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## Improving transfer feasibility for older travelers inside high-speed train station

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### ABSTRACT

China is faced with a severe aging crisis, and the seniors' long-distance travel is becoming more challenging with the rapid development of high-speed trains. This paper studies the transfer feasibility for elderly passengers passing through specific barriers at high-speed train stations. Questionnaires were distributed at Beijing High-Speed Train Station, with 716 valid samples involved. This paper divides the transfer procedure into seven phases, and proposes various points of interest at each phase with different barriers. These points of barriers are categorized into three major different types: Serious AND Common, Serious BUT NOT Common, and Common BUT NOT Serious. The quantitative relationships between each point of barriers and old travelers' information have been explored using decision tree and binary logistics regression. As a conclusion, we suggest some recommendations for improving the transfer environment, long-distance mobility, as well as wellbeing of the older adults at high-speed train stations. To the best of our knowledge, we are the first to study the transfer feasibility at high speed train stations for seniors both qualitatively and quantitatively, especially dealing with the complicated transfer procedure.

### 1. Introduction

World Health Organization Reports (2015) predicts that the population of seniors in China ( $\geq 60$  years old) will increase from 194 million by 2015 to 400 million by 2030, and this is equivalent to the total population of 15 European Union countries. The statistics shows that China is faced with an aging crisis, which is more severe than anywhere else in the world. These old adults tend to travel longer distances due to social, economic and cultural factors in China. For example, the young generation of the One-Child Policy migrates to big cities for work, and old people have to travel long distances to visit their children and grandchildren. Since China heavily relies on public transportation (e.g., bus and train) instead of private vehicles, it has built the world's largest high-speed train system to improve efficiency and experience of traveling around the country. This drives the rapid growth of the seniors' demand for long-distance mobility, and most trips have been completed by high-speed trains. Back to a few years ago, seniors in China travelled much less frequently for long distances and most of their transfers happened at traditional train stations. High-speed train stations are quite different from those traditional ones in terms of complicated transfer procedures, and large groups of old people have been suffering during their transfers. Such an increasing need of long-distance travel of the elderly people urges high-

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speed train stations to provide sufficient and opportune facilities as well as service throughout the transfer phases, which needs consider various personal, household, neighborhood, and trip characteristics (Kim and Ulfarsson, 2004). However, transferring at train stations, especially at high-speed train stations, has received few attentions so far.

The relevant body of literature is based on four streams of research: (1) short-distance travel, (2) long-distance travel, (3) transfers at train stations, and (4) seniors' travel behavior.

### 1.1. Short-distance travel

Research about short-distance (and also daily mobility) focuses on age-related deficiencies, such as changes in cognition, sensory function, physical abilities, and psychology. The deficiencies of different traveling modes are affected by various personal and built environment factors (Kim, 2011). Hess (2012) identified daily barriers by comparing actual walking distance and its estimation, which are between residential addresses and transit stops for older adults in metropolitan areas. He found out that with inferior pedestrian infrastructure (e.g., low walkability) not only the walking ability of seniors declines, but also their likelihood of giving up driving will decrease. This in turn requires more appropriate public transit modes to keep seniors mobile. Potential opportunities include higher frequency of bus routes, fare-free public transportation during off-peak time, and use of driverless cars (Mackett, 2015). Travel patterns also vary significantly among individuals who have different health conditions. Empirical research has suggested a positive correlation between general state of health and trip making (Ruopila and Suutama, 1997). Nordbakke's work (2013) showed the older adults' mobility could be sustained by alternative travel modes, including walking and public transportation. In addition, multiple travel modes are necessary to keep people connected with their social networks and Julien et al. (2015) suggested free or reduced-fare public tickets and amenities, and accessibility of services for the elderly. Nordbakke and Schwanen (2015) proposed that enhancing driving ability, shortening the distance to public transportation stations, and improving the connectivity between transfer stops and destinations are key points to raise the mobility and the well-being of seniors.

### 1.2. Long-distance travel

The major concentration of existing studies is on driving restrictions of older people, which are related to safety and driving abilities. Anstey et al. (2005) showed that long-distance driving and driving in unfamiliar environments may cause crashes and other dangerous driving behaviors. It was suggested that older drivers can use self-feedback to regulate their own driving abilities (Hassan et al., 2015). However, some seniors might overvalue their driving abilities while others perceive their driving abilities more negatively (Jouk et al., 2014). As a solution, driving training programs have been developed by taking advantage of driving simulators and other technologies (Cuenen et al., 2016), and in-vehicle navigation systems has been promoted (Emmerson et al., 2013). Although cars are the main mode for seniors to travel in the United States (Boschmann and Brady, 2013), a number of studies provided evidences that those who always rely on private vehicles are more likely to lose mobility and have difficulties with other modes of travel (Douissembekov et al., 2014; Mercado and Páez, 2009) Moreover, because of low percentages of older drivers in China, public transportation is much more commonly used for long-distance travel, and we discuss high-speed trains specifically in this paper.

### 1.3. Transfers at train station

Studies about transfer feasibilities in train stations generally focus on three aspects. The first one is the importance of accessibility and facilities surrounding train stations. Brons et al. (2009) found out that the accessibility to train stations is always the most important factor of one trip, and it impacts the overall satisfaction of this trip. Wang and Chen (2012) proposed a new practical location approach to increase the quality of public services around transfer hubs. Lin et al. (2014) measured the accessibility and transport connectivity to train stations based on walking distance and personal characteristics (e.g., gender, age, favored travel modes, and household income). The second aspect is the development of heuristic algorithms about dynamic train scheduling (Carey and Crawford, 2007; Törnquist and Persson, 2007). The third aspect focuses on improving the infrastructure and service of high-speed train stations, which include the use of high technology and re-engineering of track layouts (Edwards, 2013; Warrior et al., 2015) There is also a new trend that special groups (e.g., elderly, disabled and pregnant people) start receiving more and more attention (Sharma et al., 2013).

### 1.4. Seniors' travel behavior

Previous research has focused on the influences of elderly travel behavior from many perspectives, such as density, land usage and built environments. Böcker et al. (2017) conducted a study in the Greater Rotterdam area in Netherlands about the impacts of socio-demographic, health, trip, spatial and weather on seniors' mobility. Feng et al. (2013) found out that seniors in China who live together with their children and grandchildren tend to make much fewer trips and travel shorter distances than those who live alone. Such travel patterns of the elderly have been mainly determined by the unique social and cultural factors in China (Feng, 2017). Chudyk et al. (2015) studied the association between where older adults live and their travel behavior, and found out that the prevalence of these neighborhood destinations may encourage walking. Georggi and Pendyala (2001) identified that seniors and low-income people have made significantly fewer long-distance trips than others.

