MEASURING PEDESTRIAN VOLUMES AND CONFLICTS

VOLUME IV: PEDESTRIAN/VEHICLE ACCIDENT PREDICTION MODEL A USERS MANUAL

CONTRACT NUMBER: DTFH61-85-C-00079

FINAL REPORT

Prepared for:

Federal Highway Administration
Turner-Fairbank Highway Research Center
6300 Georgetown Pike, HSR-20
McLean, VA 22101

by

Roger Mingo, P.E.

Dr. H. D. Robertson, P.E.

Scott E. Davis

Dr. Ellis King, P.E.

March 1988

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

Technical Report Documentation Page

1. Report No. FHWA/IP-88-031	2. PB91-189175	3. Recipient's Catalog No.
4. Title and Subtitle MEASURING PEDESTRIAN VOLUMES AND CONFLICTS Vol. IV. Pedestrian/Vehicle Accident Prediction Model A Users Manual		5. Report Date March 1988 6. Performing Organization Code
7. Author(s) R. Mingo S. Davis, E. King, D. Robertson		8. Performing Organization Report No.
9. Performing Organization Name and Address Analysis Group, Inc. Transportation Engineering Division 1750 New York Avenue, NW, Suite 200 Washington, DC 20006		10. Work Unit No. (TRAIS) NCP-3A4B0012 11. Contract or Grant No. DTFH61-85-C-00079
12. Sponsoring Agency Name and Address Federal Highway Administration Turner-Fairbank Highway Research Center 6300 Georgetown Pike McLean, VA 22101		13. Type of Report and Period Covered Final Report (Partial) June 1985 - March 1988 14. Sponsoring Agency Code

15. Supplementary Notes

FHWA Contract Managers (COTR): Janet Coleman (HRT-20)
John Fegan (HSR-20)

16. Abstract

Users of this manual are expected to be researchers who are attempting to develop models that can be used to predict occurrence of pedestrian accidents in a particular city.

The manual presents guidelines in the development of such models. A group-type analysis approach for the prediction of pedestrian/vehicle accidents using pedestrian/vehicle conflicts and exposure measures is discussed in terms of statistical methodology, results of approach, and applications of techniques developed. Appendixes are included to discuss the discriminant analysis techniques and to present examples of the applications of the model.

This voluem is fourth in a series. The others in the series are:

Vol. No.	Title
I	Measuring Pedestrian Volumes (Report #FHWA/RD-88/306)
II	Pedestrian Accident Model (Report #FHWA/RD-88/307)
III	Measuring Pedestrian Volumes (Users Manual, Report #FHWA/IP-88-030)

17. Key Words Conflicts, Exposure Measures, Discriminant Analysis	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 21	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Introduction

This manual outlines a procedure that can be used to develop pedestrian/vehicle accident models for use in identifying potential accident sites. Volume II in this series of reports describes in detail the application of these procedures to two cities, Washington, D.C., and Seattle, but the models in those two cities cannot be generalized to all cities. Models developed from these guidelines will be tailored to conditions in the particular cities in which they are developed. Various cities exhibit somewhat different pedestrian and driver behavior patterns and are therefore best served by such customized models, but similar cities in the same general geographic region may very well be described by a commonly-developed model.

The primary users of the accident models developed according to this manual are anticipated to be local or regional traffic engineers interested in identifying and analyzing potential accident locations. Practical applications or uses of this model include prioritization of hazardous locations and evaluation of implemented accident countermeasures.

The model could assist in identifying hazardous locations and aid in the decision regarding order of treatment. As an evaluation tool, the predictive model can be used to determine the effectiveness and benefits of safety countermeasures using a before-and-after type analysis.

The manual is presented as an 11-step procedure to guide the user in terms of data variable selection, data collection, and accident modeling. Example applications are included in the appendixes.

Procedure For Developing An Accident Model

The procedure for developing a model that predicts whether an intersection or midblock crossing is likely to be a hazardous location for pedestrians involves 11 steps.

1. Choose the variables to consider.
2. Determine scope of model.
3. Define accident period.
4. Stratify data to collect.
5. Define data collection period.
6. Delete accidents.
7. Select sites.
8. Train field observers.
9. Collect data.
10. Develop model.
11. Estimate future conditions.

Each step is described in the following paragraphs.

