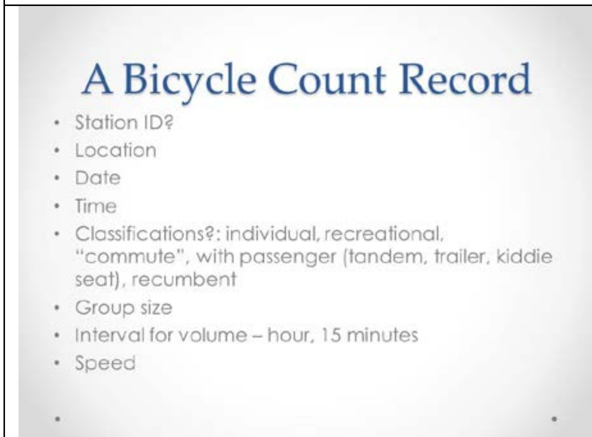
- Beyond these factoring/extrapolation elements, the literature is quite silent on data processing and storage
- While countless researchers undoubtedly have experience, it's rarely the focus of the research and therefore goes undocumented

So how do YOU factor?

Presentation materials with poll questions inserted	
Do you have experience extrapolating short-term bicycle or pedestrian counts over longer periods of time using temporal adjustment factors (HOD, DOW, Seasonal or Annual)? a. Yes b. No	If the answer to #16 is yes, what is the source of your methodology? No vote required.
Does your agency seek to estimate system/network usage based on screenline counts? a. Yes b. No	If so, are you aware of a reliable system/network estimation methodology? a. Yes (identify in chat box) b. No
Do you have a particularly effective and or unique data storage process to recommend? a. Yes (identify in chat box) b. No	
	

Presentation materials with poll questions inserted	
 	Which of the following should be MANDATORY in a national pedestrian data record a. Station ID b. Location (latitude/longitude) c. Location (route/milepost) d. Location (street name/address) e. Date f. Time g. Direction h. Classifications i. Collection Method j. Interval for volume (i.e. hour, 15 minutes) k. Purpose l. Group size m. Weather Other (enter in chat box as ped – mandatory – suggested item)
Which of the following would be nice to have in a national pedestrian data record a. Station ID b. Location (latitude/longitude) c. Location (route/milepost) d. Location (street name/address) e. Date f. Time g. Direction h. Classifications i. Collection Method j. Interval for volume (i.e. hour, 15 minutes) k. Purpose l. Group size m. Weather n. Other (enter in chat box as ped – nice – suggested item)	Which of the following should be OMITTED in a national pedestrian data record a. Station ID b. Location (latitude/longitude) c. Location (route/milepost) d. Location (street name/address) e. Date f. Time g. Direction h. Classifications i. Collection Method j. Interval for volume (i.e. hour, 15 minutes) k. Purpose l. Group size m. Weather n. Other (enter in chat box as ped – omitted – suggested item)

Presentation materials with poll questions inserted



Which of the following should be MANDATORY in a national bicycle data record

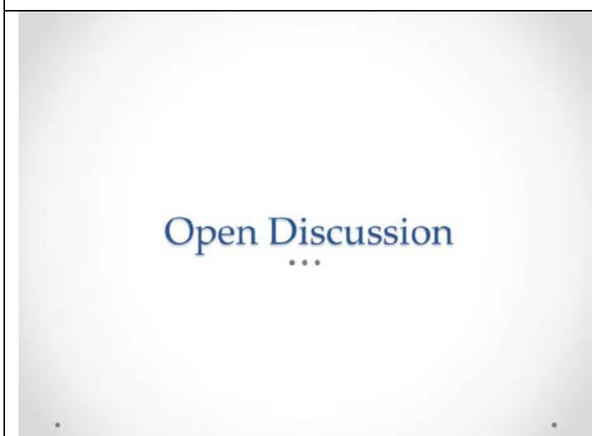
a. Station ID
b. Location (latitude/longitude)
c. Location (route/milepost)
d. Location (street name/address)
e. Date
f. Time
g. Classifications
h. Collection Method
i. Interval for volume (i.e. hour, 15 minutes)
j. Weather
k. Speed
l. Purpose
m. Other (enter in chat box as bike– mandatory – suggested item)

Which of the following would be nice to have in a national bicycle data record

a. Station ID
b. Location (latitude/longitude)
c. Location (route/milepost)
d. Location (street name/address)
e. Date
f. Time
g. Classifications
h. Collection Method
i. Interval for volume (i.e. hour, 15 minutes)
j. Weather
k. Speed
l. Purpose
m. Other (enter in chat box as bike – nice – suggested item)

Which of the following should be OMITTED from a national bicycle data record

a. Station ID
b. Location (latitude/longitude)
c. Location (route/milepost)
d. Location (street name/address)
e. Date
f. Time
g. Classifications
h. Collection Method
i. Interval for volume (i.e. hour, 15 minutes)
j. Weather
k. Speed
l. Purpose
m. Other (enter in chat box as bike– omit – suggested item)

Presentation materials with poll questions inserted	
	The following should be MANDATORY in a national pedestrian/bicycle count information (Location) record a. Station ID b. Location (latitude/longitude) c. Location (route/milepost) d. Location (street name/address) e. Start Date f. End Date g. Start Time h. End Time i. Method j. Equipment make/model for automated equipment k. Equipment technology for automated equipment l. Classification scheme m. Interval for volume (i.e. hour, 15 minutes) n. Weather o. Speed p. Purpose Other (enter in chat box as location – Mandatory – suggested item)
	

APPENDIX C – WEBINAR ATTENDEES

This project was intended to get participation from all 50 states and at least 10 Metropolitan planning organizations (MPOs.) State personnel to contact were identified through personal contacts, consultation with FHWA and the literature review. At least one contact was identified in all fifty states, the District of Columbia, and Puerto Rico, with invitations accepted by forty-one states and the District of Columbia. Twenty-four states and the District of Columbia had one or more personnel attend. Table 4 shows the number of individuals invited and the numbers attending each webinar by agency type where it could be identified. At some webinars, more than one attendee from an agency was present. Some agencies had personnel at more than one webinar. The totals reflect the number of unique agencies attending.

Table 4. Attendance Statistics

Attendance Statistics					
	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total
Invitations Sent	94	41	67	37	*
Attendance	11	27	37	24	99
State	6	9	8	14	25**
MPO		6	6	4	8**
University	2	1		1	4
Vendor	1			1	2
Town/City		2	2	1	5
Unknown/Other	3	4	4	4	

*Includes follow ups but does not include a total because number associated with the Highway CommunityExchange announcement (the FHWA community of practice web site) is unknown.

**Unique agencies represented

Table 5 identifies the states that participated in the webinars and provided input via the poll questions.

Table 5. States Represented at Pedestrian and Bicycle Data Collection Webinars

Alaska	Arkansas	Arizona	Colorado	Connecticut
District of Columbia	Florida	Georgia	Indiana	Maryland
Maine	Michigan	Minnesota	Montana	North Carolina
North Dakota	Nebraska	Ohio	Rhode Island	South Carolina
South Dakota	Virginia	Vermont	Washington	West Virginia

Table 6 identifies the MPOs that participated in the webinars and provided input via the poll questions.

