AN EVALUATION OF METHODS FOR IDENTIFYING HAZARDOUS HIGHWAY LOCATIONS

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Abstract: The identification of hazardous highway locations is an important first step for highway safety improvement. Many techniques have been applied to determine the worst locations [Brown in 1992, Zegeer in 1982 and Gharaybeh in 1991]. These techniques include the accident frequency method, accident rate method, accident severity method, rate quality control method, and others. The way hazardous highway locations are identified differ with each of these methods. For example, the accident frequency and accident severity methods identify hazardous highway locations based on number of accidents but the accident rate and rate quality control methods consider both accident frequency and traffic volumes. The individual strengths of each of these separate methods can limit overall accuracy of the results because of their narrow focus of each. A collection or combination of methods should be compared collectively for the most accurate results. Therefore, a combination of the results of various methods implemented in this research is introduced in order to increase the degree of accuracy of identifying hazardous highway locations. These methods were compared and evaluated in order to get the suitable method for identifying hazardous highway locations.

The results indicated that the accident frequency method is most similar to accident severity method and both methods are different from accident rate method, rate quality control method, and combination method. Furthermore, the individual methods are not suitable to be used alone to identify hazardous highway locations because the results from these individual methods are so highly dependent upon input data. The combination of the four earlier methods into a combination method appears to be more reliable in identifying hazardous highway locations because the results do not change much when some situations (i.e., changing accident data) vary.

1. METHODS FOR IDENTIFYING HAZARDOUS HIGHWAY LOCATIONS

This research compared five methods. These methods of identifying hazardous highway locations included the accident frequency, accident rate, accident severity, rate quality control and a newly developed combination method. These various methods were compared and evaluated in order to discern method idiosyncrasies and to develop a more dependable and desirable method. The hazardous highway locations were identified based on these methods. The details of these methods are reviewed as follows [Zegeer in 1982 and Gharaybeh in 1991]:

1.1 Accident Frequency Method

The accident frequency method is used to search the accident file for concentrations of accidents within a fixed or variable segment length. Usually one or more segment lengths (0.1-mile, 0.3-mile, 0.5-mile, 1-mile, 3-mile, etc.) are used to "float" through the accident file in which accidents are ordered by location, and sections that meet or exceed a predefined accident criterion are identified. Such floating segments generally advance in 0.1-mile increments through the file. When a roadway segment that meets the user-specified frequency criteria is identified, the location is printed out along with the corresponding accident information.

1.2 Accident Rate Method

The accident rate method consists of simply dividing the accident frequency at a location by the vehicle exposure to determine the number of accidents per million vehicle-miles of travel at highway segments (generally defined as 0.3-mile segments or less). Segments are priority ranked in order of descending accident rate. The accident rate for any highway segment that is currently used by the Tennessee Department of Transportation (TDOT) is calculated as follows:

$$R = A*1,000,000/(365*T*V*L) \tag{1}$$

where:

R = accident rate for highway segment (in accidents per million vehicle miles),
A = number of accidents for given analysis period,
T = time of analysis period (in years or fraction of years),
V = average annual daily traffic (AADT) during study period, and
L = length of highway segment (in miles).

1.3 Rate Quality Control Method

The rate quality control method not only entails the calculation of the accident rate at each location, but also a statistical test to determine if that rate is significantly higher than accident rates for other locations with similar characteristics. The statistical test is based on the commonly accepted assumption that accidents follow a Poisson distribution. For each location, a critical rate that is currently used by TDOT is computed as follows:

$$R_c = R_a + K(R_a/E)^{0.5} + 1/(2E) \tag{2}$$

where:

R_c = critical accident rate for highway segment (accidents per million vehicle-miles),
R_a = average accident rate for all highway segments of similar characteristics or on similar road types,
E = million vehicle-miles of travel on the highway segment during the study period = $(365*T*V*L)/1,000,000$, and
K = a probability factor determined by the desired level of significance for the equation. The values of K corresponding to 99% confidence level is 2.327.

The critical rate (R_c) is computed for each location and compared to the actual accident rate (R). If the actual accident rate exceeds the critical rate, then the location may be considered for improvement. Therefore, the highway locations are ranked based on their R/R_c ratio.

According to this method, the study area has to be divided into several groups. In this research, the interstate highways were divided into four groups based on the characteristics of roadway and regional offices that are responsible for maintaining the state highway system. These four regions are shown in Figure 1.