Step 1: Choose the Variables to Consider

The first step in developing an accident prediction model is to choose the variables (such as conflicts, exposure measures, and violations) that will be considered. It is not mandatory to include all of the selected variables in a particular model, since it will most likely turn out that some variables are better accident indicators than others depending on local pedestrian and vehicle behaviors and characteristics. Several of the variables that have shown promise are discussed below.

Conflicts--In general, a pedestrian/vehicle conflict occurs when a driver and/or pedestrian has to take some action, such as change direction, speed, or both, in order to avoid a collision. For purposes of developing a model for predicting accident locations, this conflict definition is appropriate. Based upon this definition, the following three types of conflicts could be used in the predictive model for identifying potential accident sites.

Code	Type of Conflict
TV	Through Vehicle Conflict - occurs when the projected paths of a through vehicle and a pedestrian intersect and either the pedestrian or the vehicle or both must change direction and/or speed to avoid a collision.
RT	Right Turn Vehicle Conflict - occurs when the projected paths of a right turning vehicle and a pedestrian intersect and either the pedestrian or the vehicle or both must change direction and/or speed to avoid a collision.
LT	Left Turn Vehicle Conflict - occurs when the projected paths of a left turning vehicle and a pedestrian intersect and either the pedestrian or the vehicle or both must change direction and/or speed to avoid a collision.

After identifying a potential accident site, the model user may wish to expand this list of conflict types in order to perform a more detailed analysis. Some locations may produce unique conflicts due to geometrics, vehicle mix, or unusual pedestrian characteristics which should be reflected in the conflict types.

It should also be noted that some prior studies have found it more important to consider severe conflicts, rather than every conflict. Severity of a conflict is determined by the strength of deceleration or acceleration, the speed differential, and how closely spaced the parties are. The concept of time also enters in since maneuvers made at the "last second" have much less margin for error than those made in less severe situations. While distinguishing between severe and "routine" conflicts may be difficult, and undoubtedly requires additional definition and judgement, the results may be worth the effort.

Exposure Measures--In order for a conflict or accident to occur, both a pedestrian and a vehicle must be present. Pedestrian and vehicle volumes can be used to determine the "exposure to risk." Pedestrian and vehicle volume counts can be used to compute various exposure measures which may be more meaningful than the individual counts alone. Some of the measures suggested in prior studies are the product of the two volumes (P x V) and P x V divided by percent turning vehicles. It should be noted that neither of these measures performed well as accident predictors in the Washington, D.C., and Seattle studies documented in the companion volume to this manual.

The time spent crossing a road is another measure of exposure. This exposure to risk can be represented by the distance walked or the number of lanes crossed by the pedestrian. The longer the pedestrian remains in the roadway, the greater the potential for a conflict or accident occurrence.

Violations--In some locations, pedestrian and vehicle violations affect the occurrence of accidents. Where pedestrian and/or vehicle volumes are low, violations may be of little importance since the opportunity for a pedestrian and vehicle to occupy the same point at the same time is relatively rare. Under higher volumes, however, violations may play an important part in accident occurrences.

The following pedestrian and vehicle violations are recommended for use in developing an accident prediction model. It should be noted, however, that the relationship between violations and accidents is likely to be dependent on many other factors that influence the severity of the violation other than its mere occurrence.

Pedestrian Violations:

- starting to cross during the clearance interval,
- starting on the prohibited crossing interval,
- anticipating the WALK or green signal and stepping out prematurely,
- crossing outside the marked crosswalk (if it exists) within 50 feet of the intersection.

Vehicle Violations:

- entering during the yellow interval,
- entering during the red interval, and/or not following special signing or signal constraints such as NO RIGHT TURN ON RED (signal control),
- running or not stopping completely for a stop sign (stop control).

Type of Traffic Control--The type of traffic control, which is reflected in a traffic control variable, may be an indicator of the level of pedestrian and vehicle activity. A stop or yield control at an intersection usually indicates either high-pedestrian or high-vehicle activity or both. Therefore, this variable may aid in determining accident potential.

Site Configuration--The site configuration may have a pronounced influence on both driver and pedestrian behavior. These differences may be readily noted when evaluating intersection crossings and midblock pedestrian crossings and due to these differences, a distinction should be made between these two types of crossings. Pedestrian crossings at the intersections of one-way streets may also have differing characteristics that should be recognized.

