U.S. Department of Transportation
Office of the Secretary of Transportation

# Evaluation Workbook for Public Safety Managers



Reprinted
September 1982

TECHNOLOGY SHARING REPRINT SERIES

Prepared for

Virginia Commonwealth University

# EVALUATION WORKBOOK FOR PUBLIC SAFETY MANAGERS

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Printed in the United States of America

# EVALUATION WORKBOOK FOR PUBLIC SAFETY MANAGERS

By

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and

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## INTRODUCTION

This evaluation workbook is intended for individuals responsible for planning and managing highway safety programs. In this age with millions of dollars being spent each year on highway safety improvement programs, the highway safety manager is faced with increasingly more complex budgetary and program development decisions. In order to be an effective and efficient manager, a number of systematic milestones must be met. First, the manager must develop a clear understanding of personal and organizational goals with relationship to highway safety. These goals should eventually focus on a reduction in the number and severity of motor vehicle accidents. Second, there must be a process of problem identification through which motor vehicle accidents are analyzed and over-represented elements are isolated. Once this is accomplished the third milestone is to develop a plan or strategy to solve the problem. This plan should result in countermeasures designed to impact the problems identified.

Selecting an appropriate countermeasure depends upon the characteristics of the accident problem, and is made easier when the manager has a knowledge of countermeasures that have been successful in the past. This knowledge, however, must not be derived from what "seemed to work" in the past, but rather from documented evidence of impact. Evidence of impact is gained from the last milestone that must be met by the highway safety manager--a systematic evaluation of countermeasure impact. This last milestone is the culmination of the preceeding milestones, and when impact has been statistically demonstrated the manager has reached his goal of reducing the number and severity of motor vehicle accidents.

Statistically demonstrating impact also documents a proven countermeasure. Equipped with proven countermeasures the manager can better justify future resource allocations, better prepare and manage highway safety grants and more accurately develop and execute highway safety programs.

Demonstrating the impact of a highway safety program is not an easy task. As a result, program managers and planners nationwide have had difficulty evaluating countermeasure impact. One reason appears to be directly related to the complexity of the problem itself. The various facets of the highway safety problem occur in a extremeley complicated and changing setting. Consequently, to measure impact, the program manager or planner must first quantify (count) and normalize (mathematically make comparable) data on a wide variety of variables. Often impact evaluation stops here because data is either not available, is inaccurate or because of a lack of understanding of evaluation concepts and mathematical procedures.

Of all the milestones or tasks to be met by the effective and efficient highway safety manager, evaluating impact is the most difficult. For this reason an evaluation worksheet (see p. 11) has been developed. It provides the manager with an easy to understand, yet sophisticated mathematical procedure for evaluating highway safety programs. The worksheet process results in a prediction, based on previous years of accident experience, of future accidents expected within the jurisdiction. The actual accident experience can then be compared to the predicted values to yield an indication of countermeasure impact.

Read the following narrative describing the process to be used and the data necessary to complete this process. You may feel overwhelmed by what seems to be a great deal of work that must be accomplished before the worksheet can be completed. Don't be discouraged, data collection is not difficult--only time consuming; and in agencies where previous years of accident data are easily retrievable, time actually is not a factor.

## HOW PREDICTIONS ARE MADE

Before any highway safety project can be evaluated, an accurate prediction must be made to determine what the accident frequencies would have been if no improvement project has been implemented. Once the highway safety manager knows what to expect under normal circumstances with regard to accident frequencies at a particular location, he then has a standard against which to compare the actual accident frequencies. Actual accident frequencies are those accidents that are occurring during and/or at the conclusion of the highway safety project. These accident frequencies can be obtained through the normal record keeping process.

Arriving at a predicted value against which to compare the actual value is much more difficult. Because of this difficulty it is rarely done, and as a result most impact evaluations only reflect actual accident frequencies. This evaluation worksheet has been designed to minimize the difficulty of predicting accident frequencies. Its basis is a statistical process known as simple linear regression. Applying this statistical process has been simplified by the worksheet through the elimination of all statistical notation and replacing it with common terms such as <u>sum</u> and <u>average</u>. The worksheet is designed in a step-by-step format and involves nine pages of simple fill-in-the-box narrative and instructions.

