Model Pedestrian Safety Program: An Overview

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The model pedestrian safety program was the final project in a series of pedestrian studies sponsored by the Federal Highway Administration. The objectives of this project were (a) to consolidate the results of the earlier studies with pedestrian safety data from numerous other sources into a usable format and from that (b) to develop guidelines for communities interested in initiating or augmenting a pedestrian safety program. This paper gives an overview of the entire project. The literature review resulted in classification of 450 documents into a 71-item subject matrix for easy reference by anyone interested in pedestrian safety. During the review of operational experience, contacts were made with 19 American communities to gather data on the day-to-day operations of ongoing pedestrian safety efforts. Finally, a six-point users' manual was developed. These guidelines detail (a) identification of the extent of the pedestrian safety problem, (b) identification of alternative countermeasure solutions, (c) selection of the best alternative, (d) implementation of the alternative chosen, (e) evaluation of its effectiveness once initiated, and (f) maintenance of the safety program.

The objectives of the model pedestrian safety program were to consolidate pedestrian safety data from numerous sources and to develop programmatic safety guidelines based on these data. Collection of these data consisted of a massive literature review and a survey of 19 American communities that had successful, ongoing pedestrian safety programs. The Users' Manual (1) developed from the data offers guidance in program planning and presents design strategies based on empirical research results and operational experience.

REVIEW OF THE LITERATURE AND OPERATIONAL EXPERIENCE

Numerous innovative ideas about pedestrian safety have been developed during the past several years. Many of these have been evaluated and discussed in various documents and research studies. Unfortunately, a large number of these documents are distributed on a limited basis and their contents are never considered for incorporation into pedestrian safety programs. Other innovative ideas have been developed by local safety officials and incorporated into their community safety programs. Unfortunately, the results of these efforts are frequently never communicated beyond the cognizant jurisdiction.

The initial efforts of the model pedestrian safety program were twofold:

1. To identify all documents relevant to the development of a model pedestrian safety program and to assemble these documents into a useful format for reference by anyone interested in pedestrian-related literature, and
2. To survey several American communities that have successful, ongoing safety programs to obtain data on the real world of pedestrian safety efforts.

Literature Review

The screening and review of literature on pedestrians resulted in a bibliography of 450 documents. The information in each was reviewed and classified into a 71-item literature review subject matrix. A sample portion of the matrix is shown in Figure 1.

The data from the documents were grouped into five major topic areas:

1. Facilities—engineering and physical countermeasures designed to aid pedestrians in crossing the street or to prevent them from entering the street at particular locations; subcategories identify different types of facilities and behavioral-attitudinal responses to, problems associated with, design of, and warrants for installation of these facilities.
2. Accidents—system failures that involve a pedestrian; subcategories identify population groups, locational and environmental factors, and accident types (preaccident behaviors).
3. Behavior—the ways pedestrians act, patterns of actions, tendencies to respond in particular manners, and reasons for reacting; subcategories identify subpopulations (age groups, the handicapped, drivers), locational and environmental factors, and behavior types.
4. Safety programs—potential and existing efforts toward pedestrian safety, types of safety programs, and responses to these efforts.
5. Type of document—the general class of document (research report, bibliography, or discussion).

Dots along a row in the matrix indicate topics discussed in that document. Conversely, documents about a particular subject can be identified by reading down the relevant column and cross-checking documents in that row. Matrix subject, subfactor definitions, and the complete matrix and bibliography appear in Volume 1 of the project interim report (2).

Review of Operational Experience

The final objective was to develop methodological guidelines that localities of all sizes can use to initiate or augment pedestrian-oriented safety efforts. The findings and ideas from the literature must be considered within the context of the operational experience of already-established safety programs. Localities that have successful pedestrian safety efforts had much to offer to the development of the users' manual. Therefore, a survey was made of the operational experience of 19 regionally and socioeconomically varied American cities with successful ongoing pedestrian safety programs.

The American Automobile Association (AAA) 1976 pedestrian safety inventory program collected data on local and state safety programs. It was used as a data base to identify cities making efforts to maintain pedestrian safety. During December of each year, survey forms are distributed to participating localities by the local automobile clubs. Small towns, large cities, counties, and states participate voluntarily by filling out a two-page survey. Safety program performance ratings are made based on an evaluation of activities in eight basic areas:

1. Pedestrian deaths and injuries,
2. Accident records,
3. Legislation,

Figure 1. Sample page of literature review subject matrix.