Although researchers have made continuous efforts to investigate various factors and measurements associated with the mobility of older travelers, there are still huge research gaps of the existing literature. First, short-distance travel is the main focus, which includes community, shopping, and other daily activities by foot or by bus. Second, most studies are about seniors in western countries, where private vehicles are the major travel mode for older adults. However, public transportation has always been the most popular transportation mode in many densely-populated countries, especially with the rapid development of high-speed trains. Compared to traditional train stations, high-speed stations are more complex with more automated machines and much faster passenger's flows. Last but not the least, previous railway-relevant research mainly focuses on infrastructure, rail line spacing, phase time and accessibility to stations. As contrast, how to improve these facilities as well as services for seniors' transfer has received little attention.

All the above has motivated us to launch a large-scale survey at Beijing High-Speed Train Station to describe the barriers that elderly adults may encounter throughout the transfer procedure at high-speed train stations in China. In our research, the transfer feasibility is defined as an older traveler's experience with entering the station to board the train and getting off the train to access other travel modes. To the best of our knowledge, we are the first to study the transfer feasibility at high-speed train stations for seniors both qualitatively and quantitatively, especially with a focus on how to deal with the complicated transfer procedure. Also, because all of the high-speed train stations in China are similar in terms of construction structure and transfer procedure, the recommendations about improving transfer feasibility for seniors in Beijing can be applied to high-speed train stations in other countries.

The rest of the paper is organized as follows. In Section 2, we explain how we recruited the older adults for the survey and also summarize the participants' general information (e.g. personal characteristics, and traveling habits). In Section 3, we not only qualitatively classify the transfer barriers but also quantitatively explore the correlative factors of barriers using decision tree and binary logistic regression. The factors considered in this study include age, gender, health condition, education, income, trip purpose, trip distance, travel frequency, and subjective travel deficiency. In Sections 4 and 5 we draw conclusions of barriers and make practical suggestions to accommodate elderly travelers.

## 2. Data and methods

### 2.1. Questionnaire design

In China, most large high-speed train stations are constructed with a three-floor structure: waiting rooms and terminals (departure) on top, train platforms and the entrance on ground, and arrival areas underground. Moreover, there are two check-in gates. The most important one is the gate of the entire building, which passengers have to pass through security checkpoints. The other gate is located between waiting rooms and terminals, before passengers board trains. The ticket office is usually a separate building next to the station, and passengers who have purchased tickets online in advance still need go to that office to get physical tickets for entering the train station. According to such unique construction features and the complicated security screening system at high-speed train stations in China, the whole transfer procedure is divided into seven key phases in our research. They are (1) arriving at the high-speed train station, (2) insides the ticket office, (3) entering through security checkpoints, (4) from security checkpoints to different individual waiting rooms, (5) insides waiting rooms, (6) from waiting rooms to the train platform, and (7) leaving the station from the exit to connect to other modes of transportation. For each single phase, we have identified several specific points of interests

**Table 1**  
Points of evaluation at each transfer phase.

Transfer phase	Points of interests (spatially)
1. Arriving at the high-speed train station	1.1. Accessibility to the train station 1.2. Parking 1.3. Moving luggage to the entrance
2. Insides the ticket office	2.1. Use of self-service machines 2.2. Waiting in line
3. Entering through security checkpoints	3.1. Waiting in line 3.2. Moving and lifting luggage
4. From security checkpoints to different individual waiting rooms	4.1. Reading information from screens and signs 4.2. Movement across different floors 4.3. Walking distance to waiting rooms
5. Within waiting rooms	5.1. Locating correct check-in gates to the terminal 5.2. Waiting time and space 5.3. Check-in through the gates 5.4. Problems with using restrooms
6. From waiting rooms to the platform	6.1. Movements across different floors 6.2. Stuck by fast passenger flow 6.3. Walking time to the train
7. Leaving the station from the exit and connecting to other modes of transportation	7.1. Accessibility to transit points, including signs and walking distance 7.2. Waiting time and space

(spatially) to measure the difficulty or the barriers which seniors encounter when they transfer at high-speed train stations. These points of interests are shown in Table 1. For simplicity's sake, in the rest of this paper these points are called Point 1.1, Point 1.2 and so forth.

In this survey we designed four types of questions: (1) general information and physical conditions of participants; (2) psychological conditions and changes of participants; (3) characteristics of participants' transit behavior and travel habits; and (4) barriers which participants encountered when they transferred at high-speed train stations. There are 34 questions in total, and the questionnaire is included in Appendix I. All the questions are multiple choice questions.

We considered different health conditions including “deteriorative hearing or sight” and “walking difficulty” based on the relevant study of Mackett (2015). We classified “trip purpose”, “number of times to Beijing before”, and “annual income” using the criteria published by National Bureau of Statistics of China (NBS, 2017); and used different subjective travel deficiencies proposed by Kim and Ulfarsson (2013).

The core part of our survey is participants' responses on the encountered barriers. To quantitatively measure the difficulty of each barrier, we asked participants to rate their experience on a scale of 1–3, where 1 means “no/light”, 2 means “moderate”, and 3 means “serious”. If the participant chose “serious”, it means that his or her transfer was fully blocked by this barrier.

Because of potential reading problems of some older adults, conversations were used to help capture the required information from all the participants. The average time to complete each questionnaire was about 10 min.

## 2.2. Participant recruitment

This survey was conducted at Beijing High-Speed Train Station in China, of which the size is close to Grand Central Station in New York City (Roberts, 2013). Questionnaires were distributed on several random days from April to August in Year 2015 and these days are April 12, April 17, May 5, June 30, July 31 and August 1. All the responses were anonymous and kept confidential. It is worth mentioning that in our study, we used the chronological age of 60 years as a definition of ‘elderly’ or older person (Mirkin and Weinberger, 2001).

1526 seniors were invited for this survey, but only 974 of them agreed to participate. After eliminating participants who were younger than 60 years old and who did not provide complete information, 716 participants were qualified for our survey in the end.

## 3. Results analysis

The results of our survey at Beijing High-Speed Train Station are summarized in Table 2. In this table, there are 15 independent variables about participants' characteristics, including their personal information, travel history and travel preferences. We grouped the seniors' responses based on the level of barriers they encountered, namely no/light barriers, moderate barriers and serious barriers. The discussions in this section will focus on sample characteristics, classification of barriers, and quantitative relationships between barriers and sample characteristics.

