MODELING SIGNALIZED INTERSECTION TRAFFIC ACCIDENTS: A PILOT STUDY CONDUCTED IN CITY OF NORFOLK, VA

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ABSTRACT

This pilot study is an attempt to apply a proactive approach using traffic pattern and signalized intersection characteristics to predict accidents at signalized intersections in a city's arterial network. An analysis of historical accident data at selected intersections within the City of Norfolk indicated that in addition to traffic volume, other controllable factors contributed to traffic accidents at specific intersections. The structural factor included variables such as area topography, lane patterns, type of road signs, turning lanes, etc., the administrative factor included variables such as signal types, signal polices, road closures, etc., and maintenance factor included variables such as road conditions, condition of the signals, condition of road signs, etc. The accident data was statistically analyzed to ascertain variables that were significantly related to the average number of traffic accidents at intersections. The analysis resulted in formulation of a six variable linear regression model that explained around 90% of variability in the data set. Such a model could have potential uses in designing intersections, assist in improving road structures, and/or modify the administrative policies to reduce accidents and congestion in the city's arterial network.

Keywords: *Traffic Management, Accident Modeling, City of Norfolk, Signalized Interaction Accident Analysis.*

1. INTRODUCTION

The traffic route system in an arterial network of a city consists of a finite number of routes shared by traffic for transporting vehicles from one point in the city to another. The system executes a set of cyclic processes encompassing the vehicle's movement through cross-routes, which are controlled by traffic lights at the signalized intersections. The coordination of traffic access to the routes is accomplished by signalized intersections through a sequence of signal timings. The interruption or slowing of traffic flow at the intersection is a major cause of accidents and subsequent congestion along the arterial network. Intersection safety has been identified as an emphasis area by the U. S. Department of Transportation under the Highway Infrastructure and Operations theme, since 50% of all vehicular crashes occur at intersections. Congestion, attributed to crashes at an intersection often lowers the performance of a city's arterial network, thus posing significant challenges to the expanding transportation industry.

Statistical models built from traffic flow patterns and intersection layouts are ideally suited to predict traffic accident frequency based on inherent factors prevalent at an intersection. The common multivariate approach concerns the applicability of multiple regression analysis for which studies have been conducted, giving the possibility of analytically predicting accident frequency based on traffic patterns and intersection layout design. The results from previous studies show multiple linear regression as a convenient model to predict accidents at specific intersections controlled by a sequence of signal timings. Extension of such models to a widely available set of signalized intersections in an arterial network needs to be developed to arrive at an applicable model for accident prediction. The model could be used by policy makers to identify signalized intersections that pose safety problems, thereby improving the design, road structures, and/or modifying the administrative policies to reduce accidents and congestion.

This study attempts to construct a multiple linear regression model using traffic pattern and intersection characteristics to predict accidents at signalized intersections in a city's arterial network. Multiple linear regression has been used extensively to study signalized intersections and develop models to predict vehicular traffic accidents. These models become computationally complex due to numerous related factors, accuracy of reported accident data, and administrative policies. Clearly, there is a need to take a fresh look at this complex problem from a different perspective in order to address the subjects: 1) the limitations of current statistical models, 2) the scope of controllable factors contributing to traffic accidents at intersections, and 3) the application of multiple regression analysis as a tool to predict accidents.

The remaining paper is organized as follows: The next Section 2 provides a literature review of previous studies conducted on the significance of the problem, and application of statistical models to predict traffic accidents. The methodology of the study is presented in Section 3. Section 4 discusses the statistical analysis and results, and finally, Section 5 contains conclusions, limitations, and scope for further research.

