



Summary of Cascading Failure in Urban Traffic Network

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Abstract: Cascading failure of urban transportation network will cause serious traffic problems and have a huge negative impact on the lives of the inhabitants and economic development. This paper summarizes the research on cascading failure of transportation network by scholars at home and abroad. Firstly, this paper summarizes the research results of many scholars on the causes of cascading failure in transportation networks. Secondly, it combs the relevant literature on the reasonable evaluation of the degree of cascading failure. Finally, it summarizes how to alleviate the negative impact of cascading failure in traffic network. This paper provides a more scientific and reasonable reference for the realization of network traffic management.

Keywords: urban transportation, cascade failure, evaluation, mitigation strategy

1. Introduction

With the continuous development of domestic economy and the growing demand of urban residents for travel, the construction of China's urban transportation network is constantly improved, the scale of transportation network is increasing, and the phenomena of traffic congestion, traffic accidents, exhaust pollution and so on are more and more frequent. Because the urban traffic network is a complex network formed by the interconnection between different traffic nodes, the traffic problems in the network will cause the chain reaction of road network congestion and cascade failure effect. Cascading failure is a common phenomenon in network systems. In different network systems, the cascading failure of network system functions will be caused by network overload, which will seriously affect the overall efficiency of the network. Network topology, traffic distribution mode and load management strategy are important factors.

In the urban traffic network with complex structure, once the function of a road section or intersection temporarily fails for some reasons, resulting in short-term congestion, it will successively lead to congestion on the surrounding intersection roads. In serious cases, this congestion phenomenon will spread to the whole road network system. Therefore, in this context, the research on urban traffic cascade failure has profound practical significance. At present, the relevant research on failure in the field of transportation mainly includes the causes, scale evaluation and mitigation strategies.

2. Research status of cascade failure in transportation field

In the research on cascading failure of public transport network, ZHANG [1] weighted the initial load capacity of public transport stations, deliberately attacked the public transport network system based on the weight value, and deeply explored the inducement of cascading failure according to the feedback information of simulation data. YAO [2] proposed to build a SIS model based on the mean field theory to analyze the delay diffusion phenomenon in the traffic network, reasonably analyze the causes of delay and delay diffusion in the road network, and determine the outward diffusion threshold of the delay phenomenon in the traffic network, which provides a new perspective for the study of the cascade failure of traffic delays. SHEN [3] established a multi-level traffic composite network by combining two different travel modes of subway and public transport, first attacked the composite traffic network in different ways, then analyzed and tested the network cascade failure survivability, and conducted cascade failure survivability analysis and test for the network structure of single traffic travel mode. The research shows that the performance of composite network is better than that of single network structure, and provides a reasonable mitigation strategy for the cascade failure of traffic network, which has a certain reference significance for the planning of urban composite traffic network. LI [4] conducted research based on the Congestion Propagation of rail transit network. On the basis of considering the travel path selection preference and traffic flow redistribution under road congestion, Li compared and analyzed the differences in the scale of cascading failure of urban rail transit network under the failure of different initial nodes. MA [5] used ML model to simulate the cascading failure phenomenon in rail transit network. It is considered that dynamic restriction on the traffic network will induce the cascading failure of subway network.