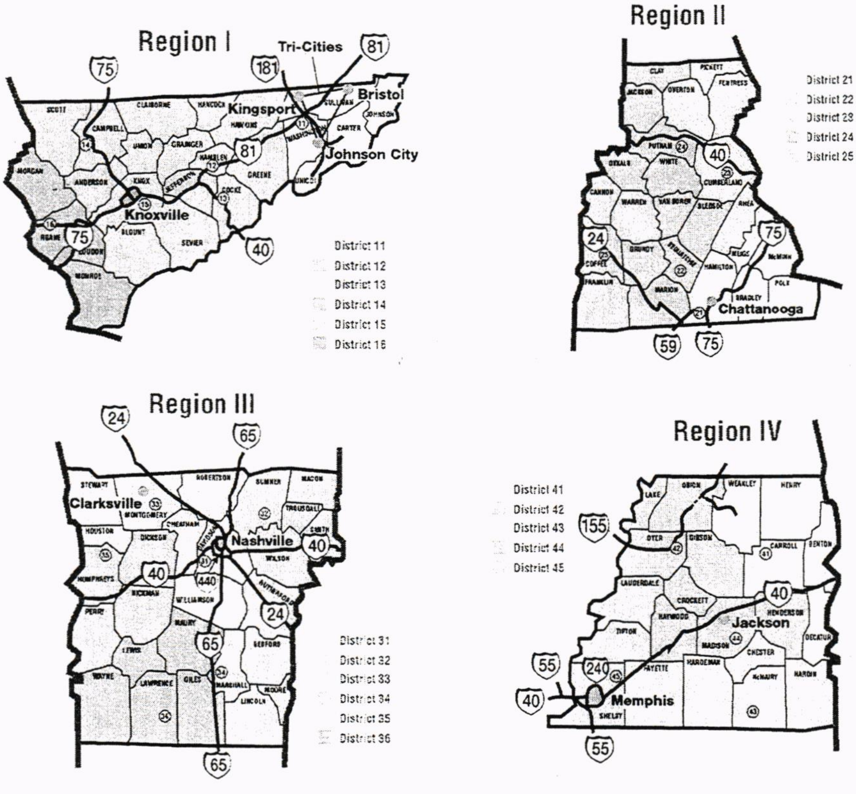


Figure 1 Four Regions of Tennessee

1.4 Accident Severity Methods

Accident severity methods are used to identify and/or rank locations based on the number of severe accidents at each location. Accident severity is defined by the National Safety Council and many states in the following categories:

- Fatal Accident,
- A-Type Injury (Incapacitation) Accident,
- B-Type Injury (Nonincapacitating) Accident,
- C-Type Injury (Probable Injury) Accident, and
- PDO (Property Damage Only) Accident

The severity index (SI) that is used to rate roadway segments in the Tennessee Department of Transportation (TDOT) is determined using the following equation:

$$SI = (F + PI) / Total\ Accidents \tag{3}$$

where:

SI = severity index,
F = number of fatal accidents during study period,
PI = number of personal injury accidents during study period, and
Total = total number of all types of accidents for this segment.

This method used by TDOT is categorized clearly as an accident severity method. High hazardous highway locations can be identified using this severity index.

1.5 Combination Methods

The major contribution of recent research was the development an improvement decision management tool. A combination method combines all four methods described previously together (or other various selected combinations), and their inherent individual strengths, in order to create a better decision-making tool for selecting hazardous highway locations. The hazardous highway locations are ranked on the basis of a newly developed Hazardous Index (HI) determined by the following equation:

$$HI = (F\_Rank + R\_Rank + S\_Rank + Q\_Rank) / 4 \tag{4}$$

where:

HI = hazardous index,
F_Rank = rank of location by accident frequency method,
R_Rank = rank of location by accident rate method,
S_Rank = rank of location by accident severity method, and
Q_Rank = rank of location by rate quality control method,

(Note: The denominator value of "4" must correspond to the number of methods whose ranks are totaled in the numerator.)

The location that has the lowest Hazardous Index will be ranked first. The location that has the next highest Hazardous Index will be second and so on.

2. ACCIDENT DATA

The latest three years of accident data from Tennessee Department of Transportation (TDOT) are used. The system has been implemented in the earlier step of the research to determine the hazardous highway locations based on these methods mentioned above. Additional required data included traffic data, interstate route data, and group of interstate routes data.

3. COMPARISON AND EVALUATION OF THE METHODS

In this research, hazardous highway locations were identified by using the four existing methods of accident frequency, accident rate, accident severity, and rate quality control and by developing a new combination method. The new, flexible system was implemented and made available to the user to identify hazardous locations based on one method alone or by combining two, three or all methods together. The user also has the flexibility to specify the number or ranking of just how many locations will be considered hazardous. The results from the different methods are compared and evaluated in the following sections.

3.1 Sensitivity Tests

There are various types of questions that may arise during analyses to identify high accident locations. One such question is "How much difference is there in identified locales as model selection varies?"

Sensitivity tests were performed to address these and other questions. The main purpose of these sensitivity tests was to study how the hazardous highway locations identified by differing methods varied as segment lengths, study areas, amounts of accident data, traffic volumes, and other variables changed. Furthermore, a number of sensitivity tests were performed to compare and study the different methods of hazardous locations identification in various situations. This section presents the comparisons of different methods in various actual situations.

