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Investigating the Factors Effective on Prevention of Urban Accidents through Modification of Streets and Intersections

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Abstract- Routes and their geometric conditions are considered as the most important traffic factors that play a crucial role in occurrence of accidents. In addition, the cost of such accidents is considered as one of the most important indices in terms of prioritization of geometric modification projects of accident-prone spots. This research investigates the effects of conditions of geometric modification of streets on occurrence of urban accidents. In this regard, the term geometric modification is referred to as the operation of analysis of system management and various geometric reformation models. The research is a field study and its required data are collected through library studies and field operations including inspection of streets; consistency of methods of implemented designs with consultants' views and controlling the entrance and exit of passages. For the purpose of data analysis, the variance analysis method is applied. Results of this research indicate that a significant difference exists between rate of accidents before and after implementation of reformations. Before and after reformations, the rates of accidents differed significantly only between 9 to 12 and 12 to 15 hours. Before and after geometric reformations, accidents only differed in terms of manner of front side collision.

Keywords- *Route Geometry, Urban, Accidents, Intersection, Modification of Streets, Traffic Element*

I. Introduction

Urban routes occupy only less than a third of entire urban grounds and are yet considered as the main skeleton of every town or city. Humane and natural elements play a significant role in formation and construction of every town or city's morphology. In this regard, human elements, network of streets and passages and in general, communication networks are the most effective factors in occurrence of accidents in a city. Researchers have already made several scientific research efforts. Yet sometimes it is observed that some of these researchers are either not time effective or not cost effective. In fact it can be stated that a researcher can only attempt to perform a study when a necessity is felt for that study. With no doubt, as the main components of traffic, routes and their technical and geometric conditions play a crucial role in occurrence of incidents and accidents. On the other hand, the costs of the very same accidents and incidents have been referred to as effective indexes in prioritization of geometric reformation projects for accident prone zones.

II. Review of Literature

A research was performed in order to investigate the role of geometric design of traffic network in management of traffic and transportation. The author of this research has tried to both categorize the constituent elements of the traffic network that combine the traffic sector with issues rising from traffic networks; and describe the problems of geometric design of level and non-level intersections, transactions and especially controlling the entrance ramps and their positive effects, structure of overpass bridges despite their negative effects on the rest of the network, and requirements of parking lots outside streets (Ardakanian, 2002).

In another research, it was tried to incorporate the ideas and views of safety experts into geometric, physical and functional conditions of routs in order to determine the effective criterions in prioritization of accident-prone intersections, and to construct the primary prioritization for the aforementioned intersections. Calculating the extent of importance of each criterion can be useful in terms of multi-criterion decision making methods. The calculated numbers can be used as the input-matrix of weight of criterions. One of the most important advantages of such weight matrixes is homogenization of prioritization of various intersections since the mentioned matrix is a unit matrix. The Delphi method was used for identification of the so-called effective criterions and their importance. This method is a group decision making technic. A total of 14 effective elements were identified in terms of prioritization of accident-prone intersections along with their importance extent (Safaar Zadeh et al. 2010).

In another distinct study, urban highways of the city of Tehran were considered as the case of study and the required data belonging to the period of 2004-2007 were collected from different organizations. With respect to qualitative-ness of collected data, a 0 and 1data bank was prepared using the ACCESS software. Afterwards, for the purpose of modeling the dependent and independent variables were identified and the dependent variable of accident intensity was defined at two levels including fatal-injury accidents and accidents resulting in financial losses. Results of investigation of models provided by this study shows that the following variables increase the intensity of accidents in highways: driving at young ages (-25 years), gender of the driver (male), darkness, lack of ability in controlling the vehicle, deviation to the left, excessive speed, a traffic volume of less than 2000 vehicles per hour, driving in reverse gear on highways, technical issues in vehicles, collision with motor-bikes and bicycles, collision on bridges, head to head collision and multi-vehicle crash (Abutorabi and Rezaei Moghadam, 2010).

