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 Original Research

Motivations and barriers to using high-speed rail: An application of conjoint analysis – Insights from Vietnam

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Background: Nowadays, a gradual change in customers' attitudes towards transport service makes it more challenging to understand the reasons behind customers' travel decisions. High-speed rail (HSR) has been mentioned recently and is expected as the best and most modern transport option in long-distance trips in Vietnam. However, research studies have paid scant regard to how HSR's attributes may affect potential users, and therefore the motivations and barriers to adopting HSR are still unknown.

Objectives: This study aimed at examining motivations and barriers to take-up HSR for considering customers' preference on the proper attributes and levels of HSR.

Method: This study drew on a nationwide survey and conjoint analysis to investigate customers' behaviour.

Results: In Vietnam's context, HSR ticket was found to be the principal barrier to adoption, whereas the speed of HSR was identified as the least important behavioural driver amongst potential HSR users. The results show that HSR design and planning should provide a combination of minimum check-in and waiting time, a 20-min frequency, average speed of 250 km/h, all add-on services and facilities, ticketing of approximately VND 500–700 thousand per 300–500 km and nearby all-day parking.

Conclusion: This investigation has demonstrated the value of conjoint analysis to compare a wide range of attributes associated with consumers' decision to use HSR. The findings indicate that in countries such as Vietnam, in particular, where train usage is low, policymakers and transportation agencies seeking to boost the use of HSR must take attributes other than fare into consideration.

Keywords: high-speed rail; attributes; levels; conjoint analysis; ticket fare; check-in and waiting time.

Introduction

The extreme global challenges faced because of climate change, high energy consumption, congestion on roads and poor air quality are well established. It has been proposed that the innovative energy technology of high-speed rail (HSR) can mitigate road-related environmental issues. There has been substantial progress globally in the use of HSR, with the greatest development seen in China. Multiple studies have stressed that both the attributes and impacts of HSR can be beneficial. Its speed, frequency and reliability are not only attractive to users (Zhan, Wong & Lo 2020) but also contribute socially and economically by raising the standards of living, encouraging tourism and facilitating access to migrant labour (Guirao, Casado-Sanz & Campa 2018; Guirao, Lara-Galera & Campa 2017; Pagliara, Pietra, Gomez & Vassallo 2015; Yin, Pagliara & Wilson 2019).

The Vietnamese government has taken a range of measures to reduce greenhouse gases and traffic accidents. Encouraging consumers to use rail rather than road transportation can ensure a better balance between mobility demands, air pollution and traffic safety. High-speed tail represents the best and most modern transport option with regard to speed, comfort and contribution to socio-economic urban and regional development. Vietnam currently relies heavily on road transportation to move passengers and freight; hence, policymakers must craft HSR policy to meet the needs of Vietnamese society. The Vietnamese government is increasingly interested in rolling out HSR as an innovative way of addressing national transport challenges. It is thought that HSR will both relieve the current pressure on road traffic and reduce the time it takes to travel between Hanoi and Ho Chi Minh city, cities that drive much of the country's economy. Recent studies of the design and planning of HSR in Vietnam have paid scant regard to how its attributes may affect users. As HSR in Vietnam is financed entirely by central government funds, consideration must be given to ensuring social equity and meeting public needs.

A strategy statement from the Vietnamese government with regard to developing transportation services indicates that by 2030 HSR will have the capacity to carry approximately 55 million passengers, sevenfold the volume carried by conventional rail in 2019 (before the outbreak of the coronavirus disease 2019 [COVID-19] pandemic) (Government of Vietnam 2014). Designing and planning HSR to fulfil this promise, however, is challenging. There is the risk that if user demand for HSR falls short of the forecast, the debt incurred by investment will rise, as will road-related emissions, congestion and accidents.

Researchers have investigated the impacts of HSR from several perspectives. One recent study used house prices and city-level gross domestic product (GDP) to evaluate impacts on industrial development (Zhou & Zhang 2021). Other researchers have assessed the impact of HSR on urbanisation and population (Wang et al. 2019), choice of destination amongst tourists (Campa, López-Lambas & Guirao 2016; Chen & Haynes 2012; Liu, Yun & Liu 2016; Pagliara & Mauriello 2022), social inequity (Liu et al. 2016; Ren et al. 2020; Zhang & Meng 2016) and mode market share (Álvarez-SanJaime et al. 2015; Borsati & Albalate 2020). Behavioural researchers have extended the theory of planned behaviour (TPB) to investigate travellers' intentions to use HSR (Borhan, Ibrahim & Miskeen 2019). Despite this burgeoning literature, however, research of consumer preferences around HSR features is lacking. This study therefore contributes to filling this gap, with a particular focus on how potential users assess HSR features when deciding whether or not to choose it over other modes of transportation.

The insights gathered by this study will be of use to policymakers who require data to inform HSR strategy choices. The data gathered will also be useful for private-sector and other social actors seeking to identify and develop HSR-related opportunities. In this way, government and the private sector can collaborate on building parking facilities near HSR stations to boost take-up of HSR.

This article is not intended to advise on the technological aspects of implementing HSR or the drawing up of HSR-related business plans. Instead, it assesses the preferences of potential users when they are offered the opportunity to use HSR.

This article is organised into five sections. The next section presents the literature review, which is followed by the 'Materials and methods' section and 'Results and discussions' section, which outlines results and discusses the study. Finally, the last section presents conclusion and policy implications.

