

Exploring correlates of passenger satisfaction and service improvement priorities of the Shanghai-Nanjing High Speed Rail

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Abstract: Assessing passenger satisfaction is essential to enhancing loyalty and increasing ridership on high speed rail (HSR). Many studies explore passenger satisfaction with transit and conventional railway, but there are only a few that look at HSR. Although the HSR studies provide information on the relationship between service quality and passenger satisfaction, few identify the attributes that have the largest impact or improvement priorities for existing HSR. This study employs multivariate regression and importance-performance analysis to identify influential attributes and service improvement priorities for the Shanghai-Nanjing HSR. We found that the most important correlates of passenger satisfaction were staff attitudes, convenience of ticket purchase, and ease of the access trip. In general, passengers are satisfied with HSR services, especially with the attributes that are critical to overall HSR satisfaction. However, we found that improving toilet sanitation and seat comfort on the Shanghai-Nanjing HSR would increase passenger satisfaction.

Keywords: importance-performance analysis, rail transit, quality of service, customer loyalty, HSR

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1 Introduction

Passenger satisfaction reflects the quality of transportation service from the perspective of customers (TCRP, 2003). Passenger satisfaction assessment helps service providers to set strategic development goals and to determine service improvement priorities within limited budgets (Cao & Cao, 2017; de Oña & de Oña, 2015; Zhang, Cao, Nagpure, & Agarwal, 2017), to ultimately improve the performance of service providers (Irfan, Kee, & Shahbaz, 2012).

Although many studies explore passenger satisfaction with urban transit (e.g., Cao, Cao, Zhang, & Huang, 2016; Guirao, García-Pastor, & López-Lambas, 2016; Mouwen, 2015; Shen, Xiao, & Wang,

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2016) and conventional railway (e.g., Eboli & Mazzulla, 2015; Ieda, Kanayama, Ota, Yamazaki, & Okamura, 2001; Nathanail, 2008), only a limited number of studies focus on satisfaction with high speed rail (HSR). HSR is mainly an inter-city service, distinct from urban transit serving intra-city passengers. Accordingly, HSR passengers and transit riders should value different service attributes. Moreover, although both conventional railway and HSR serve inter-city passengers, HSR is a premium service and priced substantially higher than conventional railway. Accordingly, HSR passengers tend to demand higher quality of service than conventional railway passengers. HSR and conventional railway passengers emphasize different service attributes (Liou & Tsao, 2010). Practitioners cannot rely on the studies on transit and conventional railway to design and improve HSR service; HSR-specific studies are needed.

Some studies examine the relationships among service quality, corporate image, customer satisfaction, customer loyalty, and/or behavioral intentions. However, most are from a marketing perspective. Very limited effort has been devoted to differentiate the relative importance of different service attributes to passenger satisfaction and to identify improvement priorities of the HSR being studied from a transportation planning perspective. This knowledge is critical for HSR design and service improvements.

It is time to study service satisfaction of the Chinese HSR. Since its debut in 2003, HSR in China has expanded dramatically. According to the National Bureau of Railroad, HSR in China grew to 22,000 km by 2016, accounting for 2/3 of HSR worldwide. The network is expected to grow in the next decade because of ongoing construction and planned projects. Although public media reported that the Shanghai-Nanjing HSR achieved an occupancy rate of 120% (the quotient between the number of passengers and the number of seats), the overall occupancy rate of the Chinese HSR is approximately 70% (China Railway, 2016). Understanding the correlates of HSR passenger satisfaction and enhancing its quality of service are critical to continued ridership growth.

Using the Shanghai-Nanjing HSR as a case study, this paper first applies multivariate regression to identify significant correlates of passenger satisfaction and the most important service attributes, to inform the design of future HSR. Then it employs importance-performance analysis (IPA) to identify the attributes to be prioritized for service improvements. These improvement priorities offer managerial implications for the Shanghai-Nanjing HSR. This study's contribution to the literature is threefold. First, HSR has proliferated during the past decades. However, a very limited number of studies have explored the correlates of HSR satisfaction from a transportation planning perspective. This hinders the capacity of practitioners to design and enhance HSR service with informed empirical knowledge. Second, although Chinese HSR accounts for about two-thirds of HSR mileage in the world and it is still growing, few studies have explored passenger satisfaction in China. Cao and Chen (2011) is the only study in the literature we could find. The lack of empirical studies is inconsistent with the development of HSR worldwide. Hence, Chinese HSR merits more scrutiny. Lastly, although IPA is a useful diagnostic tool for evaluating quality of service from a customer's perspective in many industries (Azzopardi & Nash, 2013), few studies have employed the technique in HSR studies. Chou, Kim, Kuo, & Ou (2011) appears to be the only application. Since IPA is particularly useful to identify improvement priorities, this study offers additional and important implications for HSR planning.