3.1.1 Comparison of the Methods for Several Situations

Several methods of analysis were tested and compared to each other using actual Tennessee data. The three cases studied varied segment length, study area, and interstate route as follows:

- segment lengths = 0.1 mile, 0.2 mile, 0.3 mile, 0.5 mile, and 1.0 mile.
  In this case, the entire Tennessee interstate highway system was considered. Three years of accident data (from 1993 to 1995) were used in the analysis. The segment length used for analysis varied from 0.1 mile to 1.0 mile in order to compare methods and results across varying segment lengths.
- study areas = Davidson County, North East Tennessee (Region I), South East Tennessee (Region II), Middle Tennessee (Region III), West Tennessee (Region IV) and entire Tennessee.
  In this case, the study area varied from a single county (Davidson) to the entire state of Tennessee. Three years of accident data (from 1993 to 1995) were again analyzed. The 0.5-mile of segment length was applied consistently for analysis and the various methods were applied and the results studied and evaluated.
- individual interstate routes = I-24, I-40, I-65, and I-75.
  In this case, individual Tennessee interstate highway routes were considered. These four interstate highway routes were selected because more accidents occur on these routes. Three years of accident data and 0.5-mile of segment length were again used for these analyses.

For all cases, the highway segments ranked in the top 100 by individual methods are considered and compared. Then ranked segment lengths for each compared method were studied, and the overlapping segments (i.e., the same segments identified by separate methods) were presented. For example, in comparing the accident frequency method (F) and accident rate method (R), the program used the accident frequency method to get the highway segments ranked in the top 100. Then the program was run using the accident rate method to get the highway segments ranked in the top 100. Comparing these two lists of the top 100 shows 42 segments that are the same if a 0.1 mile segment is used. Then 42 was entered in Figure 2. The number of the same (overlapped) segments tends to indicate the degree of difference (or similarity) of the compared methods. The compared methods that have a high number of overlapped segments indicate the methods are essentially identifying the same hazardous locations. The results presented in Figure 2 through Figure 4 indicate trends visually.

