Development of a Method to Predict Passenger Numbers upon Resumption of Train Service

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The huge number of people carried by railway systems in major Japanese cities means that trains operate at extremely frequent intervals. Train drivers and conductors are constantly working to keep trains running exactly on schedule—measured by the second. Japanese trains are famous throughout the world for their punctuality. Nevertheless, when an accident causes an interruption to service, traffic controllers must reschedule trains to resume normal operations as soon as possible. The aim of this study is to obtain information on the number of trains required when service is resumed from an estimation of passenger numbers, so that better methods of train rescheduling can be formulated.

Faced with a sudden interruption to train service, passengers must decide what course of action to take. They can wait until service on the line resumes, use the extensive rail network to take another, less direct route to their destination, use an alternative means of transport such as bus or taxi or cancel their travel plans altogether. An Internet questionnaire survey was conducted on rail users that experienced such a disruption to service. To understand in detail the reasons behind passengers' decisions regarding the best course of action to take, it is necessary to ask them about the experience while it is still fresh in their minds. Passengers were therefore asked to respond on the day of the disruption. Analysis of the survey results revealed the following.

(a) The vast majority of passengers opted to continue their journey by rail—over 90% chose to wait for service to resume or use an alternative route (Fig. 1).

(b) Over 85% of such passengers made their own prediction with regard to the time it would take for service to resume (Fig. 2).

A model was constructed for the two main actions taken—using an alternative route and waiting for service to resume. The disaggregate logit model, widely employed in transport demand forecasting, was used. The explanatory variables were given the following properties.

(a) The time required to reach the destination in the case of waiting for service to resume is the total of the journey time including transfers and the time waiting for service resumption (as provided by station staff or predicted by the passenger).

(b) The threshold is introduced into difference in utility between taking an alternative route and waiting for service resumption using the inverse of the waiting time.

Using this model, a case study simulation was performed based on the assumption of a sudden interruption to rail service on a certain line (Fig. 3). This model was used to calculate the probability that passengers arriving at Station X would choose to travel using an alternative route at 1-minute intervals following the interruption (Fig. 4). This enables the number of passengers waiting at Station X for service resumption to be calculated.

The reproducibility of the model was verified by comparing the actual decrease in customer numbers as a result of disruption to service (using origin/destination data from automatic ticket gates) and the decrease calculated using the model. Commercial use of this method of predicting passenger numbers is now anticipated as its validity has been confirmed.

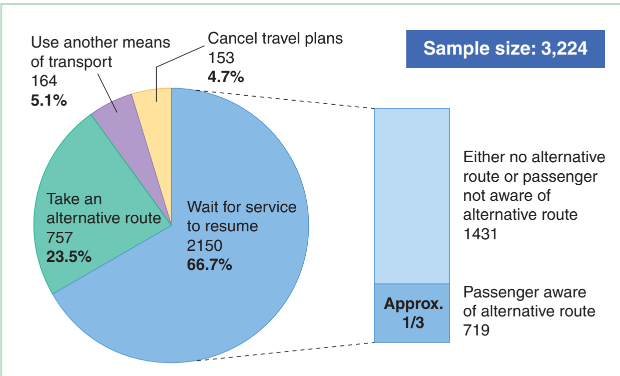

Fig. 1 Decisions taken by passengers

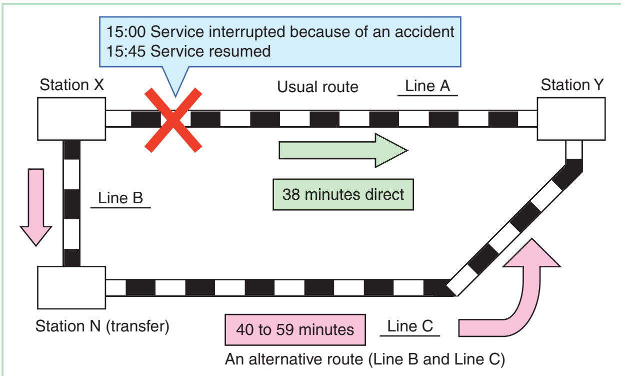

Fig. 3 Case study railway line

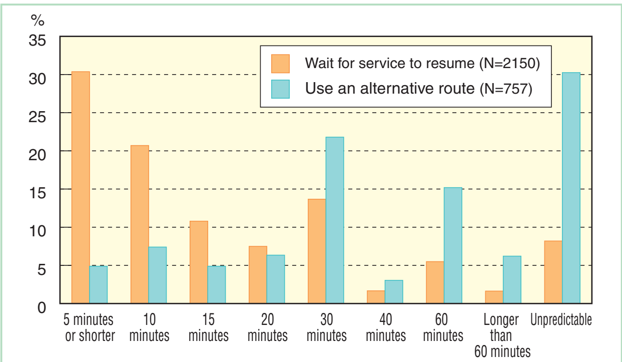

Fig. 2 Action taken by passengers and predicted time for service to resume

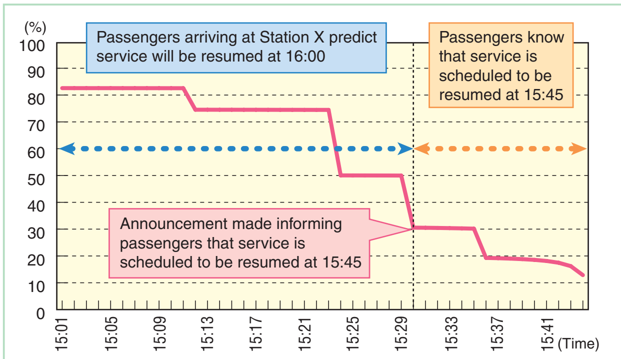

Fig. 4 Percentage of passengers choosing to take an alternative route as calculated using the model