In order to maximize the influence f engineers on safety related problems, we are required to perform adequate reformations in different levels of development of passage networks. By implementation of effective design principles, many problems can be avoided at the first place through planning and designing safer new roads. Ultimately, one may determine the accident-prone areas of the passage network in a way that safety modifications are able to reduce the possibility and severity of accidents in mentioned areas. It has been proven that this is one of the most effective methods for improvement of safety of roads in developing countries (England’s central road and transportation research laboratory, 1998).

III. CALMING TRAFFIC IN RESIDENTIAL AREAS

In Iran, most urban communication networks lack the principles of urbanism and traffic engineering. In residential areas, secondary roads usually intersect with main roads with no previous hierarchies. In addition, since the vehicle lanes are usually a straight line, drivers also usually drive at exceeding speeds on these roads. Furthermore, in addition to creation of noise and air pollution; passing vehicles are also a danger to pedestrians, especially the children. Large number of accidents in such secondary roads is the witness to this claim. In many of the aforementioned areas, people themselves have decided to put barriers on the roads such as multiple bezels, in order to make passing cars drive at lower speeds. However these barriers are technically rejected and simultaneously will diminish the aesthetics of the passages. In addition, many of these barriers and bezels cause damage to passing vehicles, even those trafficking at low speeds. Taking into account all the aforementioned content, it seems that the traffic calming plan that was first implemented decades ago in Netherland, and later in England and Germany; can be experimentally implemented in Iran too. Calming traffic in residential areas is defined as prevention of entrance of passing vehicles to residential areas as well as reduction of speed for the residents themselves aimed at maximal improvement of the safety of residential areas (Arabani, 2005).

IV. A REVIEW ON THE PROCESS OF EVALUATION

In general, the process of engineering evaluation is initiated when an intersection is diagnosed with performance or safety related issues. The aim of this process is detection of the most effective solution for the issue. In most cases, the so-called evaluation process is considered as a section of a total system management process during which, the entire problematic transportation facilities are subjected to studies and investigations. Levels of system management process are shown in figure 2-1.

The process of evaluation includes three phases of the system management process. In the first phase, the possibilities are detected. In second phase, engineering studies are performed in order to investigate the amount of influence of each individual possibility. Ultimately, in the third phase, the best option is selected based on amount of its positive influence in improvement of motion of transportation vehicles and etc. in addition to these analyses, the required budget for performance of the modification is also studied and in case of sufficiency of the budget, the intersection is modified and then controlled for making sure that the primary issue has been solved (Shahi and Naderan, 2007).

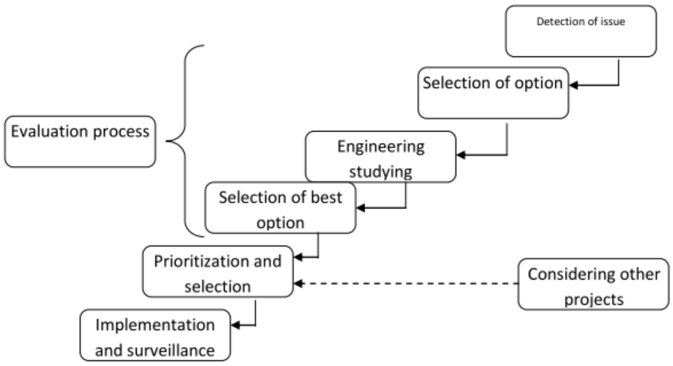

Figure 1. Phases of system management process

V. TRAFFIC BARRIERS

A. Barriers on the middle of streets

Middle or central street barriers are aimed at separation of opposite traffic lanes and prohibition of traffic of pedestrians in danger-prone zones. One of the safety applications of such barriers is that it prevents head-t-head crashes. Furthermore, pedestrians are guided towards safer zones for crossing streets and roads as well. The difference between safety and traffic guidance barriers should be understood. Safety barriers are larger because they are used to re-route vehicles to their primary directions and to absorb a large amount of the energy of collisions. These barriers are commonly of the height of 600millimeters or taller. Meanwhile, traffic guidance barriers that are only implemented for guidance of drivers can also be in form of short curbs.