	Facilities																Accidents		
	Safety Islands	Signing	Signalization	Crosswalks, Pavement Mkgs.	Barriers	Sidewalks	Crossing Guards	Grade Separation	Ped. Environment Urban	Ped. Environment Residential	Other	Impact	Attitudes Toward	Problems	Design	Warrants	Children	Adults	Elderly, Handicapped
RTKL, 1976b								●	●	●		●		●	●				
Rubenstein, 1972						●		●			●				●				
Rudofsky, 1969						●		●	●		●	●	●	●	●				
Rumar, 1966											●			●					
Russam, 1975				●							●	●			●		●		
Safety Through...,n.d.																	●		●
Salvatore, 1973																			
San Diego, 1971		●	●	●			●	●							●	●			
San Jose (1), 1972			●	●			●									●	●	●	●
San Jose (2), 1972a				●			●				●				●				
San Jose (3), 1972b							●												

4. Enforcement,
5. Traffic engineering,
6. School traffic safety,
7. Public information and education, and
8. Safety program coordination.

From over 2400 cities in the AAA data base, 19 were selected and contacted for further information. These 19 cities covered a wide range of socioeconomic factors (determined from 1970 census records), spanned a large range of population categories (the smallest city has 14 000 inhabitants; the largest has 800 000), and were regionally representative of other cities in their population category.

Each of the cities selected was contacted to obtain more detailed data about its pedestrian safety program. Sixteen of the cities were visited for 1 d to observe the safety efforts in operation. Discussions with city personnel generally centered around the following subject areas:

1. Safety program coordination—the organization (governmental, citizen group, business, local) responsible for the total pedestrian safety effort;
2. Traffic engineering—physical and engineering facilities designed to create a safer environment for pedestrians;
3. School and child safety—specific programs aimed at young pedestrians;
4. Provisions for the elderly and handicapped—specific safety efforts aimed at older and disabled pedestrians;
5. Public information and education—media and teaching efforts on safety problems and regulations;
6. Enforcement of pedestrian-related laws;
7. Accident analysis—types of data collected and how they are used; and
8. Safety program recommendations—general underlying philosophy of pedestrian safety.

Detailed discussions on the AAA pedestrian safety inventory, the city selection process, and most important, the results of these contacts (both individual and in summary) are available in the interim report, Volume 2 (3).

USERS' MANUAL

The users' manual is based on the literature and the operational data obtained during the early stages of the project. The manual is designed to be both a guide and a resource for individuals and organizations interested in planning and in creating safer environments for pedestrians. It identifies steps to follow to set up a pedestrian safety program and provides information to help in choosing solutions. It lists numerous possible solutions to safety problems and provides lists of additional references. The manual is written for both those individuals with minimal safety program experience and those already involved in a program. The guide presents methods and techniques useful in developing a complete and effective pedestrian safety program and is a source of additional ideas, which can be incorporated into an ongoing program.

The model pedestrian safety program users' manual provides the what and how of creating an effective safety program. In combination with the motivation, involvement, and long-term interest of local individuals, the manual can help create safer pedestrian environments.

The guidelines are presented in a six-step process:

Step 1—Determine the extent of the pedestrian safety problem,
Step 2—Identify alternative solutions,
Step 3—Select the best alternative (benefit-cost analysis),
Step 4—Implement selected alternatives,
Step 5—Evaluate the effectiveness of the implemented alternatives, and
Step 6—Maintain the pedestrian safety program.

Step 1: Extent of the Pedestrian Safety Problem

The goal of every pedestrian safety program should be to reduce fatalities, injuries, and material losses from pedestrian accidents. The initial effort should be to determine the extent of the pedestrian safety problem by identifying hazardous locations and unsafe pedestrian behaviors. Step 1 describes three procedures useful for determining where pedestrian accidents and unsafe behaviors are occurring, the data important for choosing rational solutions, and how the relevant data can be collected.