The statistical process of linear regression analyzes the relationship between variables. The variables involved in this worksheet are <u>motor vehicle accidents</u> and <u>time.</u> By applying linear regression one can predict the change in the number of accidents given a change in time. This is achieved by an analysis of the variations in previous years accident data. Using data to work through the worksheet provides the evaluator with a predicted value for accidents. Comparing this predicted value with the actual value observed after a highway safety project has been implemented will provide the user with insight into the effectiveness of the project.

## HOW TO USE THE WORKSHEET

Before the worksheet can be employed the evaluator must address the following issues:

- site selection
- variable selection
- data collection

## Site Selection

If the worksheet is to be used for evaluative purposes the site selected should be the location where a particular highway safety project has been focused. It may be the goal of the highway safety project to have generalized city-wide impact. If this is the case then the entire city would constitute the test site. If, however, the goal is to reduce accidents at a particular intersection, then this intersection should be the site selected for the analysis. The choice of site is dependant upon the intent of the highway safety project.

## Variable Selection

The worksheet incorporates the use of two variables (time and motor vehicle accidents). The time variable simply involves gathering data for the last six consecutive years.

The motor vehicle accident variable or impact variable is dependent upon the intent of the highway safety project. For example: if the objective of the project is to reduce the number of alcohol related accidents at a particular location then alcohol related accidents should be the impact variable selected for study. Likewise, if the project is targeted at reducing the number of pedestrian accidents in a section of a city then pedestrian accidents should be the impact variable selected. Once the impact variable has been determined then data can be collected for the previous six consecutive years relating to that variable and site.

Data Collection

Select the best data available concerning the impact variable. The best data for use with this worksheet are serious accidents (fatal accidents plus personal injury accidents) expressed in the form of rates.

Transforming raw accident data into rates is achieved by dividing the accident totals (F+PI) for each year by an exposure value for that year (F+PI)/EXPOSURE. Exposure is a term used to describe the extent to which vehicles use the highways. Various kinds of exposure data are: average daily traffic (ADT), total miles driven, licensed drivers and registered vehicles. The recommended exposure values to use in calculating rates for the worksheet are ADT and/or total miles driven. ADT is the best for an analysis of a particular location (intersection or section of roadway) and total miles driven is generally best for city, county or statewide analysis. These exposure values can generally be obtained from the city or county engineer's office and/or State Department of Highways and Transportation.

The evaluator must determine how the rate is to be expressed. Statewide accident rates are usually expressed in terms of accidents per 100 million miles traveled. If a city experienced 3245 serious accidents (fatal plus personal injury accidents) in a particular year and the total miles driven during that year was 785 million miles, then the accident rate for that state in that year would be 413.376. This translates into 413.376 serious accidents for every 100 million miles traveled. To arrive at this rate divide 3245 by 7.85 (3245/7.85=413.376). The number 7.85 was used because the rate is to be expressed in terms of accidents per 100 million miles. There are 7.85 x 100 million in 785 million, or 785 million/100 million=7.85.

Expressing statewide rates in accidents per 100 million miles traveled is generally the practice. This is the case because of the large number of miles usually driven in a state during any particular year. The 785 million miles used in this example is much lower than what would generally be experienced.

If the evaluator is analyzing a particular location and using ADT as the exposure value, then the rate will be expressed in slightly smaller values. This rate should be expressed in accidents per 1 million vehicles. However, the evaluator can express the rate in whatever increments that best fit the analysis. REMEMBER, when calculating rates from one year to the next, express those rates the same way each time.

Calculating rates using ADT is performed in much the same way as with total miles traveled. If a particular location has experienced 54 serious accidents in one year and the average daily traffic count (ADT) for that location is 12,300 vehicles then the accident rate for that location that year would be 12.028 (12.028 serious accidents per 1 million vehicles). To arrive at this rate, divide 54 by 4.4895 (54/4.4895=12.028). The number 4.4895 was determined through a two step process. The first step is to convert the average daily traffic count (ADT) of 12,300 vehicles to a yearly number. To do this, multiply 12,300 vehicles x 365 days which equals 4,489,500 vehicles. There were approximately 4,489,500 vehicles that used this particular location in the year the ADT was made. The next step is to divide the yearly traffic count by 1 million so that the rate can be expressed in accidents per 1 million vehicles (4,489,500/1,000,000=4.4895). There are 4.4895 x 1,000,000 in 4,489,500.

