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Non-spatial Analysis for the Road Traffic Accidents

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Abstract

Road traffic accidents are huge health and development problem. The number of the accidents has been increasing in Turkey as in the world. In this study the road traffic accidents in Osmaniye are analysed using chi-square test for goodness of fit, χ^2 . This test known as non-spatial analysis investigates the validity of a distribution assumed for phenomena. It evaluates that the accidents are distributed uniformly according to the different types of variables for the accidents such as for seasons, months, days of a week, daylight, hours of a day, occurrence type of the accident, the number of the vehicles involved in the accidents, type of the vehicle involved in the accident. The findings show whether or not the variables have significant relationships with road accidents in the city centre. The significant variables need to be paid particular attention. The results will help to solve the accident intensive problem and support the decision makers for city planning and transportation planning which are the ways of the sustainability. This study is the preparedness for spatial analysis of the accident data with the coordinate values obtained from GPS (Global Positioning System) and integrated into GIS (Geographic Information System). It is another way through the information technology management.

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1. Introduction

The development of urban centers inevitably results in the increase of the number of road vehicles that daily use the road infrastructure. Collecting and analyzing data on traffic flow in urban environment has a great importance (Zupanovic, Grgurevic and Filipic, 2012). Accurate, complete and timely traffic record data is essential to enhance decision making and to improve traffic safety. With continuous monitoring the increase of the traffic accidents are seen on the roads. The impact of road traffic accidents is an economic, social, physical,

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psychological and public health challenge (WHO, 2004). To prevent the accidents on the roads spatial, non-spatial and temporal analysis are applied to the data on the accident reports. While the coordinate information are needed for the spatial analysis, all textual information are used in the non-spatial analysis such as dates, number of people/vehicles in the accidents, daylight, age, weather conditions, road/traffic signs conditions..etc.

Road accidents have increased in Turkey as worldwide (TSI, 2013). Osmaniye in Turkey is a developing city. For sustainable urban planning and safety there is a need for analysis of the traffic accidents in urban center. The traffic accidents in Osmaniye for 29 months from 1 January 2010 to 30 May 2012 are analyzed in the relation with weekdays, daylight, hours of a day, seasons and months.

2. The survey on chi-square method for road traffic accidents

There have been numerous studies into traffic accidents such as human factors, weather/road/environment conditions, vehicle characteristics, temporal factors, social/economic influences. Also many different geospatial and non-spatial statistical methods are applied for analyzing the accidents. Weather can be a significant cause of road accidents. Andersson and Chapman (2011) used climate change scenarios and temporal analogue to investigate the relationship between temperature and severe road accidents in the West Midlands in the United Kingdom. Andreescu and Frost (1998) analyzed the effects of rain, mean temperature and snow on automobile accidents monthly, annual and the entire study period. While some studies dealt with the weather effects on road accidents (Datla and Sharma, 2008; Edwards, 1996; Keay and Simmonds, 2006; Koetse and Rietveld, 2009; Nofal and Saeed, 1997), some of them investigated road conditions, human factors and temporal variations (Bullas, 2004; Engeland, Skurtveit and Morland, 1996; Khan and Tehreem, 2012; Smolensky, Milia, Ohayon and Philip, 2011; Wade, Hommand and Kim, 2004; Zaranka, Peceliunas and Matijosius, 2012).

One of the most frequently used methods to analyze the road traffic accidents is chi-square goodness of the fit. Wade, Hommand and Kim (2004) ran chi-square analysis if the different patterns of the accidents in Minnesota between no engagement of driver error and remaining cases were statistically meaningful after the descriptive statistics such as driver error vs severity of injury, engagement of driver vs daylight condition, daylight condition vs severity of accident. A study in Brasil characterized traffic accidents involving motorcycles and their relationship to mortality (Oliveira and Sousa, 2011). In the result of the increasing level of road traffic accidents in Nigeria it was discovered that there were significant differences among the various causes of accidents and accident cases with the respect to types of vehicles involved over the years (Ohakwe, Iwueze and Chikezie, 2011). Data interpretation for road traffic accidents in Dibrugarh city in Assam in India was done using degree of freedom, chi-square test for goodness of fit, chi—square test for independence of attributes (Goswami and Sonowal, 2011). Erdogan, Ylmaz, Baybura and Gullu (2008) calculated the number of the accidents in each 1 km parts of the highway in Afyonkarahisar in Turkey and created frequency table for each route for every year. Two expected and observed frequency tables were used to compare whether the accidents created a pattern. Chi-square test was used to find out whether two sets of frequencies were significantly different. One of the studies for Eskişehir in Turkey analyzed the relationship between the drivers' ages and the accidents faults, and between the drivers' genders and the accident fault types (Karacasu and Er, 2011). The other one was on variations in traffic accidents on seasonal, monthly, daily and hourly basis by using chi-square test (Karacasu, Er, Bilgic and Barut, 2011).