Table 6. MPOs Represented at Pedestrian and Bicycle Data Collection Webinars

Nashville Are MPO (TN)	Capital Regional Council of Governments (CT)	Miami-Dade MPO (FL)
Pima Association of Governments (AZ)	Baltimore Metropolitan Council (MD)	Mid-Ohio Regional Planning Commission
Des Moines Area MPO (IA)	Region XII Council of Governments (IA)	

In addition to explicit invitations, an announcement matching the invitation was posted to HighwayCommunityExchange after the first webinar to make knowledge of the project generally available. (HighwayCommunityExchange is the web site for the FHWA community of practice. The Travel Monitoring section was where the announcement was posted.)

Table 7 identifies other organizations that participated in the webinars and provided input via the poll questions.

Table 7. Other Organizations Represented at Pedestrian and Bicycle Data Collection Webinars

Other Municipalities		
City of Boulder (CO)	City of Seattle (WA)	City of Frederick (MD)
Prince George's County (Parks and Rec) (MD)	Arlington County Division of Transportation (VA)	Lewis and Clark County (MT)

Educational/ Research Organizations		
Texas Transportation Institute	University of Colorado Denver	Portland State University

Others including Advocacy Groups and Vendors		
MNSU	Bike Walk Twin City	Minneapolis Publish
National Park Service	Centers for Disease Control	Cambridge Systematics
Alert Systems	RDS Traffic	PBIC

The invitation process had two components: a targeted e-mail group and a general announcement. The targeted e-mail group included state agencies, MPOs, FHWA Division personnel and members of Transportation Research Board committees with an interest in the topic. The initial contacts at the state agencies and MPOs were contacted via e-mail (Figure 2) and one follow up to get a current list of individuals associated with pedestrian and bicycle data collection.

Dear _________:

FHWA expects to include pedestrian and bicycle counting in the next version of the Traffic Monitoring Guide. In anticipation of the inclusion of these data FHWA is gathering relevant information on the state-of-the-practice and methods/processes used to collect this information. Such information includes proper counting techniques, quality assurance procedures, and processing techniques.

As part of an ongoing research project on this subject, interactive webinars will be conducted on several dates in September 2011. The primary purpose of these webinars is to solicit practitioner input on both experiences and needs as they relate to bicycle and pedestrian counting activities. Participation by one or more individuals from each state's transportation department is desired. It is expected that the state bicycle and pedestrian coordinator will be the most appropriate webinar participant in many instances. If that is true in your case, please let us know and we will be back in touch soon with a formal invitation. If another individual within your agency would be a more appropriate attendee given the subject matter, please provide his or her e-mail address and phone number. Finally, please let us know if you are aware of regional or local transportation agencies within your state which would be particularly beneficial to include in the invitee list.

Your participation (or designation of an alternate participant) is much appreciated.

Figure 2. Initial Contact Note

Copy of final invitation

Figure 2 shows the e-mail message which was sent to targeted participants as an initial invitation. The same invitation, edited to include only the remaining webinar dates, was also used to follow up with agencies that had not yet participated.

You are invited to attend a webinar on pedestrian and bicycle data collection at one of the following times (we have made 4 available to make attending one of them possible):

August 24, 2011, 2-3 pm Eastern **September 12, 2011, 2-3 pm Eastern**

September 19, 2011 11 am – 12 noon Eastern

September 21, 2011 10-11 am Eastern

To login: http://fhwa.adobeconnect.com/fhwatalkingtraffic

Phone: 877-848-7030 **passcode: 6217068**

The FHWA research project on Pedestrian and Bicycle Data Collection is seeking information on the state-of-the-practice in collecting, storing and using pedestrian and bicycle count data. To solicit input from practitioners at the state and regional level, four identical webinars are being held. The results of the webinar will be used by FHWA in deciding what materials and methods should be included in the current revision of the Traffic Monitoring Guide on pedestrian and bicycle data collection.

Figure 3. Final Webinar Invitation (Part 1)

The webinar will present results from a recent literature review of the topic using U.S. and international materials. We will be discussing equipment types, strengths and weaknesses; uses of and needs for pedestrian and bicycle data, factoring short counts, and the potential content of standard records for data storage.

A series of inquiries will be posed to attendees about their current data collection practices and present anticipated needs for this data.

The webinar will include:

> What type of bicycle and pedestrian data are you interested in and how do you report this data to your customers?
>
> What type of agency do you represent and how long has that agency been collecting pedestrian and or bicycle data? Is the data collected project specific or for trends/network evaluation?
>
> What kinds of equipment do you use? What information would you like to have about equipment? Are you using automated or manual methodologies? Do you use passive or active (i.e. GPS) technologies?
>
> What factoring methods do you use for short counts? Low volume counts? Screenlines?
>
> How do you store your data? What information do you need to store? What information would be nice to have?

If you are not available for any of the proposed dates and would like to provide input, please contact Barbara Ostrom (Barbara.Ostrom@amec.com) or Peyton McLeod (pmcleod@sprinklecounsulting.com) for a copy of the webinar material.

Figure 4. Final Webinar Invitation (Part 2)

APPENDIX D – WEBINAR POLL RESULTS

During the course of the four webinars, input from the participants was collected in three formats:

1. Screenshots of poll results as broadcasted during the webinars,
2. CSV files downloaded from the software used for polling, and
3. Answers provided via the chat box.

Input received through the three formats was combined to provide the summary of results for each question. In some cases answers were not obtained in every format for each question as a result of software malfunctions.

Invitations for the first webinar targeted individuals and agencies that were known to have experience in the area. Later webinars were announced to a wider audience. The results of the individual webinars are reported in this appendix to provide a measure of variation or lack of it between the webinar groups.

The majority of the questions allowed multiple answers from the attendees. Questions that permitted <u>multiple answers</u> have percentages typically based on the maximum <u>number of responses</u>, not the number of respondents. In such cases, the rates are likely to be labeled frequency rather than percentage. Questions which were <u>single answer</u> per participant have percentages based on the <u>number of respondents</u>.

The questions are grouped into the following five categories:

1. Who is participating,
2. Current and anticipated data uses,
3. Experience (with equipment),
4. Data processing practices, and
5. Data sharing by means of a commonly accepted record format.

Who is Participating?

The first series of questions was asked to see who was responding to the questions posed during the webinar.

The first question asked was "Why are you attending the webinar?" The answers over the series of webinars showed roughly 40% of people attending were interesting in learning more about data collection, reporting methodologies and best practices for bicycle and pedestrian facilities. The target group, state agencies and MPOs, had a percentage closer to 50% for those same categories. About 20% of the respondents wanted data to help justify investment for pedestrian and bicycle facilities or for planning and design of pedestrian or bicycle facilities. That percentage increases to 30% for investment and 35% for planning and design for state agencies and MPOs as a group.

Question 1 - For which type of agency do you work?

Through the four webinars hosted, over 100 people participated represented by 99 individual logins with about 50% of the attendees representing state agencies and another 20% representing MPOs.

Question 2 - For how many years have you/your agency been collecting bicycle and or pedestrian count data?

The webinar attendees had little if any experience with data collection in this area, with 72% of agency personnel reporting three or fewer years of experience. A handful of state agencies acknowledge the greatest experience.

Question 2	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Not yet	6	5	7	10	28	44%
1-3 years	4	7	4	3	18	28%
4-7 years	1	5	3	1	10	15%
8-10 years	0	1	2	2	5	8%
11+ years	0	1	1	1	3	5%

Question 3- Is your pedestrian/bicycle data collection program (characterized by which type of frequency) -

Of the webinar attendees who have a pedestrian or bicycle data collection program, periodic scheduled counts, on demand counts, and recurring and on demand counts in combination were the most common descriptors of the counting program intervals.