Step 2: Determine Scope of Model

Prior to collecting data, the user should determine the specific purpose to be served by the model that is to be developed, that is, whether specific types of pedestrian accidents will be targeted. If the focus is on all types of pedestrian accidents occurring at all hours of the day and night, for example, general variable definitions and long pedestrian and vehicle volume estimates of 2, 6, or 12 hours are usually adequate. If the user intends to investigate school trip accidents, however, pedestrian flow rates are likely to be highly variable, and volume estimates and other data for much shorter time periods are needed.

Similarly, the user will need to determine specific levels of data collecting, e.g., by lane or approach, or entire site total, depending on the problem that is being investigated.

Step 3: Define Accident Period

Due to changing traffic and physical conditions at many sites, excessively long accident history periods should be avoided. By the same token, however, pedestrian accidents at a given location are (hopefully) such rare events that short accident history periods are likely to inadequately sample their occurrence. As a necessary compromise, 1- to 3-year accident histories are recommended for use in model development. Accidents that occurred more than 3 years in the past may have had different conditions than exist at present. Even short accident histories could contain significant changes in a site's conditions. Thus, the site histories should be investigated thoroughly to assure uniform conditions over the selected time period.

Step 4: Stratify Data to Collect

The accident sites should be stratified based upon the number of accidents occurring at the site during the chosen accident history period. Each intersection will be placed in a group having a similar accident experience. In most cities, it would be expected that a large number of intersections will have experienced no pedestrian accidents in a 3-year period, and that the next largest group of intersections will have experienced one accident. Thus for the two largest groups, all sites within each will have experienced the same accident frequency. As the accident frequency increases, however, the number of sites per group decreases. Therefore, higher-accident groups may need to be combined in order to increase the sample size for each group.

In each group, an equal proportion of sites with similar traffic controls and geometric configurations should be maintained. In some instances such as 4-way stop control and three leg intersections, this equal proportion can not be as easily maintained as for signal versus two-way stop control sites.

In stratifying the data, groups for 1, 2, 3, etc. accidents must contain similar cells of control type and configuration within each group. An example of a stratified data collection diagram is presented in figure 1. This diagram represents a single accident frequency group.

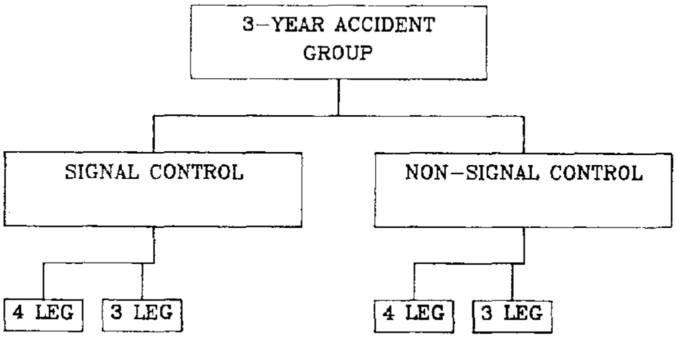

Figure 1. Stratified Data Diagram

Step 5: Define Data Collection Period

To ensure the most accurate results, the user will need to establish a long data collection period, ideally 12 or 14 hours. A collection period of this length, however, would be labor intensive and therefore expensive. Shorter data collection periods can be used to represent the entire period. These guidelines recommend data collection at random 2-hour periods. If the user is concerned with daytime accidents, 2-hour data collection sessions should be conducted in the morning, mid-day, and afternoon, collecting a total of 6 hours of data. This 6-hour collection is considered to be representative of the entire 12-to-14 hour daytime period. Volume III of this series gives examples of sampling procedures used in determining pedestrian volumes.

If the user is also concerned with nighttime accidents, additional night data collection is also necessary. It is recommended that the user consider treating nighttime and daytime separately, with data independently collected and analyzed, since pedestrian and vehicle behaviors and volumes differ during each of these times.

Since the accident histories will consist of accidents that occurred throughout the year, the collected data should also represent seasonal variations. In order to ensure this seasonal representation, data could be collected for the various sites in each group at differing times of the year, taking care to include all four seasons.

Step 6: Delete Accidents

Review the accident histories and eliminate any accidents that are not representative of the data collection period. For example, if the data collection period is for daytime hours only, pedestrian/vehicle accidents that occurred at night should be removed from the data base.