One of the most applied methods for separation of driving lanes is usage of concrete separators. This type of separator includes two rows of curbs with cement or concrete filled in-betweens. It is worth mentioning that the recommended width and height are 30 centimeters.

Figure 2. Intermediate spacers

Cons and pros of the upper content are as follows:

Advantages (Pros):

- ✓ Smoothness of the passing traffic
- ✓ Increased speed for passing vehicles
- ✓ Reduced stops resulting from left-turn movements
- ✓ Significant reduce delay time for each vehicle
- ✓ Reduced interference with turning movements

Disadvantages (Cons):

- ✓ High costs of implementation of the plan
- ✓ Increased traveling for left-turn movements
- ✓ Reduced access to alleys and streets (Behbahani, 1996)

B. *Possible solutions / Process:*

Physical barriers may be used in cases in which drivers' lack of attention to driving signs can result in severe accidents. In addition, installing such signs can help with achievement of other goals as well. These barriers are usually installed in the center of vast multi-lane streets and include those barriers especial to pedestrians as well. Such barriers prevent vehicles from turning. In fact such turnings on streets are considered as the most dangerous maneuvers. Based on their characteristics, these barriers are also able to prevent head-to-head crashes. Using traffic islands in slow urban roads is an unnecessary action. Street barriers can also be used for guiding pedestrians towards areas with pre-installed safety facilities. Middle barriers can be used for pedestrians' crossing zones. However these barriers should be modified so that pedestrians can use them with no difficulty. A barrier with approximate height of 25 centimeters is enough and sufficient for prevention of vehicles from crossing. While designing barriers, the access of emergency service vehicles should also be taken into account. This can be done through substitution of the middle island in intersections or creation of gaps in sensitive areas. Closing the endings of barriers can result in reduction of related dangers. This can be done using shock absorbing paddings and pincushions along with suitable marking and installation of warning signs. In cases in which there is no need for installation of fencing panels, the minimum optimal width for the middle island is 5meters. However, in cases in which there is insufficient space, a width of approximately 1.52 meters can also be a shelter for pedestrians (Behbahani, 1996).

C. *Guiding islands*

These types of islands are aimed at guidance of drivers and facilitation of their task. By turning the unused surfaces in intersections into guiding islands and creating turning routes, certain interventions in driving could be prevented. It should be pointed out that exceeding numbers of these islands may result in confusion.

D. *Research method and data collection technics*

Several field studies have been performed in order to fully recognize the subject under investigation, which is "the role of geometric modification of streets in occurrence of traffic accidents". For certain reasons, field investigation is highly applicable and desirable in studies in the field of driving. Making presence on streets and investigation of details of projects and investigation of roles of different elements are the most important reasons. The entire data required for this study have been collected through library studies including books, articles and etc. and reference to documents related to statistics of collisions in intersections of interest.

Making presence at intersections of interest and investigation of manners of projects in terms of consistence with view of consultants and also controlling the input and output of streets and calculation of related timing have provided the field data required for the research.

E. *Data description and analysis methods*

Selection of technics for description and analysis of data depends on the complexity of the research. The data in this section elaborate on information regarding collisions taken place on selected roads. The time limit is one year prior to execution of project until a year after. On this basis it seems that the variance analysis technic is suitable for making statistical inferences from collected data. Statistical tests administered in this research tend to investigate the difference between the conditions of selected areas before and after execution of modifications including geometric modification of squares, closure of way in intersections and geometric modification of intersections. In addition, research hypotheses are validated or rejected according to the results of the aforementioned statistical tests. On the other hand, also the special characteristics of the two groups of data under investigation are compared with each other through the application of indexes of descriptive statistics. The software of Microsoft Office Excel has been used for drawing graphs and presentation of statistical data. Furthermore, the statistical tests themselves have been performed within the environment of the SPSS software. This software elaborates on the data belonging to each separate time period and validates the H0 and H1 statistical hypotheses.