2. LITERATURE REVIEW

Automobile accidents contribute to large number of deaths in United States. According to the Insurance Information Institute, New York (Hot Topic and Issues Update: Auto Crashes, 2006), 42,636 people died in motor vehicle crashes in 2004 alone and an additional 2,788,000 people were injured. There were over 6 million police reported auto accidents in 2004. It is reported that about 50% of crashes occur at the intersections (Hakkert & Mahalel, 1978; National Highway R&T Partnership, 2002). It is obvious from everyday experience and has also been reported extensively in the literature that traffic volume is the major explanatory factor for traffic accidents (Vogt, 1999). However, studies have been carried out showing that design and other related factors contribute towards 2% - 14% of accidents. Ogden, et al., 1994 reported that about 21% of the variation in accidents was explained by variations in traffic flow volume, while the remaining majority of the variation was explained by other related factors. Vogt (1999) provides a good review of the factors, which have been considered in past research studies. These factors include channelization (right and left turn lane), sight distance, intersection angle, median width, surface width, shoulder width, signal characteristics, lighting, roadside condition, truck percentage in the traffic volume, posted speed, weather, etc. Beside these factors, researchers have also considered other minor details such as surface bumps, potholes, pavement roughness, pavement edge drop-off, etc. (Graves, et al., 2005).

The relationship between the accidents and pertinent factors is usually established using multivariate analysis (Corben & Foong, 1990; Hakkert & Mahalel, 1978; Ogden, et al., 1994; Ogden and Newstead, 1994; Vogt, 1999). The study by Corben and Foong, 1990 led to development of a seven variable, linear regression model for predicting right-turn crashes at signalized intersections. This model explained 85% of the variance of accident occurrence. In a FHWA study by Harwood, et al., (2000), quantitative data on accidents and other factors were combined with the expert's judgment about design factors as well as expected impact of these design factors on the accident rate.

In recent years, several studies have applied data mining techniques along with statistical modeling to determine the impact of major factors like traffic volume and road design characteristics along with minor factors such as potholes and surface roughness. Graves, et al., (2005) reported about the impact of potholes and surface roughness on the accident rate. However, due to paucity of data a clear link could not be established between these surface factors (pot holes, roughness, etc.). Washington, et al., (2005) performed an extensive study to validate previously reported accident prediction models and methods. Validation was performed using recalculation of original model coefficients, recalculation using of additional year data, and recalculation using data from a different state. The study reported that beside traffic volume other factors should be considered on a case-by-case basis for a given site.

Most recent studies have focused on statewide data and based on rural highways. The traffic pattern and other factors may differ at rural and city intersections. Furthermore, before and after studies may be less valuable in rural settings as road design changes are not made as often as in a city with growing traffic volume. The literature review shows that traffic accident analyses are commonly conducted in a larger geographical area like one or more states. This study builds upon past research, through application of a systematic approach of identifying accident-prone intersections in a mid size city that could pose future safety problems.

3. METHODOLOGY

The study was conducted at selected signalized intersections within the City of Norfolk, VA. The initial study concentrated on 30 signalized intersections that experienced high accident rates during the period 2000 - 2004. These 30 intersections were selected over a random sample in order to cover a higher traffic flow and wider range of accident types. The intersections were ranked on the basis of accident rates, congestion and other factors, and the top 10-15 were selected for data collection and statistical analysis.

The City of Norfolk has stored traffic accident data in an electronic format for the past 11 years from 1994 to 2004. Only accidents related to single vehicles were considered in the study due to technical limitations of importing multi-vehicle into the available database. The City's accident database was developed from individual police accident reports. The information collected from police reports include type of accident, road conditions, traffic signs and signal, drivers' actions, vehicle(s) condition, demographic data, nature of injury, and other related information, all of which are subsequently entered in the City's accident database. The traffic accidents without a police report were not included in this database. Appendix 1 provides a summary of the top 30 accident-prone intersections in the City of Norfolk.