Literature review

The International Union of Railways (UIC) defines HSR as:

> [*A*] type of rail transport that has an infrastructure for new lines designed for speeds of 250 km/h and above; upgraded existing lines for speeds of up to 200 or even 220 km/h, including interconnecting lines between high-speed sections; its rolling stock is designed specifically for train sets, telecommunications, signalling, operating conditions and equipment, etc. (International Union of Railways [UIC] 2021)

Therefore, the objective of HSR is to provide a better-quality service than conventional trains and cheaper than airplanes. In support of this contention, Sperry et al. (2017) asserted that HSR is a resource-efficient transportation mode to fulfil high demand intercity trips. Similarly, Liu and Zhang (2012) identified the outperforming features of HSR in terms of economic and technical aspects such as speed, capacity, safety, eco-friendliness, convenience and energy conversion.

Recent work has highlighted the ability of HSR to boost regional economies. Currently, a large gap exists between the needs of tourists and conventional train and/or airplane services (Jung & Yoo 2014; Pagliara, Vassallo & Román, 2012; Yu 2017). The HSR can fill this gap by reducing the travel times of conventional trains whilst charging lower prices than airlines (Zhan, Wong & Lo 2020).

Researchers have examined several categories of HSR elements, which may affect user choice, as summarised in Table 1. This study took these attributes into consideration when designing the survey administered, particularly the key HSR attributes of price and travel time. Other attributes that could be used to define HSR are frequency, availability of amenities, safety and security.

Multiple strategies can be found in the HSR literature to promote sustainable travel and address congestion. However, their effectiveness can only be quantified through specific experimental methods and models. Crucial common factors to the success of all the suggested strategies are public compliance and perception. Consequently, user preferences and willingness to pay

TABLE 1: Summary of high-speed rail features used in previous studies.

Authors (year)	HSR features
Cokasova (2005)	Fare, journey time, station accessibility, schedule and frequency, punctuality and reliability, on-board comfort, luggage handling
Park and Ha (2006)	Fare, access and egress time, frequency
Gehrt et al. (2007)	Safety, connections, on-board amenities, information, HSR efficiency
Behrens and Pels (2012)	Journey time, frequency, ticket cost
Li, Kang and Liu (2011)	Fare, speed, on-board time, environment, safety, overall satisfaction

Source: Adapted from Behrens and Pels (2012); Cokasova (2005); Gehrt et al. (2007); Li, Kang and Liu (2011); Park and Ha (2006)

HSR, high-speed rail

Note: Please see the full reference list of the article, Ngoc, P.T. & Ngoc, A.M., 2022, 'Motivations and barriers to using high-speed rail: An application of conjoint analysis – Insights from Vietnam', *Journal of Transport and Supply Chain Management* 16(0), a705. https://doi.org/10.4102/jtscm.v16i0.705, for more information.

must be assessed to inform and orient interventions before they are implemented.

The standard method to analyse HSR preferences is observation of real-life use patterns. Travel mode preferences have also been investigated through simulation, discrete choice models, structural equation model (SEM) and multiple indicators and multiple causes (MIMICs). Wang et al. (2014) found a significant association between the choice to use HSR and income, travel time, trip cost and trip distance. Research using a discrete choice model to estimate whether users would choose HSR over air travel identified the most significant drivers were travel time, cost, on-board service and ticket flexibility (Valeri 2014).

This is the first study to apply conjoint analysis to an investigation of consumer preference for specific attributes of HSR, thus making a significant contribution to this field. Conjoint analysis, a contingent rating method that provides consumers with similar choice situations, enables consumer preferences to be captured with a good degree of accuracy. Conjoint analysis is one of the most common stated preference (SP) methods and recently many researchers are taking interest in studying consumers' travel decision. This method decomposes a set of multi-attribute alternatives into part-worth utilities by using a number of different paradigms. At the time of this research, HSR was not yet operational in Vietnam. Hence, it was not possible to forecast potential use through standard approaches (e.g. revealed preference or time-series models). The SP data were, therefore, used to estimate the consumer utility function.

Materials and methods

This study used the random utility theory framework (McFadden 1974) to estimate consumer preference for HSR. The following sections describe the attributes and levels used in the SP survey, after which data collection and analysis methods are discussed.

Experiment design and materials

An experiment was designed to determine subjects' preferences for HSR over alternative modes of transport. Individuals were given two options to choose a train or nothing. Studies from advanced countries revealed that a number of factors may influence the mode choice (Valeri 2014; Wang et al. 2014; Zhao et al. 2002), including fare system, capacity, frequency, amenities, etc., and they are easily controlled and managed by transport authorities. On the basis of a thorough literature review and a focus group consisting of experts from academia and government departments, the six attributes listed in Table 2 were selected. 'Check-in and waiting time' represents how much time elapses from arrival at the station to boarding the train; 'speed' indicates the operational speed of a given mode of transport; 'one-way fare' represents the tariff paid; 'amenities' refer to which additional on-board services are offered; 'frequency' represents the frequency of HSR services; and 'access' refers to whether private vehicles can fully access the HSR stations or is it only accessible by public transport.

