Seasonal Impact Analysis of climatic conditions on freeways light- vehicle traffic volume with temporal adaptation of weather parameters and traffic information

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ABSTRACT

Weather conditions are one of the most effective factors on traffic volume. So the main purpose of this study is to identify the effect of variables related to seasonal changes in climate parameters included visibility (m), wind speed (m/s), rainfall (mm), snow depth (cm) and temperature (℃) on of Lowshan- Qazvin freeway light-vehicle traffic volume. In this research, traffic and meteorology data is evaluated on three separate sections. In order to examine the existence of differences between the different climatic groups and the number of Light vehicles, U-Mann-Whitney or Kruskal-Wallis statistical tests were employed. In addition, in the proposed research method, two-way analysis of variance test was used to statistically analyze the relationship between the combination of two climatic variables with traffic volume in the studied sections. The results showed that the amount of traffic in all parts decreased by an average of about 18% with a decrease in visibility. Also increasing rainfall only in warmer seasons of spring and summer has led to a decrease in traffic volume. The results of statistical analysis of the combined effect of two-way meteorological variables on the amount of traffic in general showed that in the Kouhin-Mahmoudabad nemune section combination of rainfall and snow and snow with wind speed has affected the number of vehicles. The outputs of the proposed method, while revealing changes in freeway traffic volume under different climatic conditions, provides useful information to the relevant authorities for management and planning of traffic volume.

KEYWORDS

Seasonal Changes, Threshold Indices, Light-Vehicle Traffic Volume, Freeway, Statistical Analysis

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1. Introduction

Today, a wide range of factors affect traffic patterns. Climatic conditions are one of the most effective variables on traffic. Statistical estimates show that weather conditions lead to 544 million hours of vehicle delays annually [1]. A review of previous studies on weather conditions and traffic patterns suggests that the main focus of studies was on measuring the effect of weather in snow or rain in winter on traffic volume and other influential climate variables such as temperature, visibility Horizontal and wind speed etc. are less considered [2-6]. Second, the focus of most of the previous researches has been urban freeways [4-5]. Also, the main concentration of studies has been on the overall volume of traffic, and a small number of articles have addressed a specific class of vehicles [2, 4-5]. Therefore, in this study, it is regarded that by considering some of the climatic parameters such as horizontal visibility and wind speed, which were less studied in previous researches, as well as rainfall, temperature and snow depth, their impact on the light-vehicle traffic volume of the Loushan-Qazvin rural freeway, should be examined in all seasons.

2. Methodology

The main approach of this study is based on temporal and spatial matching of climatic parameters with traffic data to quantify the effect of different weather groups on traffic volume of three section, namely: Loushan-Kouhin, Kouhin- Mahmoudabad nemune and Mahmoudabad nemune- Qazvin. Therefore, in order to measure the independent effect of each weather parameters on the traffic volume, U-Mann-Whitney statistical tests to compare and evaluate the effect of two independent groups of weather related parameters and also Kruskal-Wallis test have been used when the compared groups are more than two [7]. Moreover, due to investigating the significance of the combined effect of two meteorological variables on the amount of traffic, two-way analysis of variance was used. Before implementing the relevant test, the correlation between all independent climatic variables was examined by using Pearson and Spearman correlation tests.

According to studies conducted by researchers, the use of weather data from each station is valid up to a radius of 32 km. In this regard, based on the nearest synoptic meteorological stations to the study axis, the information of each meteorological station has been generalized to one section [3]. Further necessary preparations are made, including sorting the hourly statistics, converting the Greenwich time of the meteorological statistics to the official time of the country, classifying the weather variables based on critical thresholds in the relevant sources, and eliminating official holidays to avoid entering traffic volume data that are likely to change under these conditions [6]. The details of classifying climatic parameters are given in Table 1.