3. Materials and method

The Traffic Accident Data for the study are provided from Traffic Accident Determination Reports at Provincial Police Department in Osmaniye. Scanned reports are for the period between 01 January 2010 and 30 May 2012. All information in the reports is arranged in Microsoft Excell format for non-spatial analysis. Data are classified into seasons, months, days of the week, daylight, and hours of the day.

Chi-square test is used to measure the goodness of fit as a statistical model to describe. It summarizes the discrepancy between observed values and the expected values.

For this study at each variable the expected number of accidents is subtracted from the observed number of accidents. The difference is squared and divided by expected number of accidents and then the results are summed for all types. Using chi-square test of goodness of fit, it is tested that there is the validity of a distribution assumed for phenomena. These tests evaluate the null hypotheses H_0 that the accidents are distributed uniformly across the categories of the variables. After the calculation by hand and using Chi-Square Table, the analyses are generated with chi-square test in SPSS (Statistical Package for the Social Sciences) program.

Using the “Frequencies” in “Descriptive Statistics” in SPSS mean, median, standard deviation, skewness, kurtosis, minimum, maximum and percentile values are obtained and also the normal curves on histograms are drawn. As a result of these it is decided that the accident distribution is normal or approximately normal and two-tailed critical values can be used to compare with test values for chi-square tests. For making a decision the test values (χ^2_{test}) are compared with the critical values (χ^2_{critical}) under assumed significance level of 0.05. If the test value is greater than the critical value (it means that sigma value is smaller than 0.05) H_0 hypothesis is rejected.

4. Analysis and results

961 scanned accident reports are used for non-spatial analysis process. Before starting the analysis all information in the reports are recorded in MS Excell format. In this paper the number of the accidents is analyzed in relation with hours, days, months, seasons and daylight. Some of the resulting graphics are drawn with MS Excell program (Fig.1). According to the graphics it can be said that the number of the accidents in the different hours and in the different daylight conditions has important high variations while the number of accidents in weekdays, months and seasons has a small variations.

Unlike MS Excell Program chi-square test is a statistical tool that enables us to test the independence of two variables. When the test result is significant, the null hypothesis concerning their independence is rejected and two variables are considered to be significantly dependent to each other (Wade, Hommand and Kim, 2004). Chi-square analysis for goodness of fit method is applied to investigate if there is a significant relationship between the accident numbers and temporal variables such as hours, days, months, seasons and daylight. The null hypotheses are formed as below:

H_01 : (hours): There is no deviation in the numbers of the accidents by the hours of a day.

H_02 : (days): There is no deviation in the numbers of the accidents by the days in a week.

H_03 : (months): There is no deviation in the numbers of the accidents by months in a year.

H_04 : (seasons): There is no deviation in the numbers of the accidents by the seasons.

H_05 : (daylight): There is no deviation in the numbers of the accidents by the daylight condition.

While analyzing, some records are missed/deleted because the lack of data or the health of the analysis. Especially while analyzing according to months and seasons, the records in 2012 are missed because there are only for five-months-data in 2012. In case using them in the analysis the results may be peak for first five months or spring season. In the analysis of weekdays at significance level 0.05 degree of freedom is 6, χ^2_{critical} which is read on the chi-square distribution table is 12.59 is and calculated χ^2_{test} in SPSS program is 4.97. Since the χ^2_{test} value is less than χ^2_{critical} value, null hypothesis for weekdays that *there is no deviation in the numbers of the accidents by the days in a week* is failed to reject. It indicates that the accidents have a uniform distribution over a week. Nevertheless other analyzes on hours, months, seasons and daylight at significance level 0.05 indicate that the accidents don't have a uniform distribution since the χ^2_{test} value is greater than χ^2_{critical} value and the null hypotheses are rejected. Table1 presents the results of chi-square tests with calculation values.