This paper is organized as follows. The next section reviews the literature on HSR passenger satisfaction and the IPA. Section 3 introduces the data and variables associated with the HSR and the analysis methods. Section 4 discusses the results of the regression analysis and IPA. The final section summarizes the key findings and makes recommendations for future research.

2 Literature review

2.1 Satisfaction with HSR

Although rider satisfaction is an important research topic in the field of transit, satisfaction with HSR has received little attention, presumably because of its limited impact on transportation systems in English-speaking countries such as the Netherlands, Australia, Canada, the UK, and the US. A literature search reveals that empirical analyses often used HSR in Taiwan and South Korea as case studies.

Studies on HSR satisfaction examine the causal mechanisms under which HSR service quality influences corporate image, passenger satisfaction, loyalty and/or behavioral intention to use HSR from a theoretical perspective. Chou and Kim (2009) employed structure equations models (SEM) to compare HSR satisfaction of 418 passengers in Taiwan and 414 passengers in Korea. They assumed that service quality affects satisfaction directly and indirectly through its influence on corporate image, and satisfaction in turn influences complaints and loyalty. In their models, service quality is a latent construct underlying five groups of observed service attributes including riding security, access convenience, service responses, tangible facilities, and riding comfort. They substantiated the relationships among service quality, corporate image, and satisfaction in both countries and concluded that service quality appears to have a stronger impact on passenger satisfaction in Taiwan than in Korea. However, this study carries limited managerial implications because they employ a reflective SEM. In particular, the latent service quality is theorized to predict the observed attributes, instead of the opposite direction (Diamantopoulos & Siguaw, 2006). Therefore, although the latent service quality predicts passenger satisfaction, researchers cannot tell which observed attributes have more important effects on satisfaction than others. This question is particularly important when lots of service attributes are assessed (as in this study) and when funding for service improvement is constrained (which is often the case). Following the research design of Chou and Kim (2009), Cao and Chen (2011) examined satisfaction of 386 passengers of the Shanghai-Nanjing HSR. They reached the same conclusion on the relationships among service quality, corporate image, and customer satisfaction as Chou and Kim (2009). Although this study sheds light on HSR in China, it is also vulnerable to the limitation of Chou and Kim (2009).

Chou and Yeh (2013) augment the customer loyalty theory by including leadership, employee satisfaction, employee loyalty, and operation performance in their conceptual model. They tested the model using 296 HSR passengers in Taiwan (a small sample). The observed indicators of service quality include items related to comfort of service, overall environment, convenience, and response ability. They also developed a reflective SEM. After dropping some observed indicators with low factor loadings, they reached a conclusion similar to Chou and Kim (2009): service quality influences customer satisfaction/loyalty directly and indirectly through corporate image. However, this study is unable to determine the relative importance of different service attributes.

Wu, Lin, and Hsu (2011) overcomes the limitation of a reflective SEM by explicitly measuring service quality. Specifically, the study developed a conceptual model to connect service quality, perceived value, corporate image, satisfaction, and behavioral intentions. It assumed that service quality is affected by three primary dimensions of HSR quality: interaction, physical environment, and outcome; the three primary measures are influenced by 10 sub-dimensions, and these sub-dimensions are derived based on a list of observed service attributes. Using 529 HSR passengers in Taiwan, the study conducted a series of regression models. It found that service quality influences HSR satisfaction through its effects on perceived value and corporate image. A comparison of standardized coefficients showed that outcome quality has the largest impact on service quality, followed by physical environment quality and interaction quality. Combined with the coefficients of the 10 sub-dimensions, Wu et al. (2011) suggested that the most important sub-dimension is valence, followed by waiting time, ambience and design, and

cleanliness. However, the study should have developed an SEM to capture the influences simultaneously, instead of using separate regressions.

Using 453 HSR passengers in Korea, Lee, Jin, and Ji (2009) explored the effects of ambient, seat, tunneling effect, and motion sickness factors on human fatigue and ride comfort. The study appeared to employ a formative SEM as the latent construct of ride comfort as predicted by seat comfort, overall satisfaction, and ride comfort. The results showed that in terms of HSR attributes, both seat factors and ambient factors affect ride comfort; seat pitch and width influence it the most.

Using 268 conventional railway users and 231 HSR passengers in Taiwan, Liou and Tsao (2010) also examined the relationships among service quality, perceived value, corporate image, customer satisfaction and loyalty. They compared the quality of the two services and concluded that HSR tends to have higher quality than conventional railway, in terms of tangibles, responsiveness, reliability, assurance, and empathy. Regression results illustrated that assurance is significantly associated with HSR passenger satisfaction whereas reliability, responsiveness, and empathy are related to railway passenger satisfaction. Therefore, satisfaction with HSR and satisfaction with conventional railway are affected by different service dimensions. However, because this study has a small sample size, a potential concern is that when insignificant results are found, the insignificance may be due to the inadequate power of the statistical tests.