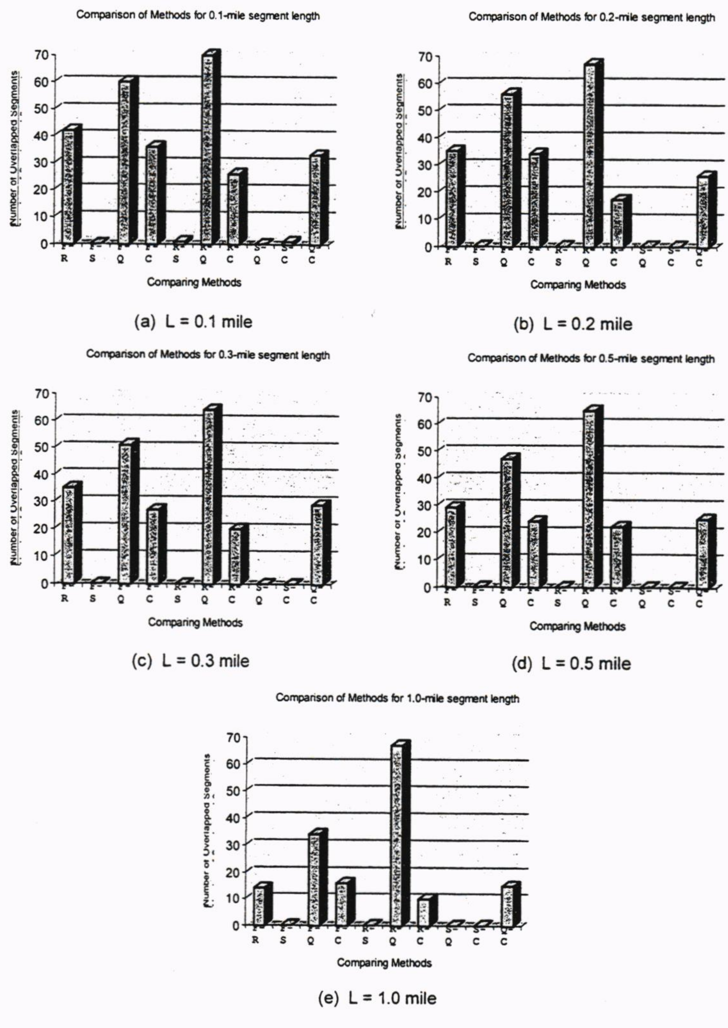


Figure 2 Comparison of Methods for Several Segment Lengths

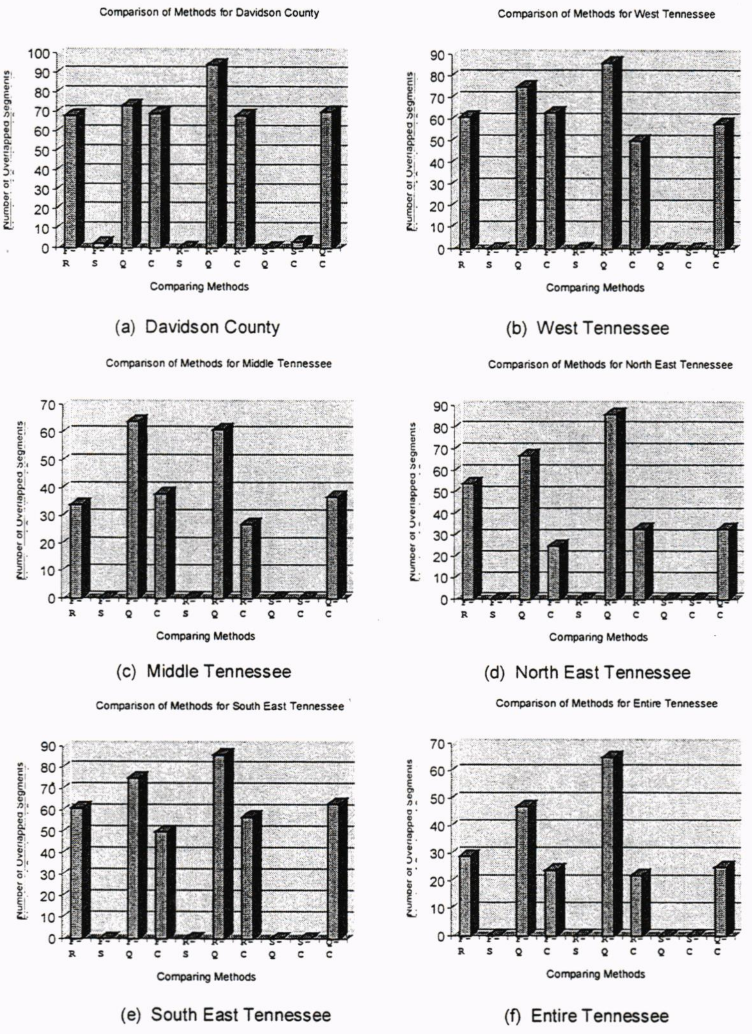


Figure 3 Comparisons of Methods for Several Regions

In Figure 2, the results indicate that:

- Comparing the accident rate method (R) and rate quality control method (Q) results produces the highest number of overlapped segments. Therefore, the R method produces similar results to the Q method.
- When comparing the accident severity method (S) to the other methods, there are no (or very, very few) overlapping segments found. Therefore, the S method appears to be very different from the other methods.
- When comparing the F method with the other methods, the F and Q methods indicated the highest number of overlapped segments (an average of 50 segments out of 100 segments over varying conditions). This suggests that the F method has similar predictive capabilities to the Q method.
- When comparing the combination method (C) (i.e., the method using a hazard index and all four individual methods) to the other methods, the results show

some similarities except when the comparison is to the S method (the average number of overlapped segments is 27, 19, 26, and 0 for comparison of C and F, comparison of C and R, comparison of C and Q, and comparison of C and S, respectively). Therefore, the combination method does give different results from the other methods. However, the degree of overlap in identifying segments with the combination method versus the F, R, and Q individual methods appears to be relatively the same.

- When the segment length increases, the number of overlapped segments tends to decrease for any comparing methods. A few exceptions to this trend are noted in 3 cases when L = 0.3 mile.

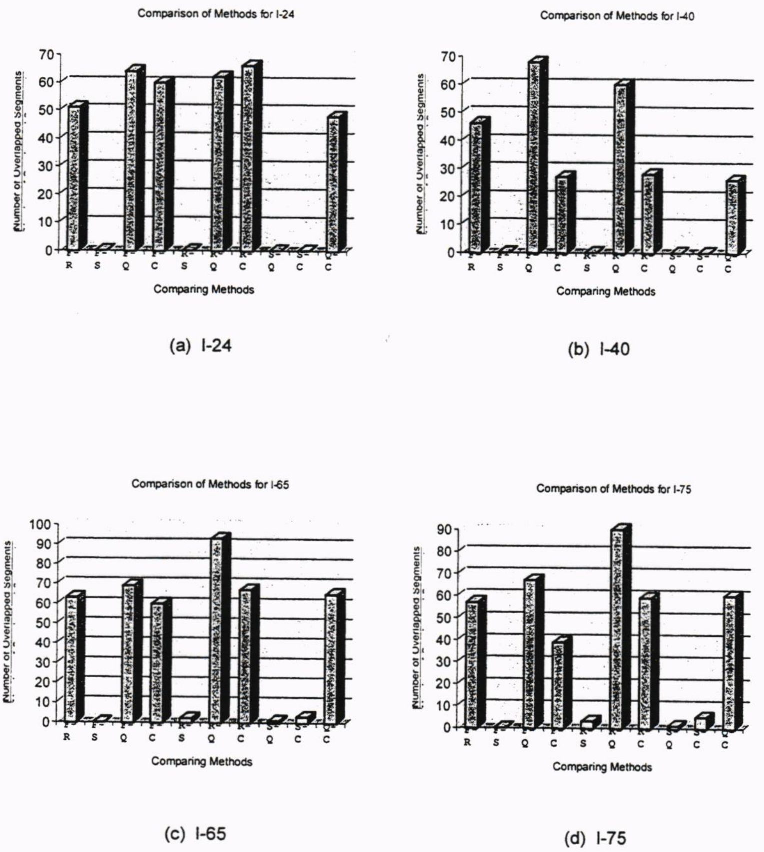


Figure 4 Comparison of Methods for Several Tennessee Interstate Hughways

In Figure 3, the results indicate that:

- Comparing the accident rate method (R) and rate quality control method (Q) gives the highest number of overlapped segments. Therefore, the R method is approximately the same as the Q method.
- When comparing accident severity method (S) to the other methods, there are little or no overlapped segments found for every cases except for the small study area (Davidson County) that has three overlapped segments for comparing S and C methods and two segments for comparing S and R methods.