Complaints from local citizens are discussed as on-scene sources identifying existing hazardous conditions and potential accident sites. It is impossible for transportation engineers, planners, and other government officials to locate every possible hazardous site. Individuals who live in a neighborhood, cross certain streets, or pass through the same intersection on a daily basis are much more familiar with the long-term problems of those locations. Data from these users can focus attention on a problem that might not have been noticed otherwise.

Pedestrian accidents are the result of a sequence of events that, if not interrupted, will produce a pedestrian-vehicle collision. Investigating accidents as sequences of events provides the opportunity to identify one or more points at which to break the collision chain. Understanding what contributes and leads to accidents and injuries must precede rational selection of countermeasures. The emphasis in step 1 is, therefore, on the use of accident reconstruction as a basis for determining behavioral causes of accidents.

This type of approach leads to the identification of

1. Major aspects of the pedestrian accident process,
2. Methods of grouping these different aspects into a behavioral accident typology in order to understand accidents with common causal patterns, and
3. Ways in which these patterns may be reversed and the identification of possible countermeasures.

This section of step 1 addresses the necessity of collecting behavioral, rather than just violation, accident data. Techniques for recording the appropriate data necessary for classifying accidents into a behavioral typology are described.

Each type of accident is distinguished by the presence or absence of critical descriptors; however, not all pedestrians exhibiting such actions are involved in accidents. The frequency of an accident-producing event sequence not leading to a collision is much higher than of it resulting in an accident. Therefore, collection of data on the frequencies of accident-producing behavior in noncollision situations should be done.

Techniques of activity sampling, the collection of nonaccident behavioral data, are also described in step 1. These are usually used as shorter term methods to determine the level of hazard of a site and to evaluate the effectiveness or noneffectiveness of an installed countermeasure.

Step 2: Alternative Solutions

Step 2 details numerous countermeasures known to be effective in solving pedestrian safety problems. The solutions are grouped into four major areas. Three of these reflect the three Es of pedestrian safety (engineering, education, and enforcement), and the fourth deals with the special problems of young pedestrians.

Engineering and physical facilities countermeasures can be designed to promote the safety of pedestrians while crossing the street or to prevent pedestrians and vehicles from coming into contact with each other. Individual subsections deal with barriers, bus stop relocation, crosswalks, grade separation, facilities for the handicapped, lighting, one-way streets and diagonal parking, retroreflective materials, safety islands, sidewalks, signalization, signs and markings, and urban pedestrian environments. Educational programs can be developed for instructing children, the general public, and the elderly about pedestrian safety and the hazards associated with interacting with vehicles. Sample instructional programs are discussed. Enforcement programs can be enacted to develop compliance with pedestrian-related laws. Child protection countermeasures can be undertaken specifically oriented toward the protection of young pedestrians. Included are subsections on preschool and child safety countermeasures, safe route to school program, school bus routing and patrols, crossing guards, play streets, other countermeasures for school children, and general considerations for child protection.

Within each of these four major sections, each countermeasure is treated as thoroughly as possible under the following headings: (a) definition, (b) associated behavioral and accident data, (c) varieties, (d) disadvantages, (e) target people, (f) target locations, (g) implementation considerations, and (h) pertinent references. In addition, tables relating each countermeasure to the type of accident it is designed to mitigate are provided.

Step 3: The Best Alternative

Step 3 describes a method for selection of the alternative having the highest anticipated benefits for the lowest anticipated costs and meeting the desired goals and necessary constraints. To combat some of the problems of other types of cost-effectiveness procedures, particularly those that attempt to apply monetary values to nonquantitative benefits and costs, the procedure outlined converts all benefit and cost variables to value ratings. The methodology of the value rating technique is described. All benefit and cost variables for each of the applicable alternatives are computed and converted to the neutral value rating score. The individual benefit and cost ratings are then summed and compared as a ratio:

$$\rho = \text{benefit/cost} \quad (1)$$

The alternative with the highest ratio that also meets the constraints (such as total funds available or severity of the problem to be solved) is selected for implementation.

In step 3, problems associated with the subjective nature of all cost-effectiveness techniques are discussed. Procedures for working within these constraints are described.

Step 4: Implementation

Once a countermeasure has been selected, the next step is to implement it. Step 4 has five requisite substeps in order for an alternative to be successfully realized in the environment.