Some studies investigated HSR satisfaction of certain market segments. For instance, Kuo and Tang (2013) examined the influences of service quality and corporate image on customer satisfaction and behavioral intention, using a convenient sample of seniors in Taiwan. They concluded that for customer satisfaction, the accessibility of the environment (such as handicap facilities and readability of navigation indices) is more important than hardware quality, staff attitude and adaptability, partly because of the characteristics of the sample: the elderly. However, because this conclusion is based on the size of factor loadings of a reflective SEM, it seems to be erroneously inferred.

Chou, Lu, and Chang (2014) studied the impacts of service quality and customer satisfaction on customer loyalty using 1,235 HSR passengers in Taiwan. Among the 24 service attributes, passengers were most satisfied with car cleanness and employee appearance and attitudes, but were the least satisfied with transfer, ticketing, and responses to complaints and suggestions. A factor analysis reduced the 24 attributes to four dimensions of service quality: personnel, tangibility, reliability, and convenience. Then reflective SEMs were used to examine the relationships among service quality (a latent construct of the four dimensions), customer satisfaction, and customer loyalty for different segments of people (such as frequent and infrequent users) and for the whole sample. Although the size of the influences varies slightly among different segments, service quality influences customer satisfaction and loyalty. Similar to Cao and Chen (2011), Chou and Kim (2009), and Chou and Yeh (2013), this study cannot differentiate the relative importance of the 24 attributes; hence, its managerial implications are also weak.

Taken together, studies examined the relationship between service quality and HSR satisfaction from a marketing perspective and substantiated the relationship (e.g., Chou & Kim, 2009; Chou & Yeh, 2013). They shed light on the significant impact of service quality on customer satisfaction, loyalty, and behavioral intention. However, the reflective SEM used in these studies does not allow researchers to differentiate which service attributes have a more important role than others. This gap hinders planners' strategic development for the design and deployment of future HSR under constrained resources. A few studies assess the relative importance of different service attributes (e.g., Lee et al., 2009; Wu et al., 2011), and enable practitioners to identify key influential attributes, to overcome the limitation. Because of the limited effort, this issue merits further investigation, particularly for HSR in China.

2.2 Importance-performance analysis

Although some studies assess the relative importance of various service attributes to passenger satisfaction, they have yet to inform planners which service attributes should be emphasized to improve existing HSR service. For instance, if a service attribute that is important to HSR satisfaction performs very well, it may not require additional improvement since the key attribute has already received efficient allocation of resources and effort. Therefore, identifying improvement priorities of an existing service requires an integrated analysis of importance and performance of service attributes. Because it is easy to implement and offer intuitive managerial strategies to enhance service competitiveness (Azzopardi & Nash, 2013), importance-performance analysis has become a popular technique to identify service improvement priorities in the transit industry (e.g., Figler, Sriraj, Welch, & Yavuz, 2011; Shen et al., 2016; Weinstein, 2000) and many other fields (Azzopardi & Nash, 2013). In particular, IPA classifies service attributes into four groups according to their importance in choosing the service and their perceived performance, as illustrated in Figure 1. Service attributes that are important but have relatively low performance (those in Quadrant IV) should be prioritized first for further improvement. These attributes are regarded as salient by riders but their performance does not meet rider expectation. The dissonance contributes greatly to dissatisfaction. So these attributes represent major threats to overall rider satisfaction. Unsatisfactory performance “on these attributes requires immediate attention and the highest prioritization in terms of resources and effort” (Azzopardi & Nash, 2013, p.224). The attributes that are important and perform well (those in Quadrant I) should be maintained to sustain satisfaction. They represent the attributes to which “scarce resources are being effectively allocated where they are needed most” (Azzopardi & Nash, 2013, p.224). They are major drivers to overall rider satisfaction. Although the attributes in both Quadrant I and IV are important to overall satisfaction, improving a well-performing attribute tends to have a diminishing return, compared to enhancing one that is performing poorly. Thus, they are treated differently in the IPA: those in Quadrant I should be kept in place whereas those in Quadrant IV need further improvement. The attributes in Quadrants II and III are classified as possible overkill and low priority, respectively, and are not critical to overall satisfaction.

| | | | | |
|-------------|--|------|-----------------------|--------------------------|
| Performance | | High | II. Possible overkill | I. Keep up the good work |
| | | Low | III. Low priority | IV. Concentrate here |
| | | | Low | High |
| | | | Importance | |

Figure 1: Important performance analysis (adapted from Martilla and James (1977))

As far as we could identify, there is only one IPA study in the field of HSR. Employing a revised IPA on the same data as Chou and Kim (2009), Chou et al. (2011) grouped HSR service attributes into four categories. They concluded that among the 18 attributes examined, station site, station transportation service, safety, information and communication technologies, information availability, staff attitude, timely responses of complaints, and personal space on train should be improved for Taiwan HSR, and response time of compliant channel, personal space on train, design of waiting space, and arrangement of moving route, information availability, staff attitudes, and stability of moving train should be addressed first for Korean HSR. It is worth noting that in this study an attribute with an average

performance of six or less (out of 10) was regarded as an improvement priority no matter whether it is important.