### 3.1. Participants' characteristics

#### 3.1.1. General information

This survey consists of 71.9% men and 28.1% women, with an average age of 67.25 years old and the standard deviation is 6.2 years old. This sex ratio is consistent with the data from other studies (Herbel and Gaines, 2011). It is worth mentioning that only 181 participants were permanent residents in Beijing, which takes up 25.3% of all the participants. Female seniors tend to more easily experience barriers during their transfers at high-speed train stations, and 38.1% of them are blocked by serious barriers at least once. One possible reason is that fewer female seniors travel for long distance (compared with the male peers).

Although 69.0% of the seniors are in excellent or good health condition, these people still experienced barriers at different levels. 52.3% people barely encountered barriers, 66.8% people met some barriers, and 79.9% participants were once fully blocked by the barriers during their journeys. Seniors with other health conditions including deteriorative hearing/sight and walking difficulty are more likely to be trapped in moderate barriers than the serious ones.

#### 3.1.2. Feelings and psychological changes

Table 2 demonstrates that 55.6% of the participants had strong willingness to maintain their mobility. However, the level of willingness has little impact on how these seniors can confront the barriers during the transfer (Chi-square = 16). For seniors who lack experiences of long-distance travel, negative self-evaluations and subjective anxieties emerge before they started their journeys. These negative concerns include but are not limited to “confused inside facilities”, “confusing traffic around transfer area,” “physical problems”, “requiring accompanies”, and “transportation fare”. Only 2.5% of the participants never had worried about their trips although all of them had troubles with transfers before. However, these anxieties seem to help reduce the negative impacts of serious barriers for these seniors, probably because they are already somewhat prepared for potential transfer difficulties.

### 3.2. Barrier distribution

For each point of interest (as discussed in Section 2.1), we calculate the percentage of participants who have experienced barriers during the transfer, as well as the percentage of participants who have experienced serious barriers. We sort these points of interests

**Table 2**  
Descriptive analysis of barriers that older traveler encountered with characteristics of the sample.

Independent variables	Measurement scale of independent variables	Total observations (N = 716)		Barriers encountered in transfer process					
				No/Light (N = 44)		Moderate (N = 503)		Serious (N = 169)	
				Frequency	Percent	Frequency	Percent	Frequency	Percent
Age	Age 60–64	283	39.5	12	27.4	199	39.5	72	42.6
	Age 65–69	197	27.5	7	16.1	141	28	49	29
	Age 70–74	126	17.6	15	33.9	87	17.3	24	14.2
	Age 75–79	88	12.3	10	22.6	57	11.4	21	12.4
	Age 80 or elder	22	3.1	0	0	19	3.8	3	1.8
Gender	Male	515	71.9	33	75	365	75.6	117	61.9
	Female	201	28.1	11	25	118	24.4	52	38.1
Health condition	Poor	16	2.2	1	2.3	15	3	0	0
	Fair	137	19.1	16	36.4	98	19.5	23	13.6
	Deteriorative hearing or sight	29	4.1	2	4.5	25	5	2	1.2
	Walking difficulty	40	5.6	2	4.5	29	5.8	9	5.3
	Excellent/good	494	69	23	52.3	336	66.8	135	79.9
Education level	Less than junior high school	189	26.4	17	38.6	127	25.2	45	26.6
	Junior high school/high school	430	60.1	22	50	309	61.4	99	58.6
	College/graduate	97	13.5	5	11.4	67	13.3	25	14.8
Annual income (\$)	< 3000	267	37.3	10	22.7	102	20.3	31	18.3
	3000–6000	375	52.4	26	59.1	258	51.3	91	53.8
	6000 or more	198	27.7	8	18.2	143	28.4	47	27.8
Beijing Residents	Yes	181	25.3	14	31.8	135	26.8	32	18.9
	No	535	74.7	30	68.2	368	73.2	137	81.1
Trip purpose	Vacation	84	11.7	5	11.4	52	10.3	27	16
	Long-term work in other cities	132	18.4	7	15.9	106	21.1	19	11.2
	Visiting families/grandchildren care	197	27.5	15	34.1	133	26.4	49	29
	Commute work and errands	58	8.1	2	4.5	46	9.1	10	5.9
	Hospital	23	3.2	2	4.5	18	3.6	3	1.8
	Going home	183	25.6	10	22.7	115	22.9	58	34.3
	Group activity	35	4.9	3	6.8	29	5.8	3	1.8
	Others	4	0.6	0	0	4	0.8	0	0
Number of times travelled to Beijing before	6 times or less	364	50.8	16	36.4	249	49.5	99	58.6
	6–20 times	89	12.4	9	20.5	65	12.9	15	8.9
	20 times or more	263	36.7	19	43.2	189	37.6	55	32.5
Long-distance travel frequency per year	5 times or less	551	77	33	75	386	76.7	132	78.1
	6–10 times	96	13.4	3	6.8	66	13.1	27	16
	10 times or more	69	9.6	8	18.2	51	10.1	10	5.9
Accompanied	Yes	182	25.4	9	20.5	122	24.3	51	30.2
	No	534	74.6	35	79.5	381	75.7	118	69.8
Trip distance	< 300 miles	377	52.7	66	78.6	267	53.1	44	34.1
	300 miles or more	339	47.3	18	21.4	236	46.9	85	65.9
Travel range	Inside Beijing	326	45.5	20	45.5	240	47.7	66	39.1
	Outside Beijing	390	54.5	24	54.5	263	52.3	103	60.9
Access or egress mode	Bus	267	37.3	83	48	117	27.8	67	46.9
	Subway	184	25.7	58	33.5	94	22.3	32	22.4
	Taxi	159	22.2	17	9.8	129	30.6	13	9.1
	Private car	106	14.8	9	5.2	68	16.2	29	20.3
	Walking	21	2.9	6	3.5	13	3.1	2	1.4
Reasons for access and egress mode choice	Lower fare	244	34.1	17	38.6	166	33	61	36.1
	More convenient	289	40.4	17	38.6	201	40	71	42
	More comfort	120	16.8	4	9.1	94	18.7	22	13
	Others	63	8.8	6	13.6	42	8.3	15	8.9
Travel willingness	None	197	27.5	15	34.1	133	26.4	49	29
	Weak	121	16.9	4	9.1	95	18.9	22	13
	Strong	398	55.6	25	56.8	275	54.7	98	58

(continued on next page)