Expressing the accident data in rates allows for a more reliable comparison from one year to the next. For example: if location "X" experienced 32 serious accidents in 1975 and then in 1976 only experienced 25 serious accidents, it would appear that the accident problem at that location had lessened from 1975 to 1976. By calculating rates the evaluator can determine more precisely if this is the case. During 1975 the location being studied has an ADT of 24,500 vehicles or 8,942,500 vehicles per year. With 32 serious accidents that calculates to a 1975 rate of 3.578 serious accidents per 1 million vehicles. But in 1976, because of the opening of a new section of interstate highway, the ADT was reduced to 11,800 vehicles or 4,307,000 vehicles per year. With 25 serious accidents this calculated to a 1976 rate of 5.805 serious accidents per 1 million vehicles. Comparing the two rates (3.578 in 1975 and 5.805 in 1976) it seems that not only did the problem <u>not</u> lessen, but in fact it increased. Expressing accidents in terms of rates is a valuable tool in accident analysis and evaluation.

When gathering data for use with the worksheet include the previous six consecutive years of data and for best results convert the accident frequencies into rates as described above. The worksheet can be made to work with raw accident frequencies, but the results are not as precise as with rate data.

<u>REMEMBER TO BE CONSISTENT</u>. If ADT is used as the exposure value, use ADT throughout the analysis. If the rate is expressed as accidents per 1 million vehicles, then this should be the increment throughout the analysis. Do not mix accident rates with accident frequencies on the worksheet. If the consistency rule is violated, then the results of the analysis will be meaningless.

Once the site for analysis has been selected, the variables indentified and data gathered and normalized, follow the steps outlined on the worksheet to obtain the results of the project.

PRECAUTIONS

- The accident frequencies used in any analysis or rate calculation should reflect the number of fatal or personal injury accidents, NOT the number of fatalities (people killed) or personal injuries (people injured). These latter figures are not consistent and vary due to chance.
- If accident frequencies are used without normalization (calculating rates), then the results of the evaluation are less reliable.
- When calculating rates BE CONSISTENT from one year to the next.
- When calculating rates avoid rounding. If it is felt rounding is necessary, then round three places to the right of the decimal place. For example: 1.376943 should be rounded off the 1.377. BE CONSISTENT.
- If rates are used in the worksheet, it may be desirable when completing the Prediction/Impact Summary Sheet to convert back to accident frequencies. Do this by reversing the rate calculation process and using the exposure for the evaluation year. To illustrate, consider the example above: with an ADT of 12,300 vehicles (4,489,500 per year) and an accident rate of 12.028 accidents per 1 million vehicles, convert this rate to an accident frequency by multiplying 12.028 (rate) X 4.4895 (exposure value) to obtain the result of 53.999, or 54 accidents.
- If possible use a calculator when completing the worksheet. Always check the calculations.
- Before claiming success or failure of a project be sure to consider other variables that may have influenced accidents.

For example: a project site may have experienced an unusual amount of construction, the opening of a shopping mall, and/or a change in the geometrics of the roadway during the project period. These factors must be considered when evaluating the results of a project and should be documented on the Prediction/Impact Summary Sheet.

- The prediction worksheet is constructed with a confidence level of 80%. In other words, if it is determined that the project did reduce the number of accidents, the evaluator can only be 80% sure that this reduction is significant.

PREDICTION/IMPACT SUMMARY SHEET

A summary sheet has been provided (see appendix) for the evaluator to record the results of the evaluation. This summary sheet should become permanent documentation of the project success or failure. It should be incorporated with the project final report and filed within the safety agency and, where applicable, submitted to the appropriate funding agency.

It is recommended that when recording the project objectives on the summary sheet that a clear concise statement be made concerning the countermeasure employed. A record of successful countermeasures may prove to be helpful for future highway safety projects.

The summary sheet includes space to permanently record the data used for the prediction and a prediction graph to pictorially display the accident trend for the past years, as well as the predicted values for the project year. The summary sheet also provides space for concluding statements concerning the project. It is in this space that the evaluator should discuss the success or failure of the project and document the presence of other variables that may have influenced the results of the evaluation.