The specific goals and objectives of pedestrian programs will vary from one jurisdiction to another. Common to all of them, however, should be

1. Reduction of the frequency of pedestrian accidents and
2. Reduction of the severity of pedestrian accidents.

It is vital that these goals be written in a policy statement from the highest level of government. Formulation of such a statement is a means of communicating the desired safety program to those who will implement it. Local priorities and safety objectives should be stated plainly in this document.

One of the major problem areas of pedestrian safety is the multitude of agencies sharing the responsibility for pedestrian affairs. This is true at all levels of government. Having many agencies involved can lead to duplication of effort or to inaction. Long-term, successful pedestrian safety programs occur only when one group or individual has the desire and authority to see that the efforts are made. Several organizational suggestions for pedestrian safety coordination at the local level are made.

The single most important criteria for successful implementation is probably the citizens' perceived value of the project. Without acceptance at the most local level—the implementation site—it is doubtful that any safety program countermeasure will be effective. A successful total safety program requires the support of all involved governmental agencies, media, schools, and businessmen, as well as the public at large. This necessity for total public support is discussed.

Many options are available for funding individual pedestrian projects. The options will vary depending on the project scope and target subjects. Possible funding sources are identified.

Time is a critical factor after a problem area has been identified. To prevent a problem from increasing in magnitude, the appropriate safety countermeasure should be implemented as soon as possible. Numerous pedestrian and other traffic projects can exist simultaneously. The limited funds available must be split between several problem areas. This section discusses a method for setting priorities on pedestrian safety projects among themselves and within the total transportation system.

"Hazard prioritization" is a technique for evaluating the degree of hazard associated with a particular problem area. Three elements are used to rate each location:

1. Severity—the degree of the problem if left unattended.
2. Probability—the likelihood of an accident if no solution is implemented.

Figure 2. Example of hazard analysis card.

HAZARD ANALYSIS CARD			
Date: ______			
Hazard Description: ______			
Severity	*Probability*	*Cost*	*Action*
• Nuisance	• Unlikely	• Prohibitive	• Defer
• Minimal	• Probable	• Extreme	• Analysis
• Critical	• Considerable	• Significant	• Immediate
• Catastrophic	• Imminent	• Nominal	
		Completion Date: ______	

3. Cost—the cost of the implemented solution.

Priorities based on the severity-probability-cost of a problem location can establish a sequence for addressing pedestrian and other safety problems. Figure 2 illustrates a sample design for a hazard analysis identification and prioritization card.

Step 5: Effectiveness

It is imperative to know whether or not an alternative was successful in creating a safer situation for pedestrians. Step 5 discusses how to (a) develop an evaluation plan, (b) conduct the evaluation, and (c) analyze the data.

Two major types of evaluations are addressed in this step:

1. Programmatic evaluation of the operation and management of the pedestrian safety program and
2. Effectiveness evaluation of the behavioral changes induced by particular facility installations.

Programmatic evaluation deals with the determination of whether or not the overall pedestrian safety program is meeting its stated policy goals and objectives. This section discusses the management of programs designed around these goals in terms of program activities.

The most difficult to obtain, but most useful evaluation data, concern the effectiveness of an implemented countermeasure at an installation site. These data are the basis for the expansion, contraction, redirection, or modification of specific elements of the program. Three substeps are discussed as parts of this type of evaluation. These deal with

1. Developing the evaluation plan—establish countermeasure goals and objectives, select what measures will show its effects, and select appropriate statistical analyses to analyze the data;
2. Conducting the evaluation—discuss logistical and operational problems of data collection and give illustrations of sample data collection forms; and
3. Analyzing and interpreting the data—describe the statistical aspects of evaluation, the various types of data that can be collected, and the mathematical procedures for data analysis.

Step 6: Maintenance

A successful pedestrian safety program requires a continual watch on the safety environment. Step 6 is not so much a definite step as a feedback movement returning to step 1. The traffic situation can be viewed as a pressure cooker—without a lid, the pot would quickly boil over; a tight lid keeps the contents under control. If the contents of the pot are thought of as the interactions between pedestrians and vehicles, without constant watch of the situation (the lid) these interactions become too intense and boil over into accidents, injuries, and fatalities. A complete program reduces the frequency and severity of accidents. The complete model pedestrian safety program begins with a return to step 1 and a recycling through the total program again and again. Quick identification of problems and timely selection and implementation of solutions is a must for a long-term safe environment for pedestrians.