**Table 2** (continued)

Independent variables	Measurement scale of independent variables	Total observations (N = 716)		Barriers encountered in transfer process					
				No/Light (N = 44)		Moderate (N = 503)		Serious (N = 169)	
				Frequency	Percent	Frequency	Percent	Frequency	Percent
Subjective travel deficiency	None	18	2.5	0	0	12	2.5	6	4.7
	Public security	34	4.7	4	3.8	20	4.1	10	7.8
	Getting lost	24	3.4	0	0	17	3.5	7	5.4
	Require assistance	86	12	7	6.7	64	13.3	15	11.6
	Lack of time	10	1.4	1	1	7	1.5	2	1.6
	Physical problems	100	14	19	18.1	71	14.7	10	7.8
	Confused inside facilities	199	27.8	42	40	131	27.2	28	21.7
	Transportation fare	90	12.6	5	4.8	62	12.9	23	17.8
	Confusing traffic around transfer area	131	18.3	24	22.9	85	17.6	22	17.1
	Others	24	3.4	3	2.9	13	2.7	6	4.7

**Table 3**  
Ranking of points of interests.

Points of Interests	Total participants having met barriers (%)	Participants having met serious barriers (%)
6.3	79.3	55.6
6.1	68.2	48.3
7.2	63.7	46.5
5.4	59.2	45.3
7.1	55.7	28.5
4.1	53.8	36.6
3.2	52.5	30.9
3.1	50.2	38.1
2.1	43.4	25.7
4.2	40.2	24.2
4.3	34.3	27.6
6.2	33.7	25.4
1.3	56.1	19.7
5.2	55.4	14.9
1.1	36.7	6.6
5.1	27.4	8.0
5.3	14.0	2.5
2.2	5.6	0.7
1.2	2.5	0.1

in decreasing order for the first percentage, and then in decreasing order for the second percentage. Any point of interests with percentage smaller than 0.1 will be neglected, and Table 3 presents the details of this ranking. It can be found out that the more people who meet barriers, the higher probability that they will encounter serious barriers.

If the percentage of total participants who have met barriers when transferring is greater than or equal to 50%, we define the corresponding point as a “common” point. It means that at this spatial point of high-speed train stations, many travelers tend to encounter barriers at some extent. If the percentage of participants who have met serious barriers is greater than or equal to 25%, we define the corresponding point as a “serious” point. It means that there are relatively more serious barriers at this spatial point of high-speed train stations. Therefore, according to the definitions of “common” and “serious”, we can divide all of the points (listed in Table 3) into four classes: Serious AND Common, Serious BUT NOT Common, Common BUT NOT Serious, and Neither Serious NOR

**Table 4**  
Classification of spatial points in a high-speed train station.

Classification	Points
Serious AND Common	6.3, 6.1, 7.2, 5.4, 7.1, 4.1, 3.2, 3.1
Serious BUT NOT Common	2.1, 4.2, 4.3, 6.2
Common BUT NOT Serious	1.3, 5.2
NOT Serious OR NOT Common	1.1, 5.1, 5.3, 2.2, 1.2

Common. Table 4 presents this classification, and what points are included in each class. Our following discussions only focus on the first three classes because the last one is relatively minor.

For each class of points, the analysis consists of two basic steps. First, all the correlated factors are selected and ranked using decision-tree analysis. As mentioned earlier, we categorize these factors into three categories: physical, psychological and traveling history/habits related. Since reducing the number of independent variables can improve the accuracy of regression model, factors that have little connection with each individual barrier are not considered. The second step is to qualitatively measure correlations using binary logistic regression analysis method and no significant multicollinearity is diagnosed in the dataset.

R Statistics software (Version 3.2.2) and R Project ([www.r-project.org/](http://www.r-project.org/)) were chosen as the appropriate tool. The results are summarized in Tables 5–7.

### 3.2.1. Serious AND common points

- Physical factors:

Deteriorative health condition is believed to reduce seniors' self-mobility as what we predicted previously. "Good/excellent" appears four times with a negative coefficient, while the other items associated with health conditions, "Deteriorative hearing/sight" and "Walking difficulty", are both with positive coefficients.

Seniors whose annual incomes are less than \$3000 (coefficients = 1.344 > 0) are more likely to fail to read the information screens and signs, in contrast to seniors who earn \$6000 or more every year (coefficients = -0.547 < 0). Most of the current generation of the elderly in China will become low income after they retire, and the income affects their transfer experience significantly. So the "annual income" is a significant variable. For example, rail is getting on the digital track. There is a growing trend that consumers purchase tickets from online or using mobile device. Seniors with low income may have limited access to the internet or do not have smart phones. For those who have to obtain information from the train stations physically, the difficulty of transfers will increase. Moreover, in general there is a significant relationship between income levels and educational attainment. To be more specific, the higher the education level of an old adult has, the higher the income he or she earns. Therefore, participants who earned less are usually those who have less than a junior high school education. Seniors having higher level of education more easily understand the complicated transfer procedure at high-speed train stations, which indicates that the less likely that they will encounter barriers. It is highly possible that the barriers which those participants encountered are caused by themselves rather than the poor design of the transfer feasibility at high-speed train stations. For example, seniors who have less than a junior high school education (coefficients = 0.875) and regard "Convenience" as the most considerable reason for accessing and egressing (coefficients = 0.630) are more likely to have issues when using restrooms.

- Psychological factors:

The older travelers usually over-forecast the travel environment before starting their trips. "Confused facilities" (four times), "Physical problems" (three times), "Requiring accompanies" (twice), "Confusing traffic around" (twice), and "Getting lost" (once) are selected as important factors. While, only "Confused facilities", "Physical problems", and "Requiring accompanies" (totally appear 8 times) have positive coefficients, and the others have negative ones.

Seniors who regard "Convenience" as the most considerable issue when choosing the mode of access and egress are less likely (coefficients = -0.572) to have the walking time limitation to access the train.

- Factors regarding traveling history and habits

People who travel more often is less likely to encounter barriers. Items of "6–20 times" and "20 or more times" to Beijing before have negative coefficients, and they occur seven times in total. However, "5 times or less long-distance travel per year" appears three times with positive coefficients.

Although "Vacation" and "Going home" have large coefficients, these two trip purposes are not excluded because of insignificance ( $p$ -value > 0.99). "Walking time limitation to the train" and "Reading the information screens and signage" are affected by two trip purposes (i.e., "Hospital", "Visiting families/ grandchildren care") with positive coefficients.

Older female travelers (coefficients = 0.440), and seniors traveling out of Beijing (coefficients = 1.174) are more likely to fall into troubles with waiting time and space at taxi stops.