## PREDICTION WORKSHEET

STEP 1: SELECT THE BEST DATA AVAILABLE:

a) BEST: = Serious Accidents/Exposure --- or "rates"

b) 2nd BEST = Serious Accident Frequencies

c) Fill out Column (4) of the Table below with accident data for all years indicated; or, data for at least the last six years prior to the year for which the prediction is to be made!!!

d) Go to STEP 2

| | write number "1" beside the first year used: write # "2" beside the second year--do this for all years used. | subtract average of Column (1) from each numberin Column (1) | multiply each number in Column (2) by itself | write accident data for each year used | subtract average of Column (4) from each numberin Column (4) | multiply each number in Column (5) by itself | multiply each number in Column (2) by the numberin Column (5) |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1975 | | | | | | | |
| 1976 | | | | | | | |
| 1977 | | | | | | | |
| 1978 | | | | | | | |
| 1979 | | | | | | | |
| 1980 | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| SUM | 3 | | 5 | 6 | | 8 | 9 |
| AVERAGE | 4 | | | 7 | | | |

STEP 2: CONSTRUCT THE PREDICTION GRAPH:

a) write the highest year's rate or number of accidents here and on line 8 of the graph below

b) multiply times .50 and write the answer in box [1] and on line 1 of the graph below

_____ x .50 = [1]

c) divide the number in box [1] by 7 and write in box [2]

_____ ÷ 7 = [2]

d) now, add the number from box [2] to the number on line 1 and write the sum on line 2 -- add the number from box [2] to the sum on line 2 and write the answer on line 3 -- continue adding the number from box [2] to each line until all the lines are filled.

(11) _____

(10) _____

(9) _____

(8) _____

(7) _____

(6) _____

(5) _____

(4) _____

(3) _____

(2) _____

(1) _____

_____ 0

19__ 19__ 19__ 19__ 19__ 19__ 19__ 19__ 19__ 19__

STEP 3: PLOT ON PREDICTION GRAPH:

a) plot each year's accident data from Column (4) on the graph by making a dot ( • ) straight above that year

******************************************************

STEP 4: COMPLETE THE CHART IN STEP 1: Follow the instructions at the top of each Column

******************************************************

a) ADD Column (1) and write the SUM in box [3] at the bottom

b) calculate the AVERAGE for Column (1) and write in box [4]

(AVERAGE = SUM OF COLUMN ÷ NUMBER OF THINGS ADDED) Example: 77.5 = 465 ÷ 6

c) do Column (2) , then (3) , then (4) , and so on until all seven are completed

-- be sure to calculate the SUM and AVERAGE for each Column, IF space has been provided

****************************************************************************************

STEP 5: CALCULATE STANDARD DEVIATIONS:

a) write the number from box [5] here → ______ ÷ ______ = [10]

b) count the number of years in Column (1) and subtract 1 -- write the answer here

c) now, divide and write the answer in box [10]

d) use an electronic calculator (√ button) and find the square root of (this) number

e) write the square root (√ ) in box [11]

$SD_x$ = [11]

f) write the number from box [8] here ______ ÷ ______ = [12]

g) count the number of years of accident data in Column (1) and subract 1 --write answer here

h) now, divide and write the answer in box [12]

i) use an electronic calculator (√ button) and find the square root of (this) number

j) write the square root (√) in box [13]

$SD_y$ = [13]

STEP 6: COMPUTE THE PREDICTION FORMULA:

a) compute the SLOPE

1. write the SUM from box [9] here ______ ÷ ______ = [14]

2. write the SUM from box [5] here

3. divide and write the answer (the SLOPE) in box [14]

b) compute the INTERCEPT

1. write the SLOPE from box [14] here ______ X ______ = [15]

2. write the AVERAGE in box [4] here

3. now, multiply and write the answer in box [15]

4. write the AVERAGE in box [7] here and number from box [15] here

______ − ______ = [16]

5. *subtract and write answer in box [16], this is the INTERCEPT

* NOTE: If the number from box [7] is smaller than the number from box [15] the result will be a "negative" (-) number

STEP 7: TRY YOUR PREDICTION FORMULA:

NOTE: A minus (-) sign on the number from box 16 changes this plus (+) to a minus (-)!!!

a) write the SLOPE from box [14] here

_______ X _______ + _______ = [17] [          ]

b) write the number of the year you want to predict accidents for here (i.e., year "6", or "7", etc.)

c) write the INTERCEPT from box [16] here

d) now, multiply the first two numbers -- then add the last number to that answer; write your predicted number (accidents or accident rates) in box [17]

NOTE: The number in box [17] is your PREDICTED number of accidents, or rate for the year you have entered into the formula. If you started with rates you must now reverse the process by which they were estimated to get raw frequencies.