Therefore, the S method appears to identify segments almost completely different from the other methods.

- When considering the comparison of the F method with the others, F and Q methods indicated the highest number of overlapped segments. This means that the F method approximates the Q method.
- For the combination method (C), when this method is compared to the other individual methods, the results are similar except when comparing to the S method (the average number of overlapped segments is 45, 43, 48, and 0 for the comparison of C and F, comparison of C and R, comparison of C and Q, and comparison of C and S, respectively). Therefore, the combination method is dissimilar to the S method but is similar to the F, R, and Q methods. Although the combination method results are similar to the F, R, and Q methods, there is much difference among C-F, C-R, and C-Q comparing method results as segment lengths change.

In Figure 4, the results indicate that:

- The accident rate method (R) and rate quality control method (Q) have the highest number of overlapped segments (varies from 60 to 90 segments out of 100 segments). Therefore, the R method gives results highly similar to the Q method.
- When comparing accident severity method (S) to the other methods, there are no overlapped segments found for I-24 and I-40 but a few overlapped segments (i.e., three segments) found for I-65 and I-75. However, these numbers are so small that one can conclude that the S method is almost completely different from the other methods.
- When considering the comparison of the F method with the others, comparing F and Q methods indicated the highest number of overlapped segments (about 65-70 segments out of 100 segments). This implies that the F method is somewhat like the Q method in its identification of hazardous locations.
- The combination method (C), when compared to the other methods, is similar except when comparing to the S method (the average number of overlapped segments are approximately 47, 55, 50, and 2 for comparison of C and F, comparison of C and R, comparison of C and Q, and comparison of C and S, respectively). Therefore, the combination method results are different from the S method but are similar to the F, R, and Q methods.

3.1.2 Comparison of the Methods Using Statistical Tests

The previous section used both visual and numerical techniques to compare methods by considering the top 100 highway segments. The number of segments used for comparing may be small. Therefore, another way of comparing and evaluating the reliability of different methods for identifying hazardous highway locations is to perform statistical tests of their respective analysis results.

Hazardous highway locations will be identified by several methods. They will be tested using paired t-Test and analysis of variance (ANOVA) statistical tests. The tests will be performed on all Tennessee interstate routes using 0.5-mile segment lengths.

A paired t-test is a test of the difference of rank of hazardous locations between two methods using the null hypothesis where $\boldsymbol{H_0}: \mu_1 = \mu_2$ or $\boldsymbol{H_0}: \mu_D = 0$ where $\mu_D = \mu_1 - \mu_2$.

The value μ_1 represents the group mean of group 1. The analysis of variance is a test of statistical significance of different hazardous locations rankings between two or more methods. An ANOVA test can group the methods which produce essentially the same results. The hypothesis that the group means are equal is accepted under the 95% significance level.

To better explain the ANOVA concept, the analysis of variance employs statistical tests based on variance ratios to determine whether or not significant differences exist among the means of several groups of observations. This was tested under the null hypothesis (H_0) that the means (μ) are all equal or $\boldsymbol{H_0}$ is true when $\mu = \mu_1 = \mu_2 = \ldots = \mu_k$ where k equals the method for identifying hazardous highway locations.

The Statistical Analysis System (SAS) is a statistical software package which has the capabilities to perform both the paired t-test and the analysis of variance (ANOVA) test. Thus SAS was used to perform these tests in this research.

The results of paired t-tests are shown in Table 1. These tables present the results of the statistical tests for segment lengths of 0.5-mile. The results indicate that the accident frequency method is not significantly different from the accident severity method (the amount of Prob>|T| is 0.6759). These two methods are significantly different from accident rate method, rate quality control method, and combination method (the amount of Prob>|T| are 0.0001 for various methods). Furthermore, the results also indicate that hazardous locations identified by the accident rate method, rate quality control method, and combination method are not significantly different. When comparing the accident rate method with the rate quality control method, the Prob>|T| values were 0.8734, 0.9809, 0.9814, 0.9981, and 0.9919 for 0.1-mile, 0.2-mile, 0.3-mile, 0.4-mile, and 0.5-mile segment lengths (L), respectively. When comparing the accident combination method with the accident rate method, the Prob>|T| value was 0.8349. In addition, when comparing combination method with rate quality control method, the Prob>|T| value was 0.8331.

Although results can be debated, the accident frequency method and accident severity method seem to be unimportant for identifying hazardous locations alone since the results of both methods do not much effect the combination method.

Other comparison statistical tests were performed using the ANOVA test. The results are shown in Figure 5. From these results, several methods can be grouped into three groups based on the premise that methods within a group are not significantly different from one another, but are significantly different from results predicted by other methods in other groups.