### 3.2.2. Serious BUT NOT Common points

As shown in Table 6, there are few common independent variables for all the listed four spatial points. However, health condition and subjective travel deficiency are still identified as the most important ones; meanwhile, gender, age, education level and income appear occasionally as well:

- Physical factors:

Seniors who have hearing or vision problems (coefficient = 1.800) encounter more barriers of "Walking distance to waiting rooms", in contrast to people in "Excellent/good" health condition (coefficient = -1.375). Deteriorative health condition

**Table 5**  
Results of Serious AND Common spatial points at a high-speed train.

		Coeff.	s.e.	z-test	p-value
<i>Walking time to the train (Point 6.3)</i>					
Intercept		-0.993	1.523	-0.652	0.514
Number of times travelled to Beijing before	20 times or more	-0.761	0.353	-2.157	0.031 <sup>†</sup>
Health condition	Walking difficulty	0.81	0.33	2.453	0.014 <sup>†</sup>
Subjective travel deficiency	Physical problems	-0.554	0.332	-1.668	0.095.
Trip purpose	Hospital	0.469	0.275	1.709	0.087.
Reasons for access & egress mode choice	More convenient	-0.572	0.322	-1.776	0.076.
<i>Movement across different floors to the platform (Point 6.1)</i>					
Intercept		-3.32	20.7	-0.016	0.987
Subjective travel deficiency	Require assistance	-1.059	0.45	-2.355	0.019 <sup>†</sup>
Number of times travelled to Beijing before	20 times or more	-0.974	0.475	-2.049	0.040 <sup>†</sup>
Health condition	Walking difficulty	0.816	0.487	1.677	0.093.
Accompanied by others	Yes	0.65	0.256	2.539	0.011 <sup>†</sup>
Health condition	Excellent/good	-1.001	0.342	-2.932	0.003 <sup>**</sup>
Trip distance	< 300 miles	-0.577	0.327	-1.763	0.078.
Subjective travel deficiency	Confused inside facilities	-0.611	0.367	-1.666	0.096.
<i>Waiting time and space (Point 7.2)</i>					
Intercept		0.877	1.519	0.578	0.564
Health condition	Excellent/good	-0.392	0.244	-1.609	0.108
Access or egress mode	Taxi	2.51	1.089	2.305	0.021 <sup>†</sup>
Number of times travelled to Beijing before	6–20 times	-1.023	0.365	-2.8	0.005 <sup>**</sup>
Subjective travel deficiency	Physical problems	-0.867	0.298	-2.911	0.004 <sup>**</sup>
Long-distance travel frequency per year	5 times or less	0.783	0.323	2.426	0.015 <sup>†</sup>
Annual income (\$)	6000 or more	-0.547	0.293	-1.869	0.062.
<i>Problems with using restrooms (Point 5.4)</i>					
Intercept		12.915	405.701	0.032	0.975
Education level	Less than junior high school	0.875	0.338	2.591	0.010 <sup>**</sup>
Reasons for access & egress mode choice	More convenient	0.63	0.316	1.997	0.046 <sup>†</sup>
Health condition	Excellent/good	-0.594	0.32	-1.859	0.063.
<i>Accessibility to transit points (Point 7.1)</i>					
Intercept		-2.408	1.469	-1.64	0.101
Number of times travelled to Beijing before	6–20 times	-1.558	0.725	-2.148	0.032 <sup>†</sup>
Access or egress mode	Subway	0.802	1.119	0.717	0.473
Annual long-distance travel frequency	5 times or less	0.967	0.365	2.649	0.008 <sup>**</sup>
Health condition	Deteriorative hearing/sight	0.477	0.301	1.588	0.112
Health condition	Walking difficulty	0.714	0.394	1.81	0.070.
<i>Reading information from screens and signs (Point 4.1)</i>					
Intercept		-2.125	1.555	-1.367	0.172
Subjective travel deficiency	Confused inside facilities	-0.795	0.262	-3.036	0.002 <sup>**</sup>
Annual long-distance travel frequency	5 times or less	1.094	0.361	3.027	0.002 <sup>**</sup>
Gender	Female	0.44	0.201	2.188	0.029 <sup>†</sup>
Travel range	Outside Beijing	1.174	0.488	2.404	0.016 <sup>†</sup>
Health condition	Poor	1.354	0.731	1.852	0.064.
Trip purpose	Visiting families	0.445	0.251	1.773	0.076.
Number of times travelled to Beijing before	6–20 times	-0.627	0.368	-1.701	0.089.
Annual income (\$)	< 3000	1.344	0.689	1.949	0.051.
Subjective travel deficiency	Getting lost	0.873	0.522	1.672	0.094.
<i>Moving and lifting luggage (Point 3.2)</i>					
Intercept		-3.539	1.985	-0.018	0.986
Trip purpose	Going home	1.86	1.83	0.01	0.992
Subjective travel deficiency	Confusing traffic around	0.537	0.296	1.813	0.070.
Health condition	Excellent/good	-1.685	0.339	-4.965	< 0.001 <sup>***</sup>
Subjective travel deficiency	Physical problems	-1.29	0.384	-3.359	< 0.001 <sup>***</sup>
Number of times travelled to Beijing before	20 times or more	-0.543	0.371	-1.463	0.144
Trip purpose	Vacation	1.876	1.834	0.01	0.992
Beijing residents	Yes	-0.799	0.39	-2.051	0.040 <sup>†</sup>
Travel willingness	None	0.576	0.317	1.82	0.069.
<i>Waiting in line at the entrance (Point 3.1)</i>					
Intercept		-3.721	1.955	-0.019	0.985
Subjective travel deficiency	Confusing traffic around	0.953	0.315	3.027	0.002 <sup>**</sup>
Health condition	Excellent/good	-2.262	0.366	-6.174	< 0.001 <sup>**</sup>
Trip purpose	Going home	1.933	1.808	0.011	0.991
Trip purpose	Vacation	1.901	1.808	0.011	0.991
Subjective travel deficiency	Requiring assistance	-0.966	0.41	-2.356	0.018 <sup>†</sup>
Accompanied by others	Yes	0.567	0.27	2.097	0.036 <sup>†</sup>

(continued on next page)



Table 5 (continued)

		Coeff.	s.e.	z-test	p-value
Number of times travelled to Beijing before	20 times or more	-1.314	0.519	-2.53	0.011 <sup>†</sup>
Travel willingness	None	0.735	0.33	2.229	0.026 <sup>†</sup>
Subjective travel deficiency	Confused inside facilities	-0.691	0.391	-1.766	0.077.

Note. Signif. codes: 0 ‘\*\*\*’, 0.001 ‘\*\*’, 0.01 ‘\*’, 0.05 ‘.’ 0.1 ‘.’ 1.

Table 6  
Results of Serious BUT NOT Common spatial points at a high-speed train.