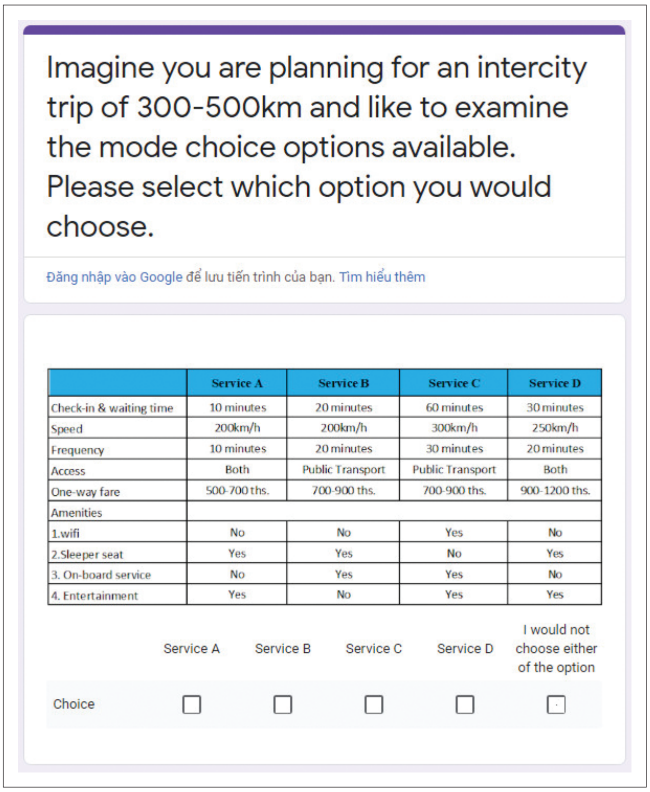
TABLE 2: List of attributes and levels used in the choice experiment.

Attributes	Levels
Check-in and waiting time	1. 10 min
	2. 20 min
	3. 30 min
	4. 45 min
	5. 60 min
Speed	1. 200 km/h
	2. 250 km/h
	3. 300 km/h
One-way fare (calculated for the distance of 300–500 km)	1. VND 500–700 thousand
	2. VND 700–900 thousand
	3. VND 900–1200 thousand
Amenities	1. Wi-Fi
	2. Sleeper seat
	3. On-board service
	4. Entertainment
Frequency	1. 10 min
	2. 20 min
	3. 30 min
Access	1. Possible to access by private vehicles
	2. Public transport only

Six attributes were considered, each of which had a maximum of five levels. Thus, 1080 different combinations were possible. As survey respondents could not assess so many combinations, this number had to be reduced. Then, the software package Ngene was used to reduce the combination as suggested by Rao (2014). In accordance with the Ngene 1.1.2 user manual (2014), this software enables a design to be selected that will efficiently generate the data required for estimating the parameters with the least possible standard errors. Following the experience from Kuhfeld, Tobias and Garratt (1994), efficiency of design reflects a combination between D-optimal and the lowest D-error. However, it is difficult to identify which design has the lowest D-error, so a design with a relatively small D-error is considered satisfactory as a D-efficient design. In this study, the D-error was 0.59, which is acceptable. A total of 36 choice sets were created. An example questionnaire is shown in Figure 1.

Data collection

A web-based questionnaire survey was taken amongst travellers who have experience of long-distance trips. All participants were informed about the objectives of the survey and the collection of information was only conducted after receiving the consent of the participants. Respondents were asked to indicate their preference for using new HSR in the hypothetical situation. The categories of demographic characteristics in the questionnaire were utilised from the previous questionnaire used in Huyen and Ngoc (2021). The survey was carried out between 2 and 20 September and resulted in a data set of 3246 respondents. Table 3 summarises the respondents by selected demographic characteristics.



Imagine you are planning for an intercity trip of 300-500km and like to examine the mode choice options available. Please select which option you would choose.

Đăng nhập vào Google để lưu tiến trình của bạn. Tìm hiểu thêm

	Service A	Service B	Service C	Service D
Check-in & waiting time	10 minutes	20 minutes	60 minutes	30 minutes
Speed	200km/h	200km/h	300km/h	250km/h
Frequency	10 minutes	20 minutes	30 minutes	20 minutes
Access	Both	Public Transport	Public Transport	Both
One-way fare	500-700 ths.	700-900 ths.	700-900 ths.	900-1200 ths.
Amenities				
1.wifi	No	No	Yes	No
2.Sleeper seat	Yes	Yes	No	Yes
3. On-board service	No	Yes	Yes	No
4. Entertainment	Yes	No	Yes	Yes

	Service A	Service B	Service C	Service D	I would not choose either of the option
Choice	☐	☐	☐	☐	☐

FIGURE 1: An example of questionnaire (translated from a Vietnamese version).

Conjoint analysis

This study used conjoint analysis (Green & Srinivasan 1978; Louviere 1988; Ortúzar & Willumsen 2011) to determine user transport preferences for intercity trips. Conjoint analysis was applied to identify the association between preference for a mode of transport and its most important attributes. Thus, it enabled the researchers to learn more about the attributes of the most popular transport options and how each attribute impacted its overall usability from the perspective of respondents.

Conjoint choice-based analysis (CBA), the most recent version of conjoint analysis (Orme 2001), simulates real-life situations in which consumers have a limited number of choices. Importantly, CBA can measure both main effects and interactions between them.