Question 3	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Continuous counts	3	3	0	2	8	13%
Periodic scheduled counts	3	8	0	4	15	24%
On demand counts	3	4	1	4	12	19%
Recurring (continuous and periodic) only	0	0	0	0	0	0%
Recurring and on demand	3	7	0	3	13	21%
Do not count [Reason? Please use the chat box]	0	1	5	8	14	23%

Current and Anticipated Data Uses

Data collection practices will be strongly influenced by the requirements and needs driving the use of the data. Participants were asked to identify what they are using the data for now and what pedestrian and bicycle related activities they expect to need data for in the future.

Question 4- Pedestrian counts are collected for:

Safety analyses, project design, project evaluation and trend analyses ranked the highest for the purpose of collecting pedestrian counts, followed by project selection (preliminary planning).

However, while looking at the results split by type of organization, state agencies typically selected project design, safety analyses and project evaluation. Regional agencies/MPOs selected trend analyses, safety analyses and project evaluation. Federal agencies collected pedestrian counts mainly for safety analyses, project selection and trend analyses. Research and educational institutions typically did pedestrian data collection for project evaluation and safety analyses.

Question 4	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Frequency
Safety analyses	5	9	10	5	29	22%
Project selection (preliminary planning)	3	5	7	2	17	13%
Project design	5	8	7	4	24	18%
Project evaluation (before and after studies)	5	8	9	4	26	19%
Modeling - long range planning	5	2	2	1	10	7%
Modeling - simulation	1	1	0	1	3	2%
Trends analyses	3	8	10	4	25	19%

Question 5 - Pedestrian counts are anticipated to be needed for:

The anticipated needs for pedestrian data collection include project selection along with the top reasons why pedestrian counts are currently collected; i.e., safety analyses, project design, project evaluation and trend analyses. These anticipated needs for pedestrian data collection did not show any notable differences based on agency type.

Question 5	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Frequency
Safety analyses	4	9	13	8	34	16%
Project selection (preliminary planning)	4	11	10	6	31	15%
Project design	6	11	12	6	35	17%
Project evaluation (before and after studies)	6	13	13	10	42	20%
Modeling - long range planning	5	5	6	7	23	11%
Modeling - simulation	0	5	3	3	11	5%
Trends analyses	5	10	13	7	35	17%

Question 6 - Bicycle counts are collected for:

Safety analyses, project evaluation and trend analyses ranked the highest for the purpose of collecting bicycle counts, followed closely by project selection (preliminary planning) and project design.

Looking at the results on an agency basis, state agencies more commonly selected project design. Regional agencies/MPOs selected project evaluation and trend analyses. Research and educational institutions selected bicycle data collection for project evaluation most frequently among all organizations.

Question 6	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Frequency
Safety analyses	2	10	10	4	26	18%
Project selection (preliminary planning)	3	9	8	3	23	16%
Project design	4	6	8	5	23	16%
Project evaluation (before and after studies)	5	8	11	6	30	21%
Modeling - long range planning	4	1	3	3	11	8%
Modeling - simulation	0	0	1	1	2	1%
Trends analyses	3	10	11	5	29	20%
Other	0	0	2	0	2	1%

Question 7 - Bicycle counts are anticipated to be needed for:

The anticipated needs for bicycle data collection include project selection along with the top reasons why bicycle counts are currently collected; i.e., safety analyses, project evaluation and trend analyses, followed closely by project design. Regional agencies/MPOs selected project selection and trend analyses more often than state agencies. Research and educational institutions more often identified safety analyses.

Question 7	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Frequency
Safety analyses	7	10	14	11	42	18%
Project selection (preliminary planning)	5	9	9	11	34	15%
Project design	4	8	12	8	32	14%
Project evaluation (before and after studies)	7	9	11	12	39	17%
Modeling - long range planning	8	3	8	6	25	11%
Modeling - simulation	2	3	3	6	14	6%
Trends analyses	7	9	14	11	41	18%
Other	0	0	1	1	2	1%

Equipment Experience

The types of methodologies and equipment currently in use were investigated.

Question 8 - Pedestrian count methods used:

The vast majority of attendees indicated that they used manual count methods for pedestrian counts with some using automated fixed location. State agencies were more likely to use automated fixed location methods for pedestrian counts than MPOs. One attendee mentioned an additional strength for manual counts as the ability to track additional attributes, like gender, helmet use, strollers, wheelchairs, etc.

Question 8	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Manual	4	17	18	12	51	61%
Automated fixed location	4	6	6	2	18	22%
Active collection (GPS, Smartphone)	0	0	1	0	1	1%
None	3	1	5	4	13	16%

Agencies with automated equipment experience include Colorado DOT, Vermont Agency of Transportation, Arlington County DOT (Virginia) and Bike Walk Twin Cities,

Question 9 - Which of the following automated technologies has your agency employed for pedestrian counts?

For the attendees who reported using automated technologies for pedestrian counts, active infrared, passive infrared and manual video were the most popular ones, with at least a third of users selecting each. State agencies most commonly used active infrared, followed by manual video. The summary table provided below includes both the experience of all respondents and the distribution of equipment types by users with at least some equipment experience.

Question 9	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	All Respondents	Respondents with Experience
Piezoelectric Pad	1	0	0	0	1	1%	3%
Active Infrared	2	2	1	2	7	10%	23%
Passive Infrared	2	2	2	2	8	11%	26%
Computer Visioning	0	1	0	2	3	4%	10%
Manual Video	0	5	2	2	9	13%	29%
Not certain/Other (identify technology or equipment in chat box)	0	0	1	2	3	4%	10%
None	6	11	14	9	40	56%	--

Question 10 - Bicycle count methods used:

The majority of attendees indicated that they used manual count methods for bicycle counts. A larger percentage indicated using automated fixed location equipment than for pedestrian counts. State agencies and MPOs showed similar trends while research and educational institutions more were more likely to use automated fixed location equipment.

Question 10	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Manual	1	15	14	6	36	49%
Automated fixed location	6	9	6	3	24	33%
Active collection (GPS, Smartphone)	0	0	1	0	1	1%
None	2	0	6	4	12	16%

Agencies which have automated fixed location equipment experience for bicycle data collection include the Arizona, Colorado, Iowa, Nebraska, South Carolina, Vermont and Washington DOTs, Arlington County DOT(Virginia), Erie County (Ohio), Prince Georges County Park and Planning (Maryland), Bike Walk Twin Cities, Seattle, Mid-Ohio Regional Planning Commission and Region XII COG (Iowa).

Question 11- Which of the following technologies has your agency employed for bicycle counts?

For the attendees who reported using automated technologies for bicycle counts, pneumatic tubes were the most common with almost 40% of attendees reporting their use. Inductive loop, passive infrared and manual video were also popular with about a quarter of attendees reporting their use. State agencies were more likely to use inductive loops and manual video than MPOs. The summary table provided below includes both the experience of all respondents and the distribution of equipment types by users with at least some equipment experience.

Question 11	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Respondents	Users
Inductive Loops	2	1	3	1	7	9%	15%
Pneumatic Tubes	1	5	4	2	12	16%	25%
Active Infrared	2	2	1	0	5	7%	10%
Passive Infrared	2	2	4	0	8	11%	17%
Computer Visioning	0	0	1	2	3	4%	6%
Manual Video	1	4	3	0	8	11%	17%
Not certain/Other (identify technology or equipment in chat box)	0	2	2	1	5	7%	10%
None	3	8	7	8	26	35%	--

During one of the webinars, there was discussion of the EcoCounter equipment that is capable of distinguishing between horses, pedestrians, bicycles, cars, etc., which is something other automated technologies cannot do.