		Coeff.	s.e.	z-test	p-Value
<i>Use of self-service machines (Point 2.1)</i>					
Intercept		-2.501	1.649	-1.517	0.129
Gender	Female	0.759	0.254	2.987	0.003 <sup>**</sup>
Subjective travel deficiency	Confused inside facilities	1.100	0.424	2.594	0.009 <sup>**</sup>
Long-distance travel frequency per year	5 times or less	0.760	0.386	1.967	0.049 <sup>†</sup>
Trip distance	300 miles or more	0.544	0.273	1.992	0.046 <sup>†</sup>
Travel range	Outside Beijing	1.184	0.540	2.191	0.028 <sup>†</sup>
Education level	Less than junior high school	0.689	0.360	1.911	0.056.
<i>Movements across different floors from the entrance (Point 4.2)</i>					
Intercept		-1.416	1.627	-0.870	0.384
Health condition	Poor	1.298	0.254	5.119	< 0.001 <sup>***</sup>
Subjective travel deficiency	Confused inside facilities	0.110	0.295	0.371	0.710
Health condition	Walking difficulty	1.644	0.615	2.672	0.008 <sup>**</sup>
Age	60–64	-1.477	0.585	-2.524	0.012 <sup>†</sup>
Age	70–74	0.679	0.346	1.961	0.050 <sup>†</sup>
Age	75–79	1.274	0.587	2.170	0.030 <sup>†</sup>
Gender	Female	0.338	0.199	1.701	0.089.
Trip purpose	Commute work	2.261	1.343	1.684	0.092.
Trip purpose	Long-term work in another city	2.602	1.469	1.771	0.077.
Subjective travel deficiency	Getting lost	0.818	0.482	1.698	0.090.
<i>Walking distance to waiting rooms (Point 4.3)</i>					
Intercept		-18.942	3218.567	-0.006	0.995
Health condition	Excellent/good	-1.375	0.549	-2.504	0.012 <sup>†</sup>
Subjective travel deficiency	Require assistance	-0.276	0.463	-0.596	0.551
Annual income (\$)	3,000–6000	-1.050	0.748	-1.404	0.160
Travel range	Insides Beijing	-0.868	0.599	-1.451	0.147
Health condition	Deteriorative hearing or sight	1.800	0.672	2.678	0.007 <sup>**</sup>
Annual income (\$)	6000 or more	-1.770	0.830	-2.132	0.033 <sup>†</sup>
Annual income (\$)	< 3000	0.776	0.411	1.889	0.059.
<i>Stuck by fast passenger flow (Point 6.2)</i>					
Intercept		-0.678	1.552	-0.436	0.663
Education level	Junior high school/high school	-0.618	0.269	-2.295	0.022 <sup>†</sup>
Health condition	Deteriorative hearing or sight	1.254	0.702	1.785	0.074.
Health condition	Walking difficulty	0.677	0.390	1.735	0.083.
Health condition	Poor	0.463	0.246	1.878	0.060.
Education level	College/graduate	-1.081	0.561	-1.927	0.054.
Accompanied by others	Yes	-0.582	0.326	-1.782	0.075.

Note. Signif. codes: 0 ‘\*\*\*’, 0.001 ‘\*\*’, 0.01 ‘\*’, 0.05 ‘.’ 0.1 ‘.’ 1.

(coefficient = 1.298 for “Poor” and 1.644 for “Poor ambulation”) are found significantly positively correlated with “Transiting between floors in hall and waiting rooms”. “Deteriorative hearing or sight” (coefficient = 1.254), “Walking Difficulty” (coefficient = 0.677), and “Poor health condition” (coefficient = 0.463) are positively associated with the “Walking collision in the rush hour”.

There is only one barrier (“Transiting between floors”) related to age. Seniors aged from 70 to 79 (coefficient = 0.679 for 70–74 and 1.274 for 75–79) are found significantly positive correlated with “Transiting between floors in hall and waiting rooms”. In contrast, although people aged “60–64” (coefficient = -1.477) are considered as older travelers, they are capable to conquer this barrier.

“Female” (coefficient = 0.759) have more difficulties with self-service devices. Also, “Females” (coefficient = 0.338) are found significantly positively correlated with “Transiting between floors in hall and waiting rooms”.

**Table 7**  
Results of Common BUT NOT Serious spatial points at a high-speed train.

		Coeff.	s.e.	z-test	p-Value
<i>Moving luggage to the entrance (Point 1.3)</i>					
Intercept		2.727	2.252	1.210	0.226
Accompanied by others	Yes	-5.165	0.596	-8.673	< 0.001***
Health condition	Excellent/good	-2.697	0.379	-7.109	< 0.001***
Gender	Female	0.488	0.285	1.710	0.087.
Travel willingness	Strong	-3.483	0.633	-5.505	< 0.001***
Health condition	Walking difficulty	1.463	0.451	3.244	0.001**
Long-distance travel frequency	6–10 times	0.728	0.500	1.457	0.145
Age	75–79	-2.808	0.897	-3.130	0.002**
Age	70–74	-1.858	0.872	-2.130	0.033 <sup>†</sup>
Annual income	6000 or more	-1.002	0.401	-2.502	0.012 <sup>†</sup>
Travel range	Outside Beijing	1.109	0.602	1.841	0.066.
Subjective travel deficiency	Confused inside facilities	-0.712	0.410	-1.739	0.082.
<i>Waiting time and space in the waiting rooms (Point 5.2)</i>					
Intercept		-1.258	1.458	-0.863	0.388
Health condition	Poor	0.992	0.252	3.938	< 0.001***
Number of times travelled to Beijing before	6–20 times	0.686	0.364	1.886	0.059.
Subjective travel deficiency	Require assistance	0.014	0.304	0.047	0.963
Age	60–64	-0.972	0.583	-1.668	0.095.
Annual income	< 3,000	1.014	0.611	1.659	0.097.
Travel purpose	Hospital	0.470	0.254	1.847	0.065.

Note. Signif. codes: 0 ‘\*\*\*’, 0.001 ‘\*\*’, 0.01 ‘\*’, 0.05 ‘.’, 0.1 ‘.’, 1.

In particular, higher education level reduces the probability of getting sucked by rush passenger flow (coefficient = -0.618 for “Junior high school/high school” and coefficient = -1.081 for “College/graduate”). Less than “Junior high school” education level (coefficient = 0.689) is positively related with the problem of using self-service devices.

• Psychological factors:

Most subjective travel deficiencies have positive coefficients. “Subjective confusing inside facilities” (coefficient = 1.100) is related with self-service devices. “Confused inside facilities” (coefficient = 0.110) and “Getting lost” (coefficient = 0.818) are found significantly positively correlated with “Transiting between floors in hall and waiting rooms”. Only “Require assistance” (coefficient = -0.276) has a negative coefficient.