To begin with, the utility (U_{ijm}) of the ith respondent from choosing the jth alternative in menu m is given by:

$$U_{ijm} = V(s_i, x_{ijm}) + \varepsilon_{ijm} = \beta' X_{ijm} + \varepsilon_{ijm} \qquad \text{[Eqn 1]}$$

where true U_{ijm} can be broken down into the observable utility V_{ijm} and the error ε_{ijm}. The observable utility can, in turn, be divided into attributes of service x_{ijm} and individual-specific variables s_i, which change according to the respondents' demographic conditions.

In case each alternative is ranked by the ith respondent as $r_i = \{r_{i1}, r_{i2}, \ldots, r_{iJ}\}$, let $\Pr(r_i) = \Pr[U_i(r_{i1}) > U_i(r_{i2}) > \ldots > Ui(r_{iJ})]$ as the probability of the ranking, then the probability is estimated as follows:

TABLE 3: Summary statistics of respondents.

Independent variable	Number of response	Share (%)
Gender		
Male	1884	58.0
Female	1362	42.0
Age (year)		
Under 18	30	0.9
18–24	958	29.5
25–34	1066	32.8
35–50	844	26.0
Above 50	348	10.7
Education		
High school and below	537	16.5
Junior college	1547	47.7
Bachelor's degree	1134	34.9
Master's degree and above	28	0.9
Occupation		
Office worker/government officer	697	21.5
Worker	404	12.4
Self-employed	900	27.7
Student	633	19.5
Seasonal worker	127	3.9
Housewife/retired/jobless	171	5.3
Other	314	9.7
Monthly income (VND)		
Without income	73	2.2
Less than 6 million	2198	67.7
6–10 m	730	22.5
10–20 m	206	6.3
20–30 m	26	0.8
More than 30 m	13	0.4
Distance (km)		
Less than 300	702	21.6
300–500	1154	35.5
500–700	382	11.8
700–1000	490	15.07
1000–1500	300	9.23
More than 1500	218	6.7

VND, Vietnamese currency.

$$\Pr[U_i(r_{i1}) > U_i(r_{i2}) > \cdots > U_i(r_{iJ})] = \Pr[U_i(r_{iJ}),\ for\ j = 2, \cdots, J]$$
$$x\ \Pr[U_i(r_{i2}) > U_i(r_{iJ})\ for\ j = 3, \cdots, J]\ x \cdots x\ \Pr[U_i(r_{j,J-1})$$
$$> U_i(r_{ij})] = \prod_{j=1}^{J-1}\left[\frac{e^{V_j}}{\sum_{m=j}^{J} e^{V_m}}\right] \qquad \text{[Eqn 2]}$$

In estimating Eqn (2), the advantage of the binary logit model is that it offers easy estimation. The log-likelihood function is derived from Eqn (2); hence, the coefficients are estimated using maximum likelihood estimation.

Results and discussions

Results of conjoint analysis

Table 4 presents the results of conjoint analysis. The model is highly significant (Pseudo R^2 = 0.3127 and significance level < 0.01). Thus, the fit and predictive validity can be considered good.

TABLE 4: Model summary statistics.

Attributes and levels	Part-worth estimate	Average importance
Check-in time (min)		18%
10	-0.190	
20	-0.095	
30	0.000	
45	0.095	
60	0.190	
Frequency (min)		3%
10	-	
20	-	
30	-	
Speed (km/h)		1%
200	-0.005	
250	0.000	
300	0.005	
Amenities		7%
Wi-Fi	0.054	
Sleeper seat	0.018	
Entertainment	-0.018	
Other	-0.054	
Fare (VND)		58%
500–700 ths.	0.257	
700–900 ths.	0.128	
900–1200 ths.	-0.257	
Access		14%
Private	0.036	
Public transport	-0.036	
Model assessment		
Log-likelihood	-859.75446	
Pseudo R^2	0.3127	
Prob > chi^2	0.0000	

The following attributes are depicted in Table 4: check-in time, speed, fare, amenities, frequency and access. For each attribute and level, part-worth estimates are provided in the second column, whilst average importance is given in the third column.

Figure 2 depicts the relative importance of each attribute of HSR. 'Fare' is the most important attribute (58%), 'check-in' is also considered important, whilst 'speed' is the least important of all the attributes considered.

An analysis of level part-worths, undertaken to give an enhanced understanding of how specific levels within each attribute drive customer choice, showed that fare had the largest part-worth range (see Figure 3). A ticket price of VND 900 000–1 200 000 was revealed as the most negative of all attribute levels (–25.7%), whilst ticket prices of VND 700 000–900 000 (12.8%) and VND 500 000–700 000 (25.7%) were the most positive. An investigation of how these attribute levels impact overall utility when included in total preference levels revealed that price ranges of VND 900 000–1 200 000 and VND 500 000–700 000 have, respectively, the highest negative and positive effect.

The distribution of preferences for various levels is depicted in Figure 4. Of total preferences for check-in and waiting time, 10, 20, 30, 45, and 60 min of pre-boarding check-in and waiting were preferred by 35.6%, 29.3%, 16.4%, 11.2% and 7.4% of respondents, respectively. Hence, there is a strong preference for a 10-min check-in and wait over 20, 30 and 45 min and somewhat of a preference over 60 min. When preference distribution was further investigated within the 'speed' attribute, 200 km/h attracted 17.4% of preferences, 250 km/h attracted 63.4% of preferences and 300 km/h attracted 19.2% of preferences. Turning to access, 69.5% of total preference was assigned to the possibility for private vehicles to access HSR stations, with 30.5% preferring public transport access, implying that HSR stations require parking facilities to boost usage.