STEP 8: DETERMINE THE STRENGTH OF YOUR PREDICTION:

a) write the numbers from boxes [11] [13] & [14] here

( _____ ÷ _____ ) X _____ = [18]

b) divide inside the ( ), then multiply the answer times the SLOPE from box 14
(your answer is called a CORRELATION COEFFICIENT or "r")

c) write the answer in box [18]

d) write the number from box [18] in these two places

_____ X _____ = [19]

e) multiply and write your answer in box [19]

NOTE: IF the number you get in box 19 is equal to, or larger than .80 this prediction formula IS appropriate for your community's analysis of this accident data. IF it IS equal to, or larger than .80, go on to STEP 9; IF it IS smaller than .80 another method is needed to analyze your community's accident data.

## STEP 9: CALCULATE THE RANGE OF NORMAL ACCIDENTS:

a) write the number of years used in Column (1) in these two places

_______ − 1 = [20]

_______ − 2 = [21]

b) subtract as indicated and write answers in boxes [20] & [21]

c) write numbers from boxes [20] and [21] here

_______ ÷ _______ = [22]

d) divide and write answer in box [22]

e) write number from box [14] in these two places

_______ X _______ = [23]

f) multiply as shown and write answer in box [23]

g) write number from boxes [10] and [23] here

_______ X _______ = [24]

h) multiply and write answer in box [24]

i) write numbers from boxes [12] and [24] here

_______ − _______ = [25]

j) subtract and write answer in box [25]

k) write numbers from boxes [22] and [25] here

_______ X _______ = [26]

l) multiply and write answer in box [26]

m) using electronic calculator (√ button) find the square root of the number in box [26] and write in box [27]

[27]

n) write the number of the year to be predicted here -- i.e., year "6" or "7", etc.

o) write the number from box [4] here

p) subtract and write the answer in box [28]

________ − ________ = [28]

q) write the number in box [28] in these two places

________ × ________ = [29]

r) multiply and write the answer in box [29]

s) write the numbers from boxes [29] and [5] here --divide and write answer in box 30

________ ÷ ________ = [30]

t) write the number of years used in Column (4) here

1 ÷ ________ = [31]

u) divide and write answer in box [31]

v) write the number from box [31] here

1 + ________ + ________ = [32]

w) write the number from box [30] here

x) add as indicated and write the answer in box [32]

y) use an electronic calculator ($\sqrt{\ }$ button) and find the square root of the the number in box [32] -- write the answer in box [33]

[33]

z) now, find the number from box [21] here and underline the number (here) to its right

| | |
|---|---|
| 1 | 1.376 |
| 2 | 1.061 |
| 3 | .978 |
| 4 | .941 |
| 5 | .920 |
| 6 | .906 |
| 7 | .896 |
| 8 | .889 |
| 9 | .883 |
| 10 | .879 |

$\alpha$ .20 one-tailed "t"
$\alpha$ .40 two-tailed "t"

aa) write the three or four digit number from this column in box [34]

[34] ______

bb) write the numbers from boxes [33] , [34] and [27]

______ X ______ X ______ = [35] ______

cc) multiply and write the answer in box [35]

dd) write the numbers from these boxes as indicated

box [35] box [17]

______ + ______ = [36] ______

______ – ______ = [37] ______

ee) add and subtract as indicated and
write the answers in boxes [36] and [37]

NOW, Write the number from box [17] here ______________
-- this is the BEST prediction possible
with this data of future accident experience!!!

Write the numbers from boxes [36] and [37] here ________ TO ________
-- this is the range within which accidents can be expected,
or within which they may vary

PLOT THESE EXPECTED VALUES ON THE IMPACT SUMMARY SHEET AND ON THE PREDICTION GRAPH (PAGE 12)