• Factors regarding traveling history and habits

“5 times or less long-distance travel per year” (coefficient = 0.760), “300 miles or further trip” (coefficient = 0.544), and “Outside Beijing” trip (coefficient = 1.184) all increase the chance of having difficulties with self-service devices. “Inside Beijing” trip (coefficient = -0.868) is negatively related to “Walking distance to waiting room”.

Older travelers who travel for “Commute working” (coefficient = 2.261) as well as “Long-term working far away from hometown” seem more influential, although they are only selected once (coefficient = 2.602).

3.2.3. Common BUT NOT Serious points

• Physical factors:

There are significant positive correlations between “Moving luggage to the entrance” and “Poor ambulation” (coefficient = 1.463), while “Excellent/good Health condition” (coefficient = -2.697) are negatively correlated. “Waiting area” (capacity and fatigue) is strengthened by “Poor health condition” (coefficient = 0.992).

It is worth mentioning that there are significant negative correlations between “Age between 70 and 79” (coefficient = -1.858 for 70–74 and coefficient = -2.808 for 75–79) and “Handing baggage to the entrance. “Female” (coefficient = 0.488) is also related to “Handing baggage to the entrance”.

• Psychological factors:

Items of “Accompanied by others” (coefficient = -5.165), “Strong travel willingness” (coefficient = -3.483), and subjective

travel deficiency of “Confusing inside facilities” (coefficient =  $-0.712$ ) are negatively correlated with “Handing baggage to the entrance”; however, subjective travel deficiency of “Require assistance” (coefficient =  $0.014$ ) has a small impact on “Waiting time and space”.

- Factors regarding traveling history and habits

There are positive correlations between “Moving luggage to the entrance” and variables in term of “6–10 times long-distance travel per year” (coefficient =  $0.728$ ) and travel “Outside Beijing” (coefficient =  $1.109$ ).

“Waiting time and space” is strengthened by “6–20 Number of times travelled to Beijing before” (coefficient =  $0.686$ ), and traveling to “Hospital” (coefficient =  $0.470$ ).

#### 4. Discussions

It is obvious that the age is not the main factor which makes seniors encounter multiple barriers when they transfer at high-speed trains stations. For the “Serious AND Common” spatial points, health conditions rather than chronological ages matter more in mobility. It is also indicated that when facing the same barrier, older adults with better health tend to have a smoother journey than relatively younger peers but with worse health conditions. (Wahlin et al., 2006). Therefore, achieving good public health (Brownson et al., 2001) evidently becomes an essential methodology to sustaining mobility and enhancing accessibility of an aging society. Specifically, seniors older than 75 years old have a general deterioration of sight and hearing rather than ambulation. So voice broadcasts and signs (both printed and electric) should be modified appropriately.

Psychological factors have a great impact on the very beginning of a trip and even before this trip starts. As is shown in Table 4, there are some significant and universal correlations between the eight “Serious AND Common” points and psychological factors (Subjective travel deficiency), physiological situation (Health condition), and travel history (Number of times travelled to Beijing before, Trip purpose, and Long-distance travel frequency per year). Older passengers’ perception of the transfer environment and deficiency, as measured by binary logistic regression covering all the three categories of barriers, are apparently self-exaggerated before the beginning of a journey. Most coefficients between barriers and items of subjective travel deficiency being negative reveal that older adults actually maintain better traveling ability than their self-judgment, and this is a result of insufficient travel experience. Our study shows that many older adults have not taken a trip out of the city yet over the past five years. So it is reasonable to predict that they may hardly have appropriate knowledge of the transfer process or know how to adapt to the changes in a high-speed train station. As a result, the travel willingness of these older adults is relatively weak, which in turns discourages their travel enjoyment.

The analysis about physical and psychological factors demonstrates that different genders perform differently when they transfer at high-speed train stations. Even though most participants, regardless of the gender, preferred independent trips, this survey has found that Chinese male seniors have a stronger independence and higher travel frequency than females of similar ages. Since older female travelers are more likely to bear psychological burdens, such as abandonment, fear (Herbel and Gaines, 2011) and encounter barriers (as shown in Tables 5 and 6), they are always accompanied by family members when traveling, especially on long-distance trips. Nevertheless, because most females cherish their mobility more compared with the male peers, symptomatic focus and measures are expected to meet their demand. Furthermore, there is an interesting conflict between the willingness to travel independently and the fear of traveling alone. This shows that most senior are eager to travel, but they are intimidated by potential barriers they will meet when taking public transport, such as high-speed trains. So, it is vital to provide seniors with a relaxing transfer environment in order to maintain their mobility and well-being.

Factors regarding traveling history and habits (e.g. travel distance, travel frequency, and travel purpose) do not show continuous influence as factors about health condition and subjective travel deficiency do. The older adults who travel further have a higher probability of running into barriers due to heavier luggage, longer travel time, more anxiety, and ticket scarcity. The interaction between “Number of times travelled to Beijing before” and “Long-distance travel frequency per year” reveals that appropriate travel experience would increase the ability of seniors to overcome barriers.

Similar to young adults, the elders are also able to gain traveling skills and experience, such as reading the information screen, handling electric equipment, counseling, finding signs, and so forth. In addition, it should be noted that travel ability is more relevant to traveling history rather than education level. In this case, the transfer ability of the general public can be trained.

Our survey shows that older adults, voluntarily or not, are still a branch of migrant workers, which is consistent with previous study (Peng and Fei, 2013). At the same time, the older adults are one of the main forces of offsite grandchild-care in China, which is the consequence of “One-Child Policy” and migrant-work trend. (Lu et al., 2016; Sun, 2013). It is not unusual to see seniors bring either a child or a lot of luggage at high-speed train stations. Therefore, improving the transfer feasibility for these seniors is important.

#### 5. Suggestions and conclusions

The goal of this study is to explore the barriers throughout the transfer process at high-speed train stations, and to give advice to make travel more feasible and easier for aging travelers in China. In addition, we hope to lay a foundation for further research on this

subject. Based on the results and discussions from our survey, major suggestions on improving the facilities to better seniors' transfer experience are listed as follows:

- Travel training program

Different training programs can be established to educate seniors, which are of long-term benefits. For example, training booth, information display walls or boards can be set up right in front of station squares to inform senior travelers about the transfer procedure in the train stations. The training can be also done through community sustainable training. Trainees are expected to demonstrate some improvements on understanding the transfer procedure (e.g., using high-technology devices) as well as the mobility during the transfers (Burkhardt et al., 2014; Mobley and Matherly, 2012). Such training programs are beneficial from both psychological and physical perspectives, and female seniors should be particularly encouraged to participate.