Question 12 - Has your agency independently evaluated the effectiveness of any automated count equipment types?

Only about a quarter of the attendees have independently evaluated the effectiveness of automated count equipment with research and educational institutions and advocacy groups having higher percentages than other agencies, although research and educational institutions were a smaller percentage of the participants.

Question 12	Yes	No
Webinar 1	5	2
Webinar 2	4	12
Webinar 3	2	16
Webinar 4	3	10
Total	14	40
Percentage	26%	74%

Question 13 - How many pedestrian counts do you do a year?

Almost 50% of the attendees conduct less than 10 pedestrian counts a year. Approximately another 20% conduct between 10 and 20 counts a year. There were no notable differences between agency types.

Question 13	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Under 10	4	8	5	3	20	47%
10 to 20	0	4	3	2	9	21%
21 to 50	1	2	1	2	6	14%
51 to 100	0	2	2	0	4	9%
100 plus	0	0	2	2	4	9%

Question 14 - How many bicycle counts do you do a year?

Almost 60% of attendees conduct less than 10 bicycle counts a year. For other attendees, 11% and 20% reported conducting 10 to 20 and 21 to 50 counts a year, respectively. Regional agencies and MPOs were more likely than state agencies to conduct more than 10 counts a year.

Question 14	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Under 10	6	9	7	3	25	57%
10 to 20	0	3	1	1	5	11%
21 to 50	2	2	2	3	9	20%
51 to 100	0	2	0	0	2	5%
100 plus	0	0	2	1	3	7%

Question 15 - How many permanent bike and or pedestrian counters do you operate on an ongoing basis?

Over 80% responding have fewer than 5 permanent bicycle or pedestrian permanent counters. Fewer than 10% of attendees indicated having more than 10 permanent counters.

Question 15	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage
Under 5	4	13	4	7	28	82%
5 to 10	0	1	2	0	3	9%
11 to 20	0	0	0	0	0	0%
21 to 30	0	1	0	0	1	3%
31 or more	1	0	0	1	2	6%

Processing Data Practices

Covering large areas with counters to obtain pedestrian and bicycle counts is not common practice. In most cases counts are done in specific areas or for a specific purpose. The ability to use these counts to draw inferences about long periods or other locations is an area in which more investigation is needed as demonstrated by the experience reported by the participants.

Question 16 - Do you have experience extrapolating short-term bicycle or pedestrian counts over longer periods of time using temporal adjustment factors (HOD, DOW, Seasonal or Annual)?

The majority of attendees do not have experience extrapolating short-term bicycle or pedestrian counts over longer periods of time using temporal adjustment factors. During the course of the webinars, there were several questions asked about extrapolating short-term bicycle and pedestrian counts. Attendees were interested in the best practice for this.

Question 16	Yes	No
Webinar 1	1	6
Webinar 2	1	17
Webinar 3	1	7
Webinar 4	3	11
Total	6	41
Percentage	13%	87%

Question 17 - If the answer to #16, is yes, what is the source of your methodology?

It was mentioned that some attendees do use seasonal counts to develop seasonal adjustment factors. There was no in-depth discussion of using any type of adjustment factors for extrapolating short-term bicycle or pedestrian counts. However, there was interest expressed in receiving guidance on this topic.

Question 18 - Does your agency seek to estimate system/network usage based on screenline counts?

The majority of attendees do not seek to estimate system/network usage based on screenline counts.

Question 18	Yes	No
Webinar 1	2	6
Webinar 2	0	14
Webinar 3	5	6
Webinar 4	1	12
Total	8	38
Percentage	17%	83%

Question 19 - If so, are you aware of a reliable system/network estimation methodology?

There seemed to be very limited awareness of reliable system/network estimation methodology with only one person indicating yes. That individual did not elaborate on his or her experience.

Question 19	Yes	No
Webinar 1	0	7
Webinar 2	0	11
Webinar 3	0	10
Webinar 4	1	2
Total	1	30
Percentage	3%	97%

Question 20 - Do you have a particularly effective and or unique data storage process to recommend?

The vast majority did not have a particularly effective and or unique data storage process to recommend. Some of the processes indicated were Excel and Oracle Traffic Count Database. With many attendees either looking to start bicycle and pedestrian counts or grow their currently limited counts, effective data storage for these new counts was of interest to many.

Question 20	Yes	No
Webinar 1	2	6
Webinar 2	1	12
Webinar 3	0	14
Webinar 4	1	7
Total	4	39
Percentage	9%	91%

Standard Pedestrian Count Record

The ability to share data is based on a common understanding of the data, most typically through use of a generally accepted format. One of the items to be identified as an outcome of this project was a recommended format for pedestrian volume counts.

Question 21 - Which of the following should be MANDATORY in a national pedestrian data record?

Most attendees felt that date, time and interval for volume should be mandatory in a national pedestrian data record. Station ID, location (latitude/longitude), location (street name/address), direction, collection method, and weather were also selected by the majority of attendees to be included as mandatory information for a national pedestrian data record. There were no large differences between agency types. The items selected as mandatory most often refer to information about the count that will be needed for efficient analysis of data. The summary table provided below has the number of times a response was selected and the percentage of respondents who selected a particular item.

Question 21	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage of Respondents
Station ID	4	10	9	11	34	67%
Location (latitude/longitude)	6	11	11	10	38	75%
Location (route/milepost)	3	5	5	5	18	35%
Location (street name/address)	5	13	7	8	33	65%
Date	8	16	13	14	51	100%
Time	8	18	11	14	51	100%
Direction	6	8	6	10	30	59%
Classifications	5	5	3	7	20	39%
Collection Method	4	11	6	9	30	59%
Interval for volume (i.e. hour, 15 minutes)	7	15	9	14	45	88%
Purpose	1	2	2	2	7	14%
Group size	1	3	0	2	6	12%
Weather	5	16	8	9	38	75%
Other (enter in chat box as ped - mandatory - suggested item)	0	1	0	1	2	4%

Question 22 - Which of the following would be nice to have in a national pedestrian data record?

Location (street name/address), direction and classifications were the items indicated most as information that would be nice to have in a national pedestrian data record. Almost all items were selected by between 30-50% of attendees. The percentages and number of responses here are much lower than the percentages and responses for the items the attendees felt were mandatory, but the overall number of respondents was roughly the same.

The responses to this question have two percentages computed. The first, Respondents to question, is the percentage of respondents who selected a particular answer for this question. The second, Respondents to mandatory, is the percentage based on the number of participants who responded to the mandatory question. This was taken to represent the maximum number of people with any input to the question and was used to compensate for the fact that no guidance was provided on whether having selected mandatory a vote for nice could or not also occur.

Question 22	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Respondents to Question	Respondents to mandatory
Station ID	2	5	1	5	13	48%	25%
Location (latitude/longitude)	5	4	2	6	17	63%	33%
Location (route/milepost)	6	5	3	5	19	70%	37%
Location (street name/address)	9	5	6	6	26	96%	51%
Date	5	7	3	5	20	74%	39%
Time	5	7	3	6	21	78%	41%
Direction	6	8	6	7	27	100%	53%
Classifications	4	9	7	7	27	100%	53%
Collection Method	5	7	4	7	23	85%	45%
Interval for volume (i.e. hour, 15 minutes)	5	4	2	6	17	63%	33%
Purpose	5	5	4	7	21	78%	41%
Group size	3	6	7	5	21	78%	41%
Weather	7	5	6	9	27	100%	53%
Other (enter in chat box as ped - nice - suggested item)	0	1	0	0	1	4%	2%

Question 23 - Which of the following should be OMITTED from a national pedestrian data record?