Step 7: Select Sites

Randomly select sites in each accident-frequency group where pedestrian activity exists. Since pedestrian/vehicle accidents are being modeled, it would be wasted effort to collect data at locations having no pedestrians. The number of sites selected for each group should be based on statistical need, but may be constrained by ecomonic considerations. This manual does not recommend the actual number of sites needed in each group, but the greater the number of sites included, the more accurate the developed model. For a more detailed discussion of setting up a detailed site plan, see Accident Research Manual, published by FHWA in February 1980 (Report # FHWA/RD-80/016).

In some cases where numerous accident-frequency groups exist, some groups can be combined to produce a frequency-range group. It is recommended that the zero-frequency group not be merged with another group. Merging of groups may reduce the need for selecting numerous sites and, therefore, the cost of data collection.

Step 8: Train Field Observers

Before actual field data collection, the observers should be given instructions on data collection procedures and familiarized with variable definitions. Sessions of in-class and field training are recommended. In-class training involves reviewing a videotape of a test site. While reviewing this tape, field observers will learn to recognize conflicts and violations and to distinguish between the types of each.

Field training involves on-site instruction wherein the trainer and field observer collect conflict data simultaneously and independently and then after a given time compare the data. While results may vary from observer to observer, 95 percent compliance between trainer and observer is recommended to produce an accurate sample. During actual data collection, the trainer needs to spot-check observers in order to maintain quality control.

Step 9: Collect Data

After adequate training, as assured by consistent results between trainer and observer, data collection can begin. At high-volume sites, two observers may be needed: one collecting pedestrian and vehicle volumes, and the other collecting conflict data. A sample data collection form is presented in appendix A.

Step 10: Develop Model

Modeling techniques must be chosen carefully because of the stratified accident data. A scatter diagram of the raw data of conflicts versus accidents may look something like the example in figure 2, but it must be remembered that the points represent different numbers of intersections. Employing graphical "best fit" techniques would produce erroneous results because of the different sampling rates in each stratum. In the example illustrated in figure 2, for example, only 1 out of each 100 intersections with 0 accidents was included in the sample, while half the intersections with 4 accidents were included. Thus each 0-accident point represents 100 other such intersections while each 4-accident intersection only represents 2 such intersections. Each point on the scatter diagram must be "weighted" by the number of intersections it represents. This can be calculated by dividing the total number of intersections in a stratum by the number of intersections in that stratum's sample.

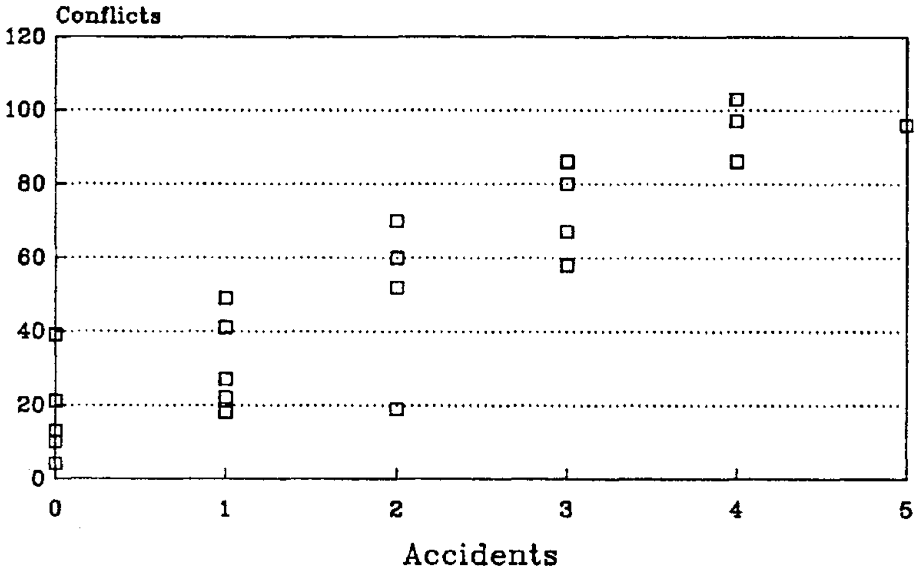

Figure 2. Scatter Diagram of Conflicts versus Accidents

If a statistical analysis computer package is being used, the weighting factor can probably be used directly in a regression procedure. If a hand method is being used, it would probably be easiest to divide all the weighting factors by a convenient number to simplify calculations. This can be done because it is the relative weighting of one intersection versus another that is important, rather than the actual weighting factor.