APPENDIX A

# Prediction/Impact Summary Sheet

## PREDICTION/IMPACT SUMMARY SHEET

DATE ____________________

SITE ____________________________________________________________

PROJECT TITLE ____________________________________________________

PROJECT OBJECTIVES _______________________________________________

__________________________________________________________________

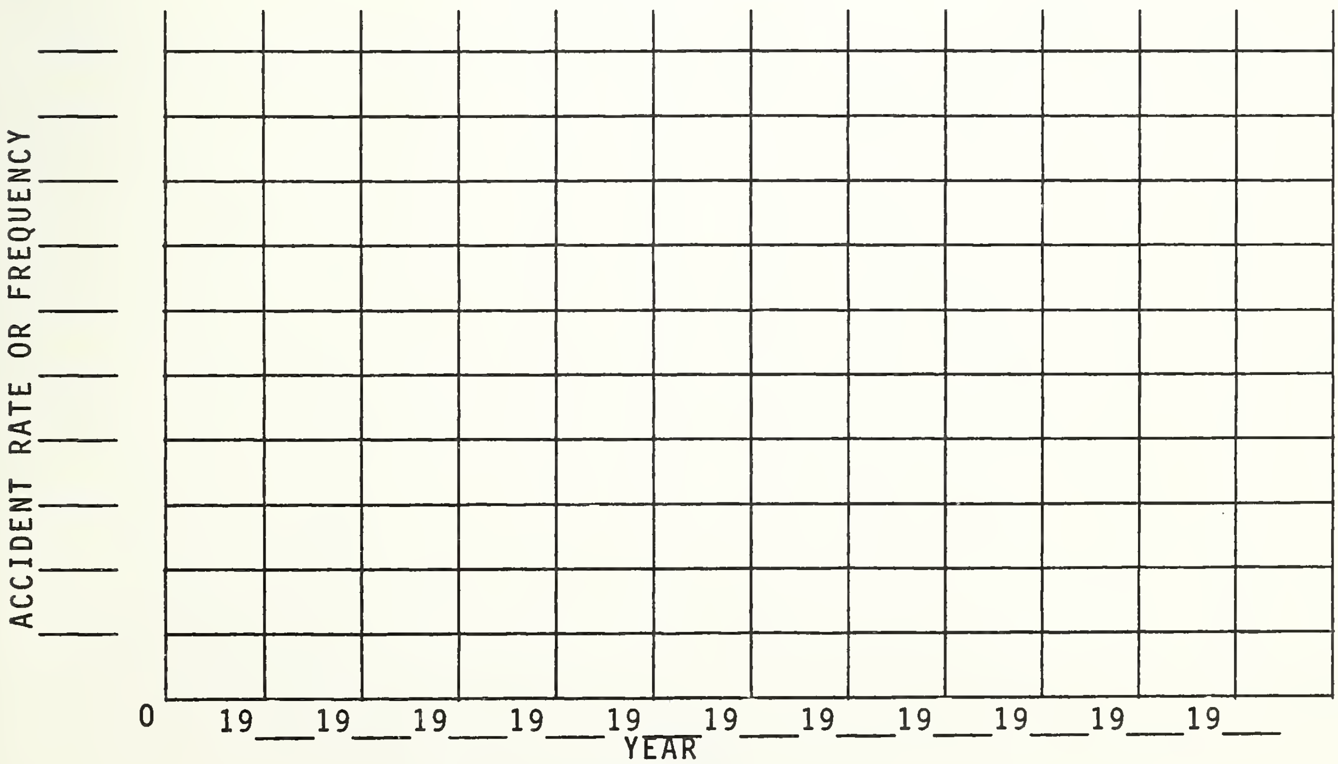
__________________________________________________________________

__________________________________________________________________

### DATA USED FOR PREDICTION

| YEAR | IMPACT VARIABLE FREQ. | | | EXPOSURE | RATE |
|---|---|---|---|---|---|
| ////////// | F | PI | TOTAL | //////////////// | //////////////// |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

### PREDICTION GRAPH



PREDICTED NUMBER OF ACCIDENTS FOR YEAR EVALUATED__________________

NORMAL RANGE OF PREDICTION: ________ACCIDENTS-TO-________ACCIDENTS

ACTUAL NUMBER OF ACCIDENTS FOR YEAR EVALUATED_____________________

THE DIFFERENCE BETWEEN THE NUMBER OF ACTUAL ACCIDENTS OBSERVED AND THE NORMAL RANGE PREDICTED ( + OR - ) ____________________________

CONCLUDING STATEMENT______________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

EVALUATOR'S NAME__________________________________________________

# APPENDIX B

## Software Package for TRS-80 Microcomputer

(Model I or III, Level 2, 16K)

# BASIC LINEAR REGRESSION

This program was written by Mike McDonald and Bob Breitenbach, at Virginia Commonwealth University. It uses basic linear regression to enable you to "predict" future accidents, crime rates -- or other type of occurence in your community. To run this program you must enter at least six years of data, for time periods equal to that for which you wish to make a prediction.