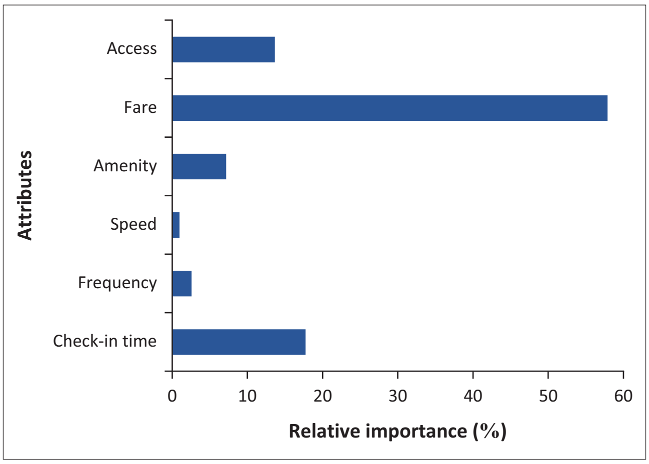


FIGURE 2: Average importance of attributes.

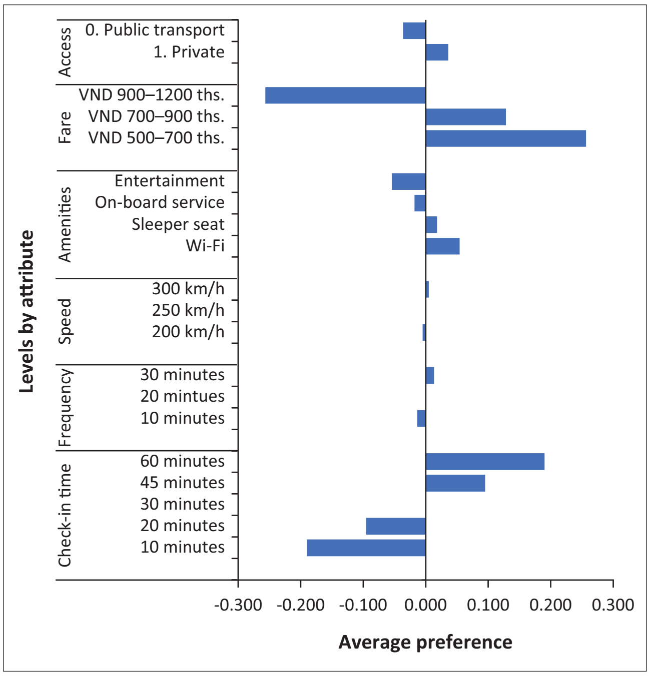


FIGURE 3: Level part-worths.

Differences in socio-economic status

Using $p = 0.05$ as cut-off value as per the conventions of social science research, the part-worth of attribute for subpopulation was compared. No significant differences were found in sub-group categorised by gender, age, occupation and education (analysis of variance [ANOVA], $p > 0.05$).

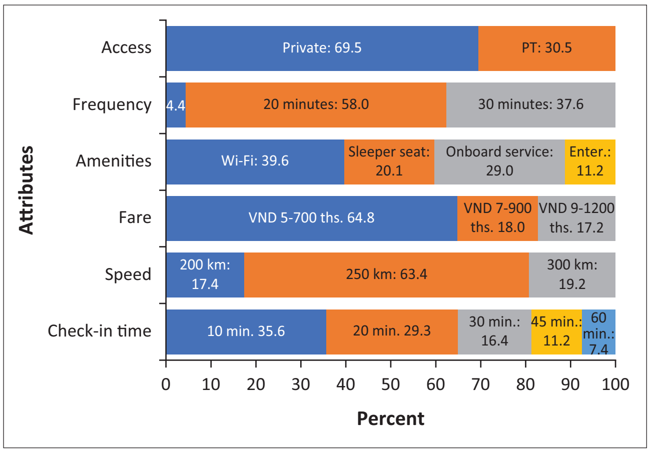


FIGURE 4: Distribution of preferences for levels.

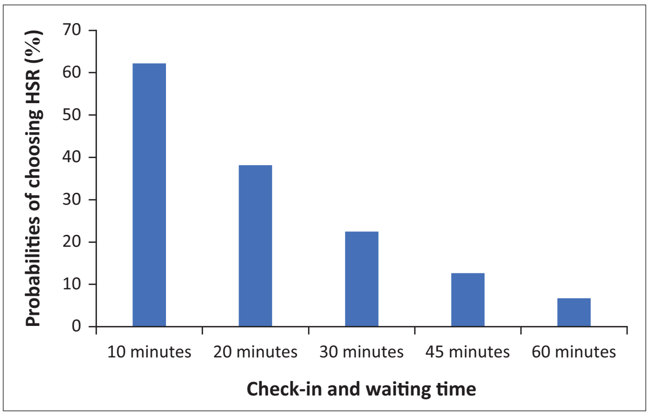


FIGURE 5: Probability of choosing high-speed rail based on check-in and waiting time.