Although China has the largest HSR network in the world and is undergoing rapid service expansion, scholars have yet to assess service quality and service improvement. Cao and Chen (2011) is the only passenger satisfaction study and its objective is to test the connections among different constructs from a marketing perspective. This study aims to identify key influential service attributes and improvement priorities from a transportation planning perspective.

3 Methodology

3.1 Data and variables

This study uses data from a survey of HSR passengers along the Shanghai-Nanjing corridor in 2016. The area is the most developed and densely populated region in China. The corridor includes two HSR lines, Shanghai-Nanjing and Beijing-Shanghai. It is the most patronized corridor.

The questionnaires are designed based on the literature and informed knowledge. They were pre-tested by the members of the research team and HSR passengers and revised based on their feedback. Before launching sample recruitment, the survey was explained in detail to the interviewers and training was provided on how to randomly recruit HSR passengers to avoid selection bias. We offered a “red pocket” of 10-30 RMB (a random amount equivalent to \$2-5) as an incentive to each of the respondents who completed the entire survey.

The survey was conducted during January 10–24, 2016, and February 24–May 23, 2016. We planned to study regular daily travel, so we excluded data collection during public holidays such as Chinese New Year and the golden week in May when travel demand is extremely high. The sample includes passengers who boarded HSR at 13 stations along the Shanghai-Nanjing corridor (Figure 2). The corridor has 28 HSR stations. Each of the chosen stations served at least 50 pairs of HSR when the survey was administered. The 13 stations serve passengers to and from cities of three scales: Nanjing and Shanghai are provincial capitals; Changzhou, Wuxi, Zhenjiang, and Suzhou are prefecture-level cities; Danyang and Kunshan are county-level cities. We planned to recruit passengers at station exits since HSR regulations do not allow on-board sample recruitment. However, few people accepted our invitation because they were in a hurry. Alternatively, we sought and received approval from staff to recruit respondents in the station waiting halls.

Sample recruitment took place from 6 am to 10 pm, including passengers travelling during both peak and non-peak hours. First, the interviewers asked respondents to fill in a short recruitment survey asking about their travel attributes, access trip, and demographic characteristics, and then they received a QR code and a URL to answer an online survey to be completed after their HSR trip regarding waiting periods, line-haul trips, and egress trips. If participants were not comfortable with using the internet to complete the online questionnaire, they were advised to seek assistance from family members.



Figure 2: HSR stations in the survey

At the departure lounges, we recruited 4,237 HSR passengers. The online survey was completed by 993 respondents, a response rate of 23.4%. We conducted quality control of the questionnaires, especially the online ones, to filter out those that appeared to be randomly filled out and/or completed in less than 10 minutes. This study included 851 respondents.

Table 1 illustrates demographic characteristics of the sample. Men, younger, highly-educated and high-income individuals are overrepresented in the sample than are found in the general public. These results may not be surprising given that (1) conventional trains are available along the Shanghai-Nanjing corridor, and a low-income individual with fewer time constraints may prefer to ride conventional trains, and (2) most, if not all, of the respondents are internet users, who tend to be younger, highly-educated, and affluent. Since HSR passenger population data are not available, making a rigorous comparison between the sample and the population is not an option. In general, our observation of HSR passengers in the waiting halls is roughly consistent with the distribution of the general demographic, although the exact proportion may not be similar. Overall, because the sample was collected from an online survey, it is likely it does not represent the population of HSR passengers along the corridor. However, since the purpose of this study is not to illustrate the univariate distribution of customer satisfaction, but to explore the relationships between service attributes and customer satisfaction, the sample representativeness is not likely to materially affect the results (Babbie, 2007). That is, the results are still generalizable.