- Group A: accident rate method, rate quality control method, and combination method
- Group B: accident severity method and combination method
- Group C: accident frequency method and accident severity method

The results from ANOVA tests showed some of the same results as the earlier paired t-test analyses. ANOVA tests also indicated that the accident frequency method and accident severity are different from the other three methods and are not suitable for applying alone to determine hazardous highway locations. The combination method seems to be the best method because this method combines all methods together and provides similar results to the accident rate method and the rate quality control method. The additional reasons why the combination method is the most desirable for identifying hazardous highway locations are presented in Section 3.2 entitled "Evaluation of the Methods."

Table 1 Comparison of various methods by t-test (L=0.5 mile)

METHODS		Frequency	Rate	Severity	Rate Qualit Control	Combination of Four Methods
Frequency	N		10412	10412	10412	10412
	Mean		260.6255	17.4042	260.7005	262.8919
	Std. Dev	-	1448.8200	4248.1900	1230.9500	1284.2000
	T		18.3557	0.4180	21.6108	20.8887
	Prob >|T|		0.0001	0.6759	0.0001	0.0001
	95% Significant Diff.		Yes	No	Yes	Yes
Rate	N	10412		10412	10412	10412
	Mean	260.6255		243.2213	0.0750	2.2663
	Std. Dev	1448.8200	-	4348.8100	752.0938	1109.6900
	T	18.3557		5.7069	0.0102	0.2084
	Prob >|T|	0.0001		0.0001	0.9919	0.8349
	95% Significant Diff.	Yes		Yes	No	No
Severity	N	10412	10412		10412	10412
	Mean	17.4042	243.2213		243.2963	245.4876
	Std. Dev	4248.1900	4348.8100	-	4380.9300	3727.5000
	T	0.4180	5.7069		5.6668	6.7202
	Prob >|T|	0.6759	0.0001		0.0001	0.0001
	95% Significant Diff.	No	Yes		Yes	Yes
Rate Quality Control	N	10412	10412	10412		10412
	Mean	260.7005	0.0750	243.2963		2.1913
	Std. Dev	1230.9500	752.0938	4380.9300	-	1060.9800
	T	21.6108	0.0102	5.6668		0.2107
	Prob >|T|	0.0001	0.9919	0.0001		0.8331
	95% Significant Diff.	Yes	No	Yes		No
Combination of Four Methods	N	10412	10412	10412	10412	
	Mean	262.8919	2.2663	245.4876	2.1913	
	Std. Dev	1284.2000	1109.6900	3727.5000	1060.9800	-
	T	20.8887	0.2084	6.7202	0.2107	
	Prob >|T|	0.0001	0.8349	0.0001	0.8331	
	95% Significant Diff.	Yes	No	Yes	No	

3.1.3 Comparison of the Methods Using Output Maps

This section presents maps showing identifying hazardous locations within Tennessee by various methods. The locations were identified for 0.5-mile segments, and only those that ranked in the top 50 were shown on the map of Tennessee.

The results indicate that there are not much difference in the hazardous locations determined by the accident frequency, accident rate, rate quality control, and combination methods as shown in Figure 6. The accident severity method selected many hazardous locations that were different from the others, and the results were not convincing enough to select the locations for safety improvements solely on the basis of this method.

One-Way ANOVA for Comparison between Methods

Analysis of Variance Procedure
Class Level Information

Class	Levels	Values
METHODS	5	COMB FREQ QUAL RATE SEVE

Number of observations in data set = 45925

Analysis of Variance Procedure

Dependent Variable: RANK Rank of Hazardous Locations

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	418093312.39379800	104523328.09844900	14.05	0.0001
Error	45920	341520448325.61700	7437291.99315370		
Corrected Total	45924	341938541638.01100			

R-Square	C.V.	Root MSE	RANK Mean
0.001223	59.62007	2727.13989248	4574.19797496

Source	DF	Anova SS	Mean Square	F Value	Pr > F
METHODS	4	418093312.39379800	104523328.09844900	14.05	0.0001

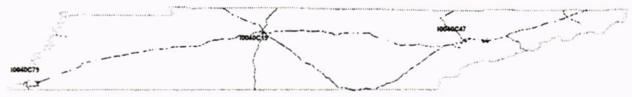
Tukey's Studentized Range (HSD) Test for variable: RANK

NOTE: This test controls the type I experimentwise error rate, but generally has a higher type II error rate than REGWQ.

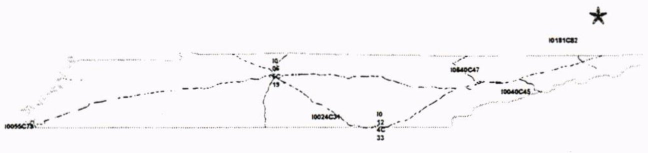
Alpha= 0.05 df= 45920 MSE= 7437292
Critical Value of Studentized Range= 3.858
Minimum Significant Difference= 109.78
Means with the same letter are not significantly different.