F. *Concepts used in the study*

Since in this research the effect of performed reformations on the count, type and manner of collisions is investigated, therefore the performed geometric reformation or modifications are considered as independent variables. On the other hand, the count, type and manner of collisions are considered as the dependent variables of the study.

G. *Count of collisions in investigated areas prior to performance of modifications with type specification*

Table and figure 3 show that among the entire occurred collisions (181), 162 collisions had happened between two vehicles; 13 had occurred between multi-vehicles and 6 were also pedestrian collisions. Among the places, the highest rate belonged to the square 3 with 32 accidents. After that, it was the square 5 with 25 accidents and intersection 1 with 19 accidents. In addition the lowest rate of accidents belonged to the square 1 with 2 accidents. Furthermore, the highest rate of collision between two vehicles belonged to the square 3 with 31 accidents and intersection 6 with 29 accidents. Nonetheless, the highest rate of multi-vehicle crash belonged to the square 5 with 5 counts of accidents and the highest rate of pedestrian involved collisions belonged to the intersection 3 with 3 accidents.

TABLE I. ABUNDANCE DISTRIBUTION TABLE FOR COUNT OF COLLISIONS PRIOR TO PERFORMANCE OF GEOMETRIC MODIFICATION WITH TYPE SPECIFICATION

Place	Count	Type		
		Two Vehicles	Multi-Vehicles	Pedestrian
Intersection 1	19	17	1	1
Intersection 2	9	9	-	-
Intersection 3	15	11	1	3
Intersection 4	11	11	-	-
Intersection 5	14	14	-	-
Intersection 6	32	29	2	1
Square 1	2	1	-	1
Square 2	8	5	3	-
Square 3	32	31	1	-
Square 4	14	14	-	-
Square 5	25	20	5	-
Total	181	162	13	6

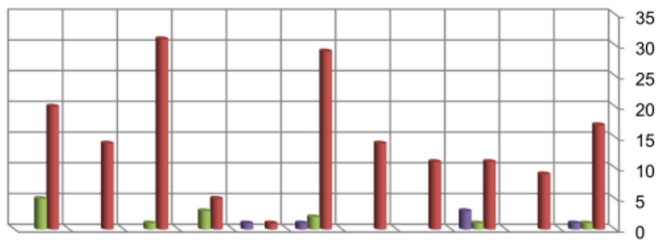

Figure 3. Abundance distribution diagram for count of collisions prior to geometric modifications

VI. DATA ANALYSIS

Although that the amount of information collected prior and post to performance of modifications was not huge, still the Wilcoxon test was used for comparisons. The aforementioned test is a non-parametric test which is used for comparison of two sets of data in two different time periods.

TABLE II. DESCRIPTIVE STATISTICS AND TEST STATISTICS

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
Prior	11	16.4545	9.70941	2.00	32.00
Post	11	9.7273	7.39041	2.00	26.00
Test Statistics					
			Post Prior		
Z			-2.536[a]		
(Asymp. Sig.) 2-tailed			0.011		
a. Based on positive ranks. b. Wilcoxon Signed Ranks Test					

The Wilcoxon test compares the count of collisions prior and post to performance of modifications in 11 selected passages. It can be seen that a significant difference exists between the two time periods in terms of count of collisions. Considering that the sig. amount is less than 0.05, it can be stated that significant differences exist between counts of accidents prior and post to execution of modifications. In addition it has been shown that prior to modifications (16.45) the average rate of accidents was higher compared to post-modification (9.72).