Table 1: Sample demographics

| Attributes | Distribution | Percent (%) |
|---------------------|----------------------------|-------------|
| Gender | Male | 64.2% |
| | Female | 35.8% |
| Age | 18-22 | 21.4% |
| | 23-30 | 54.5% |
| | 31-38 | 16.0% |
| | 39-46 | 5.7% |
| | ≥47 | 2.4% |
| Education | High school and under | 9.0% |
| | Associate degree candidate | 4.7% |
| | Associate degree | 16.6% |
| | Bachelor candidate | 14.4% |
| | Bachelor degree | 40.3% |
| | Postgraduate and above | 15.2% |
| Monthly income(RMB) | under 3,000 | 8.9% |
| | 3,000-4,999 | 24.1% |
| | 5,000-6,999 | 22.0% |
| | 7,000-9,999 | 14.0% |
| | 10,000-14,999 | 12.0% |
| | Over 15,000 | 19.0% |

Again, the survey captures the following HSR passenger information: travel attributes, access trip, time use planning, satisfaction with waiting halls, use of facilities at waiting halls, time use at waiting halls, satisfaction with HSR, on-board time use, egress trip, and demographics. This study focuses on the HSR satisfaction section. The survey asked about respondent satisfaction with 17 HSR service attributes and line-haul travel on a seven-point scale ranging from “extremely unsatisfied” to “extremely satisfied.” The 17 attributes include frequent HSR service, safety, carriage cleanliness, staff attitudes, adequate power outlets, staff responses to passengers’ demand, cell phone signal, staff professional ability, passengers’ manner, toilet sanitation, operating speed, ease of access trips, ease of egress trips, HSR fare, HSR inside temperature, seat comfort, and convenience of ticket purchase. In the sample, 24% of respondents are unsatisfied with HSR, 19% are neutral, and the rest are somewhat or extremely satisfied.

3.2 Analysis approaches

In this study, we adopt a multivariate regression to examine the influences of various service attributes on passenger satisfaction. The dependent variable is passenger satisfaction and the explanatory variables include the 17 service attributes and demographic characteristics. We use the p-value of 0.1 to determine significant service attributes and use the elasticities of the 17 attributes to assess their relative importance.

The IPA is conducted as follows. The average performance of service attributes is obtained directly from the customer satisfaction survey. In the literature, importance can be obtained in two ways. It could be asked directly in the survey. The IPA using explicitly-stated importance assumes that explicit importance and performance are independent. However, this assumption does not hold (Matzler, Sauerwein, & Heirschmidt, 2003). Alternatively, the importance of service attributes can be implicitly derived from empirical models such as bivariate correlation and multivariate analysis (de Oña & de Oña, 2015). This study uses the elasticities derived from the multivariate regression to measure importance. Four quadrants are constructed using the median elasticity and the median of the average performance of the 17 attributes.

4 Results

4.1 Regression models

Table 2 illustrates the regression results with robust error. The adjusted R^2 is 0.268, which is considered typical for a linear regression model with a relatively large sample size (Greene, 2012). We checked potential multicollinearity among the explanatory variables. Since the largest variance inflation factor is smaller than three, multicollinearity does not seem to be an issue.

Table 2: Robust multivariate regression for HSR satisfaction

| Variables | Elasticity | t | P-value |
|---------------------------------------|------------|-------|---------|
| Staff attitudes | 0.104 | 2.12 | 0.034 |
| Convenience of ticket purchase | 0.095 | 2.96 | 0.003 |
| Ease of access trips | 0.059 | 1.76 | 0.080 |
| Operating speed | 0.052 | 1.59 | 0.112 |
| Carriage cleanliness | 0.046 | 1.20 | 0.231 |
| Frequent HSR service | 0.045 | 1.72 | 0.086 |
| Toilet sanitation | 0.043 | 1.52 | 0.128 |
| Staff responses to passengers' demand | 0.038 | 0.80 | 0.422 |
| Seat comfort | 0.038 | 1.17 | 0.242 |
| HSR fare | 0.021 | 0.97 | 0.331 |
| HSR inside temperature | 0.016 | 0.42 | 0.675 |
| Staff professional ability | 0.011 | 0.81 | 0.417 |
| Ease of egress trips | 0.004 | 0.11 | 0.909 |
| Safety | 0.003 | 0.08 | 0.936 |
| Cell phone signal | -0.000 | -0.03 | 0.978 |
| Adequate power outlets | -0.005 | -0.14 | 0.892 |
| Passengers' manner | -0.022 | -0.96 | 0.336 |
| Male | -0.007 | -1.09 | 0.277 |
| Age | 0.038 | 2.04 | 0.041 |
| Education | 0.028 | 2.08 | 0.038 |
| Income | 0.001 | 0.13 | 0.897 |
| N of observations | 851 | | |
| Adj. R^2 | 0.268 | | |

The model shows that staff attitudes and the convenience of ticket purchase are positively associated with passenger satisfaction at the 0.05 level; ease of access trip and frequent service have positive associations at the 0.1 level; and all other service attributes have a p-value of 0.1 or larger. Since the second column of Table 2 reports the elasticities, rather than the coefficients, of the explanatory variables, we can identify the relative importance of these variables. For example, the staff attitudes variable is the most important to passenger satisfaction, with an elasticity of 0.104. It means that associated with a 1% increase in staff attitudes, passenger satisfaction will increase by 0.104%, on average. It is worth noting that although the coefficients of cell phone signal, adequate power outlets, and passengers' manner are negative, they are not statistically significant from zero. The negative signs are not a concern. Among the four demographic variables, age and education are positively associated with passenger satisfaction,

whereas gender and income have no significant impacts.