Purpose and group size were the items selected by the majority as information that should be omitted from a national pedestrian data record. There was some discussion between webinar attendees that purpose is not as important as many trails/facilities are either used primarily by recreational users or commuters, and therefore purpose was not important. There was also mention that purpose is not included in records for vehicles. Purpose also would need to be obtained from a survey, as it is not apparent by observation.

The responses to this question have two percentages computed. The first, Respondents to question, is the percentage of respondents who selected a particular answer for this question. The second, Respondents to mandatory, is the percentage based on the number of participants who responded to the mandatory question. This was taken to represent the maximum number of people with any input to the question and was used to compensate for the fact that no guidance was provided on whether having selected mandatory a vote for nice could or not also occur.
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Question 23	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Respondents to Question	Respondents to mandatory
Station ID	1	1	1	1	4	15%	8%
Location (latitude/longitude)	0	1	0	1	2	8%	4%
Location (route/milepost)	0	0	0	2	2	8%	4%
Location (street name/address)	1	1	0	1	3	12%	6%
Date	0	1	0	0	1	4%	2%
Time	0	1	0	0	1	4%	2%
Direction	0	1	1	2	4	15%	8%
Classifications	1	2	0	2	5	19%	10%
Collection Method	0	2	0	0	2	8%	4%
Interval for volume (i.e. hour, 15 minutes)	0	1	0	0	1	4%	2%
Purpose	3	9	6	8	26	100%	51%
Group size	7	6	2	7	22	85%	43%
Weather	0	2	0	1	3	12%	6%
Other (enter in chat box as ped - omit - suggested item)	0	0	0	0	0	0%	0%

Standard Bicycle Count Record

The ability to share data is based on a common understanding of the data, most typically through use of a generally accepted format. One of the items to be identified as an outcome of this project was a recommended format for bicycle volume counts.

Question 24 - Which of the following should be MANDATORY in a national bicycle data record?

Most attendees felt that date and time should be mandatory in a national bicycle data record. Station ID, location (latitude/longitude), interval volume, and weather were also selected by the majority of attendees to be included as mandatory information for a national bicycle data record. There were no large differences between agency types. Similar to the pedestrian data record, attendees felt that items regarding information about the count were most important for the data records. The summary table provided below has the number of times a response was selected and the percentage of respondents who selected a particular item.

Question 24	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Percentage of Respondents
Station ID	6	9	4	12	31	66%
Location (latitude/longitude)	6	11	8	5	30	64%
Location (route/milepost)	3	5	3	5	16	34%
Location (street name/address)	4	8	6	4	22	47%
Date	9	17	9	12	47	100%
Time	9	17	8	11	45	96%
Classifications	3	6	2	2	13	28%
Collection Method	6	8	3	8	25	53%
Interval for volume (i.e. hour, 15 minutes)	8	11	3	9	31	66%
Weather	4	13	1	10	28	60%
Speed	0	0	1	1	2	4%
Purpose	1	1	0	0	2	4%
Other (enter in chat box as bike-mandatory - suggested item)	0	1	0	1	2	4%

Question 25 - Which of the following would be nice to have in a national bicycle data record?

Most every option was selected between 25-45% of attendees with the exception of interval for volume and station ID as information that would be nice to have in a national bicycle data record. Classifications had the largest percentage selected at 44%. Other information indicated by the attendees that would be nice to have in a national bicycle data record included helmet use, gender, lights, sidewalk versus roadway use, trail surfacing, land use characteristics, and roadway volumes. Again, the percentages and number of responses here are much lower than the percentages and responses for the items the attendees felt were mandatory, but the overall number of respondents was roughly the same.

The responses to this question have two percentages computed. The first, Respondents to question, is the percentage of respondents who selected a particular answer for this question. The second, Respondents to mandatory, is the percentage based on the number of participants who responded to the mandatory question. This was taken to represent the maximum number of people with any input to the question and was used to compensate for the fact that no guidance was provided on whether having selected mandatory a vote for nice could or not also occur.

Question 25	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Respondents to Question	Respondents to mandatory
Station ID	2	4	1	2	9	38%	19%
Location (latitude/longitude)	4	4	0	6	14	58%	30%
Location (route/milepost)	5	5	2	1	13	54%	28%
Location (street name/address)	8	5	1	4	18	75%	38%
Date	4	5	2	3	14	58%	30%
Time	4	5	1	3	13	54%	28%
Classifications	2	10	4	8	24	100%	51%
Collection Method	4	5	1	3	13	54%	28%
Interval for volume (i.e. hour, 15 minutes)	3		0	1	4	17%	9%
Weather	4	5	6	3	18	75%	38%
Speed	4	7	4	4	19	79%	40%
Purpose	3	4	4	6	17	71%	36%
Other (enter in chat box as bike - nice - suggested item)	0	2	1	1	4	17%	9%

Question 26 - Which of the following should be OMITTED from a national bicycle data record?

Purpose and speed were the items selected by the majority of the attendees as information that should be omitted from a national bicycle data record. There was some discussion between attendees regarding speed, whether that was referring to the speed of the bicycle or the speed of the facility the bicycle was using. The speed of the facility can often be an important factor for safety analyses.

The responses to this question have two percentages computed. The first, Respondents to question, is the percentage of respondents who selected a particular answer for this question. The second, Respondents to mandatory, is the percentage based on the number of participants who responded to the mandatory question. This was taken to represent the maximum number of people with any input to the question and was used to compensate for the fact that no guidance was provided on whether having selected mandatory a vote for nice could or not also occur.

Question 26	Webinar 1	Webinar 2	Webinar 3	Webinar 4	Total	Respondents to Question	Respondents to mandatory
Station ID	1	1	2	0	4	12%	9%
Location (latitude/longitude)	0	0	0	1	1	3%	2%
Location (route/milepost)	1	1	0	1	3	9%	6%
Location (street name/address)	0	0	0	1	1	3%	2%
Date	0	0	0	0	0	0%	0%
Time	0	0	0	0	0	0%	0%
Classifications	3	1	0	3	7	21%	15%
Collection Method	0	0	0	0	0	0%	0%
Interval for volume (i.e. hour, 15 minutes)	0	1	1	0	2	6%	4%
Weather	1	2	0	1	4	12%	9%
Speed	6	5	2	3	16	48%	34%
Purpose	3	15	7	8	33	100%	70%
Other (enter in chat box as bike - nice - suggested item)	1	0	0	0	1	3%	2%

Question 27 - Like the TMG station record, is there information about the count and or its location that would be useful for a bicycle/pedestrian station record?

The most important items chosen as information about the count and or its location that would be useful for a bicycle/pedestrian station record selected by the majority of attendees were station ID, location (latitude and longitude), location (street name/address), start date, end date, start time, end time, method, and interval for volume. Other information indicated by attendees that would be beneficial to have about the count and or its location include bicycle facility type, pavement type, pavement condition, lighting, and surrounding land use and facilities.

This question was not asked as a multiple choice in the first webinar, but rather as a free form discussion.

