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Service quality evaluation for urban rail transfer facilities with Rasch analysis

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ABSTRACT

This paper evaluates the service level of urban rail transfer facilities based on Rasch analysis, taking into account transit users' subjective perceptions. A total of 3970 respondents who usually transfer between different urban rail lines at least 3 times a week and who are between 15 and 75 years old were randomly surveyed. We evaluate the transfer station service quality by capturing satisfaction with a range of service items. The items are grouped into five criteria: information, mobility, comfort, convenience and safety. The satisfaction with the five criteria is further distinguished based on trip purpose. From the results, it was concluded that service items related to transfer time (train arrival information, walking distance) are important to users during commute, educational, business and leisure trips. Instead important service items for transfer convenience when on shopping or leisure trips are walking amenity, waiting space, parking lot usability or specific facilities such as the presence of baby-care rooms. Considering also the characteristics of Seoul's transit network we discuss which transfer facilities are likely to be a key for encouraging people to use urban rail and suggest that Rasch analysis is a suitable tool for this type of evaluation that is not frequently used in transport planning.

1. Introduction

Demand for transportation refers to the amount and type of travel that people will choose under certain conditions and factors such as prices and service quality. There has been increased attention as to how to measure the impacts of service quality on travel demand and how to predict the impacts of specific service quality changes toward transport elasticities (Litman, 2013). In particular, public transportation has been becoming increasingly important for environmental goals. With growing competition, it is expected that service quality will have an increasing impact on the public transport demand. Improvements of service quality can help smoothen the operation and make transit a more attractive travel option (Iseki et al., 2007). More specifically, a range of academic and consultancy studies have shown that transfer inconvenience discourages potential users from taking mass transit and reduces the satisfaction of existing users (Hine and Scott, 2000; CTPS, 1997; Steer Davies and Gleave, 1998; Wardman, 2001; Guo and Wilson, 2011). Hence, improving transit facilities may play an important role in raising public transport satisfaction and positively affect ridership in the long term.

Several aspects of transfer service quality and their respective importance are difficult to quantify for many travelers. We therefore utilize in this paper Rasch analysis. The approach was developed to increase objectivity and invariant comparisons between items and persons (Engelhard, 2013). In other words, the goal is better comparability of different persons answering several questions. Some persons might be very familiar with a question's content whereas others might find it very difficult to answer the same question, as they have never been exposed to the problem. To provide one example where Rasch analysis is frequently used, we refer to Hawthorne et al. (2008) who establish the utility score for the Assessment the Quality of Life (AQoL)[1] instrument. In transport planning it has been less used. An exception is Cheng (2011) who evaluates public transport web site service quality by adopting Rasch analysis. Following examples might show why we believe that using Rasch analysis is also appropriate for the problem addressed in this paper:

Questions regarding satisfaction with parking facilities at a station will be easy to answer for travelers familiar with park-and-ride. In contrast, passengers who make only or mostly transfers between two public transport lines at the same station will have much more difficulty answering the same question. Similarly, questions regarding satisfaction with children facilities will only be answerable for a subgroup of

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[1] Assessment the Quality of Life (AQoL) instruments measure health-related Quality of Life. The four instruments differ in sensitivity and length in different domains of health.

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the travelers. Instead other questions regarding, for example, waiting time experiences could be answered fairly well by all public transport travelers. We therefore suggest that Rash analysis can contribute to control for the bias in usage and/or knowledge about certain transfer facilities.

2. Literature review for transit service

Several studies evaluating transit performance have emphasized efficiency, effectiveness, productivity and service quality (Eboli and Mazzulla, 2011). Litman (2008) investigated the value transit users place on qualitative factors and explored how service quality factors affect travel time values and transit ridership. He indicated that service quality improvements can be converted into travel time units and provide benefits comparable to speed improvement that reduce total travel time. Nathanail (2008) developed a framework for monitoring and controlling the quality of services provided to their passengers based on the estimation of 22 indicators, grouped under six criteria. These are itinerary accuracy, system safety, cleanliness, passenger comfort, service and passenger information. In addition, several other studies have focused on the measurement of transit service quality by customers as monitoring of passenger satisfaction with simple descriptive statistical analysis is already ongoing in several cities around the Hensher et al. (2003) established a methodology to measure and calculate an overall service quality level which includes 13 attributes, such as bus travel time, bus fare, walking time to the bus stop, seat availability, information, driver attitude, etc. Based on focus group analysis Hu and Jen (2006) developed an evaluation scale that contains 20 items and group them into four dimensions. These are comprised of direct passenger facilities, tangible service equipment, convenience of service and operating management support. Eboli and Mazzulla (2011) propose a methodology to evaluate transportation service quality considering both subjective and objective measures of service performance. They considered the judgment of passengers' perception as a subjective measure of service quality, while the performance measures provided by transit operators are taken as objective service quality measures. Liou et al. (2014) proposed a novel information fusion model that addresses the relationships among the various criteria for a method of non-additive weighted gap analysis aimed at evaluating and improving the service quality of bus systems in Taipei.