TABLE III. WILCOXON TEST FOR COMPARISON OF RATE OF ACCIDENTS PRIOR AND POST TO PERFORMANCE OF GEOMETRIC MODIFICATIONS IN TERMS OF TYPE OF COLLISION

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
VAR00003	11	14.7273	9.19881	1.00	31.00
VAR00004	6	2.1667	1.60208	1.00	5.00
VAR00005	4	1.5000	1.00000	1.00	3.00
VAR00006	11	8.3636	6.87419	2.00	24.00
VAR00007	3	1.3333	.57735	1.00	2.00
VAR00008	8	1.3750	.74402	1.00	3.00

Test Statistics[d]			
	VAR00006 - VAR00003	VAR00007 - VAR00004	VAR00008 - VAR00005
Z	-2.501[a]	.000[b]	-1.000[c]
(Asymp. Sig.) 2-tailed	0.012	1.000	0.317
a. Based on positive ranks. b. The sum of negative ranks equals the sum of positive ranks. c. Based on negative ranks. d. Wilcoxon Signed Ranks Test			

The Wilcoxon test compares the count of collisions prior and post to performance of modifications in 11 selected passages with respect to manner of collision. This table shows that the only significant difference is in terms of collision of two vehicles. Since this was the only value of sig. smaller than 0.05; the differences between multi-vehicle crash and pedestrian collision rates before and after modifications are not statistically significant. In addition it has been shown that prior to modifications (14.72) the average rate was higher compared to post-modification (8.36).

TABLE IV. WILCOXON TEST FOR COMPARISON OF RATE OF ACCIDENTS PRIOR AND POST TO PERFORMANCE OF GEOMETRIC MODIFICATIONS IN TERMS OF CAUSE OF COLLISION

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
VAR00009	6	3.0000	1.41421	1.00	5.00
VAR00010	10	9.7000	4.21769	5.00	17.00
VAR00011	9	4.0000	3.67423	1.00	12.00
VAR00012	2	4.0000	.00000	4.00	4.00
VAR00013	2	1.0000	.00000	1.00	1.00
VAR00014	5	4.0000	4.52769	1.00	12.00
VAR00015	9	1.8889	.92796	1.00	4.00
VAR00016	10	4.4000	3.27278	1.00	11.00
VAR00017	7	3.2857	3.30224	1.00	9.00
VAR00018	2	4.0000	1.41421	3.00	5.00
VAR00019	1	2.0000	.	2.00	2.00
VAR00020	5	2.0000	2.23607	1.00	6.00

The Wilcoxon test compares the count of collisions prior and post to performance of modifications in 11 selected passages with respect to cause of collision. This table shows that the only significant differences are in terms of lack of yield sign and sudden change of direction. Since these were the only sig. values smaller than 0.05, rest of the causes are not considered as statistically significant. By taking a look at the upper table it can be seen that before modifications, the average values of lack of yield sign (9.7) and sudden change of direction (4) were higher than their values (4.4 and 3.8) after modifications.

The Wilcoxon test compares the count of collisions prior and post to performance of modifications in 11 selected passages with respect to time of collision. This table shows that the only significant differences belonged to the hours of 9-12 and 12-15 since their sig. values were smaller than 0.05. Therefore it can be stated that the only significant differences that have been developed after modifications belong to the hours of 9-12 and 12-15. By taking a look at the upper table it can be seen that before modifications, the average values of hours of 9-12 (4) and 12-15 (3.54) were higher than their values (1.63 and 1.81) after modifications.

TABLE V. WILCOXON TEST FOR COMPARISON OF RATE OF ACCIDENTS PRIOR AND POST TO PERFORMANCE OF GEOMETRIC MODIFICATIONS IN TERMS OF TIME OF COLLISION

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
VAR00026	11	2.3636	2.01359	.00	6.00
VAR00027	11	4.0000	3.06594	.00	9.00
VAR00028	11	3.5455	3.11010	.00	9.00
VAR00029	11	3.6364	1.91169	1.00	6.00
VAR00030	11	2.0000	1.94936	.00	6.00
VAR00031	11	.8182	1.16775	.00	3.00
VAR00032	11	.0909	.30151	.00	1.00
VAR00033	11	1.0000	1.18322	.00	3.00
VAR00034	11	1.6364	1.56670	.00	5.00
VAR00035	11	1.8182	2.31595	.00	8.00
VAR00036	11	2.3636	1.91169	.00	5.00
VAR00037	11	1.6364	1.36182	.00	4.00
VAR00038	11	.6364	.80904	.00	2.00
VAR00039	11	.6364	1.12006	.00	3.00