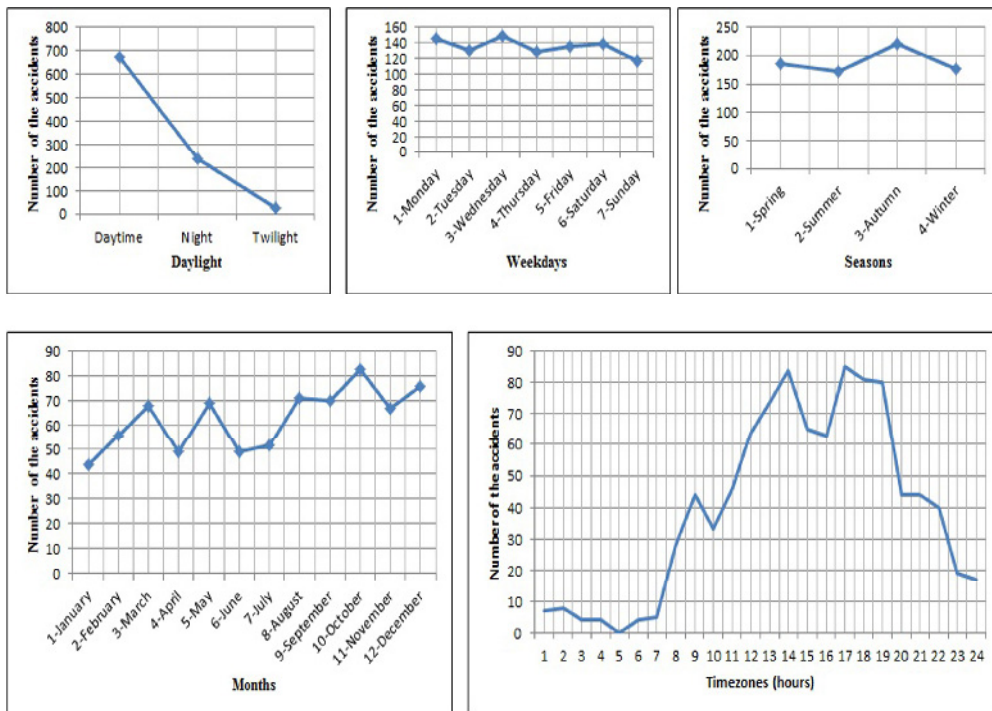


Figure 1: The distribution of the accidents according to the temporal factors graphically

	Significance level	df	$\chi^2_{critical}$	χ^2_{test}	H ₀ (Reject/ Fail to Reject)
Seasons	0,05	3	7,82	40,88	REJECT
Months	0,05	11	19,68	26,76	REJECT
Weekdays	0,05	6	12,59	4,97	FAIL TO REJECT
Timezones	0,05	22	33,92	453,12	REJECT
Daylight	0,05	2	5,99	690,32	REJECT

Table 1: The results of chi-square tests with calculation values

The number of the accidents is less in summers than the other seasons since Osmaniye has hot and wet climate properties in the summers (TSMS, 2013). In this season people prefer to spend their days at the seashores and highlands. Some of them use their annual permission rights from their works, others prefer to travel between work place and home in every morning and evening if the distance is not so far. Therefore the population in traffic flow decreases in summers and so do the accidents. This situation affects the number of the accidents over the months. September and October are the months of return from holidays and living at seashores or highlands, one of the most important reasons of this is the opening of the schools. Also second period of August is the month of preparations for schools and winter in means of food and firewood. These movements affect the traffic in the city center. The intensity of the accidents during the day is inevitable since the traffic is more intensive during the day. However the determination of the time zone of the day is needed. After midnights until 7:00 the

number of the accidents is very low. After 7:00 it starts to increase but it has a decrease between 14:00 and 17:00. After 17:00 until 19:00 it has high degree again and after 19:00 it starts to decrease. Between 20:00 and 24:00 the traffic has a low flow and the accidents decrease. It means that the accidents are intensive at the starting and ending times of the work.

5. Conclusion

A city plan is necessary for the development of the city. In urban planning traffic flows and traffic accidents should be under controlled. An organized and safety traffic system is one of the requirements to achieve a sustainable road transportation system for a healthy city life. The data analysis of the traffic accidents are needed for high-quality traffic planning in urban centers.

In this paper temporal non-spatial analyses are generated to help the traffic system in the urban center. As a result of the analyses the peak periods of a day are (AM peak 08:00 to 09:00), (PM peak 13:00 to 14:00) and (evening peak 16:00 to 17:00) while each weekday has a uniform accident distribution. At these hours extra traffic controls should be provided. It is observed that the number of the accidents has a peak value in autumn season, especially in October because the city life goes into action.

For better urban traffic planning as a next step is to study spatial analysis to determine the accident-intensive roads (hot spots) on the network and to determine whether the traffic signs are sufficient.

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