Evaluation of Train Rescheduling Alternatives Using Station Service Indices

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During the disruption of train services, a series of timetable alterations must be made to return services to normal. This series of corrective actions is called train rescheduling. To evaluate train rescheduling alternatives, a number of indices have been proposed, such as the total time of train delays, and the number of trains canceled. However, such indices deal only with matters from an overall operational standpoint, and do not reflect the standpoint of individual passengers suffering the inconvenience of the service disruption. In addition, evaluation results cannot be understood instantly.

This paper proposes the use of individual station service indices to evaluate train rescheduling alternatives. Each station service index expresses, in terms of actual travel speed, the extent of service that passengers departing from the station can receive on average, under a specific rescheduling timetable. When determining these individual station service indices, we added a component reflecting passenger dissatisfaction with the increase in congestion.

Individual station service indices are calculated as follows.

(1) Using the train rescheduling timetable and automatic ticket inspection machine data, infer the trains that each passenger takes from their departure station toward their intended arrival station, then calculate the actual time required for their travel, including wait time.

(2) From the data on the number of passengers in each train, estimate each passenger's dissatisfaction quotient with regard to crowded conditions, and expressed this quotient as time. Add this time to the actual time required for travel.

(3) Divide the distance from the departure station to the intended arrival station by the sum of (1) and (2), to obtain the effective speed (perceptible travel speed) for each passenger.

(4) Calculate the average effective speeds for each of the departure stations and assume it as the station service index for that departure station.

Using these station service indices, we evaluated an actual train rescheduling plan (Rescheduling Plan X, Fig. 2) that was implemented in a quadruple-track section (track layout shown in Fig. 1), and an operations rescheduling alternative (Rescheduling Alternative Y, Fig. 3) that was based on a different concept. The train rescheduling was required after a traffic accident involving injury occurred at Station D, forcing the operation of up and down trains on the inside tracks to stop for about 30 minutes, beginning at 5:26 p.m. In this section, express trains normally run on the outside tracks, while rapid and local trains run on the inside tracks. Under Rescheduling Plan X, the route for rapid trains indicated by the brown lines in Fig. 2 was changed from the inside to the outside track. Rapid trains ordinarily stop at Station C. However, in Rescheduling Plan X, rapid trains do not stop at the station because the station has no platform for the outside tracks. On the other hand, under Rescheduling Alternative Y, rapid trains continue running on the inside tracks, with no change in track. In this case, rapid trains could stop at Station C, but the problem of a delay of the rapid train arises. The calculated station service indices for these two cases are shown in Fig. 4.

Under Rescheduling Plan X, the station service index for Station F, where express trains do not stop, is higher than under Rescheduling Alternative Y. On the other hand, station service indices at stations A and B are higher under Rescheduling Alternative Y than under Rescheduling Plan X. This is because with Rescheduling Alternative Y, although two up rapid trains would be forced to stop at Station F for a long time, express trains running on the outside tracks would not be delayed. Thus, use of station service indices makes it possible to easily ascertain the convenience quotient of passengers departing from each station.

Our future tasks with regard to station service indices include considering passenger dissatisfaction levels for matters other than the longer travel time and greater vehicular congestion (e.g., their need for extra transfers), and improving the accuracy of models representing passenger behavior during service disruption.

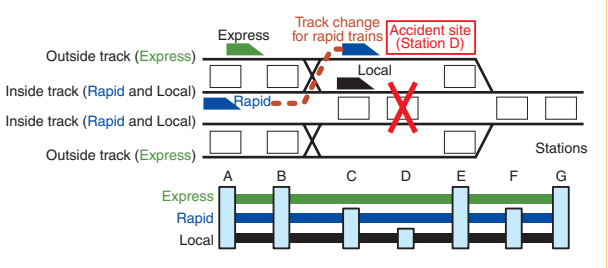

Figure 1. Track layout of affected section

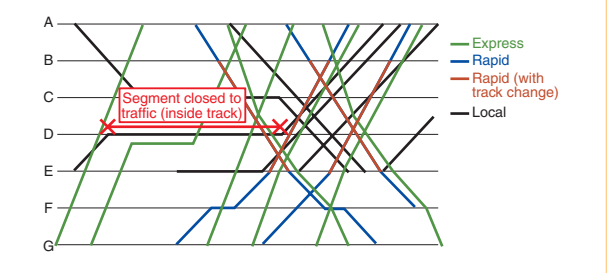

Figure 2. Train Rescheduling Plan X (plan actually implemented, with track change)

Figure 3. Train Rescheduling Alternative Y (modified plan, without track change)

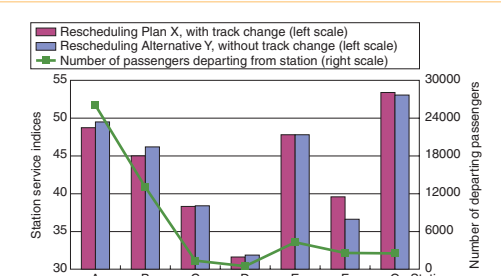

Figure 4. Calculated station service indices