Staff attitudes have the largest impact on passenger satisfaction. This result highlights that HSR is a premium service and passengers value the intangible component of the service. Convenience of ticket purchase is the second most important. The capacity increase resulting from frequent service effectively meets the daily demand for train travel: obtaining a train ticket is not very difficult. Before the deployment of HSR, some passengers of popular train routes had to get up early in the morning and wait for hours or even days to purchase a ticket, or pay a premium to illegal ticketing agents. The two senior authors of this study both had previous terrible experiences purchasing tickets. Furthermore, with the availability of electronic payments, the recently-developed ticketing website and the smart phone application, ticket purchase and rescheduling are very convenient: passengers do not make a special trip to ticketing offices to wait in long lines. Along the Shanghai-Nanjing corridor, passengers can use their official ID to board HSR. Ease of access trip ranks third in importance. Accessibility is one important determinant of a successful public transportation system (Curtis & Scheurer, 2017). This is especially the case for HSR. For a short HSR trip, access and egress trips may take longer time than the line-haul segment on HSR. If rail transit is not an option to reach HSR stations, travel time reliability may be another concern. This helps explain why ease of access trip is a more important attribute than ease of egress trip. Therefore, an efficient multimodal connection with HSR stations is important.

4.2 Importance-performance analysis

Table 3 presents the relative importance and the average performance of the 17 service attributes. The third column illustrates the average performance. Since HSR satisfaction was measured on a seven-point scale, the value “4” is considered “neutral.” On average, HSR passengers are unsatisfied with power outlets and cell phone signal as their mean performances are inferior to “neutral.” These results are not surprising since power outlets are not widely available on HSR carriages, particularly second-class carriages where most passengers stay, and cell phone signals are intermittent at the high speed of 300 km/hour.

Table 3: Importance and performance of HSR service attributes

| Item | Importance | Mean Performance |
|---------------------------------------|------------|------------------|
| Staff attitudes | 0.104 | 5.278 |
| Convenience of ticket purchase | 0.095 | 5.395 |
| Ease of access trips | 0.059 | 5.079 |
| Operating speed | 0.052 | 5.288 |
| Carriage cleanliness | 0.046 | 5.375 |
| Frequent HSR service | 0.045 | 5.032 |
| Toilet sanitation | 0.043 | 4.719 |
| Staff professional ability | 0.038 | 5.027 |
| Seat comfort | 0.038 | 4.794 |
| HSR fare | 0.021 | 4.183 |
| HSR inside temperature | 0.016 | 5.085 |
| Cell phone signal | 0.011 | 3.774 |
| Ease of egress trips | 0.004 | 5.110 |
| Safety | 0.003 | 5.605 |
| Adequate power outlets | 0.000 | 3.865 |
| Staff responses to passengers' demand | -0.005 | 4.884 |
| Passengers' manner | -0.022 | 4.331 |
| Median | 0.038 | 5.032 |

The second column of Table 3 duplicates the elasticities of the 17 attributes in Table 2, which indicate the implicit importance of these variables to overall HSR satisfaction. It is worth noting that safety could be an important factor for HSR since it is fundamental to many services. However, Chinese HSR maintains an excellent record of safety since the rear-end collision in 2011. Once the performance of safety reaches a certain level, its contribution to service satisfaction may become less important (Matzler et al., 2003). This highlights the importance of using implicit importance to conduct IPA, rather than the importance stated by respondents in a questionnaire.

Figure 3 illustrates Table 3 graphically and classifies the attributes into different quadrants. The elasticity of toilet sanitation (which measures its practical importance) ranks seventh among all 17 service attributes and its average performance is lower than the median average performance. Accordingly, toilet sanitation falls into the fourth quadrant and should be prioritized for additional improvement. This result is not surprising because restroom sanitation is often a problem in developing countries including China. Although HSR has better toilet facilities than conventional railway, it has room for improvement. For example, soap, paper towels, and bath tissue are often unavailable; toilets are not cleaned frequently so water and sometimes bath tissue are on the ground; the ventilation system is not