Another alternative is to use a group-prediction modeling technique. Discriminant analysis is recommended as one such group-prediction technique. This analysis basically uses discriminating variables to distinguish between groups. The groups in this case are defined by accident frequencies, i.e., group 1--zero-accident sites, group 2--one accident sites, etc. The mathematical and statistical theories behind discriminant analysis are beyond the scope of this manual, but appendix B presents the basic theory, describes model evaluation, and lists references of this modeling technique.

Step 11: Estimate Future Conditions

As mentioned earlier, the model you will develop predicts accidents or accident groups for given periods of time at a given location. For example, a model developed using a 3-year accident history data base could be used to directly predict accident potential at selected intersections over the next 3 years. Since the 3-year model was developed using present data to define the past 3-year accident history, the next 3-year accidents will have to be predicted using data for the third future year. Therefore, a means of estimating these data needs to be established.

Pedestrian and vehicle volumes can be estimated using available trip generation rates. Conflict and violation variables, however, need to be estimated by using relationships that exist between these variables and volumes.

Conflicts have correlated significantly with the exposure measures of P x V and P x V/%T. Pedestrian and vehicle violations have correlated well with pedestrian and vehicle volumes, respectively. You can investigate these correlations with your own data base. Based on the significance of the correlations, you can set up rates of occurrence of these variables as a function of selected volume measures. If, for example, you determine the number of conflicts that currently occur for each unit of pedestrian times vehicle volume (P x V), you can estimate future conflicts by multiplying that rate of occurrence times the estimated future P x V exposure measure.

Examples are presented in appendixes C and D to demonstrate the model's applications and the discriminant analysis process.

Conclusion

This users manual has been presented as a set of guidelines for the traffic engineer to follow in developing his or her own pedestrian accident prediction model. The variables that were used in the study upon which this users manual was based clearly do not define the comprehensive set that should be considered in future model development. Because of the collinearity of the most important variables (that is, wide streets tend to have more traffic, and more traffic tends to produce more conflicts), it is possible to get fairly good correlations between accidents and most of the variables. It is not at all clear, however, which of the variables are the best predictors of accidents, or indeed, which have any causal relationship whatsoever. Much more work in this area is needed, and traffic engineers using this manual are encouraged to consider it a starting point. They are also encouraged to share their results with others so that future pedestrian accident studies will have a greater body of data upon which to draw.

Appendix A

Data Collection Form

City____________

Intersection ______________________ Date__________ Coder______________

Type of Control: A____ B____ C____ D____ Time__________

Period & Leg	Conflict Events			Violations		Volumes			
	TV	RT	LT	Pedestrian	Vehicle	Pedestrian	Vehicle		
							L	T	R

FIGURE 3.
Pedestrian/Vehicle Conflict Data Collection Form

Appendix B

Discussion of Discriminant Analysis

Discriminant analysis models group type variables (1, 2, 3, etc.) using discriminating variables. Figure 4 shows a conceptual diagram of two discriminating variables, X1 and X2, defining Groups 1, 2, and 3. X1 and X2 act as independent variables defining a dependent variable, group number. Depending on the coordinate of X1 and X2, a group is identified if this coordinate lies inside a group's boundary.

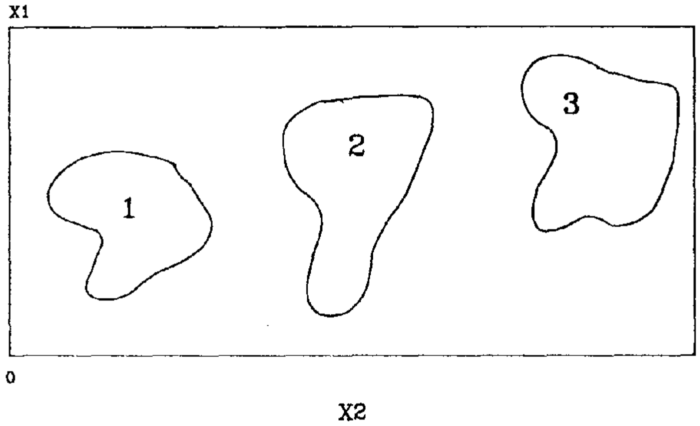

Figure 4 Conceptual Model of Discriminant Modeling

Each group is defined by a linear equation:

$$\text{Group } 1 = C1(X1) + C2(X2) + C3$$
$$\text{Group } 2 = C4(X1) + C5(X2) + C6$$
$$\text{Group } 3 = C7(X1) + C8(X2) + C9$$

where:

C1, C2,..., C9 = constants

Values of X1 and X2 are substituted into all group equations. The group which best defines these variables is the group with the largest value. With respect to the first diagram (figure 4), two of the values will be zero since the specific values of X1 and X2 can only lie in one group. In general, however, groups do not have the distinct boundaries shown in this diagram.

Figure 5 demonstrates group overlap which is caused by the variation that exists in the discriminating variables. When group overlap occurs, all the group equations will result a value. Thus, the group with the largest value will be the group which best defined the values of X1 and X2.

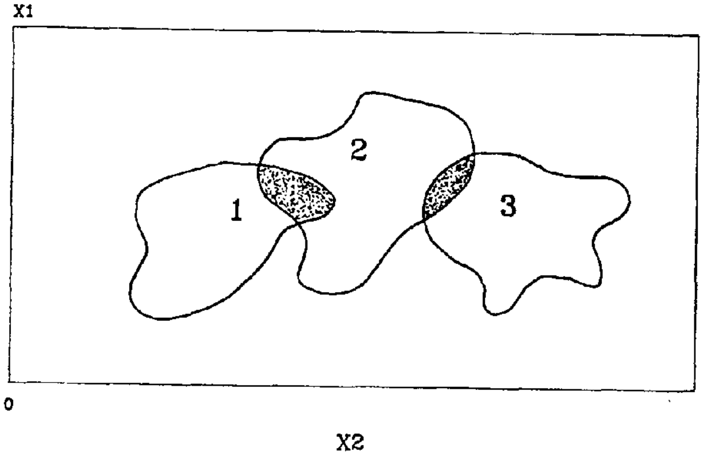

Figure 5. Group Overlap

The evaluation of the accuracy of a discriminant model (all group equations) depends on the number of correct groups that are identified by the variables in the model. In other words, each set of X1 and X2 variables were initially identified by a group (1, 2, or 3). Thus, based on the model, all sets of variables should define their initial group number. Depending on these variables' variations and their true relationship with their group indication, however, they may not define their initial group.

Shown in figure 6 is a classification matrix that the discriminant analysis procedure produces. The column labeled GROUP identifies the initial group that the variables were in. The EXPECTED GROUP column indicates the groups in the model. Lastly, the NUMBER column indicates the groups which the variables defined. To determine the accuracy of the model, the percentage of correctly identified groups is calculated. From this matrix, the percentage is 62.5% (15/24). This percentage was hampered primarily by the poor results in Group 1, thus, additional variables may need to be entered into the model to better define this group and improve the accuracy of the model.

GROUP	EXPECTED GRP	NUMBER
1	1	1
1	2	5
1	3	1
		TOTAL = 7
2	1	2
2	2	13
2	3	0
		TOTAL = 15
3	1	0
3	2	1
3	3	1
		TOTAL = 2

Figure 6. Classification Matrix

For additional information on discriminant analysis refer to the following reference:

Nordcliff, G.B. Inferential Statistics for Geographers: An Introduction. 2nd Ed. Hutchinson & Co. Ltd., London, 1982.

Appendix C

Prioritizing Hazardous Sites

The following example demonstrates the pedestrian/vehicle accident prediction model when used for prioritizing hazardous sites to determine an order for remedial treatment.

The models used in this application are presented below. These models were developed from a hypothetical city's data base using discriminant analysis.

$$\begin{aligned} \text{Group 1} &= 0.0023P - 0.0047V + 0.0943C + 1.6625L - 9.4869 \\ \text{Group 2} &= 0.0058P - 0.0065V + 0.1365C + 2.0950L - 14.0488 \\ \text{Group 3} &= 0.0155P - 0.0082V + 0.1702C + 2.4968L - 27.3187 \end{aligned}$$

where:

Group 1 = 2 and 3 accidents (3-year)
Group 2 = 4 and 5 accidents (3-year)
Group 3 = 6 and 7 accidents (3-year)
P = pedestrian volume
V = vehicle volume
C = conflicts
L = number of lanes

Five intersections with the following characteristics are being evaluated.