The Commonwealth of Virginia collects and maintains data on traffic volume on the primary roads in every state locality. Traffic volume data on secondary streets (collector and local) is not directly available from the Commonwealth's database. This study used the average daily traffic volume data published by the Commonwealth of Virginia. The City does not maintain longitudinal data (data over a period of time) on road conditions, road improvement (barring major changes), signaling policy changes, road maintenance schedules, etc. As past data for these factors was not available, traffic volume data was collected for the four-year span from 2001-2004. The top 15 intersections were considered using four years of cumulative accident frequency. The traffic volume data for all collector and local roads was not available in the State's published reports; hence five of the top 15 intersections were dropped. Table 1 provides the final list of ten intersections considered for further analysis.

Table 1. Rank Order of Top 10 Intersections Based on Cumulative Number of Accidents from 2001-2004

No.	Street 1	Street 2	Abbreviation
1	VA Beach Blvd	Military Hwy	VM
2	Hampton Blvd	Int. Terminal Blvd	HI
3	Little Creek Road	Chesapeake Blvd	LC
4	Little Creek Road	Granby Street	LG
5	Military Hwy	Noview Ave	MN
6	Little Creek Road	Tidewater Drive	LT
7	Military Hwy	Azalea Garden Rd	MA
8	Little Creek Road	Hampton Blvd	LH
9	Tidewater Drive	VA Beach Blvd	TV
10	Brambleton Ave	St Paul Blvd	BS

In addition, the City provided aerial photographs of the intersections, but intersection layout (measurement of size, angles, etc.) could not be extracted at the time of this study due to lack of available software and computer tools. Hence, the physical attributes of each of the ten intersections were collected through direct observations. The physical attributes included number of lanes, type of lanes, type of turn signals, existence of median and shoulder, pedestrian crossing, number of driveways with 250' of the intersection, and other safety features shown schematically in Figure 1. A total of 60 variables were observed at the ten intersections (refer to Appendix 2).

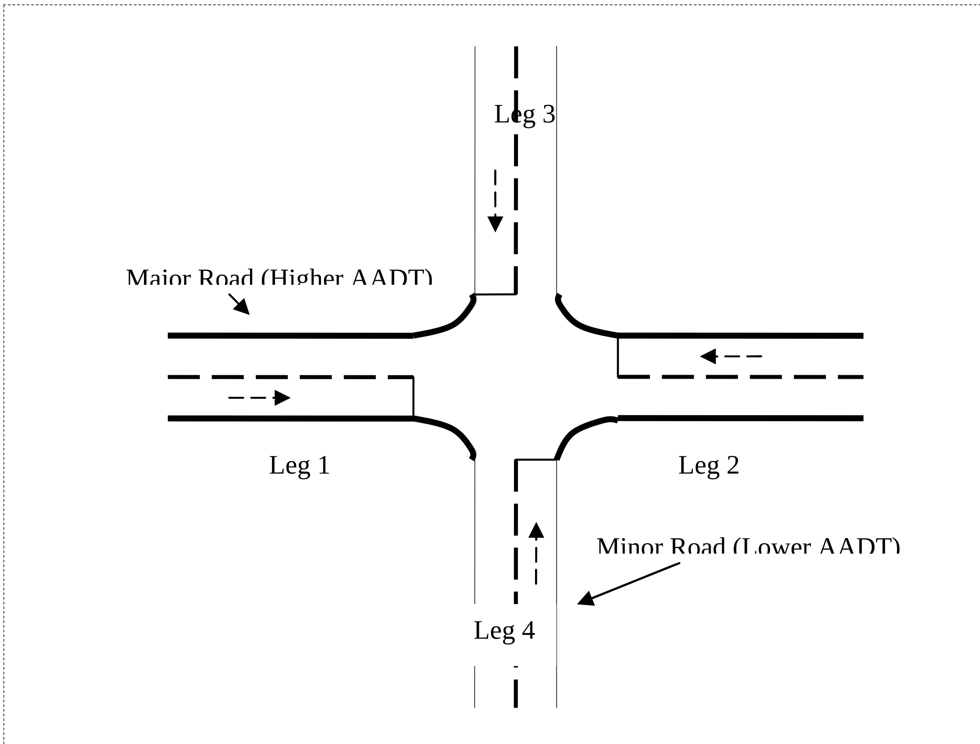
4. ANALYSIS AND RESULTS

The analysis was carried out in four steps as follows:
Step 1: The selection of the intersections for analysis was made using the *crash frequency method*