In contrast, there are few studies focusing specifically on service quality of transfer facilities. Kim et al. (2008) established service evaluation indicators for transit facilities in the high-speed railway station in Korea. They noted that the most important element for transfer facility evaluation is the connectivity from the departure to the arriving stations. Their proposed indicators comprise of a general level of service indicator, the propriety of allocation and the quality of information throughout the transfer facilities. Iseki et al. (2007) developed an evaluation instrument for transit agencies which can be used to assess the quality of service at transit transfer facilities and eventually to improve travel connectivity for increasing ridership. They argued that transit users' main requirements for transfer facilities can be classified into three groups. These are minimal transfer time and distance, convenience and comfort, as well as safety and security. Furthermore, they identified physical attributes of transfer facilities as one area where transit agencies can reduce wait, walk and transfer penalties for facility passengers. Other literature instead classified attributes determining transfer satisfaction into following five factor categories: 1) access, 2) connection and reliability, 3) information, 4) amenities, and 5) security and safety (Land and Foreman, 2001; Horowitz and Thompson, 1995; Metropolitan Transportation Commission, 2006; Iseki et al., 2007).

There are further a number of other studies focusing on pedestrian movements during transfers. Fruin (1971) is an early study that developed an algorithm for calculating the service level in pedestrian facilities, including footways, stairs and queuing areas. The assessment is based on pedestrian velocity, space and conflict probability. Yao et al. (2012) investigated the design scale, layout form, and operating status of typical transfer subway stations in Beijing. They furthermore evaluated the transfer facility service level with a pedestrian behavior model focusing on stairs, corridors and platforms. They argue that the service level can be evaluated based on the quantitative observation of pedestrian parameters, such as velocity, density and flow. Yun and Lee (2010) proposed an evaluation method for pedestrian level of service in transfer facilities by using queuing theory in order to consider that walking speeds and pedestrian density are not sufficient for evaluating the service level. Jang et al. (2010) instead discuss the quality of specific facilities in transfer stations. They obtain the time spent at ticket booths and ticket vending machines through queuing theory and determine pedestrians' service level. The importance of different facilities is obtained by applying AHP (Analytic Hierarchy Process) and is discussed for five urban railroad transfer stations in Seoul.

Closer to our study, Lois et al. (2016) explored the predictive capacity of attitudes towards several service factors on general satisfaction with transport interchange. By estimating a path model, they demonstrated that safety perception and a good evaluation of information provided at the travel interchange are important predictors of general transfer facility satisfaction. Our study continues the analysis conducted by Kang et al. (2015) by using the same data set but utilizing different survey items. Kang et al. evaluated the individual level-of-service of urban railway transfer facilities in Seoul metropolitan area. Their analysis shows that there are correlations between the quantitative factors of facility characteristics and qualitative factors representing users stated perceived service level. Neither Kang et al. (2015) nor Lois et al. (2016) look into the importance of trip purpose nor do they control for response difficulty.

In conclusion, we suggest that most studies have evaluated the service quality of transfer facilities focusing on the measurement of design aspects. However, this does not answer the question as to how transit users perceive the importance of walking speed, queuing as well as factors such as safety and comfort. The aforementioned study of Liou et al. (2014) also identified this as a research gap. We propose that Rasch analysis can overcome this problem. In the following we evaluate the level of service according to five criteria that appear to cover the range of issues involved when transferring; these are: information, mobility, comfort, convenience and safety. We hypothesize that user satisfaction level would show different tendencies depending on trip purpose i.e. whether travelers are on a business, commuting, educational, leisure or shopping trip.

3. Data

3.1. Data collection

The survey was implemented in form of personal interviews conducted in 43 metro transfer stations in Seoul's metropolitan area between 17th December 2013 to 22th January 2014. A total of 3970 respondents were surveyed with roughly the same number of samples for each station (around 90). We targeted urban rail users who transfer to a subway line more than three times a week. The frequency of using the station was one of the first questions and if the respondent does not fulfill this criteria, the survey was not continued. Besides this restriction, the data was collected by randomly approaching respondents at the platforms or in the stations. We acknowledge though that we can not exclude the possibility for some biases. For example, the rate of busy, time conscious travelers refusing to answer the survey might be higher.

Respondents are aged between 15 and 75 with an average age of 37.8. 50.4% were men, 47% hold a university degree, whereas the highest education of 44.2% was high school graduation. Approximately half of the respondents ($n = 1846$) answered that their monthly household income is between 3000 and 4500 US$ (assuming an exchange rate of 1000 Won to 1 US$). More detailed information is