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Competing with Future High Speed Railway in India: Pricing Policies and Operations Strategies for Conventional Railway

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Abstract

India is currently building its first High Speed Rail (HSR) corridor between Mumbai and Ahmedabad on the western coast. The alignment of this corridor is parallel to the existing conventional rail lines connecting Mumbai and Ahmedabad via cities like Surat, Vadodara. Due to this, the future HSR is expected to take a significant share of its ridership from the existing conventional rail services. The aim of this study is to model the inter-modal competition between the conventional rail services and the upcoming HSR services in India, deriving the policies for pricing and operations. A combined revealed and stated preference survey was conducted at an intercity train station in Mumbai. The passengers waiting to board trains towards Ahmedabad were questioned about their choice between conventional train and HSR based on travel time, cost and comfort criteria. The collected data was modelled in a binary logistic environment to generate the utility function of both the modes, conventional train and the HSR. The results of this study show the positive effect of sleeping comfort provided in conventional trains on the mode choice. The travel cost elasticity of comfort was found to be -0.731 whereas, the travel time elasticity of sleeping comfort was -1.71 hours. It was found that the modal share of conventional train in its competition with HSR, would increase by around 10% with the provision of sleeping comfort by the conventional rail. Study concludes that the Indian Railways need to emphasize on plying trains with AC sleeper coaches, especially for longer distances, to compete better with the upcoming HSR corridor in India.

Keywords: High Speed Rail, Conventional Rail, Pricing Policies, Railway Operations.

1 Introduction

The High Speed Rail (HSR) is a significantly faster mode of fixed-route surface transport that 'shrinks the space-time geography' [1] of the regions in connects due to the travel time gains it offers. Many developed countries in the world have constructed the HSR in the last few decades whereas several developing countries like India are expecting to build the HSR networks in the near future [2]. India's first HSR corridor between Mumbai and Ahmedabad on the western coast of India is currently under construction. Along with the terminals, this corridor is expected to connect intermediate cities like Surat and Vadodara. Though the HSR is often considered as a primary competitor to the airlines [3], the Mumbai - Ahmedabad HSR is expected to take a significant share of its ridership from the existing conventional rail services [4]. In many cases around the world, the HSR has reduced the passenger ridership on conventional rail routes, leading to "freeing up" of conventional rail corridors [5]. Studies show that the construction of Wuhan - Guangzhou HSR in China has resulted in the permanent cancellation of several conventional rail services [6] leaving a negative impact on the low income classes. Despite the recorded negative impacts of HSR on the conventional rail services, existing literature lacks the studies modeling the HSR and conventional rail competition and determining corresponding policy outcomes for fair and inclusive multi-modal transport services. The previous studies on willingness to pay for Mumbai - Ahmedabad HSR have suggested pricing policies for the HSR [7]. The purpose of this study is to model the inter-modal competition between the conventional rail services and the upcoming HSR services in India, along its first HSR corridor between Mumbai and Ahmedabad. The study also aims to identify critical aspects of the competition to come up with the pricing policies and operational strategies for the conventional railway. The binary choice model between conventional rail and HSR provided insights into the perception of sleeping comfort among rail passengers. The study concludes that the Indian Railways need to ply trains with AC sleeper coaches, especially for longer distances, to compete better with the HSR.

2 Methods

The first High Speed Rail corridor in India is under construction between Mumbai and Ahmedabad. The alignment of this corridor is parallel to the existing conventional rail lines connecting Mumbai and Ahmedabad via Surat, Vadodara. The Mumbai - Vadodara section of this conventional rail route is concurrent with the Mumbai - Delhi trunk line as well, which carries a significant rail passenger traffic. Hence, the study area for this research was defined as the conventional rail line between Mumbai and Ahmedabad and the target population was existing travelers by conventional rail on this route.

The primary data was collected by conducting a combined revealed and stated preference (RP-SP) survey on this target population. The data collection was done by taking a questionnaire-based survey of passengers waiting to board the trains at an inter-city train station in Mumbai. Respondents were selected through random sampling among all waiting passengers and were surveyed if their long distance

journey's destination was between Mumbai and Ahmedabad. The respondents were first asked about their socio-economic background, followed by the trip characteristics such as destination, the purpose of travel, duration of advance booking etc. The second part of the survey was revealed preference (RP) where the details of respondents' current mode of travel such as journey duration, ticket price, class of travel were asked. This was followed by the stated preference (SP) choice cards.