Income was found to impact the average part-worth of speed, fare and amenities. More utility was assigned to these attributes by high-income (over VND 20m) than lower-income groups (ANOVA, $p < 0.05$). This finding aligns with previous studies, which found that higher-income groups tend to prefer modern modes of transport (He et al. 2013; Liu et al. 2016).

Probability of choosing high-speed rail for each attribute and levels

As discussed here, varying one of the attributes of HSR results in a change to the probability of the model. Using Train's (2009) method to outline the impact of a variation at each level of attribute, this study reveals that 49.7% of respondents, on average, would choose to travel by HSR. As shown in Figure 5, when all other attributes remain steady, the highest selection probability (62.2%) is assigned to check-in and waiting time of under 10 min, whilst aggregated results demonstrate that the lowest selection probability is assigned to check-in and waiting time of 60 min.

Turning to the frequency options, as shown in Figure 6, the highest selection probability (20.6%) is assigned to trains at 20-min frequencies and when this frequency is reduced to 10 min and 30 min, the probability that users will select HSR drops to 19.7% and 19.9%, respectively.

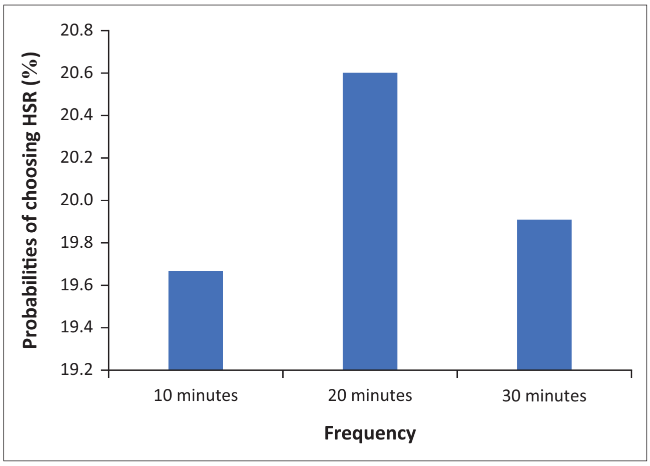


FIGURE 6: Probability of choosing high-speed rail based on frequency.

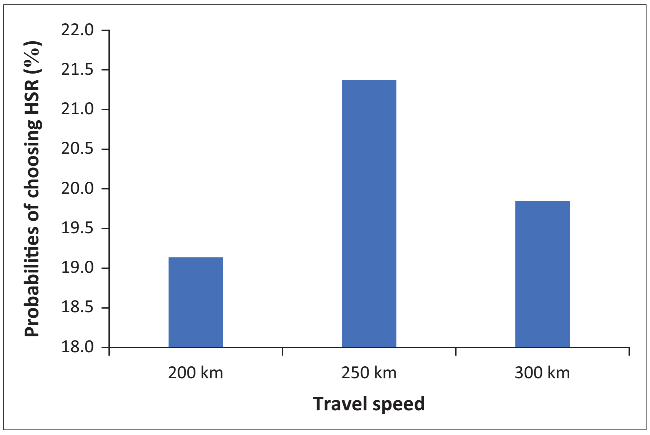


FIGURE 7: Probability of choosing high-speed rail based on speed.

As shown in Figure 7, the highest percentage of respondents (21.4%) would select HSR travelling at a speed of 250 km/h. Reducing the speed to 200 km/h, meanwhile, causes a drop in selection probability to 19.1% (–2.2%).

The probability that users will select HSR increases each time a service or facility is added, although, as demonstrated in Figure 8, the likelihood impacts vary across services. The highest impact is associated with the availability of Wi-Fi, which boosts selection probability by 9% over a similar HSR service without Wi-Fi. The second most popular additional feature is on-board service, which can increase selection probability by 2.4%, with sleeper seats (1%) and entertainment services (0.5%) having the third and fourth highest likelihood impacts. Making all additional services available can raise the selection probability by 12%: from 20% (no extra services) to 32% (all extra services available). These data give valuable insights for providers seeking to compare cost of providing extra facilities against the higher likelihood that users will select HSR travel.

The impact of increasing ticket prices is shown in Figure 9. As can be seen, there is considerable sensitivity amongst users with regard to fare: When a single ticket costs VND 900–1200 thousand, selection probability is 18% but when the ticket price drops to VND 500–700 thousand, this probability

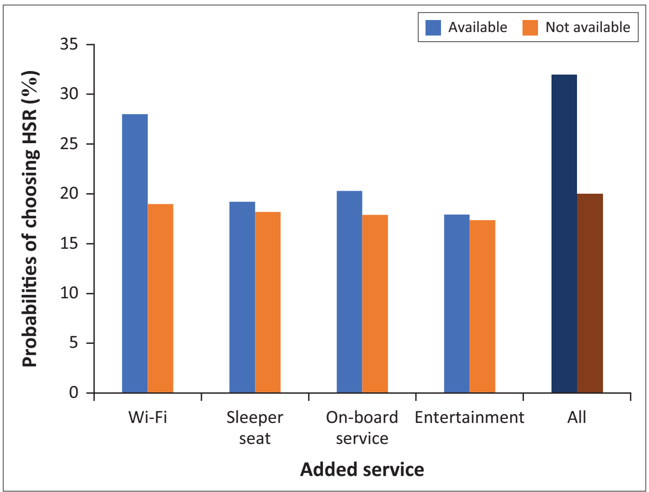


FIGURE 8: Probability of choosing high-speed rail based on amenity options.

