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RESEARCH PAPER

# Estimation of Travel Time Values for Urban Public Transport Passengers Based on SP Survey

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**Abstract:** Quantitative study on the travel costs of urban transit passengers has great significance for scientifically evaluating social benefits of public transportation system. Analysis of travel time values is one of the most important parts of traveler's travel cost estimation. According to the stated preference (SP) survey data for Beijing residents, factors that influence public transport values of travel time are analyzed and a Logit-based model is used. An improved SP survey based model is proposed, in which traveler's income is introduced as a variable. The parameters estimating the travel time values under the trip purposes of work/business and leisure are calibrated. Then the values of travel time under different conditions in Beijing are obtained (i.e. different trip purposes and with/without transferring). The results indicate that the travel time values for work are generally higher than those for leisure. The waiting time values are higher than transferring time values and in-vehicle time values under any circumstances, and the waiting time values are higher with transferring than those without transferring.

**Key Words:** urban traffic; public transit; stated preference (SP) survey; travel time value; scenario design

## 1 Introduction

Travel time value analysis plays an important role in the economic benefit evaluation of transportation projects. Travel time savings are the principal benefit of public transport investment projects that can be quantified. However, there are different perceptions of travel time values for different regions, eras and trip purposes[1]. The research on travel time values for public transport system is one of the most important and difficult tasks.

Many studies on travel time values have been conducted recently by domestic and international scholars. After a review of the literature in China and foreign countries, three widely used methods to calculate travel time values emerged. They are the product method, the income method and the willingness-to-pay method, which are based on the Probit model or the Logit model[2,3]. Nowadays, Stated Preference (SP) survey has been used extensively in the field of transportation because of its capability to make good use of data, its high efficiency and its low cost[4]. For example, Wang[5] discussed the definition of travel time value and its influencing factors in depth. He established a simplified travel time value model for Beijing residents. SP survey was adopted to collect data and calibrate model parameters. The travel time values for residents in Beijing were obtained. Fu *et al*[6]. quantified the travel time values of Beijing residents with a simplified Multinomial Logit (MNL) model. The time values of urban public transport system in Beijing were calculated based on an analysis of transit travelers characteristics. Travel time, travel cost, income and other factors were also considered. Hess et al. [7] discussed some of the issues that arose with the computation of the implied values of travel-time savings in the case of discrete choice models allowing for random taste heterogeneity. The coefficients of Multinomial Logit (MNL) and Mixed Multinomial Logit (MMNL) models for travel time values estimation were calculated, and distributions of travel time values were presented. Steimetz and Brownstone[8] applied the multiple imputation method to estimate the travel time values of commuters (full-time workers and part-time workers), which varied with trip distance.

In general, progress has been made in the studies of travel

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time valuations after many years of research. However, the existing studies concentrate on the relationship between travel time values and costs rather than on the income. The impact of the travel process of transit travelers on estimating travel time values has not been analyzed in detail. To this end, the Logit model has been chosen as a basic model in this paper and traveler's income is introduced as a new variable. The number of transfers is also considered to estimate the waiting time values, in-vehicle time values and transferring time values under different trip purposes.

## 2 Data collection in SP survey

### 2.1 SP questionnaire design

In the SP survey, the correlation among different factors is relatively low, so it is possible to get several data from each respondent. As a result, we can make good use of the surveyed data. The questionnaire is designed according to the following four principles:

① Trips include work/business purpose and leisure purpose.

② Basic information of respondents includes sex and income. Income is divided into five groups (1-1200, 1201-3000, 3001-6000, 6001-10000, ＞10000 Yuan per month).

③ The questionnaire type is designed with a transferring vs. without transferring scenarios. The with transferring scenarios are further divided into four types; transferring from bus to bus/subway with one-transfer trip, transferring from rail to bus/subway with one-transfer trip, transferring from bus to bus/subway with two-transfer trip and transferring from rail to bus/subway with two-transfer trip.

④ When designing the scenarios for trips using a public transport system, typical statistics on trips for residents in Beijing should be analyzed. Thus, the range of travel costs and times can be obtained. These travel costs and times are categorized into 6 scenarios using a uniform design[5] method, which are designed to investigate the differences between the with transferring and without transferring scenarios, as shown in Tables 1 through 5.

Table 1 Without transferring scenario

| Bus (without transferring) | | | | Subway (without transferring) | | | |
|---|---|---|---|---|---|---|---|
| Total time | Waiting time | In-vehicle time | Fare | Total time | Waiting time | In-vehicle time | Fare |
| 23 | 9 | 14 | 0.8 | 11 | 2 | 9 | 2 |
| 38 | 10 | 28 | 1.5 | 21 | 3 | 18 | 2 |
| 49 | 11 | 38 | 0.4 | 32 | 5 | 27 | 2 |
| 25 | 13 | 12 | 1.2 | 11 | 6 | 5 | 2 |
| 39 | 16 | 23 | 0.2 | 21 | 8 | 13 | 2 |
| 55 | 18 | 37 | 1 | 33 | 9 | 24 | 2 |

Table 2 Scenario of Transferring from Bus to Bus/Subway with One-transfer Trip

| Bus to Bus (one transfer) | | | | | Bus to Subway (one transfer) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Total time | Transferring time | Waiting time | In-vehicle time | Fare | Total time | Transferring time | Waiting time | In-vehicle time | Fare |
| 34 | 1 | 7 | 26 | 1.5 | 19 | 2 | 3 | 14 | 2 |
| 56 | 4 | 13 | 39 | 1.2 | 37 | 5 | 5 | 27 | 2 |
| 39 | 5 | 14 | 20 | 1 | 22 | 6 | 8 | 8 | 2 |
| 48 | 5 | 6 | 37 | 0.8 | 32 | 7 | 3 | 22 | 2 |
| 34 | 6 | 11 | 17 | 0.4 | 19 | 8 | 4 | 7 | 2 |
| 46 | 6 | 13 | 27 | 0.2 | 32 | 9 | 7 | 16 | 2 |

Table 3 Scenario of Transferring from Rail to Bus/Subway with One-transfer Trip

| Rail to Bus (one transfer) | | | | | Rail to Subway (one transfer) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Total time | Transferring time | Waiting time | In-vehicle time | Fare | Total time | Transferring time | Waiting time | In-vehicle time | Fare |
| 35 | 2 | 9 | 24 | 1.5 | 21 | 1 | 3 | 17 | 2 |
| 58 | 6 | 15 | 37 | 1.2 | 37 | 4 | 6 | 27 | 2 |
| 42 | 6 | 19 | 17 | 1 | 22 | 5 | 8 | 9 | 2 |
| 53 | 9 | 8 | 36 | 0.8 | 34 | 6 | 3 | 25 | 2 |
| 35 | 8 | 12 | 15 | 0.4 | 20 | 7 | 5 | 8 | 2 |
| 57 | 10 | 18 | 29 | 0.2 | 35 | 8 | 8 | 19 | 2 |