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Measures of Reliability and Transportation Quality on an Urban Rail Transit Network in Case of Links' Capacities Loss

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Abstract : Urban rail transit (URT) plays a significant role in dealing with traffic congestion and environmental problems in cities. However, equipment failure and obstruction of links often lead to URT links' capacities loss in daily operation. It affects the reliability and transport service quality of URT network seriously. In order to measure the influence of links' capacities loss on reliability and transport service quality of URT network, passengers are divided into three categories in case of links' capacities loss. Passengers in category 1 are less affected by the loss of links' capacities. Their travel is reliable since their travel quality is not significantly reduced. Passengers in category 2 are affected by the loss of links' capacities heavily. Their travel is not reliable since their travel quality is reduced seriously. However, passengers in category 2 still can travel on URT. Passengers in category 3 can not travel on URT because their travel paths' passenger flow exceeds capacities. Their travel is not reliable. Thus, the proportion of passengers in category 1 whose travel is reliable is defined as reliability indicator of URT network. The transport service quality of URT network is related to passengers' travel time, passengers' transfer times and whether seats are available to passengers. The generalized travel cost is a comprehensive reflection of travel time, transfer times and travel comfort. Therefore, passengers' average generalized travel cost is used as transport service quality indicator of URT network. The impact of links' capacities loss on transport service quality of URT network is measured with passengers' relative average generalized travel cost with and without links' capacities loss. The proportion of the passengers affected by links and betweenness of links are used to determine the important links in URT network. The stochastic user equilibrium distribution model based on the improved logit model is used to determine passengers' categories and calculate passengers' generalized travel cost in case of links' capacities loss, which is solved with method of successive weighted averages algorithm. The reliability and transport service quality indicators of URT network are calculated with the solution result. Taking Wuhan Metro as a case, the reliability and transport service quality of Wuhan metro network is measured with indicators and method proposed in this paper. The result shows that using the proportion of the passengers affected by links can identify important links effectively which have great influence on reliability and transport service quality of URT network; The important links are mostly connected to transfer stations and the passenger flow of important links is high; With the increase of number of failure links and the proportion of capacity loss, the reliability of the network keeps decreasing, the proportion of passengers in category 3 keeps increasing and the proportion of passengers in category 2 increases at first and then decreases; When the number of failure links and the proportion of capacity loss increased to a certain level, the decline of transport service quality is weakened.

Keywords : urban rail transit network, reliability, transport service quality, links' capacities loss, important links
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