Tukey Grouping		Mean	N	METHODS
	A	4675.06	9185	RATE
	A			
	A	4674.91	9185	QUAL
	A			
B	A	4592.21	9185	COMB
B				
B	C	4483.99	9185	SEVE
	C			
	C	4444.81	9185	FREQ

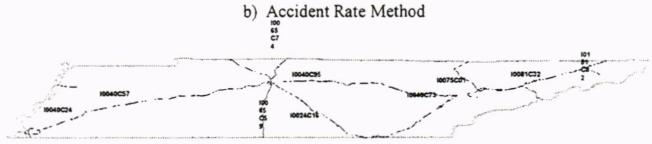
Figure 5 Comparison of various methods by ANOVA test



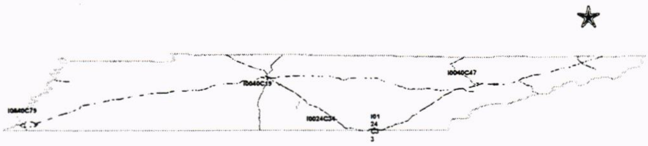
a) Accident Frequency Method



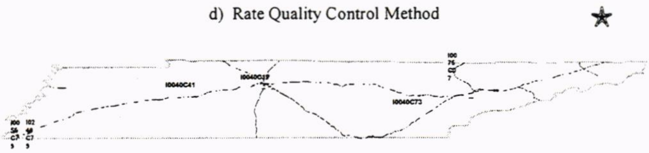
b) Accident Rate Method



c) Accident Severity Method



d) Rate Quality Control Method



e) Combination Method

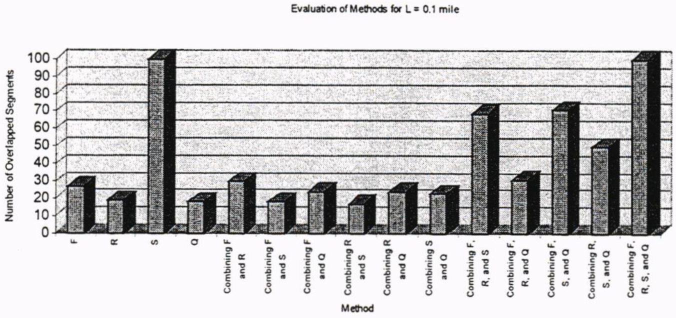
Figure 6 Comparison of Methods Using Output Maps

3.2 Evaluation of the Methods

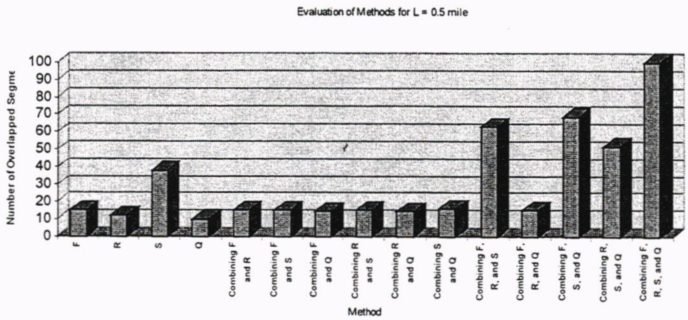
In this section, each method was evaluated as accident data varies from one year (1995) to three years (from 1993 to 1995) of accident data.

In this case, the entire Tennessee interstate highways were considered. The number of accident data vary from one year to three years, as mentioned above, in order to compare each individual method based on the number of accident data. The segment lengths used for analysis are 0.1 mile, 0.5 mile, and 1.0 mile.

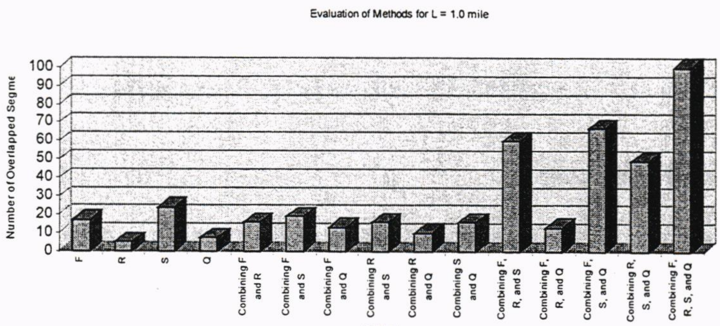
Highway segments ranked in the top 100 by individual methods for one year were considered and then used as a comparison standard. The same segment length for the same method, but for three years and an increased number of accidents, was next analyzed. The same segments ranked by the individual method for both one and three years of data were tabulated. For example, in evaluating accident frequency method (F), the program was run by using the accident frequency method and using one year of accident data to get the highway segments ranked in the top 100. Then the program was run by using the same method (accident frequency method) but using three years of accident data to get the highway segments ranked in the top 100. Comparing these two lists of the top 100 shows 80 segments that are the same. Then 80 would be presented in Figure 7.