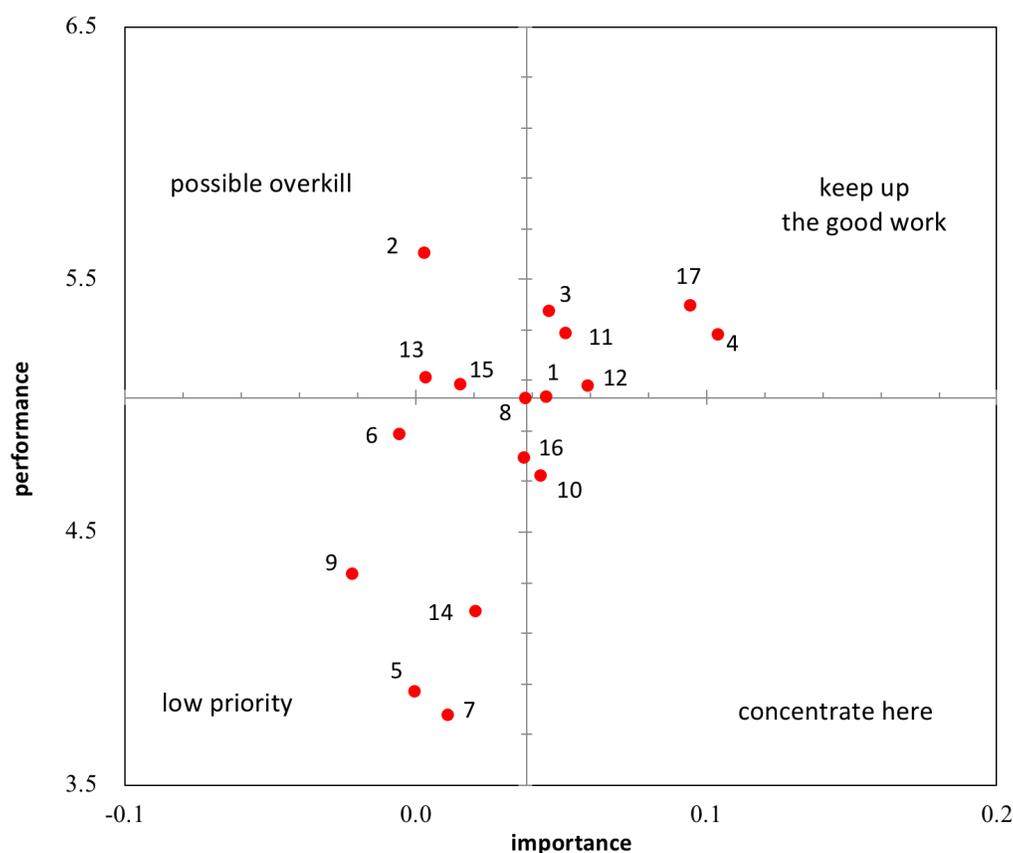


Figure 3: The results of importance and performance analysis

Notes:

- | | | |
|-------------------------|-----------------------------------|---|
| 1=Frequent HSR service | 2=Safety | 3=Carriage cleanliness |
| 4=Staff attitudes | 5=Adequate power outlets | 6=Staff responses to passengers' demand |
| 7=Cell phone signal | 8=Staff professional ability | 9=Passengers' manner |
| 10=Toilet sanitation | 11=Operating speed | 12=Ease of access trips |
| 13=Ease of egress trips | 14=HSR fare | 15=HSR inside temperature |
| 16=Seat comfort | 17=Convenience of ticket purchase | |

as effective as it should be. Seat comfort is on the boundary of Quadrant III (low priority) and Quadrant IV (concentrate here) in Figure 3. It can be further improved because it is somewhat important, but has an inferior performance. As Lee et al. (2009) suggested, additional studies are desirable to explore which seat dimension (seat width, pitch, or leg room) causes the low performance. It is worth noting that the average performances of power outlets and cell phone signal are lower than the neutral scale (4). That is, they have sub-standard performances. If the neutral scale is chosen as the minimum service standard as Chou et al. (2011) did, these two attributes should be enhanced. These improvements could be important for business travelers, as they need power and cell phones for work-related activities.

The IPA shows that HSR should maintain the performance of high operating speed and frequent service, which contributes greatly to passenger satisfaction. Before the debut of HSR in 2010, travel time from Nanjing to Shanghai ranged from 2.5 to 6 hours. By contrast, it takes the fastest HSR 60 minutes to complete the trip, a dramatic improvement over conventional railway. Because of the high speed, more service can be scheduled between the two cities: there are almost 200 HSR from Nanjing to Shanghai daily. Frequent service makes travel more flexible, and enables travelers to make both scheduled and impulsive journeys (Curtis & Scheurer, 2017). Staff attitudes, convenience of ticket purchase, ease of access trips, and carriage cleanliness also fall into the “keep up the good work” category. According to the IPA, these six attributes represent the service characteristics with efficient resource allocation that should be kept in place.

