Research on the Analysis Method of Highway Traffic Impact Under Large-Scale Emergencies with Passenger Cars as an Example

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Abstract. For the monitoring of highway network operation under the influence of large-scale emergencies, based on the historical traffic flow data, using time series and other models to predict the traffic flow that is not affected by large-scale emergencies, combined with the same spatial and temporal scales of the affected flow data, to conduct a comparative analysis, and put forward the flow judgement model based on the attenuation factor. Finally, the data of expressway passenger train operation in Guangdong Province is taken as the research object to verify. The experiment proves that the model has a good effect, which can provide support for the traffic prediction of expressway management departments in the case of large-scale emergencies, and support them to make scientific decisions in high-speed management business.

Keywords: major emergency events; expressway; attenuation factor; traffic forecast

1 Introduction

Extreme weather events, major natural disasters, public events and other natural and man-made disturbances of a wide range of emergencies on the safety of highway traffic has brought a huge impact on the direct manifestation of the change in people's travel behavior and demand, increasing the risk of people's travel. In the context of the increasingly prominent impact of transportation on social and economic development, scientific assessment of the impact of large-scale emergency disturbances on highway traffic flow is of great significance to enhance the monitoring level of highway network and improve the safety of highway traffic. Therefore, it is necessary to study and analyze the impact of large-scale emergencies on highway traffic volume and reveal the related mechanism, so as to scientifically respond to the occurrence of similar events in the future.Therefore, this paper takes Guangdong Province's expressways as the research object, selects The statistical data of highway passenger flow in April and June

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2021 are selected, and combines LSTM network to build a quantitative analysis model of the impact of large-scale emergencies on expressway traffic volume. [1][2]

2 Flow Analysis in the Context of the Impact of Widespread Emergencies

2.1 Traffic Flow Forecasting Model

In this paper, we consider the impact of large-scale emergencies and introduce an attenuation factorλ. That is, the predicted value of flow under the influence of a large-scale contingency (Q') It should be the predicted flow value (Q) andλThe result of the combined effect is shown in equation (1):[3]

$$Q' = \alpha \cdot \lambda \cdot Q \tag{1}$$

In the formula, theα-Empirical values for types of large-scale emergencies, and$0 \le \alpha \le 1$, defaults to 1.λ-decay factor, and$0 \le \lambda \le 1$; Q-The volume of traffic unaffected by public events.Q'-Traffic affected by public events.

2.2 Flow Attenuation Factor

Different types of traffic are affected by a wide range of emergencies with different intensity, so the attenuation factor is not a fixed constant, i.e., as in equation (2).

$$\lambda = f(Q) \tag{2}$$

In the formula, theλ-attenuation factor.f(Q)—λAboutQfunctions; theQ-Traffic volumes unaffected by public events.

According to historical statistics, whenQThe greater the impact of widespread emergencies on traffic flow, the greater the impact ofλThe smaller. For example, during the Spring Festival, May Day and other holidays, the public travel increase, traffic will increase significantly, if a public event occurs at this time, the traffic will be significantly reduced compared with normal conditions. On weekdays when the traffic volume is low, due to the regularity of vehicle travel is more fixed, the impact of public events is relatively small. Combined with the actual statistics, the two exponential functions are more in line withλThe pattern of change.

2.3 Calculation of Attenuation Factors Based on Exponential Functions, the

$$\lambda = f(Q) = \begin{cases} \min\left(\alpha \cdot e^{(a+b\cdot \ln(Q))},\ 1\right), & Q > 0 \\ 0, & Q = 0 \end{cases} \tag{3}$$

In the formula, thea-The function parameter, which represents the intercept of the exponential trend line.b-The parameter of the function, which represents the rate of change of the curve.Q-The volume of traffic that is not affected by a public event.λ-Decay factor, in particular, is defined when$Q = 0$When$\lambda = 0$。

At this time.f(Q)The image of the function is shown in Figure 1 below. [4]

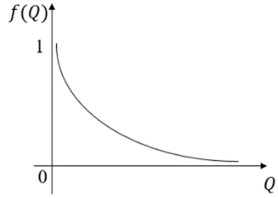

Fig. 1. A Schematic representation of the decay function

Based on the data, after dividing 5 days as the test values and the rest as the training set, the empirical values of the attenuation factor were calculated and the following results were obtained.