(Pawlovich, 2002), where all intersections were ranked according to the total number of traffic accidents. An accident within 250 feet of an intersection was considered *intersection related accident* (Hardwood, et al., 2000). For currency purposes, the last five years of available data (2000-2004), was used to rank the top 10 intersections shown in Table 1. For these 10 intersections, the previous 6 years of data (1994-1999) were also analyzed to look for linear trends in the accident rate.

Figure 2 shows two intersections having statistically significant trends (linear regression coefficient being significant at 5%). These intersections include (1) Hampton Boulevard and International Terminal Boulevard (HI) and (2) Brambleton Avenue and St Paul's Boulevard (BS). The Hampton Boulevard and International Terminal Boulevard trend shows a general increase in the number of accidents over the past 11 years. Conversely, the Brambleton Avenue and St Paul's Boulevard trend shows a decrease in the total number of accidents over the years. It was noted that both these intersections did not have any major roadway improvements in the past several years.

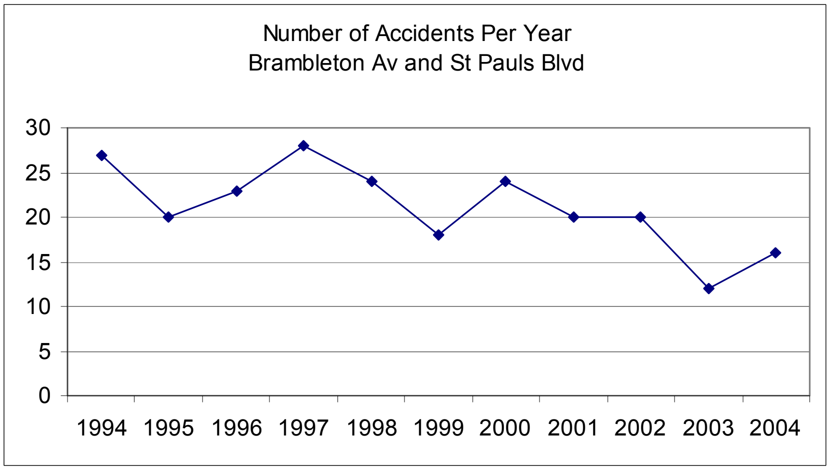
Figure 1. Schematic of an Intersection

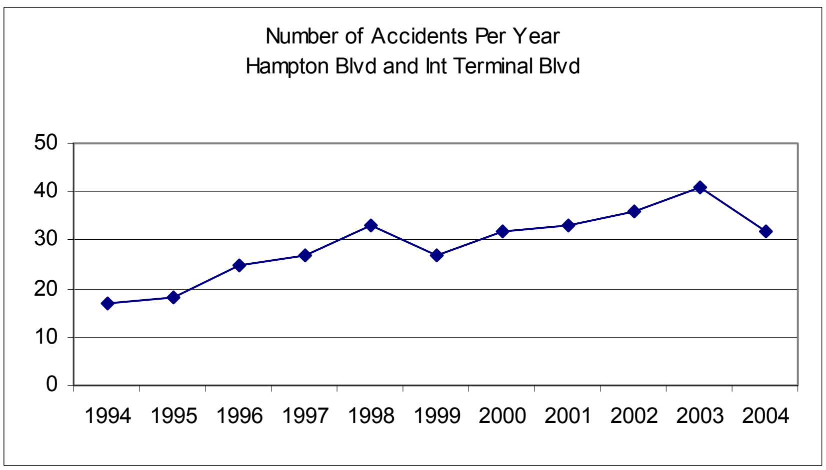


The traffic volume for the 10 intersections was computed using the Annual Average Daily Traffic (AADT) data published by the Commonwealth of Virginia (refer to Table 2). The total AADT for each intersection was calculated by adding traffic (AADT) coming into and leaving the intersection for both highways. The total AADT at an intersection is the sum of the average of AADT for the each highway as follows:

> Intersection total AADT = {[(Traffic Volume Approaching the Intersection from Direction 1 + Traffic Volume Leaving Intersection from Direction 1)/2]+[(Traffic Volume Approaching the Intersection from Direction 2 + Traffic Volume Leaving Intersection from Direction 2)/2]}

Figure 2. Intersections with Significant Trend in Accident Rates.