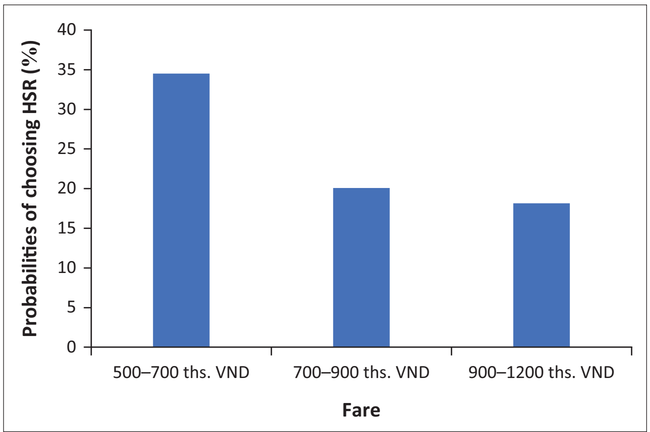


FIGURE 9: Probability of choosing high-speed rail based on fare.

almost doubles, to 34.5%. This variation in selection probability, as depicted in Figure 9, underlines the particular importance of ticket pricing in determining travel behaviours. Moreover, bearing in mind that most Vietnamese have a relatively low annual median income (~$ 2785), long-distance trips in particular are very price-sensitive. Hence, policymakers must balance demand for HSR against the revenue requirements of private-sector actors.

Finally, Figure 10 depicts how selection probability varies according to the accessibility of HSR stations to solely public or public and private, transport. Clearly, there is considerable sensitivity to the availability of parking spaces in or near HSR stations for private vehicles, as shown by a 25% selection probability for HSR when parking and access for private vehicles is available as compared with 19.9% when they are not. This result aligns with Vietnamese cultural practices, as it is normal to pick up relatives; thus, users being met at HSR stations would expect their relatives to be able to park nearby. Awareness of the impact of making available parking for private vehicles offers a further insight into HSR decision-makers.

This section has presented and discussed how HSR attributes can be combined and suggested best options per level. The HSR design and planning should ensure check-in and

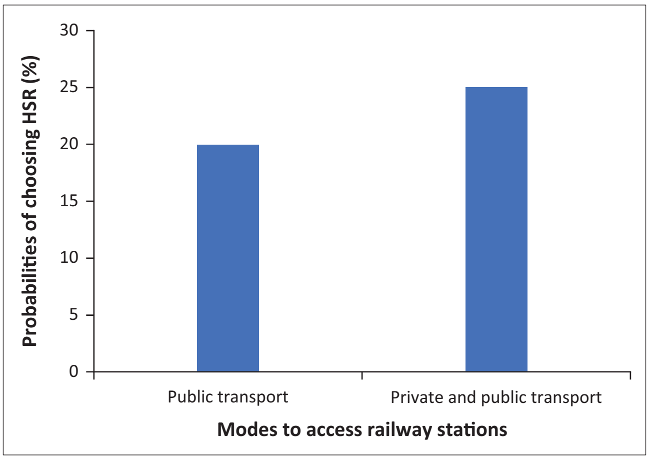


FIGURE 10: Probability of choosing high-speed rail based on accessibility.

waiting is kept to a minimum and that trains run at or near a 20-min frequency and average operation speed of 250 km/h. All add-on services and facilities should be made available, ticketing should be based on approximately VND 500–700 thousand per 300–500 km and nearby all-day parking should be offered for private vehicles.

Conclusions and policy implications

Product design and development, especially when new products are complex, has made widespread use of conjoint analysis. Likewise, this type of analysis serves as an efficient means to reveal the utilities of a range of attributes considered when making complex transport decisions. Importantly, conjoint analysis should be perceived as a thought experiment rather than a laboratory investigation, and, unlike a true experiment, it does not allow for the manipulation of each attribute in isolation or the use of a control population.

This study fills a gap in the literature by going beyond travel costs to also consider non-price-related variables that impact HSR user uptake, namely check-in and waiting time, speed, frequency, add-on services and the availability and accessibility of parking facilities for private vehicles. This study therefore sheds new light on which dimensions should be considered, as well as the interaction between them, by decision-makers and policymakers. It also adds to the findings of research and policies regarding other types of travel behaviour. The findings of this study will be of use to private-sector actors seeking to work with government bodies to develop parking facilities that incentivise active take-up of public transport choices for long-distance travel.

The multiple policy implications of the present study can be generalised across several contexts. Firstly, it is apparent that manipulation of HSR fares is the most effective policy tool but ensuring the most appropriate check-in and waiting times is also an important part of authorities’ quests for a fair and equitable transport policy. Hence, Vietnamese transportation agencies should pay greater attention to achieve policy synergy by bundling appropriate pricing and reductions of check-in time. Moreover, the research makes clear that non-price-related attributes also moderately impact user decisions regarding HSR take-up; policymakers should therefore also consider these attributes in designing the transport service (e.g. the frequency of the service) and even the facility design costs (e.g. provision of private parking at stations). The potential societal benefits of HSR have been well established. However, Vietnamese people appear somewhat sceptical about choosing HSR to meet their transport needs. This investigation has emphasised the need of dialogue with potential users to identify the most important factors in driving them to actively adopt HSR. Furthermore, it has demonstrated the value of conjoint analysis to compare a wide range of attributes associated with consumers' decision to use a given mode of transport.

