Influence of Internal Space Factors of High-Speed Train on Passenger Behavior

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Abstract. This paper explores the influence of internal factors of rail trains on passengers' behavior, and studies the redesign of the interior layout of high-speed trains to reduce unnecessary behaviors of passengers and create a comfortable ride experience. Based on behavioral experience and regression analysis, it is found that factors such as seat comfort have a positive impact on passenger behavior, and secondly, the use of luggage rack can also reduce unnecessary behavior of passengers, both of which have important effects on passenger behavior. The use of toilets and drinking fountains is contrary to the research hypothesis, which has little or no impact on passengers. This study can provide high-speed train designers with new ideas for interior design, improve passengers' comfort, and reduce passengers' spontaneous behavior and unnecessary social behavior.

Keywords: Interior design of high-speed train; Behavioral experience; Regression analysis.

1 Introduction

On April 1st, 2023, the official information of China National Railway Administration was released, and the China-Hongkong-Wuhan high-speed railway was officially opened, which further proved the rapid development of China's high-speed railway. With the development of technology, the demand of high-speed rail tourism market is also rising. High-speed rail has become an indispensable part of people's daily life. In recent years, the research on passengers' behavior preference is very limited. With the development of domestic high-speed rail technology and the increase of passenger traffic, it means that we will grasp passengers' psychological and behavioral preferences from the internal space, explore the most comfortable ride mode and spatial layout relationship for passengers, and analyze the passenger path according to the behavioral influence of internal facilities on passengers to explore the appropriate spatial layout.

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2 Research and Discussion on the Related Papers on the Influence of High-Speed Trains on Passenger Behavior

Group dynamics theory points out that the consumer's environment and the behavior of others around him will have an impact on the consumer's behavior [1] In addition, social environment, support services and accessibility together constitute seven factors affecting passenger comfort. Chen Zhensong and others found that temperature, air quality, food and beverage cost performance, power socket and wireless network, seat comfort, waiter's attitude and courtesy of surrounding passengers affect passengers' riding comfort, and the factors that passengers care most about are temperature suitability, seat comfort and air quality [2]; Ozlem Alpu pointed out that advertising and information service, food service, material conditions, attitude and behavior of staff will all affect passengers' comfort satisfaction in high-speed trains [3]. According to the above research and investigation, it is found that the behavior of train passengers is influenced by many aspects, including the train service, the layout of train space facilities and the influence of surrounding passengers.

3 Research Hypothesis

H1: Seats have a positive impact on passenger behavior.

As the component that passengers have been in contact with for the longest time, seats are also the most basic and important facilities in high-speed train carriages. Seat comfort is directly related to the user experience of passengers and is the most important research object in rail transit [4]. Most of the ergonomic research on the seat is inseparable from the comfort of the seat. There will be various postures and activities during the high-speed train ride, especially for long-distance passengers, who have to change their postures in their seats for a longer time and have more behaviors, so the seat comfort has a great influence on passengers' behaviors. This paper assumes that the comfort of train seats will have a positive guiding effect on passenger behavior.

H2: Train lighting has a positive impact on passenger behavior.

The purpose of high-speed train lighting design is to provide passengers with a good visibility and a comfortable riding environment. Some light sources can be used as indicative icons to guide passengers' behavior. Comfortable lighting design can maximize the use value and aesthetic value of train space, provide passengers with a good visual environment and create a comfortable and suitable lighting environment.

H3: The portability of luggage storage has a positive impact on passenger behavior.

The luggage rack has the function of storing passengers' luggage. The luggage rack in the train consists of semi-suspended luggage storage places above the seat and large luggage storage places at the door. The use frequency of the top luggage storage place is much higher than that of the luggage desk and large luggage storage places, and the large luggage storage place is the most convenient place for women and the elderly. However, at present, the number of large luggage storage places is small, and the space is narrow and difficult to find.

H4: Functional area layout has a positive impact on passenger behavior.

The internal functional areas of high-speed trains mainly include toilets, drinking fountains, maternal and child rooms and barrier-free toilets. Toilets and drinking fountains are generally placed at the junction of two carriages[5]. The small number of toilets and the use situation can not be clearly communicated to passengers will increase the behavior of passengers repeatedly looking for toilets in the carriage, resulting in bad behavior experience.

According to the above research, the independent variables of this study are set as four parts: seat, lighting, luggage rack storage area and functional area, so the correlation of factors affecting passenger behavior and satisfaction is drawn, as shown in Figure 1.

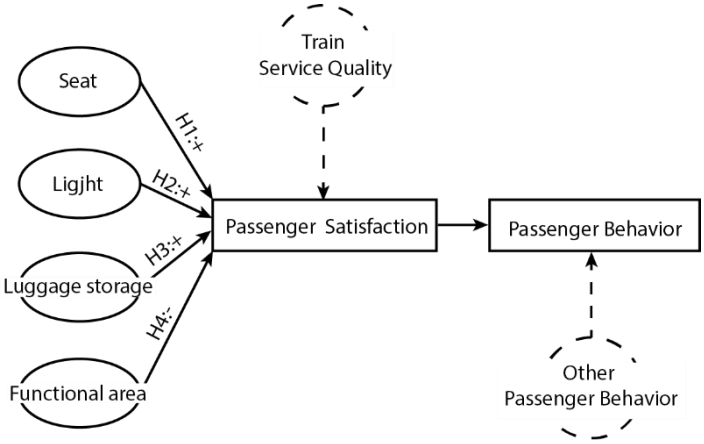

Fig. 1. Influence of related facilities and services of high-speed trains on behaviors (made by the author)

4 Method

In this study, through the design and distribution of questionnaires, the behavior patterns of passengers on the train and the contents that passengers' satisfaction needs to know and study are discussed. The questionnaires are mainly divided into the following parts: a. Basic information of passengers; B, information of passengers taking the train; C, the time spent on the bus and the factors that affect behavior; D, passenger satisfaction of each facility; E, the degree of influence of various facilities on passenger behavior.