- Exclusive service

Considering the complicated transfer procedure at most high-speed train stations in China, we propose three strategies to mitigate possible barriers which seniors may encounter: (1) a special security scanner embedded on the ground so that there is no need to lift luggage; (2) a priority ticket check gate exclusively reserved for seniors; and (3) some exclusive resting areas for seniors during the connection to other modes of transportation.

- Senior-friendly facilities

There are many self-service devices at high-speed train stations, such as ticket vending machines, schedule information checking machines, and electric guiding maps. Some of these devices should be designed for seniors specifically, for example, displaying characters in large font size print. In addition, assistants are expected in the ticket office to guide the seniors to purchase tickets on ticket vending machines. Resting areas reserved for older adults are supposed to be set near ticket checking points in waiting rooms. Last but not the least, electronic wheelchairs and scooters are better to be available to seniors in train stations.

- Optimizing infrastructure

The infrastructure can be re-designed or re-built to better accommodate the seniors' needs. For example, the distance from the exit of a high-speed train station to the ongoing transit spot (e.g., taxi and bus) is usually too long for seniors. Drop-off and pick-up areas can be moved closer to the exit, with lines reserved for seniors and benches for resting.

- Providing private service

With the increasing household income in China, there is a growing need for private service including door-to-door shuttle and paid accompany. These services are usually offered by third party companies, and can obviously improve both mobility and quality of life for seniors when they transfer at high-speed train stations.

In this paper, we have identified major spatial points at a high-speed train station where many seniors will meet some barriers or easily experience serious barriers when they transfer. However, there are still some limitations of this study. For example, our research was conducted in Beijing, and travelers' geographical-related characteristics haven't been taken into account (e.g. living habits). Further research can be expanded to different cities. In this case, we can grasp the information about the changes in travel behavior for seniors and make more reasonable and insightful suggestions.

Other future research directions include but are not limited to: 1) taking advantage of virtual reality (VR) technologies to simulate scenarios where possible transfer barriers would occur, and then improve service, facilities, infrastructure accordingly; 2) quantitatively studying physiological and biological factors which have caused seniors hard to overcome these transfer barriers; and 3) learning experience from other relevant applications (e.g., airport and bus), such as setting up reserved lines for seniors during peak time.

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**Appendix A. Survey questionnaire**

For every single question, please select only one answer which is most close to your case/feeling/situation.

**Date :**                      **Time :**                      **Location:**

*Note: location here is the point of interests as discussed in Section 2.1*

**Section 1: Personal Information**

**1.1 Age:**

[60-64]                      [65-69]                      [70-74]                      [75-79]                      [80 or elder]

**1.2 Gender:**

[Male]                      [Female]

**1.3 Health condition**

[Poor]      [Fair]                      [Deteriorative hearing or sight]      [Walking difficulty]  
[Excellent/good]

**1.4 Education level:**

[Less than junior high school]      [Junior High school/high school]  
[College/graduate]

**1.5 Annual income (\$):**

[Less than 3,000]                      [3,000-6,000]                      [6,000 or more]

**1.6 Beijing Residents**

[Yes]                      [No]

**Section 2: Trip History and Information**

**2.1 What is your (main) purpose of this trip?**

[Vacation]                      [Going home]                      [Hospital]                      [Group activity]  
[Long-term work in other cities]                      [Visiting families/grandchildren care]  
[Commute work and errands]                      [Others]

**2.2 How many times have you travelled to Beijing before?**

[6 times or less]                      [6-20 times]                      [20 times or more]

**2.3 How often do you have a long-distance travel (i.e., at least 2 hours) every year?**

[<5]                      [6-10]                      [>10]

**2.4 Are you accompanied with your family or friends during this travel?**

[Yes]                      [No]

**2.5 Where are your orientation and destination?**

Origin:                      Destination:

**2.6 Which of the followings do you think that you are most worried about during your journey?**

- [None]
- [Transportation fare]
- [Require assistance]
- [Getting lost]
- [Public security]
- [Physical problems]
- [Confused inside facilities]
- [Confusing traffic around transfer area]
- [Lack of time]
- [Others]

**Section 3: Transfer Phases**

**3.1 How did you come to the high-speed train station?**

- [Bus]       [Subway]       [Taxi]       [Driven by others in a private car]
- [Drove by yourself]

**3.2 How long did you get from your origin to high-speed train station (minutes)?**

- [0-15]       [15-30]       [30-45]       [45-60]       [60-90]
- [>90]

**3.3 How long did you get from bus station/taxi zone/subway station/parking lot to the high-speed train station entrance (minutes)?**

- [0-5]       [5-10]       [15-20]       [20-30]       [>30]

**3.4 Did you have any problem of using self-service machines ?**

- [No/Light]       [Moderate]       [Serious]

**3.5 How long did you spend in line through the restricted aisle? (If there is no queue, please choose 0)**

- [0 (no queue)]       [0-2]       [2-5]       [5-10]       [10-20]       [>20]

**3.6 Did you encounter barriers when lifting baggage up/down to/from security scanner?**

- [No/Light]       [Moderate]       [Serious]

**3.7 Did you encounter barriers when reading information screens and signage?**

- [No/Light]       [Moderate]       [Serious]

**3.8 Did you encounter barriers when transiting between floors?**

- [No/Light]       [Moderate]       [Serious]

**3.9 How long did you walk from in-door entrance (after security check) to the waiting room (minutes)?**

- [<2]       [2-5]       [5-10]       [10-20]       [>20]

**3.10 Did you encounter barriers when finding the signs and gate need to pass by to the platform?**

- [No/Light]       [Moderate]       [Serious]

**3.11 Did you find a seat available in waiting area?**

- [No/Light]       [Moderate]       [Serious]

**3.12 How long did you take to find a restroom?**

[<2]	[2-5]	[5-10]	[10-20]	[>20]
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**3.13 Did you encounter barriers when checking in with the ticket?**

[No/Light]	[Moderate]	[Serious]
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**3.14 Did you encounter barriers after check-in (e.g., pushed and shoved by rush flow of people)?**

[No/Light]	[Moderate]	[Serious]
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**3.15 How long did you take to walk from the check-in location to the train?**

[<2]	[2-5]	[5-10]	[10-20]	[>20]
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**3.16 Did you encounter barriers from getting off the train to finding the next transportation mode? (For example, in order to find a bus station to take a bus, was it hard to read a road direction?)**

[No/Light]	[Moderate]	[Serious]
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**3.17 How long did you take to walk from getting off the train to next transfer station (like bus station, taxi station, subway, parking lot)?**

[<2]	[2-5]	[5-10]	[10-20]	[>20]
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**3.18 Did you encounter other barriers? If yes, please specify them in detail.****3.19 Do you have any suggestion of management or design of future high-speed railway station?****References**

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