Test Statisticsc							
	VAR00033 - VAR00026	VAR00034 - VAR00027	VAR00035 - VAR00028	VAR00036 - VAR00029	VAR00037 - VAR00030	VAR00038 - VAR00031	VAR00039 - VAR00032
Z	-1.757a	-2.237a	-2.200a	-1.667a	-.086a	-.427a	-1.732b
(Asymp. Sig.) 2-tailed	0.079	0.025	0.028	0.095	0.931	0.669	0.083

a. Based on positive ranks.
b. Based on negative ranks.
c. Wilcoxon Signed Ranks Test

TABLE VI. WILCOXON TEST FOR COMPARISON OF RATE OF ACCIDENTS PRIOR AND POST TO PERFORMANCE OF GEOMETRIC MODIFICATIONS IN TERMS OF MANNER OF COLLISION

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
VAR00040	11	.2727	.46710	.00	1.00
VAR00041	11	10.8182	5.49214	.00	20.00
VAR00042	11	1.7273	1.79393	.00	5.00
VAR00043	11	2.8182	4.21469	.00	13.00
VAR00044	11	.8182	1.40130	.00	4.00
VAR00050	11	.4545	.52223	.00	1.00
VAR00051	11	5.7273	4.19740	.00	11.00
VAR00052	11	.6364	.92442	.00	3.00
VAR00053	11	1.6364	3.13920	.00	10.00
VAR00054	11	1.2727	.90453	.00	3.00
Test Statistics					
	VAR00050 - VAR00040	VAR00051 - VAR00041	VAR00052 - VAR00042	VAR00053 - VAR00043	VAR00054 - VAR00044
Z	-1.000[a]	-2.295[b]	-1.441[b]	-1.897[b]	-.866[a]
(Asymp. Sig.) 2-tailed	0.317	0.022	0.150	0.058	0.386
a. Based on negative ranks. b. Based on positive ranks. c. Wilcoxon Signed Ranks Test					

The Wilcoxon test compares the count of collisions prior and post to performance of modifications in 11 selected passages with respect to manner of collision. This table shows that the only significant difference belonged to the head-to-side collision manner since its sig. value was smaller than 0.05. Therefore it can be stated that the only significant difference that has been developed after modifications belongs to the head-to-side collision manner. By taking a look at the upper table it can be seen that before modifications, the average value of head-to-side collision manner (10.81) is higher than its value (5.72) after modifications.

While investigating and analyzing the collected data it was revealed that among the entire 181 collisions which had taken place prior to modifications, 18 were resulted from lack of attention to the forward, 97 were resulted from lack of yield sign, 38 were resulted from sudden change of direction, 8 were resulted from crossing red-lights, 2 were resulted from driving on opposite lanes, and 20 were resulted from other causes. Among the entire collisions which had taken place prior to modifications, 26 had taken place between 6-9A.M; 44 had taken place between 9-12A.M; 39 had taken place between12-15; 40 had taken place between15-18; 22 had taken place between 18-21; 9 between21-24 and 1 between 24-6AM.

Among the entire accidents occurred before modifications, 3 were head-to-head; 119 were head-to-side; 19 were head-to-rear; 31 were side-to-side and 9 were other types of collision. Among the entire accidents that occurred post to modifications (107); 92 were between two vehicles, 4 were between multi vehicles and 11 included pedestrians. Causes of 17 accidents were lack of attention to forward, 44 were caused by lack of yield sign, and 23 were caused by sudden change of direction, 8 were caused by crossing red-lights, 2 were caused by driving on opposite directions, 3 were caused by wrong turning manner and 10 were caused by other causes. 11 had taken place between 6-9A.M; 18 had taken place between 9-12A.M; 20 had taken place between12-15; 26 had taken place between15-18; 18 had taken place between18-21; 7 between21-24 and 7 between 24-6AM. 5 accidents were head-to head, 63 were head-to-side, and 7 were head-to-rear, 18 were side-to-side and 14 were other types of collisions.