The SP choice cards were designed as a binary choice between the conventional train and the HSR. The attribute levels of the conventional train were set as collected from the RP questions. The attribute levels of HSR were set with five levels of travel time and three levels of travel cost. The travel time levels were defined using five levels of average HSR speed varying between 167 km/h to 350 km/hr. The values of HSR travel time varied with the respondents' destination, depending on these HSR speed levels. The comfort criteria for both the modes was defined as a binary variable of whether the sleeper facility is available or not. The full factorial method was used to generate a total of 15 choice scenarios for each response. A total of 298 passengers were surveyed and the complete responses of 256 of them were used for the analysis. The collected SP data was then analyzed in a binary logistic choice modeling environment using Limdep's NLOGIT 5 software package.

3 Results

The data was modeled as a binary logistic model with two choices defined as conventional rail and HSR, with later as the base case. The coefficient values of variables in the best fitting model are shown in **Error! Reference source not found.**.

Variable type	Variable	Coefficient	Std. error	p-value
Generic variables	Travel Cost (in 000's of INR)	- 0.657	0.059	0.000
	Travel Time (in hours)	- 0.281	0.049	0.000
	Sleeping comfort	0.480	0.216	0.026
Alternative specific variables (train)	Distance (in 00's of km)	0.066	0.077	0.390
	Purpose as work	0.199	0.102	0.049
	Age (in years)	- 0.012	0.004	0.002

Table 1: Model Estimates

Log Likelihood = - 1234.62; Rho-square = 0.08

Three variables whose attribute levels were determined for the SP survey were categorized as generic variables, whose value varied among the alternatives, i.e. conventional train and HSR. Three important variables from socio-economic variables and trip characteristics were identified as alternative specific variables, specific to the choice of conventional train (referred to as train). Hence, the utility functions of both the modes were defined as follows:

$$U_{HSR} = (-0.657) * Cost_{HSR} + (-0.281) * Time_{HSR} + 0.48 * Comfort_{HSR} \quad (1)$$

$$U_{train} = (-0.657) * Cost_{train} + (-0.281) * Time_{train} + 0.48 * Comfort_{train} + 0.066 * Distance + 0.199 * Purpose_{work} + (-0.012) * Age \quad (2)$$

Using these utility functions for both the modes, the mode share of conventional train was determined while competing with future HSR. The properties of existing conventional sleeper and non-sleeper trains were compared with the properties of future HSR for three different destinations, viz. Ahmedabad, Vadodara and Surat. The proposed fare and travel time values of rapid HSR service were taken from the feasibility study of Mumbai - Ahmedabad HSR [4] whereas the fare and travel time values of the conventional train were collected from the existing train timetable. The HSR was considered to be a mode without any sleeping comfort. The age of the traveler was considered as the average age of respondents, which was 37 years and the purpose of traveling was considered as non-work-related travel. The results of the modal competition are summarized in **Error! Reference source not found.**.

Conventional train type	**Destination**	**Distance (km)**	**HSR**		**Conventional train**		
			Travel cost (INR)	Travel time (hrs.)	Travel cost (INR)	Travel time (hrs.)	Mode share (%)
Without sleeping comfort	Ahmedabad	500	2305	2	700	8	32.2%
	Vadodara	400	2000	1.5	600	6	37.2%
	Surat	275	1680	1	500	4	41.8%
With sleeping comfort	Ahmedabad	500	2305	2	850	8	41.0%
	Vadodara	400	2000	1.5	750	6	46.4%
	Surat	275	1680	1	600	4	52.1%

Table 2: Modal Competition

4 Conclusions and Contributions

Utility equations were obtained for the two modes using the binary choice model and the modal shares were calculated for two different scenarios. Following conclusions can be drawn from the obtained results of this study.

- The mode like conventional trains with sleeper coaches would have a utility value of 0.48 units more than the mode lacking the sleeping comfort such as HSR.
- The mode-share of conventional trains increases by 9 - 10% with the sleeping comfort.
- The travel cost elasticity of sleeping comfort is (-0.731), which means the provision of sleeper coaches can compensate for an increase in ticket prices as high as INR 700.

- The travel time elasticity of sleeping comfort shows that the utility of conventional train with sleeping comfort will be higher for travel time differences up to 1.71 hours.
- Passengers traveling longer distances for work-related purposes would prefer conventional train over HSR more as compared to others.

Suggestions on operational strategies and fare policies for Indian Railways to operate conventional trains minimizing the loss due to modal switch to HSR are as follows.

- Indian Railways needs to focus on the provision of more sleeper coaches in the trains on routes competing with the future HSR.
- The ticket prices of sleeper trains can be increased up to INR 700 higher than the non-sleeper train, to maintain the total revenue.
- Sleeper trains for longer distances would result in a lesser modal switch to HSR and hence relatively more ridership of conventional rail.
- More overnight sleeper trains from Mumbai to Vadodara and Ahmedabad (distance of 400 and 500 km, respectively) should be provided in order to balance out the ridership loss of non-sleeper trains running during the daytime.

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