Provincial Buses.
Parameters obtained by training using the training set$a = 6.0373$, parameters$b = -1.0072$, then the function expression is.

$$\lambda = \begin{cases} \min\left(e^{(6.0373 - 1.0072 \cdot \ln(Q))},\ 1\right), & Q > 0 \\ 0, & Q = 0 \end{cases} \tag{4}$$

Data from 5 days after use were tested and the results are shown in Table 1, with an average absolute percentage error of 7.77%.

Table 1. Provincial bus results schematic diagram

DataTime	Unaffected test values	Attenuation coefficient	The affected predicted value	The affected true value	MAPE
25-Jun	533.9605	0.7495	400.202	392.8412	1.87%
26-Jun	505.8752	0.7914	400.3581	372.2492	7.55%
27-Jun	500.5271	0.7999	400.3888	444.2599	9.88%
28-Jun	489.5887	0.8179	400.4527	433.3335	7.59%
29-Jun	493.3973	0.8116	400.4303	454.8681	11.97%

Outbound Buses.
Trained to obtain the parameters$a = 1.7028$, parameters$b = -1.2195$, then the function expression is.

$$\lambda = \begin{cases} \min\left(e^{(1.7028 - 1.2195 \cdot \ln(Q))},\ 1\right), & Q > 0 \\ 0, & Q = 0 \end{cases} \tag{5}$$

Data from 5 days after use were tested and the results are shown in Table 2, with an average absolute percentage error of 10.26%.

Table 2. Outbound bus results schematic diagram

DataTime	Unaffected test values	Attenuation coefficient	The affected predicted value	The affected true value	MAPE
25-Jun	533.9605	0.7495	400.202	392.8412	1.87%
26-Jun	505.8752	0.7914	400.3581	372.2492	7.55%
27-Jun	500.5271	0.7999	400.3888	444.2599	9.88%
28-Jun	489.5887	0.8179	400.4527	433.3335	7.59%
29-Jun	493.3973	0.8116	400.4303	454.8681	11.97%

Incoming Buses.
Trained to obtain the parametersa $= 0.7311$, parametersb $= -0.6348$, then the function expression is.

$$\lambda = \begin{cases} \min\left(e^{(0.7311 - 0.6348 \cdot \ln(Q))},\ 1\right), & Q > 0 \\ 0, & Q = 0 \end{cases} \tag{6}$$

Data from 5 days after use were tested and the results are shown in Table 3, with an average absolute percentage error of 8.14%.

Table 3. Incoming bus results schematic diagram

DataTime	Unaffected test values	Attenuation coefficient	The affected predicted value	The affected true value	MAPE
25-Jun	4.78	0.7695	3.678	3.6419	0.99%
26-Jun	4.8268	0.7647	3.6911	3.5621	3.62%
27-Jun	5.1413	0.7347	3.7772	4.1089	8.07%
28-Jun	4.403	0.8106	3.5693	4.0552	11.98%
29-Jun	4.3196	0.8206	3.5445	4.2213	16.03%

Interprovincial Buses.
Trained to obtain the parametersa $= -2.3947$, parametersb $= -0.7747$, then the function expression is.

$$\lambda = \begin{cases} \min\left(e^{(-2.3947 - 0.7747 \cdot \ln(Q))}, 1\right), & Q > 0 \\ 0, & Q = 0 \end{cases} \tag{7}$$

Data from 5 days after use were tested and the results are shown in Table 4 with an average absolute percentage error of 2.64%.

Table 4. Interprovincial bus result diagram

DataTime	Unaffected test values	Attenuation coefficient	The affected predicted value	The affected true value	MAPE
25-Jun	0.0465	0.9824	0.0457	0.0454	0.62%
26-Jun	0.0517	0.905	0.0468	0.049	4.52%
27-Jun	0.0506	0.9202	0.0466	0.0461	1.00%
28-Jun	0.0548	0.8651	0.0474	0.0476	0.41%
29-Jun	0.0544	0.87	0.0473	0.0507	6.65%

3 Conclusion

After calculation, the flow prediction error after increasing the attenuation factor is smaller, and the overall error is controlled within 10 %, which is within the acceptable range. The model can effectively assist the expressway operation management unit to conduct scientific research and judgment on the traffic situation. [5]

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