Intersection	3-year Accidents	Number of Lanes	Volumes		Conflicts
			Pedestrian	Vehicle	
1	3	16	256	989	24
2	3	17	167	1034	36
3	3	20	224	1234	18
4	3	15	356	867	46
5	3	17	247	1097	32

The volumes were projected using third year pedestrian and vehicle trip generation rates. Shown below are the projected conditions for the five intersections. The projected conflicts were calculated by using the present conflict counts and the existing and projected pedestrian-vehicle volume product. For example:

$$\text{Projected Conflicts} = \frac{24}{256 \cdot 989} \cdot (478 \cdot 1456) = 66$$

Intersection	Number of Lanes	Volumes Pedestrian	Volumes Vehicle	Conflicts
1	18	478	1456	66
2	17	302	1879	118
3	20	476	1867	58
4	15	578	1067	92
5	21	489	1289	74

Substituting the third-year projected variables into the three models results in the following:

Intersection	Group 1	Group 2	Group 3
1	20.9155	25.9911	24.3221
2	21.7950	27.2681	24.5354
3	21.5402	26.3939	24.5355
4	20.4326	26.3528	25.9866
5	27.5117	34.5839	34.7935

The largest group value determines the group in which the site best fits. Thus, intersections 1 through 4 fall into Group 2 while intersection 5 is in Group 3. Based on these results, intersection 5 should be treated first since the projected accidents are 6 and 7 while the other intersections have a lesser potential of 4 to 5 accidents over the next 3 years.

Appendix D

Evaluation of an Implemented Countermeasure

The following example demonstrates the pedestrian/vehicle accident prediction model for use in evaluating an implemented safety countermeasure. The safety countermeasure is a pedestrian signal installed at a 4-way intersection.

The models used in the application are presented below. These models were developed from a hypothetical city's data base.

$$\text{Group 1} = 0.0023P - 0.0047V + 0.0943C + 1.6625L - 9.4869$$
$$\text{Group 2} = 0.0058P - 0.0065V + 0.1365C + 2.0950L - 14.0488$$
$$\text{Group 3} = 0.0155P - 0.0082V + 0.1702C + 2.4968L - 27.3187$$

where:

Group 1 = 2 and 3 accidents (3-year)
Group 2 = 4 and 5 accidents (3-year)
Group 3 = 6 and 7 accidents (3-year)
P = pedestrian volume
V = vehicle volume
C = conflicts
L = number of lanes

The existing intersection conditions are:

3-year Accidents	Number of Lanes	Volumes Pedestrian	Volumes Vehicle	Conflicts
5	15	324	2468	50

After installing the pedestrian signal and allowing time for the pedestrian population to adjust to the new situation, a conflict count of 5 was observed. From third-year trip generation rates, the pedestrian and vehicle volumes were projected to be 398 and 3678, respectively. Using the existing and projected pedestrian-vehicle volume product and the conflict count of 5, the conflicts that would exist in the third year were calculated.

$$\text{Projected Conflicts} = \frac{5}{324 \cdot 2468} \cdot (398 \times 3678) = 9$$

The projected volumes and conflicts and the number of lanes were substituted into the three group model with the results shown on the next page. The largest value determines the group in which the intersection best fits, or Group 1.

Group 1	Group 2	Group 3
-0.05744	-2.95948	-12.2994

Since Group 1 encompassed 2 and 3 accidents, this intersection has the potential for this number of accidents over the next 3 years with this pedestrian signal installed. When compared to the past 3-year accident history, this countermeasure will reduce the number of accidents by 2 or 3.

For a more realistic comparison, the projected 3-year accidents were calculated without the pedestrian signal implementation, and using the projected volumes, the third year conflicts were computed.

$$\text{Projected Conflicts} = \frac{50}{324 \cdot 2468} \cdot (398 \times 3678) = 92$$

Substituting the variables into the group functions produced the following results.

Group 1	Group 2	Group 3
7.71090	8.28526	1.72151

Based on these results, if the pedestrian signal had not been implemented, the 3-year projected accidents would have been 4 and 5. Therefore, by installing this countermeasure, pedestrian accidents may be reduced by as many as three accidents over the next 3 years.