Table 1. Critical thresholds of climate variables

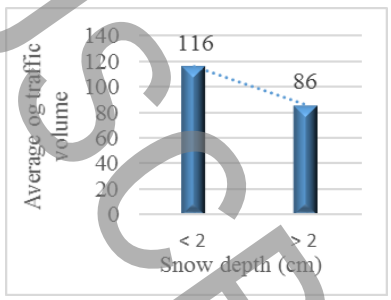
Variable	Critical thresholds
Horizontal Visibility (m)	0– 200, 200- 1000 and >1000 [8]
Rainfall (mm)	0– 1, 1- 5, 5- 10 and >10 [9]
Wind Speed (m/s)	0–3, 3-7, 7-13, 13- 20 and 20-28 [10]
Snow Depth (cm)	<2 and >2 [8]
Temperature (°C)	0 and <0, 0- 35 and >35 [9]

After integrating meteorological and traffic statistics, in order to select the appropriate statistical test, the distribution of the studied data with Kolmogorov-Smirnov test has been measured. Based on the results the distribution of data can be assumed to be abnormally reliable. But when the sample is large, the central limit theorem ensures that parametric tests can be used even if the distribution is not normal [7].

3. Results

In order to measure the effect of each climate parameter on traffic volume, U-Mann-Whitney or Kruskal-Wallis statistical tests were performed. The following diagram that displays the changes of traffic volume in terms of snow depth climate parameter, is given as an example in Figure 1. The numbers on the chart indicate the average of light vehicle traffic volume in each of the climatic subgroups, in the period of 1390 to 1397.

Figure 1. The average of light vehicle traffic volume in terms of snow depth in winter (Kouhin- Mahmudabad nemune section)



The results show that the traffic volume in all parts has decreased by an average of about 18% with a decrease in visibility. The wind speed parameter also Tables must had no effect on the movement of vehicles

[10]. This is in fact a confirmation of the lack of significant effect of wind speed up to 14 meters per second on traffic volume, because winds with a speed of 2 to 13 meters per second are in the category of mild winds according to the Beaufort global scale. In addition, due to the results, only in the hot summer season, with the increase in rainfall in the two sections of Loushan-Kouhin and Mahmoudabad nemune-Qazvin, the traffic volume has reduced by about 40%. In order to confirm the accuracy of this output, the result of one of the previous studies in this field indicate that rainfall is effective only in summer season [6]. In conditions of heavy snowfall in winter, the volume of traffic has decreased by more than 70% in the higher part of Loushan-Kouhin. Also, in the cold seasons of autumn and winter, with the reduction of air temperature, the number of light vehicles in all three sections is reduced by more than 55%. In a recent study conducted by Wang et al. In 2018, similar to the present study, the basis for classifying the temperature parameter into two categories was below zero and above zero [11].

To measure the combined effect of climate parameters on traffic volume, in the first, the results of Pearson and Spearman correlation test showed that the output of correlation matrices between all independent climate variables was similar to each other. This output confirms that based on the central limit theorem, it can be acknowledged that in a huge amount of data, including 8-year traffic and meteorological statistics (21,712 rows for each section in all seasons), the application of each of the parametric and non-parametric tests will have similar results. Secondly, the outputs indicate that only in the Loushan-Kouhin section there was a correlation between the two parameters of snow depth and wind speed, and since the snow days were low, this variable in favor of the wind speed parameter was removed for statistical analysis. The results of two-way analysis of variance showed that in Loushan-Kouhin section, wind speed in combination with rainfall and also wind speed along with temperature factor, in Kouhin-Mahmoudabad nemune section, a combination of snow with wind speed and in Mahmoudabad nemune-Qazvin, horizontal visibility with snow depth, horizontal visibility and temperature as well as horizontal visibility in combination with wind speed factor, in addition to combining rainfall conditions with wind speed on the number of vehicles Has been impressive.

4. Conclusion

Overall, the results of measuring the independent effect of meteorological variables on the amount of traffic indicate the effect of summer rainfall, temperature decrease, heavy snowfall conditions in winter and reduced horizontal visibility on traffic volume. Based on the results of this study and citing the recommendations of preventive intervention of police and the country's road safety regulations, equipping the freeways with a road warning system and informing the weather conditions using an online system in similar climate conditions and with the knowledge of the possible approximate of traffic volume changes, will be useful in order to manage and control traffic and save time and prevent other consequences of traffic congestion, including increasing repair costs and Maintenance, noise and air pollution, increase fuel consumption and travel time [13].

5. References

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