Question 27	Webinar 2	Webinar 3	Webinar 4	Total	Percentage of Respondents
Station ID	10	8	11	29	97%
Location (latitude/longitude)	13	7	9	29	97%
Location (route/milepost)	7	3	5	15	50%
Location (street name/address)	12	9	5	26	87%
Start Date	12	9	9	30	100%
End Date	11	9	9	29	97%
Start Time	10	7	7	24	80%
End Time	11	7	7	25	83%
Method	10	8	9	27	90%
Equipment make/model for automated equipment	7	3	2	12	40%
Equipment technology for automated equipment	3	5	4	12	40%
Classification scheme	3	4	3	10	33%
Interval for volume (i.e. hour, 15 minutes	7	9	9	25	83%
Weather	9	5	6	18	67%
Speed	1	2	0	3	10%
Purpose	0	0	0	0	0%
Other (enter in chat box as bike- omit - suggested item)	2	0	1	3	10%

APPENDIX E – SUMMARY OF DISCUSSIONS WITH PRACTITIONERS

Subsequent to the interactive webinars, a series of more detailed one-on-one discussions were held. Individuals were selected for these discussions because of their extensive and or unique experience on the subject, as discovered through the Task 1 literature review, the webinars, or both. Each of the selected individuals was contacted by phone and asked if he or she would be willing to participate in a more detailed interview to obtain specific information about their experience, practice, and recommendations. The last webinar was held on September 21 2011, and the phone interviews were conducted between September 26 and October 3, 2011. E-mail requests to potential international survey participants were sent on September 30, 2011.

A list of scripted questions was prepared for the discussions to create some degree of consistency, though interviewees were encouraged to provide more information about any aspect of their experience and topics varied to some degree based on the individuals' areas of interest and expertise. Among the targeted discussion topics were the following:

- General count program experience,
- Specific technologies used or tested,
- Observed problems with inaccuracies,
- Potential role of "active" data collection,
- Best uses for count data (particularly related to safety, funding, and facility design), and
- Best practices for both storing/sharing data and extrapolating to system-wide or network-wide counts.

The questions asked of the participants were submitted to the FHWA prior to being asked of the survey participants. These questions are provided below:

1. Please describe the nature of your experience with bicycle and pedestrian count programs.
2. Which count technologies have you used and or evaluated the effectiveness of (examples: manual, video, passive infrared, active infrared, inductive loops, pneumatic tubes, and piezometric pads)?
3. Amongst these technologies, to what extent have you encountered or observed problems with distinguishing between bicyclists and pedestrians or amongst groups of users? Regarding the latter, do you feel that group size adjustment factors may be appropriate?
4. What other sources of inaccuracies have you encountered and how are they minimized and or accounted for?
5. Do you envision a scenario in which active data collection techniques (i.e. those in which those being counted are actively participating in a study, likely through some sort of GPS-enabled device) can be used in a national bicycle and pedestrian monitoring program?
6. How do you feel bicycle and pedestrian count data can be used to address the following topics?

- Safety
- Funding or Legislative Mandates
- Facility Design

7. Can you offer any best practices on the storing and sharing of count data?

8. Are you aware of any reliable system/network count extrapolation processes?

The individuals who agreed to provide input are shown in Table 8.

Table 8. Individual Discussion Participants

Organization/Agency	Individual	Title/Position
Colorado Department of Transportation	Ms. Liz Stolz	Traffic Analysis Unit Manager
Minnesota Department of Transportation	Ms. Lisa Austin	Bicycle and Pedestrian Planner
City of Boulder, Colorado	Mr. Michael Sweeney	Transportation Operations and Planning Coordinator
City of St. Petersburg, Florida	Ms. Cheryl Stacks	Bicycle and Pedestrian Coordinator
San Francisco County Transportation Authority	Ms. Elizabeth Sall	Acting Deputy Director for Technology Services
University of California, Berkeley	Dr. Robert Schneider	Researcher
Texas Transportation Institute	Mr. Shawn Turner	Division Head
Transport for London	Mr. Brett Little	Manager, London Pedestrian Monitoring Program

The list of scripted questions was prepared for the discussions to create some degree of consistency, though interviewees were encouraged to provide more information about any aspect of their experience and topics varied to some degree based on the individuals' areas of interest and expertise. Among the targeted discussion topics were the following: general count program experience, specific technologies used or tested, observed problems with inaccuracies, the potential role of "active" data collection, best uses for count data (particularly related to safety, funding, and facility design), and best practices for both storing/sharing data and extrapolating to system-wide or network-wide counts.

The breakdown of principal topic areas by practitioner is shown in

Table 9.

Table 9. Practitioners and Principal Topics

Practitioner	Technology Evaluation	Video Counting	Count Programs	Sampling	Factoring	Count Accuracy
Ms. Lisa Austin	X			X	X	
Ms. Cheryl Stacks		Manual	X			
Dr. Robert Schneider	X		X	X	X	X
Ms. Elizabeth Sall			X*			
Mr. Michael Sweeney			X			X
Mr. Shawn Turner	X		X	X	X	X
Ms. Liz Stolz	X		X		X	
Mr. Brett Little		CCTV				

*Active data collection

MS. LISA AUSTIN – MINNESOTA DEPARTMENT OF TRANSPORTATION

Ms. Austin is a Bicycle and Pedestrian Planner for the Minnesota Department of Transportation. Minnesota has been the site of much bicycle and pedestrian monitoring research over the past decade and, while she has not directly tested or evaluated any specific count technologies, Ms. Austin and her agency are well-informed of and highly interested in the subject. Minnesota DOT is just beginning a new research project related to bicycle and pedestrian counting, and Ms. Austin believes the timing of this FHWA research is perfect for her agency and others around the United States.

Ms. Austin described research conducted in Minnesota several years ago that tested video recognition software. Video recognition is able to establish user types, but the consensus was that the technology was not yet ready for widespread implementation because there is no standard manual for use and it requires a good bit of “cockpit intelligence” on the part of the user. Another recent research project conducted by the University of Minnesota described the pros and cons of existing count technologies. Research conducted in Minneapolis regarding bicycle and pedestrian activity levels shows the same general trends as the American Community Survey. Based on this research, Ms. Austin suggests that adjustments to the peak periods identified through the National Bicycle and Pedestrian Documentation Project are warranted. Furthermore, she stresses the importance of agencies conducting at least some 24-hours counts to verify shorter-term counts. She believes that adjustment factors will always be needed to account for automated technologies’ undercounting of bicyclists and pedestrians traveling in groups.

Minnesota DOT is currently more interested in in-road counts than with trail counts, recognizing that the former is more difficult. Another area of interest is whether there is a maximum appropriate level of detail for state DOTs with regard to collecting and disseminating bicycle and pedestrian count data. Among the valuable uses for bicycle and pedestrian count data, Ms. Austin notes investment decisions, analysis of trends, knowing what level of service is being provided, tracking benefits related to tourism and economic development, the impacts of building complete streets (before and after studies), safety analysis (particularly for gathering exposure data), and determining complete street facility types based on variations in demand.

MS. CHERYL STACKS – CITY OF ST. PETERSBURG, FL

As the City of St. Petersburg's Bicycle and Pedestrian Coordinator, Ms. Stacks oversees an ambitious city-wide bicycle count program. The City conducts routine counts for its bike lane locations, of which there are several dozen. The counts are rotated by City region, such that each location is counted every six months on average. Before and after counts are routinely performed when a new bike lane is installed. In addition, counts occur on demand in response to particular incidents or citizen inquiries. The counts are performed using pneumatic tubes and are conducted for an entire week. Two City staff members from the traffic unit install the equipment and one picks it back up, thereby requiring little effort on the part of the City.

St. Petersburg also conducts pedestrian counts, but only on its system of shared use paths. These counts are conducted using battery-operated cameras placed on utility poles. The cameras allow for remote viewing, with the operator having the ability to tilt and zoom the view as needed. The cameras record digital still photos every one-half second, but the resolution is not particularly good. Ms. Stacks reports that it takes a staff person two to three hours to reduce a day's worth of video data because of the ability to fast forward.