The program is written in Radio Shack Level II BASIC and requires 16K (RAM) memory to run -- especially if you wish to modify it to run correlations on large sets of data. (By removing line 452 you can compute a Correlation Coefficient (r) and a Coefficient of Determination ($r^2$) for up to 100 sets of matched data -- line 452 must be removed to allow data sets with $r^2 < .80$ to run!)

The program produces: 1) a best possible prediction; 2) a confidence band -- or high and low prediction ( $\alpha$ = .20, one-tailed "t"); 3) a correlation coefficient, "r"; 3) a coefficient of determination, "$r^2$"; and 4) a "WARNING" if data are not suitable for this method of analysis (are not linear).

```
3 DIM X(100):DIMY(100):DIMC(100):DIMD(100):DIMH(100):DIMI(100):D
IML(100):DIMV(100):DIMFL(100)
10 CLS
11 REM *** COPYRIGHT 1982 BY R.M. MCDONALD & R.J. BREITENBACH **
*
13 REM ** X(P) = VALUE OF EACH TIME PERIOD USED; A = SUM OF X'S;
B = AVG. OF X'S; C(P) = DEVIATION SCORES FOR X;D(P) = DEVIATIONS
CORES FOR X SQUARED***
14 REM ** E = SUM OF C(P)'S; Y(P) = VALUE FOR EACH ACCIDENT PERI
OD; F = SUM OF Y(P)'S; G= AVG. OF Y(P)'S; H(P) = Y DEV. SCORES
15 REM *** I(P) = Y DEV. SCORES SQUARED; J= SUM OF Y DEV'S;L(P)
= XY DEVIATION SCORE CROSSPRODUCTS; M = SUM OF XY CROSSPRODUCTS
***
20 PRINT @133,"THIS PROGRAM USES RECORDS DATA FROM PAST TIME"
22 PRINT"     PERIODS WITHIN YOUR COMMUNITY TO PREDICT THE NUMBE
R"
24 PRINT"     OR RATE OF FUTURE OCCURRENCE(S)."
42 PRINT:PRINT "      TO USE THIS FORMULA YOU MUST ENTER ACCURATE
"
43 PRINT "      DATA OR RATES FOR AT LEAST 6 PAST TIME PERIODS EQ
UAL "
44 PRINT "      TO THAT FOR WHICH YOU WISH TO MAKE A PREDICTION."
45 PRINT @916,"PRESS ANY KEY TO CONTINUE"
47 IF INKEY$="" THEN 47
50 CLS:PRINT:PRINT
100 PRINT "      ENTER THE NUMBER OF TIME PERIODS (YEARS,"
110 PRINT "      QUARTERS, MONTHS, ETC.) OF DATA TO BE USED"
120 INPUT"     IN THIS ANALYSIS:
  ";N
127 IF N<6 OR N>100 THEN GOTO 1800
131 CLS:PRINT:PRINT
132 PRINT "      ENTER THE NUMBER (1,2 ETC.) OR YEAR (1977, 1978
ETC.)"
133 PRINT "      FOR EACH TIME PERIOD TO BE USED: "
134 PRINT
135 FOR P=1TON:PRINT "      PERIOD/YEAR "P" = ";:INPUT X(P)
137 A = X(P) + A:B=A/N
138 NEXT P
```

```
139 CLS:PRINT:PRINT
140 PRINT "      ENTER THE NUMBER OF FUTURE TIME PERIODS"
150 PRINT "      FOR WHICH YOU WISH TO MAKE A PREDICTION: ";
160 INPUT "      ";R
166 CLS:PRINT:PRINT
168 PRINT"     ENTER RECORDS DATA (ACCIDENT RATE, CRIME RATE, ET
C.)"
170 PRINT
180 FOR P = 1 TO N
181 PRINT "      FOR PAST PERIOD ";X(P);
190 INPUT "      ";Y(P)
200 F = Y(P) + F
205 G = F/N
210 NEXT P
215 CLS
220 FOR P=1TON
230 C(P) = X(P) - B
240 D(P) = C(P)*C(P)
250 E = D(P) + E
260 NEXT P
280 FOR P = 1 TO N