Step 2: At this stage of the analysis, it was important to establish the relationship between traffic volume and accident frequency. Using an analogy from reliability analysis, a failure of a system could be considered as an accident. To assess the reliability of system a Mean Time Between Failures (MTBF) is calculated; similarly to assess the safety (reliability) of traffic system, the mean number of vehicles between accidents can be calculated. In other words, it calculates an average number of vehicles passing the intersection between two accidents. If the safety standards are increasing at an intersection, the mean number of vehicles between accidents must increase. The mean number of vehicles between accidents for the selected top 10 intersections is provided in Table 3.

Table 2. Total Annual Average Daily Traffic (AADT) for Each Intersections from '01-'04

No.	Intersection	2001	2002	2003	2004
1	VABchBl&MilHwy	70500	75500	75500	76000
2	HmptBl&IntTerBl	58000	62000	52000	53000
3	LttlCrkRd&ChsBl	53500	54000	58500	59000
4	LttlCrkRd&GrnbySt	52500	55000	56500	55500
5	MilHwy&NrvwAv	51500	55000	56500	57000

6	LttlCrkRd&TdWtrDr	47500	48000	45000	44000
7	MilHwy&AzGrdRd	41000	43500	46500	47000
8	LttlCrkRd&HmptBl	52000	54000	48500	48500
9	TdWtrDr&VABchBl	44000	42500	44500	47500
10	BrmbltnAv&StPlsBl	47500	51000	50000	51000

Table 3. Mean Number of Vehicles Between Accidents from 2001-2004.

No.	Intersection	2001	2002	2003	2004
1	VABchBl&MilHwy	485518.9	656131	706602.6	513703.7
2	HmptBl&IntTerBl	641515.2	628611.1	462926.8	604531.3
3	LttlCrkRd&ChsBl	1084861	615937.5	889687.5	582027
4	LttlCrkRd&GrnbySt	598828.1	692241.4	606544.1	844062.5
5	MilHwy&NrvwAv	1445962	590441.2	859270.8	671129
6	LttlCrkRd&TdWtrDr	912500	834285.7	586607.1	845263.2
7	MilHwy&AzGrdRd	1151154	635100	707187.5	779772.7
8	LttlCrkRd&HmptBl	1460000	1314000	632232.1	1361731
9	TdWtrDr&VABchBl	944705.9	969531.3	738295.5	788068.2
10	BrmbltnAv&StPlsBl	866875	930750	1520833	1163438

The mean number of vehicles between the accidents varies significantly from one intersection to another. This is due to several factors including the capacity of the highway. However, an increasing or decreasing trend in the mean number of vehicles between the accidents on a specific intersection may signify a change in some of the road conditions, traffic control changes, or other engineering changes at the intersection. Three intersections (1) Little Creek Road and Chesapeake Blvd (LC), (2) Military Hwy and Norview Ave (MN), and (3) Tidewater Drive and VA Beach Blvd (TV) show lower trends, i.e., the mean number of vehicles between the accidents is decreasing or the traffic accident frequency compared to traffic volume is increasing, where as the intersection of Little Creek Road and Granby Street (LG) shows a higher trend in mean number of vehicles between the accidents. Other intersections do not show distinctive increasing or decreasing trends.