ACKNOWLEDGMENT

This project was performed under contract to the Federal Highway Administration.

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Publication of this paper sponsored by Committee on Pedestrians.

Some Characteristics of Bicycle Travel and Accidents in Towns

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Findings of bicycle field surveys are presented, including 685 interviews with riders in six Israeli towns that have very different levels of bicycle use. Data are analyzed on bicycle accidents and on mode of travel to work and school in 29 towns. Estimates are made of the number of bicycles in use, the number of riders, and annual travel by age and sex of rider for major trip purposes. It is concluded that bicycle travel represents an overall addition of 12 percent to urban travel at present levels of use in Israel and, on this basis, accident risk per kilometer of bicycle travel is approximately the same or even lower than that for passenger automobiles. Furthermore, bicycles are not only an extremely important means of transport for the 10- to 19-year age group, but in towns where bicycle use is high (20 percent of total trips) all ages of males and females use the mode actively for shopping, recreation, and work. Trip lengths are rarely above 5 km and vary according to age, sex, and trip purpose. In general, trip length characteristics are similar to those found in Europe. For towns with flat topography and populations of 100 000 or less, multiple regression analysis indicated that six factors accounted for 59 percent of the variance in bicycle use in the 24 towns studied: population, radius, density, number of persons per household, percent welfare expenditure, and percent working out of town. It was further found that in very small and poor towns, walking was an alternative to bicycling. In other towns, industry-provided transportation appeared to be an alternative mode to bicycling.

Conventional transportation planning has been concerned with predicting travel demand, primarily for automobiles. Today planners are turning their attention from prediction of trends to intervention in the distribution of the modal split. This change has come about in developed, motorized countries because of the need to ease the problems of traffic congestion and the fear of further environmental degradation associated with ever increasing use of automobiles. In underdeveloped, less motorized countries, the promotion of modes of transport less costly than the automobile is considered essential.

There is clearly little possibility of expanding the recently rediscovered use of bicycles without a more thorough description of the basic travel characteristics of the mode—trip lengths, frequency, purpose, generators, attractors, and other basic elements. Furthermore, in the case of bicycles, unlike proposed innovative rail modes, the problem of safety in an expanded system looms as an unknown and serious problem.

The field work reported in this paper was carried out while attempting to answer elementary questions basic to establishing policy for national bicycle planning. Data from the survey support what the casual observer of the Israeli countryside knows well, namely, that in certain towns bicycles are an important part of the existing transport system. The findings are based on four stages of data gathering and analysis: a survey of bicycles in use, interviews with bicycle riders, analysis of accident data, and an analysis of national travel data.

Every Israeli municipality requires that bicycle owners purchase an annual permit at a minimal fee and display a metal registration plate. The number of licensed bicycles is very low because neither party to the transaction is especially concerned about its implementation. To estimate the number of bicycles in use, a survey was made of all towns over 5000 population (40 towns) to establish how many licenses had been issued. Observations were then made of the proportion of bicycles displaying licenses in 7 towns and the data were combined to estimate the actual number of bicycles in use.

METHOD

Interviews were conducted with 685 riders on main streets of six towns at locations on the periphery of the central business districts (CBDs). The six towns had very different levels of bicycle use.

Town	Population	Level of Use	Number Interviewed
Kiryat Haim	24 000	High	192
Nahariya	25 000	High	197
Hadera	32 000	Medium	102
Herzlia	45 000	Low	65
Givatayim	50 000	Low	50
Tel Aviv	400 000	Special	79
Total			685

Age and sex of the population interviewed were predetermined by all-day counts of bicycle riders in each town. The overall distribution of age and sex of riders was 52 percent children (11.5 percent girls, 40.5 percent boys) and 48 percent adults (10.5 percent women, 37.5 percent men). The children interviewed were 10 through 19 years old. The riders interviewed in Tel Aviv were young males and adult men who use their bicycles in the CBD, mostly in connection with their work. The interview form included questions on trip purpose, trip