3. Study on cascading failure evaluation of urban transportation network

YIN [6] believes that cascade failure will cause traffic network congestion, and proposes to divide the road traffic network into two independent levels: Road and network, establish different road traffic congestion index models according to different road levels, and establish a traffic congestion index calculation model based on the network layer, and use the network connectivity congestion index calculated by the model to express the congestion degree of the traffic network. By mastering the degree of congestion, the failure degree of road network traffic cascade can also be intuitively understood. REHAK [7] believes that network cascading failure evaluation is an important field of network cascading failure research. The evaluation behavior is a reasonable deduction after using mathematical relationship to simulate the ability and relationship of network nodes. In the research, it is proposed to integrate the risk of cascading failure propagation in the network into the logical algorithm, which can reflect the specific situation of network cascading failure through scientific calculation. Experimental examples show that this evaluation method can effectively evaluate the impact of cascade failure on road network traffic when applied to traffic network. ZHU [8] combines three different indicators to evaluate the resilience of urban public transport network. By comparing and analyzing the changes of index values before and after the network is attacked by the outside world, it can intuitively reflect the network state and the resilience of traffic network. Therefore, this study can also provide inspiration for the evaluation of cascade failure degree. ZHANG [9] analyzed the cascading failure characteristics of railway transportation network. Based on the relevant research results of other scholars, he proposed to use the network global efficiency parameters and the network maximum link subgraph as the index to evaluate the network performance after the cascading failure of railway transportation network. The index evaluation results adjust and update the road network traffic, which is conducive to the prevention and scale control of cascading failure. ZHANG [10] in order to accurately evaluate the state of transportation network nodes, an integrated coupled mapping lattice model is constructed, and on this basis, the subway passenger flow is subdivided, and the new inflow flow is scientifically allocated, so as to reasonably evaluate the impact of cascade failure on traffic.

4. Mitigation strategy of cascading failure in urban transportation network

The spread of traffic network congestion will lead to the cascade failure of network functions, which will have a great impact on the normal operation of the road system, lead to certain economic losses, and even harm people's life and health. Many foreign scholars have proposed many mitigation strategies to suppress the cascading failure of traffic network.

PATTANAİK [11] believes that road traffic congestion has become a serious problem that all countries in the world need to consider, and the cascade failure caused by congestion will cause serious losses to the economy. Based on this, an intelligent congestion avoidance technology is proposed to give travel decision-making suggestions from the perspective of individuals. This method uses the clustering algorithm to predict the road traffic congestion, and uses the algorithm to calculate the shortest travel path. When the user inputs the target location at the terminal, the user can obtain the best travel suggestions and dynamically adjust according to the user's needs. Therefore, travelers can more flexibly avoid traffic congestion, so as to avoid traffic congestion caused by individual aggregation or aggravating congestion, which is conducive to the mitigation of urban traffic cascade failure. XING [12] compared the damage degree of random attack and malicious attack on the subway transportation network. The results show that malicious attack will cause greater damage to the network than random attack. In order to curb the adverse impact of external attacks on the traffic network, it is necessary to identify the important nodes in the network, control and strengthen the key traffic nodes. If necessary, lines can be added in the traffic network to alleviate the traffic load of existing lines and improve the operation efficiency of the traffic network, which can improve the robustness of the network and improve the mitigation ability of road network traffic to cascade failure. RUI [13] made an in-depth analysis on how to mitigate cascading failure, simulated the propagation process of cascading failure in the network by using the virus propagation model, redistributed the traffic in the network fault area, and started the second wave of traffic distribution according to the node load capacity and clustering coefficient until all traffic was successfully transformed by the network, The network cascading failure crisis can then be alleviated or eliminated. XIONG [14] observed and analyzed the propagation law of traffic congestion in the road network, and believed that there is a range boundary for the propagation of node failure congestion. If the propagation range of traffic congestion in the network can be identified and traffic flow dredging measures can be taken in time, the extension of congestion in the middle layer of the network and the occurrence of cascade failure can be blocked.

5. Conclusion

The research on cascading failure of urban transportation network has very important practical significance. The reason is that once cascading failure occurs in the road transportation network, it will lead to large-scale paralysis of the transpor-

tation network in a very short time, seriously affect residents' travel, and even have a huge negative impact on the urban transportation industry and medical emergency services.

Therefore, many scholars have carried out research on the causes of cascading failure of road traffic network, the evaluation of cascading failure scale and the mitigation strategies of cascading failure, in order to provide valuable reference for urban traffic planning and management. With the continuous development of urban transportation network, researchers should put more energy into thinking about how to minimize the occurrence of network cascade failure and its negative impact on travel network.

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