Ms. Stacks reports that she has not observed inaccuracies resulting from group travel, but inaccuracies have resulted from vandalism of the tube counters and from the location of the "before" counts when motorists drive over the bicycle counters in the shared lane environment. In addition, the City has grappled over the treatment of strollers (not knowing whether the stroller counts as a pedestrian or even if it necessarily contains a child) and with the classification of certain vehicles such as motorized bicycles.

Among the safety-related benefits of the City's count program, Ms. Stacks notes that enforcement activities can be stepped up in high activity areas. The City sometimes uses the counts as a way to bolster Transportation Enhancements funding because the level of use is seen as a justification for new facilities.

DR. ROBERT SCHNEIDER – UNIVERSITY OF CALIFORNIA, BERKELEY

Dr. Schneider, a researcher for UC Berkeley's SafeTREC, is the author of several research reports that were reviewed as part of the Task 1 literature review. In 2005, he was the Project Manager for an FHWA project that identified nationwide bicycle and pedestrian data collection trends. While the research, which explored plans and programs in 29 U.S. communities, was broader than just counting/monitoring-based data collection, it did include communities which were early adapters of using technologies such as inductive loops, pneumatic tubes, piezometric film, and active and passive infrared detectors for the purpose of counting bicyclists and or pedestrians.

In 2008, Dr. Schneider conducted research for Alameda County, California that used a combination of two-hour manual counts and automated infrared counts at intersections. One outcome of the research was a set of temporal adjustment factors used to extrapolate the short-term counts to longer-term pedestrian volumes. These adjustment factors use weather data that corresponded to the actual times of the manual counts. Dr. Schneider suggests that these temporal factors from Alameda County are probably not transferable enough nationwide for a *Traffic Monitoring Guide* type of application, but he notes that they are likely just as good as what is used currently for the auto mode.

The comparison of manual and automated counts from Alameda County initially suggested that undercounting was relatively minimal and did not vary significantly between low-volume and high-volume locations. However, more recent follow-up research that Dr. Schneider conducted for the San Francisco Municipal Transportation Agency indicates that undercounting remains consistent (and low) at lower pedestrian volumes but reaches 40-50% in crowded locations. As a result, he suggests that if adjustment factors are created to account for undercounting, the adjustment should not be linear (i.e. they could be exponential as a function of the pedestrian volume) and might not be transferable to all locations. A related observation from both studies is that infrared detector counts can be affected by people walking back and forth. This means that sorting through the data is not an automatic process and that placing counters near bus stops or other similar locations is not ideal.

Dr. Schneider also has experience evaluating inductive loop counts for the bicycle mode, citing an accuracy rate of 90-95%. He mentioned that Eco-counter has a bicycle/auto filter that works well for shared lane environments. Further, he noted that adjustment factors can be developed to account for sidewalk riding that is missed by in-roadway inductive loops.

Regarding active data collection, Dr. Schneider believes it would have to be used for a very specific purpose, not for traffic monitoring or pure volume counts, in order to be appropriate, citing the problems of sampling bias and behavioral changes that result from participants knowing that their habits are being observed.

Dr. Schneider believes that a key element of bicycle and pedestrian monitoring is capturing exposure data for crash analysis. He states that simply knowing how many people are bicycling and walking is important to overcome general public unawareness and the perception that these modes of transportation may be trivial. Regarding facility design, Dr. Schneider suggests that count data can be used not only for roadway cross section allocation, but also for appropriate signal timing.

Regarding the sharing of data, Dr. Schneider believes that a standard count record, in which very basic things are identified for every agency to collect, is how it almost has to be done. He recognizes that this is tough to do, and that the flexibility to allow participating agencies to collect additional information is important. He believes that in such a program FHWA should actually be responsible for acquiring the actual data rather than having the local agency, which would only submit the location and raw count, to it.

MS. ELIZABETH SALL – SAN FRANCISCO COUNTY TRANSPORTATION AUTHORITY

Ms. Sall is a Principal Transportation Planner and the Acting Deputy Director for Technology Services for SFCTA. She was chosen for a discussion because of the desire to have a representative with extensive experience related to active bicycle and pedestrian data collection. Ms. Sall works with SFTCA’s CycleTracks, which is a GPS-based smartphone application used to record users’ bicycle route choices.

Ms. Sall was asked about the potential application of CycleTracks or other related active data collection applications within a broad traffic monitoring context. In the case of CycleTracks, she explained that the ultimate goal is to be able to create a bicycle travel demand model, not to validate or explain what is happening on the ground. Ultimately, Ms. Sall confirms what other interviewees and webinar participants have expressed by saying that any program in which a user has to opt in is not appropriate for the aims of FHWA. This is based on the commonly noted problem of having to possess a smartphone in order to enter data, which leads to a lack of good representation of what is really happening on an area’s street or trail system.

Ms. Sall notes that there are many ways to be more “big brother-ish,” and that one of the less invasive techniques is Bluetooth-based monitoring, something that is currently done for speed monitoring more than for activity counts. She suggests that a survey would be needed for correction factors, and that it would ultimately become more passive than active in nature.

MR. MICHAEL SWEENEY – CITY OF BOULDER, CO

Mr. Sweeney is the City of Boulder's Transportation Operations and Planning Coordinator. The City of Boulder is well-known for its efforts in promoting non-motorized transportation, as summarized by Mr. Sweeney in citing a general City policy to "enhance mobility through alternative modes of transportation." The City therefore needs metrics to determine how well the policy is working ("Boulder is fascinated with data"), which has led to an emphasis on bicycle and pedestrian monitoring. The two primary count programs are pedestrian counts performed in conjunction with intersection turning movement counts (Mr. Sweeney cites a constant struggle with the accuracy of these counts) and inductive loop-based bicycle counts on the shared use path system. The City has also experimented with video data collection, but it ultimately proved infeasible.

Boulder's bicycle monitoring program began in 1998 with the installation of twelve permanent count stations on paths. The loops generally work well, but Mr. Sweeney has experienced some problems over the years, including the following:

a. Data is sometimes lost because of power outages to the loop amps,
b. Adequate staffing is a constant struggle, which can lead to languishing of the data unless a researcher is inclined to examine it,
c. There is no standardized data validation procedure,
d. The loops are not time stamped (though times can be roughly back-calculated based on the time of the download),
e. While staff can tell if the loops fail completely, they cannot tell if they are merely off by 10%, and
f. The accuracy has been shown to deteriorate after years of use.

One of the most successful uses of the data has been the ability to compare actual ridership with travel diaries that are regularly completed by residents and employees. Mr. Sweeney also uses the data to track trends; for example, he knows that bicycle travel peaked in Boulder in 2008.

More recently a thirteenth loop, the first to be used in a roadway setting, was installed. Mr. Sweeney reports an error range of ±5% for this counter. He notes that the "inductive footprint" of bicycles is decreasing and that Eco-counter (the manufacturer of this newer detection device) does a good job of dealing with composite-material bicycles.

Mr. Sweeney is among those who cite the use of counts to measure exposure data for crash analysis rather than just the frequency of bicycle and pedestrian crashes. Another significant benefit of the City's count program is that "a lot of the debate has gone away" regarding the need to provide facilities for bicycling and walking because of the amount of use that the counts show. Ultimately, he believes that the count program is an important piece of the City's bicycle and pedestrian planning puzzle, but certainly not the whole puzzle.