VII. CONCLUSION

Comparing the count, type, manner and time of collisions in the aforementioned 11 selected sites before and after modifications shows that the modifications have resulted in a significant difference. The Wilcoxon test shows that the only significant difference in terms of cause of accident is lack of yield sign and sudden change of direction. In addition the most effective changes belonged to the time periods of 9-12 and 12-15. In addition, in terms of type of collision, the head-to-side type is the only type that has significantly changed. Among the entire occurred collisions, 162 were between two vehicles, 13 were multi-vehicle crashes and 6 also included pedestrians. Among the places, the highest crash rates belonged to crossroads and squares with 32 accidents. The highest rate of two vehicle crash belonged to squares and then intersections with 29 counts. The highest rate of multi vehicle crash also belongs to squares with 5 crashes and the highest rate of pedestrian involved accidents belong to intersections with 3 crashes.Among the entire 181 collisions prior to modifications, 18 resulted from ignoring the forward, 97 resulted from lack of yield sign, 36 resulted from sudden direction change, 8 resulted from crossing the red-lights, 2 resulted from driving on opposing lanes and 20 resulted from other causes. The highest rate of ignoring the forwards belongs to intersections with 5 counts. The highest rate of lack of yield sign belongs to squares with 17 counts. Highest rate of sudden change of direction also belongs to squares with 12 counts, highest rate of crossing the red-lights belongs to intersections, highest rate of driving on opposite lanes belongs to intersections and squares and most of other causes are also observed in intersections. Among the entire collisions occurred prior to reformations, 26 occurred between 6-9am, 44 between 9-12; 39 between 12-15; 40 between 15-18; 22 between 18-21;9 between 21-24 and 1 between 24-6am. Among the entire collisions occurred before reformations, three were head-to head; 119 were side to head, 19 were head to rear; 31 were side to side and 9 were other types of collision. In intersections there was one head to head crash. Highest rate of head to head crashes belonged to squares with 20 counts; highest rate of head to rear crashes belonged to intersections with 5 counts and highest rate of side to side crashes belonged to intersections with 13 counts. Among the 107 entire occurred collisions after the reformations, 92 were between two vehicles, 4 were multi-vehicle crashes and 11 also included pedestrians. Among the places, the highest crash rates belonged to intersections with 26 accidents. The highest rate of two vehicle crash belonged to intersections with 24 counts. The highest rate of multi vehicle crash also belongs to intersections with 2 crashes and the highest rate of pedestrian involved accidents belong to intersections with 3 crashes. Among the entire 107 collisions post to modifications, 17 resulted from ignoring the forward, 44 resulted from lack of yield sign, 23 resulted from sudden direction change, 8 resulted from crossing the red-lights, 2 resulted from driving on opposite lanes and 10 resulted from other causes. The highest rate of ignoring the forwards belongs to intersections with 11 counts. The highest rate of lack of yield sign belongs to intersections with 11 counts. Highest rate of sudden change of direction also belongs to squares with 9 counts, highest rate of crossing the red-lights belongs to intersections with 4 counts, highest rate of driving on opposite lanes belongs to squares and most of other causes are also observed in intersections with 6 counts. Among the entire collisions occurred post to reformations, 11 occurred between 6-9am, 18 between 9-12; 20 between 12-15; 26 between 15-18; 18 between 18-21;7 between 21-24 and 7 between 24-6am.

The entire collisions happening in squares count as 2 prior to modifications. One of these was resulted in personal injury and the other only in financial loss. After modifications, the total number accidents reduced to three with them all resulting in financial losses.

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