285 H(P) = Y(P) - G
290 I(P) = H(P)*H(P)
295 J = I(P) + J
300 L(P) = C(P) * H(P)
310 M = L(P) + M
315 NEXT P
349 REM *** S = SLOPE OR 'BETA' ***
350 S=M/E
359 REM *** T = INTERCEPT ***
360 T = G - S*B
370 FOR O = 1 TO R
375 QQ = QQ + 1
380 U = X(N) + QQ
390 V(O) = S*U + T
410 NEXT O
419 REM *** W = STANDARD DEVIATION OF X ***
420 W = SQR(E/(N-1))
429 REM *** Z = STANDARD DEVIATION OF Y ***
430 Z = SQR(J/(N-1))
439 REM *** RC = CORRELATION OF X AND Y ***
440 RC = (W/Z)*S
449 REM *** RX = COEFFICIENT OF DETERMINATION OR RC[2 ***
450 RX = RC[2
452 IF RX<.80 THEN 1599
455 REM *** CONFIDENCE INTERVAL FORMULATIONS ***
470 QA = (N-1)/(N-2)
480 RA = (S*S)*E/(N-1)
490 SA = (J/(N-1))-RA
500 TA = SQR(QA*SA)
510 UA = ((X(N) + 1) - B)[2/E
520 VV = (1 + 1/N) + UA
522 VA = SQR(VV)
550 DF=N-2
552 IF DF>34 THEN DF=34
560 FOR X = 1 TO DF
570 READ K
580 NEXT X
582 RESTORE
```

```
600 DATA 1.376,1.061,.978,.941,.920,.906,.896,.889,.883,.879
610 DATA .876,.873,.870,.868,.866,.865,.863,.862,.861,.860
620 DATA.859,.858,.858,.857,.856,.856,.855,.855,.854,.854,.851
622 DATA .848,.845,.842
700 REM*** ALPHA = .20 ONE TAILED 'T'; .40 TWO TAILED 'T' ***
1500 FK = VA*K*TA
1510 FOR O = 1 TO R
1530 FL(O) = V(O)+FK
1540 FM(O) = V(O)-FK
1541 PP = PP + 1
1542 II = X(N) + PP
1545 PRINT
1550 PRINT TAB(5);"BEST ESTIMATE FOR";II;TAB(30);"LOW ESTIMATE";
TAB(50);"HIGH ESTIMATE"
1570 PRINT TAB(10);V(O);TAB(32);FM(O);TAB(52);FL(O)
1580 NEXT O
1581 GA=(V(1)-FM(1))*.25
1582 GL=FM(1)-GA:GM=V(1)-GL
1583 GP = (GM/V(1))*100
1584 PRINT:PRINT"     TO MAKE A SIGNIFICANT REDUCTION (ALPHA = .
20) WILL REQUIRE":PRINT"     THAT THE OBSERVED PROBLEM IN TIME P
ERIOD (";X(N)+1;")":PRINT"     BE HELD TO ";GL;" -- A REDUCTION
OF ";GP;"%"
1585 PRINT
1586 PRINT:PRINT "     CORRELATION = ";RC;"     RC = ";RX
1587 PRINT:PRINT
1591 PRINT "          IF YOU WISH TO MAKE ANOTHER PREDICTION PRE
SS ENTER"
1593 IF INKEY$="" THEN 1593
1594 RUN50
1595 END
1599 CLS:PRINT:PRINT:PRINT
1600 PRINT "     CAUTION: CORRELATION = ";RC;".   R2 = ";RX
1602 PRINT
1605 PRINT "     THIS MEANS THE PREDICTION IS VERY WEAK AND"
1610 PRINT "     SHOULD 'NOT' BE USED!!!!!!"
1612 FOR X = 1 TO 200:NEXT X:CLS:     FOR X = 1 TO 50:NEXT X:VD
=VD+1:IFVD=10 THEN 1700 ELSE 1599
1640 GOTO 1640
1700 RUN50
1705 END
1800 CLS:PRINT:PRINT:PRINT"     NUMBER OF PAST TIME PERIODS USED
 TO MAKE PREDICTION"
1805 PRINT"     MUST BE AT LEAST 6 --- BUT NOT MORE THAN 100"
1810 PRINT:PRINT:PRINT"               PRESS ANY KEY TO CONTINU
E"
1825 IF INKEY$=""THEN 1825
1826 RUN50
```



* U. S. GOVERNMENT PRINTING OFFICE 1982 381-428/2316

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DOT-I-82-41

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