Step 3: To test the significance of change in the mean number of vehicles between the accidents, the Student-t test was performed. It must be noted that sample size (4) is very small for each intersection. The average and standard deviation of mean number of vehicles between the accidents for the 10 intersections is presented in Table 4. Table 5 shows the p-value for the two-tail Student-t test. It is evident from Table 5, that very few data points (mean number of vehicles between the accidents) are significant at 10% level. It is partly due to the fact the sample size is very small for the t-test. However, it provides some direction as which intersections are improving or deteriorating in terms of accident frequency relative to the traffic volume.

Table 4. Average and Standard Deviation Mean Number of Vehicles Between Accidents from 2001-2004.

No.	Intersection	Avg	Std. Dev
1	VABchBl&MilHwy	590489	107558
2	HmptBl&IntTerBl	584396	82417
3	LttlCrkRd&ChsBl	793128	238322
4	LttlCrkRd&GrnbySt	685419	113920
5	MilHwy&NrvwAv	891701	386293
6	LttlCrkRd&TdWtrDr	794664	142949
7	MilHwy&AzGrdRd	818304	229626
8	LttlCrkRd&HmptBl	1191991	378090
9	TdWtrDr&VABchBl	860150	114249

10	BrmbltnAv&StPlsBl	1120474	295771

Table 5. The p-value of Two-Tail Student-t Test on Mean Number of Vehicles Between Accidents from 2001-2004.

No.	Intersection	2001	2002	2003	2004
1	VABchBl&MilHwy	9.5%	18.4%	7.9%	15.2%
2	HmptBl&IntTerBl	15.8%	21.1%	4.2%	35.0%
3	LttlCrkRd&ChsBl	6.2%	14.4%	26.7%	11.1%
4	LttlCrkRd&GrnbySt	14.0%	46.2%	15.8%	4.7%
5	MilHwy&NrvwAv	4.4%	13.5%	44.7%	19.8%
6	LttlCrkRd&TdWtrDr	12.4%	33.2%	4.3%	29.2%
7	MilHwy&AzGrdRd	4.3%	13.0%	23.2%	39.5%
8	LttlCrkRd&HmptBl	15.4%	30.8%	4.1%	24.7%
9	TdWtrDr&VABchBl	14.5%	9.8%	8.1%	17.7%
10	BrmbltnAv&StPlsBl	11.7%	17.4%	5.0%	40.9%

Step 4: The physical intersection attributes were included in this step. In absence of any longitudinal and design data, the statistical inference drawn is very limited. The physical attribute data set contains 56 physical attributes and traffic volume AADT is an additional independent variable. This make a total of 57 independent variables with a date set of 10 locations**.** However, certain independent variables could be eliminated as these variables did not vary at the intersections under consideration. The variables eliminated were shoulder variables (SHLD11...SHLD42) since there was no shoulders anywhere on the intersections under investigation expect for a shoulder on one leg on an intersection**.** Similarly, signal variables for no right turn on red (NRTR1...NRTR4), restricted red turn light (RLFL1...RLFL4), and extra hazard on minor road (HARD3 and HARD 4) were eliminated as there were either no differences, or just one intersection had a different value for these variables. Despite the elimination of these variables, there were still 39 independent variables with 10 data points.

The dependent variable (ACCAVG - average number of accidents over the period of 2000-2004) was the accidents reported and recorded within 250 feet of the intersection. Hence, it was imperative that the independent variables also reflect intersection-based data rather than data on each leg of the intersection. The available variables were reduced to eight independent variables for an intersection as shown in Table 6.

Table 6. Composite Independent Variable at an Intersection.