Although some questioned the affordability of HSR, passengers have gradually become used to the decent service. Accordingly, HSR is used substantially in affluent regions, such as the Yangtze Delta. So, it makes sense that the HSR fare is classified as a low priority. The high HSR fare filters low-income individuals to slower trains, which makes passengers more homogenous than before. This seems to significantly reduce the occurrence of inappropriate passenger behavior on board. Therefore, it is not surprising that passengers' manner is classified as low priority.

5 Conclusions

This study examines the significant correlates with passenger satisfaction and identifies service improvement priorities of the Shanghai-Nanjing HSR. In this study, the IPA uses median performance and importance as the thresholds to construct four quadrants. The outcomes will differ slightly if mean importance and performance are applied. In the literature, both practices fall within the mainstream of the IPA (Azzopardi & Nash, 2013). However, if transportation agencies have an internal guideline on the level of acceptable performance, this level, rather than the mean or median, should be chosen as the threshold. Nevertheless, this study offers a snapshot of the Shanghai-Nanjing HSR and provides significant insights for enhancing HSR quality of service.

The regression results show that among the 17 service attributes, staff attitudes, convenience of ticket purchase, ease of access trips, and frequent HSR service are statistically significant at the 0.1 level. In terms of practical importance, staff attitudes, convenience of ticket purchase, ease of access trips, operating speed, carriage cleanliness, and frequent HSR service are the top six service attributes influencing HSR satisfaction.

The IPA results indicate that for the Shanghai-Nanjing HSR, toilet sanitation and seat comfort should be prioritized for additional improvement because they are somewhat important to passenger satisfaction, but have lower performance. Furthermore, because power outlets and cell phone signal have sub-standard performance, they could be improved, delighting passengers, particularly business travelers. To improve toilet sanitation, staff should clean the toilet more frequently, refill toilet supplies regularly, and place air fresher in the toilet. In fact, it is more cost-effective to improve toilet sanitation

than the other three, which require redesign or renovation of HSR carriages. Interestingly, our findings are consistent with the recent improvements of HSR carriages. In June 2017, “Fuxing” (rejuvenation) carriages began to operate showing potential to replace the existing “Hexie” (harmony) carriages. In the newly designed carriages, both seat width and seat length are enlarged to improve passenger comfort. Furthermore, power outlets, USB connection, and free Wi-Fi service are provided to meet passenger need in the information era. These improvements are expected to enhance passenger experience. However, the extent to which they improve passenger satisfaction is an empirical question.

By contrast, other service attributes that are critical to overall HSR satisfaction generally perform well. This is reasonable because travel by conventional railway was an exhausting experience: time consuming, noisy, messy, and smelly, especially for medium and long line-haul services, whereas HSR fundamentally changes passenger perception of train services. In particular, the performance of staff attitudes, convenience of ticket purchase, ease of access trips, operating speed, carriage cleanliness, and frequent HSR service should be kept in place or enhanced. Among the six attributes, the performances of ease of access trips and frequent HSR service are close to the median performance and lower than the other four attributes. Therefore, the two attributes could be enhanced. However, increasing HSR service frequency should consider passenger demand. Improving ease of access trips requires an understanding of factors that affect satisfaction with access trips, and the coordination between HSR agencies and local transportation agencies.

Overall, HSR needs to improve important service attributes. First, mean performance of the top nine important attributes ranges from 4.7 to 5.4 (Table 3), which is not impressive for a seven-point scale. Furthermore, since the commencement of the Shanghai-Nanjing HSR is less than six years, passengers are still enjoying service improvement beyond conventional railway because their impression of conventional railway remains fresh. However, once HSR becomes a routine choice of inter-city travel in the future, passenger demand for quality HSR service is likely to grow. HSR service improvements are essential to sustain passenger satisfaction and to compete with the airlines.

Future studies should explore passenger on-board time use and their satisfaction with waiting hall services. Travel time is generally considered a cost. Making travel time productive has the potential to enhance travel satisfaction (Ettema, Friman, Gärling, Olsson, & Fujii, 2012; Lyons, Jain, & Holley, 2007). Studying on-board time use patterns can help planners understand the needs of HSR passengers (Lyons, Jain, Susilo, & Atkins, 2013). On the other hand, a substantial share of the passengers are business travelers. Providing power outlets, reliable on-board Wi-Fi service, and a comfortable working environment could make HSR a mobile workplace. Further, waiting time is an essential component of any HSR journey. Passenger experience in departure lounges could affect their satisfaction with HSR service, analogous to other types of services (Lee & Lambert, 2000; Tom & Lucey, 1995). It is known that waiting time is perceived more costly than line-haul travel time for transit users (TCRP, 2003). This makes waiting-related studies even more pertinent.

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