(a) L = 0.1 mile



(b) L = 0.5 mile



(c) L = 1.0 mile

Figure 7 Evaluation of Overlapping Segments
(When Changing Accident Data from 1 year to 3 years)

The number of the same (overlapped) segments gives an indication of consistency of each method over time. The method that has a high number of overlapped segments indicates the method has high predictability in identifying similar hazardous highway locations because the results do not change too much when the number of accident data change. Although this sensitivity analysis is interesting and useful, the researcher recognizes that comparison of one year and three years of accident data are also highly dependent upon the consistency of data (i.e., repeat location of accidents) across Tennessee over time.

In Figures 7, the results indicate that:

- Combination of four methods (F, R, S, and Q methods) is the most reliable or consistent method for identifying hazardous locations because the number of the same (overlapped) segments determined by different accident data is extremely high (100 segments out of top 100 segments).
- For individual methods, each individual method except accident severity method presented a low number of overlapped segment (about 15 segments). Although the accident severity method presented a high number of overlapped segments when using 0.1-mile segment length (100 segments out of top 100 segments), the results are not clear which highway segment should be identified most hazardous because all 100 segments ranked 1st. In addition, the accident severity method presented a low number of overlapped segment when using a 0.5-mile segment length (38 segments out of top 100 segments), and a 1.0-mile segment length (24 segments out of top 100 segments). These results would indicate that each method is not suitable to be used alone for identifying hazardous highway locations because the hazardous highway locations will vary greatly as the number of accident data change. This indicates the low reliability of each method when applied singularly.
- The number of overlapped segments appears to increase when individual methods were added to form a combination method. The combination of any three methods has the number of overlapped segments higher than the combination of any two methods or individual method, respectively (about 65 overlapped segments for combination of three methods, 25 segments for combination of two methods, and 15 segments for an individual method).

4. CONCLUSIONS AND RECOMMENDATIONS

When comparing methods, the accident frequency method is most similar to accident severity method and both methods are different from accident rate method, rate quality control method, and combination method. Both accident frequency and accident severity methods rely heavily on the magnitude of accidents and the severity of accidents. Thus these two methods are similar in their predictive capabilities, but are different from the other methods which identify hazardous highway locations based on both the number of accidents and traffic volumes. Accident rate method, rate quality control method, and combination method produce similar results because these methods each consider number of accidents and traffic volumes when identify hazardous highway locations.

Individual methods such as accident frequency, accident rate, accident severity, and rate quality control are not suitable to be used alone to identify hazardous highway locations because the results from these individual methods are so highly dependent upon input data. Rankings can change drastically when some situations are changed, such as changing amount of data and time periods, and sometimes the method presents unclear results. In general, a single identification method will allow only for the selection of a sample of locations worthy of further consideration. Consideration of several valid indicators [frequency (F), rate (R), severity index (SI), R/Rc ratio] can help to improve the reliability of the identification process. The various types of accident identification methods show considerable merit instead of relying on a single method.

The combination of the four earlier methods into a combination method appears to be more reliable in identifying hazardous highway locations because the results do not change much when some situations (i.e., changing accident data) vary. In other words, widely varying identification due to method emphasis is dampened. Furthermore, the combination method considers not only the number of accidents but also the severity of accidents, traffic volume, group classification of locations, and other factors. Thus the individual strengths of single models are still considered. These factors make the method more desirable, less variable, and provide a better quality of results.

Further research should study the effects of varying the highway segment lengths when identifying hazardous highway locations. Selection of the most desirable segment length should be determined in order to identify hazardous highway locations more correctly. Furthermore, the floating segment technique which was applied in this research should be compared with the fixed segment technique typically used to identify hazardous highway locations by many government agencies.

Other techniques such as Bayesian Identification Technique [Higle in 1988 and 1989] and Knowledge Based Expert System Technique that were not used for identifying hazardous highway locations in this research could also be considered in the future study. These identification techniques should be evaluated and compared with the methods applied in this research to find additional methods of more accurately identifying hazardous highway locations.

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PAPER SELECTION PROCEDURE

The paper selection for the Journal of the Eastern Asia Society for Transportation Studies has been conducted throughout with strict impartiality as follows;

[Full Paper Based Selection]
Paper selection for the Journal was based on a review of the full paper.

[Referees and the Reports]
One session organizer from the International Scientific Committee (ISC) and three independent peer referees were assigned to each full paper. The lists of ISC members and the referees are included in this volume.
The referee submitted his/her referee report to the session organizer.
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[Selection Criteria]
ISC set up the two borderlines of marks for the full paper based on the session organizer's report as follows;

The higher borderline: if the mark of the paper was higher than this, it was accepted without further discussion.
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[Selection by Core-Committee]
The Core-Committee, which is composed of the chairperson and the two vice-chairpersons of ISC, discussed the selection/ rejection of the paper whose mark was between the two borderlines by asking the session organizer for further comments on the paper. This discussion was made through the Internet.
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[Comments for Revision]
ISC requested the author to revise the paper according to the session organizer's report. If the revision in the final paper was not sufficient, it was rejected.

[Statistics]
(a) Number of Submitted Abstracts: 357
(b) Number of Submitted Full Papers: 242
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(d) The Rate of Acceptance (c/b): 66.5%

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