Variable	Definition
AADT	Annual Average Daily Traffic ('000) at The Intersection
LANE	Total Number of Lanes at The Intersection
TURN	Total Number of Turn Lanes at The Intersection
MEDN	Total Number of Physical Median at The Intersection (MEDN1+MEDN2+MEDN3+MEDN4)
PEDN	Total Number of Pedestrian Crossing at The Intersection (PEDN1+PEDN2+PEDN3+PEDN4)
DRWY	Total Number of Driveways at The Intersection
HZRD	Number of Legs with Extra Hazards at the Intersection
EXSF	Number of Legs with Extra Safety Features at the Intersection

The Table 7 shows Peason's correlation coefficients of average number of accidents with the eight independent variables under consideration. Four coefficients were statistically significant at alpha (α) of 0.10. The significant variables were AADT (traffic count), LANE (total number of lanes), TURN (number of turn lanes), and MEDN (total number of sides with physical median.) PEDN (number of pedestrian crossing) and DRWY (total number of driveways) variables were significant at a higher α of 0.25. The

HZRD (extra hazard) and EXSF (extra safety feature) features were not significant. In order to use the intersection and traffic characteristics to predict accidents, multiple linear regression analysis were carried out. The two variables (HZRD and EXSF) were eliminated from the consideration due to insignificant correlation.

As indicated earlier, the data set was too small for confident statistical predictive model. Hence, all six variables are kept in the model despite some of the variables being statistically not significant. Table 8 shows the linear regression coefficients of each variable in the model.

Table 7. Pearson's Correlation Coefficient with Average Number of Accidents

Variable	Correlation Coefficient
AADT*	0.858
LANE*	0.755
TURN*	0.704
MEDN*	0.563
PEDN	-0.301
DRWY	0.302
HZRD	-0.169
EXSF	0.167

Table 8. Linear Regression of ACCAVG (Average number of accidents).

Variables	Linear Regression Coefficients
Constant	2.14
LANE	-0.76
TURN	2.02
AADT	-0.10
DRWY	0.41
MEDN	7.48
PEDN	-2.19

The equation of the linear regression line is shown below.

$$ACCAVG = 2.14 - 0.76*LANE + 2.02*TURN - 0.10*AADT + 0.41*DRWY + 7.48*MEDN - 2.19*PEDN$$

Table 9 shows that the linear model is significant and explains 89.8% of variability in this small data set under consideration.

Table 9. R-Square of the Linear Regression Model

Model	R	R Square	Std. Error of the Estimate
	0.983	0.966	2.995

It must be pointed out that this study was carried out to show that statistical modeling of accident data with design and other controllable factors is very plausible in the City of Norfolk. The model presented here is not very useful for any prediction or corrective action as the sample size was very small, however, it is evident from the above analysis that the basic statistical modeling of accident rate and design factors could be useful if larger sample is available.

5. CONCLUSIONS AND LIMITATIONS

This pilot study attempted to determine a relationship between traffic accidents and controllable factors such as road design, signal policies, and other data prevalent at signalized intersections. The main focus was to rely on longitudinal data to find out how previous changes in design, roadside objects, signal policies, and other similar factors have impacted the accident rate in the City of Norfolk. The study expected to replicate some of the previously published research conducted over a wider region (Vogt, 1999; Corben & Foong, 1990) to develop a predictive statistical model for accident rate for intersections in a specific mid size city. However, this study has limitations: the sample size of 10 intersections is small and includes only the high accident intersections, excluding low accident intersections which could possibly provide additional inputs to the model; it lacks statistical validity due to unavailability of longitudinal data. For statistical analysis purposes, before and after data for each intersection were not available at the time of study to establish a relationship between improvements and accident rate. Data on each road changes and improvements need to be collected over three to five years. Moreover, signal policy changes and other major and minor road maintenance data should also be collected over time to show effectiveness of each change on the accident rate. Nevertheless, the analysis shows that traffic accidents and these factors have a relationship that could be useful for traffic engineers planning traffic projects within the City.

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Appendix 1. Rank Order of Top 30 Intersections Based on Cumulative Number of Accidents from 2000-2004.