Mr. Sweeney, citing the difficulty in storing and sharing count data, suggested that it would be easier to offer “not best practices” than best practices on the subject. He did indicate that the City is looking into creating web-based access to the data through a future grant.

Boulder continues to be challenged by how to either expand the count program or extrapolate the existing counts for a better city-wide estimate of use. They have considered implementing a spreadsheet-based model to do just that, but they worry about inappropriate extrapolation and wonder whether the twelve or thirteen existing locations constitute a representative sample.

MR. SHAWN TURNER – TEXAS TRANSPORTATION INSTITUTE (TTI)

Mr. Turner, in his role as a Division Head for TTI, has led or been involved in much research on the subject of bicycle and pedestrian monitoring. He is part of the research team applying existing *Traffic Monitoring Guide* principles to the bicycle and pedestrian modes. He cites a general philosophy that employing numerous short-term counts plus at least a couple of permanent counters for validation is the current leading approach, with the primary outstanding question being how to do that over a large bicycle and pedestrian network.

Mr. Turner's research has included projects in which he evaluated various count technologies to determine their effectiveness. He states that most of these technologies have their own issues, and that the selection of an appropriate device is highly dependent on the user and the environment in which it is deployed. Among sources of inaccuracies, Mr. Turner mentions selection of sites where people are milling about (near a trailhead, for example) or frequently traveling side by side (rather than a location where people tend to filter down to single file), as well as inductive loop detectors that receive interference from power lines, particularly for trails which run along utility corridors.

On the subject of active data collection, Mr. Turner would like to see it used more, as long as it can be calibrated somehow, because there is so much of that data "floating around" not to take advantage of it. He has experience using CycleTracks to establish travel patterns and believes that Bluetooth systems could ultimately replace intercept surveys. That said, he views active data collection as a "different piece of the (bicycle and pedestrian monitoring) puzzle."

Mr. Turner believes that bicycle and pedestrian monitoring is important for the same reasons that automobile counts are important: to show the need for facilities and appropriate accommodation. It may be even more important for the non-motorized modes because politicians and others tend to discuss bicycle and pedestrian facilities in terms of whether or not they are needed at all.

Regarding the potential for a standard count procedure, Mr. Turner is struck by the current system for storing auto travel data and believes that the bicycle and pedestrian community should be able to take advantage of that. He is aware that the Colorado Department of Transportation is doing just that by calculating reports that are already set up. He has the impression that those using the National Bicycle and Pedestrian Documentation Project system are sending data to the clearinghouse in an inconsistent format. He wonders whether someone at the Federal level should be in charge of a similar program, though it might not be mandatory.

Mr. Turner notes that extrapolation of counts is a key question, and that it is very expensive to try to do so in a responsible way. He suggests that one needs to focus on high-activity areas and recognize the inherent statistical shortcomings. More than anything, he is alarmed by some of the city-wide or region-wide count estimates he has seen that are estimated based on minimal counts (duration, locations, or both).

Mr. Turner sees the ongoing update to the *Traffic Monitoring Guide* as a "best first stab" at documenting procedures for bicycle and pedestrian monitoring, and he is hopeful that further research, specifically National Cooperative Highway Research Program project 7-19, will significantly improve the state-of-the-practice.

MS. ELIZABETH STOLZ – COLORADO DEPARTMENT OF TRANSPORTATION

Ms. Elizabeth Stolz is the Traffic Analysis Unit Manager for the Colorado Department of Transportation (CDOT). For two and a half years she has been working with CDOT's Bicycle and Pedestrian Program to incorporate bicycle counts into their traffic monitoring program. A specification has been developed for the types of counters to be used on CDOT projects.

A Kaiser Grant was used to start the bicycle and pedestrian count program off with six permanent count stations. The Colorado Traffic Data Committee, MPOs and other planning contacts were asked to recommend locations for count stations. More than 100 responses were received in just two days. Initial screening criteria - including the recommended roadway being on a connector to a CDOT facility and a willingness on the part of the local agency to help install, maintain and review data – were used to reduce the suggested locations to a top ten list. Through site visits and further conversations with local agencies six final locations were selected to be included in the initial count program. Five movable counters are included in the program. Two of these were placed and have not been moved; consequently, there are essentially eight permanent count locations.

The type of technology deployed at Colorado count stations varies. On a trail in Broomfield, loops and infrared detectors (Eco-counter) are used to detect pedestrians and bicycles and their direction of travel. Directional data was desired at this location so options were limited. Other count stations use a single (Eco-counter) loop. On U.S. 36 near Boulder two loops are used to count bicycles on the shoulder of the roadway and within the travel lane. There have been some problems keeping infrared sites up and running.

Data are compiled at a centralized data location. Local partners submit the data in a variety of formats including spreadsheets and TrafX among others. One person at CDOT is responsible for translating all data into TRADAS software (altered for bicycle and pedestrian counts). The infrared counters were tested to determine if they could detect the number of users in a group; the results suggest undercounting.

Ms. Stolz believes some sort of group factor would be desirable. She also confirmed the need for seasonal, day of week, and facility type adjustment factors, and weather related factors. She would also like to see AADTs for bicyclists created. Ms. Stolz noted that although they are using the TRADAS software they cannot identify these factors yet. She would like to have a process for creating factors and using counts in much the same way as motor vehicle counts are used.

For long-term count stations, Ms. Stolz suggests that less than 24 hours of counts should not be included in datasets. The TRADAS software requires 12:00 – 12:00 (24 hours) of data per day. Errors have occurred during cell phone provider transitions, power outages, and during translation of local partner data.

Ms. Stolz related that another data collection error occurred with their infrared counter. It reported 30,000 users in a day on a facility known to have approximately 2,500 users per day.

Ms. Stolz does believe that active data collection efforts (using GPS-enabled devices) will be used in a national bicycle and pedestrian monitoring program. She does not, however, foresee such a data collection effort being administered through the CDOT Traffic Analysis Program.

With regard to how the data can be used to address safety, funding and design topics, Ms. Stolz gave several examples. The City of Durango used counts to justify adjustments to signal timing for bicyclists. Count stations have also been used to justify snow plowing of trails; counts reveal 100–200 users will use trails where snow has fallen if the trails are plowed. Because of bicycle counts, Boulder is considering building a trail adjacent to a 60 mph roadway. She also observed that some funding – that uses either incentives or mandates – would require counts.

Ms. Stolz also indicated that for a DOT count program to be useful, there must be a centralized data warehouse.

MR. BRETT LITTLE – TRANSPORT FOR LONDON

Based on the international portion of the Task 1 literature review, several international practitioners were identified for potential inclusion in this series of one-on-one discussions. Ultimately, only one of the contacted individuals (Mr. Brett Little of the City of London, United Kingdom's transportation agency) responded, and he provided his experiences electronically.

Mr. Little researched, procured, and implemented London's Pedestrian Monitoring Programme. He researched the effectiveness of both infrared and closed-circuit television (CCTV) programs and ultimately employed CCTV, a video-based technology, for use in London's program. While the City's program is generally working well, Mr. Little notes several sources of inaccuracies including power failures, removal of poles that the cameras were mounted on, and construction work that obstructs the camera view for periods of time. Recognizing potential inaccuracies related to traveling in groups, the chosen CCTV technology includes an adjustment factor that is believed to be representative of reality.

Among London's uses of pedestrian monitoring data, Mr. Little cites the illustration in real terms of the numbers of pedestrians using routes and crossing facilities, which in turn influences both safety and design. Counts are also used as a justification of where to allocate resources and funding.