4.1 Result Analysis

In this design survey, the proportion of men and women tends to be roughly the same, with men accounting for 43.48% and women accounting for 56.52%. In the age proportion, people aged 18-25 account for.

The highest ratio is 32.37%, followed by the population aged 26-45, accounting for 24.63%. About 42% people choose second-class cars more often. During the whole

journey, we found that finding a seat, putting a suitcase and going to the toilet/drinking water occupied most of the passengers' behavior, while the problems of seat comfort and luggage storage would potentially affect the passengers' behavior during the whole journey, accounting for 25.6% and 23.6% respectively.

In order to further explore the influence of the internal facilities of high-speed trains on passengers' behavior, this study used Richter scale to investigate the seats, luggage racks, lighting and public facilities, and disassembled the characteristics of these facilities, including comfort, man-machine, etc., and divided the satisfaction into five grades. The seating facilities are discussed from six dimensions: comfort, seat spacing, seat buttons, convenience of small table board, aisle space and personal space. Among them, the convenience of small table board is the most satisfactory for passengers, and the comfort of seats is the least satisfactory, followed by seat spacing.

4.2 Data Analysis Discussion

First, this study uses spss to analyze the reliability and validity of the data. The reliability analysis of the data shows that the Kolumbach coefficient is 0.931>0.7, which indicates that the data of this questionnaire is reliable, the results are shown in Table 1. The KMO value is 0.936, which is significantly higher than 0.8, the results are shown in Table 2.

Table 1. Reliability test (made by the author)

Cronbach's Alpha	Num.
.931	22

Table 2. Test of KMO and Bartlett (made by the author)

Kaiser-Meyer-Olkin measurement of sampling adequacy.		.936
Bartlett	Chi-squared approximation	2185.488
	df	231
	Sig.	.000

Secondly, in order to explore the hypothetical results, the data were analyzed by regression, the specific results are shown in Table 3. In order to test whether the questions among the groups are related to affect the experiment, a multicollinearity test was conducted, and the data showed that the maximum VIF value of 4.165 was less than the threshold value of 5, so there was no multicollinearity problem in this study (the specific values are shown in Table 4). The standard coefficients of seat and luggage rack on passenger behavior are 0.559 and 0.341, respectively. Seat satisfaction (β=0.605, t=6.533) and luggage rack use satisfaction (β=0.359, t=5.579) have a positive and significant impact on user behavior. The comfort of high-speed train seat and the convenience of luggage rack have a positive impact on passenger behavior, and the seat is comfortable. The convenience of luggage rack can also reduce user behavior, so hypothesis 1 and hypothesis 3 are established in this paper. However, the standard coefficient of lighting is -0.035, and lighting comfort (β=-0.034, t=-0.497) has a negative

impact on passenger behavior, but the impact is small, so hypothesis 2 in this paper is not supported; The standard coefficient of the usage of public areas is -0.006, which indicates that the influence on passenger behavior is negative, but the influence of public areas on passenger behavior is almost zero because the numerical value is extremely small and negligible, which indicates that the research hypothesis 4 in this paper is not valid.

Table 3. correlation test between factors (made by the author)

		all	Seat satisfaction	light	luggage carrier	domain
Pearson	all	1.000	.766	.611	.708	.639
	Seat satisfaction	.766	1.000	.790	.701	.787
	light	.611	.790	1.000	.608	.683
	luggage carrier	.708	.701	.608	1.000	.668
	domain	.639	.787	.683	.668	1.000

Table 4. Hypothetical Test Results (made by the author)

model		Non-standardized coefficient		Std.	t	Sig.	correlation			Collinear statistics	
		B	standard error								VIF
1	(constant)	.268	.142		1.878	.062					
	Seat satisfaction	.605	.093	.559	6.533	.000	.766	.418	.274	.240	4.165
	light	-.034	.068	-.035	-.497	.619	.611	-.035	-.021	.363	2.752
	luggage carrier	.359	.064	.341	5.579	.000	.708	.365	.234	.469	2.130
	domain	-.006	.071	-.006	-.085	.932	.639	-.006	-.004	.347	2.881

5 Conclusion

The purpose of this study is to explore the influence of internal facilities of high-speed trains on passenger behavior. Passengers' satisfaction with the use of seats, lighting, luggage racks and functional areas is not a directly measurable variable, so the four dimensions are divided into groups for research. The research shows that the comfort of seats has the greatest influence on passengers' behavior, the most obvious of which is passengers' demand for the comfort of backrest and cushion, followed by the problem of luggage placement. The reasonable layout of large luggage storage and the height

layout of overhead luggage rack are more suitable for female passengers' needs, which will greatly reduce the unnecessary behavior experience brought by passengers' luggage storage. The results of this study can help designers engaged in high-speed train to grasp the user behavior deeply, thus reducing train congestion and unnecessary troubles.

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