Rank	Intersection	2000	2001	2002	2003	2004	Total
1	VABchBl&MilHwy	43	53	42	39	54	231
2	MilHwy&LowRd	39	44	49	44	24	200
3	HmptBl&IntTerBl	32	33	36	41	32	174
4	LttlCrkRd&ChsBl	35	18	32	24	37	146
5	LttlCrkRd&GrnbySt	22	32	29	34	24	141
6	NHmptBl&WesDr	33	25	19	27	22	126
7	MilHwy&NrvwAv	22	13	34	24	31	124
8	MilHwy&PopHllRd	14	19	24	29	23	109
9	LttlCrkRd&TdWtrDr	21	19	21	28	19	108
10	MilHwy&RbnHdRd	18	19	20	24	24	105
11	MilHwy&AzGrdRd	18	13	25	24	22	102
12	LttlCrkRd&HmptBl	27	13	15	28	13	96
13	TdWtrDr&VABchBl	18	17	16	22	22	95
14	BrmbltnAv&StPlsBl	24	20	20	12	16	92
15	GrnbySt&AdTssgBl	24	11	18	20	15	88
16	LttlCrkRd&DvnSt	16	18	18	20	14	86
17	BrmbltnAv&PrkAv	19	18	21	14	12	84
18	ChsBl&ByvwBl	22	15	12	21	14	84
19	BrmbltnAv&TdWtrDr	17	16	17	13	20	83
20	TdWtrDr&PrnAnnRd	18	13	15	22	14	82
21	MilHwy&JohnsRd	18	11	17	16	20	82
22	TdWtrDr&WidgeRd	12	14	26	16	14	82
23	NrvwAv&JhnSt	16	13	19	18	13	79
24	NwTwnRd&VABchBl	14	22	13	16	14	79
25	LttlCrkRd&HlprnDrl	13	14	16	15	18	76
26	LttlCrkRd&ShrDr	14	13	13	16	20	76

27	LttlCrkRd&I 64 XX	18	11	16	12	16	73
28	LttlCrkRd&OdOcvRd	16	18	10	17	9	70
29	MilHwy&HggrdRd	10	11	18	14	15	68
30	HmptBl&AdTssgBl	8	10	16	16	14	64

Appendix 2. Definition of Road Design Variables

Variable	Definition
$LANE_i$	Total Number of Lanes on The Leg i (i=1..4) at The Intersection
$LNLF_i$	Total Number of Left Turn Only Lanes on The Leg i (i=1..4) at The Intersection
$LSLT_i$	Total Number of Shared Left Turn Only Lanes on The Leg i (i=1..4) at The Intersection
$LNRT_i$	Total Number of Right Turn Only Lanes on The Leg i (i=1..4) at The Intersection
$DRWY_{ij}$	Total Number of Driveways on The Leg i (i=1..4) Direction j (1=approaching, 2== leaving) at The Intersection
$MEDN_i$	Physical Median on the Leg i (i=1..4) of a Road Yes=1, No=0
$HARD_i$	Irregular Hazards on The Leg i (i=1..4) at The Intersection Defined as Signal, Railroad Crossing, Stop Sign, etc. with in 250' of the Intersection Yes=1, No = 0
$PEDN_i$	Pedestrian Crossing at The Leg 1 of Major Road Yes=1, No = 0
$EXSF_i$	Extra Traffic Safety on The Leg 1 at The Intersection Defined as Overpass, Underpass, Extra wide Med, etc. at the Intersection Yes=1, No = 0
AADT1	Annual Average Daily Traffic ('000) on The Major Road
AADT2	Annual Average Daily Traffic ('000) on The Minor Road
ACC04	Total Number of Accidents in 2004 within 250' of the Intersection
ACCAVG	Average Number of Accidents from 2001-2004 within 250' of the Intersection
$SHLD_{ij}$	Shoulder on The Leg i (i=1..4) Direction j (1=approaching, 2== leaving) at The Intersection Yes=1, No =0
$NRTR_i$	No Right Turn on Red Sign on The Leg i (i=1..4) at The Intersection Yes=1, No =0
$RLFL_i$	Left Turn Signal on The Leg i (i=1..4) at The Intersection Yes=1, No =0