The findings indicate that in countries such as Vietnam, in particular, where train usage is low, policymakers and transportation agencies seeking to boost the use of HSR must take attributes other than fare into consideration.

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Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

P.T.N. and A.M.N. were responsible for conceptualisation of the study. P.T.N. was responsible for methodology, formal analysis, data curation, writing and original draft preparation. A.M.N. was involved in validation, writing, review, editing and supervision of the manuscript. Both authors have read and approved the final version of the manuscript.

Ethical considerations

As this study used data from a web-based questionnaire survey, institutional review board approval was not required. The respondents were selected randomly and the information was recorded by the investigator in such a manner that respondents cannot be identified directly or through identifiers linked to them.

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Data availability

The data that support the findings of this study are available upon request from the corresponding author PTKN.

Disclaimer

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References

Álvarez-SanJaime, Ó., Cantos-Sanchez, P., Moner-Colonques, R. & Sempere-Monerris, J.J., 2015, 'A model of internal and external competition in a high speed rail line', *Economics of Transportation* 4, 178–187. https://doi.org/10.1016/j.ecotra.2015.05.004

Behrens, C. & Pels, E., 2012, 'Intermodal competition in the London–Paris passenger market: High-Speed Rail and air transport', *Journal of Urban Economics* 71(3), 278–288. https://doi.org/10.1016/j.jue.2011.12.005

Borhan, M.N., Ibrahim, A.N.H. & Miskeen, M.A.A., 2019, 'Extending the theory of planned behaviour to predict the intention to take the new high-speed rail for intercity travel in Libya: Assessment of the influence of novelty seeking, trust and external influence,' *Transportation Research Part A* 130, 373–384.

Borsati, M. & Albalate, D., 2020, 'On the modal shift from motorway to high-speed rail: evidence from Italy', *Transportation Research Part A* 137, 145–164. https://doi.org/10.1016/j.tra.2020.04.006

Campa, J.L., López-Lambas, M.E. & Guirao, B., 2016, 'High speed rail effects on tourism: Spanish empirical evidence derived from China's modelling experience', *Journal of Transport Geography* 57, 44–54. https://doi.org/10.1016/j.jtrangeo.2016.09.012

Chen, Z. & Haynes, K.E., 2012, 'Tourism industry and high speed rail, is there a linkage: Evidence from China's high speed rail development', Paper presented at the ASRDLF 2012 conference special session on high speed rail, Tourism and Territories.

Cokasova, A., 2005, 'Passengers' choice between high-speed train and air transport', EUROCONTROL Experimental Centre (France) and University of Zilina (Slovakia), viewed from http://www.eurocontrol.fr/Newsletter/2005/March/Recent_Documents/ICRAT/ID%20128.pdf.

Gehrt, K., Rajan, M., O'Brien, M., Sakano, T. & Onzo, N., 2007, 'Understanding preference for high-speed rail service: A consumer logistics perspective', *Innovative Marketing* 3(4), 32–41. https://doi.org/10.1007/978-3-319-11806-2_56

Government of Vietnam, 2014, Decision 318/QD-TTg on approving the strategy for developing transportation service to 2020, oriented to 2030.

Green, P. & Srinivasan, V., 1978, 'Conjoint analysis in consumer research: Issues and outlook', *Journal of Consumer Research* 5(2), 103–123. https://doi.org/10.1086/208721

Guirao, B., Casado-Sanz, N. & Campa, J.L., 2018, 'Labour opportunities provided by Spanish high-speed rail (HSR) commuting services in a period of financial crisis: An approach based on regional wage disparities and housing rental prices', *Regional Studies* 54(4), 539–549. https://doi.org/10.1080/00343404.2018.1530751

Guirao, B., Lara-Galera, A. & Campa, J.L., 2017, 'High speed rail commuting impacts on labour migration: The case of the concentration of metropolis in the Madrid functional area', *Land Use Policy* 66, 131–140. https://doi.org/10.1016/j.landusepol.2017.04.035

He, D., Liu, H., He, K., Meng, F., Jiang, Y., Wang, M. et al., 2013, 'Energy use of and CO_2 emissions from China's urban passenger transportation sector carbon mitigation scenarios upon the transportation mode choices', *Transportation Research Part A* 53, 53–67. https://doi.org/10.1016/j.tra.2013.06.004

Huyen, L.T. & Ngoc, A.M., 2021, 'Transportation mode choice in Vietnam intercity trips', in Y. Hayashi, W. Rothengatter & K.E. Seetha Ram (eds.), *Frontiers in high-speed rail development*, Asian Development Bank Institute.

International Union of Railways (UIC), 2021, *General Definitions of Highspeed*, viewed 20 September 2021 from https://uic.org/passenger/highspeed/#General-definitions-of-highspeed.

Jung, S. & Yoo, K., 2014, 'Passenger airline choice behavior for domestic short-haul travel in South Korea', *Journal of Air Transport Management* 38, 43–47.

Kuhfeld, W.F., Tobias, R.D. & Garratt, M., 1994, 'Efficient experimental design with marketing research applications', *Journal of Marketing Research* 31(4), 545–557. http://doi.org/10.2307/3151882

Li, J., Kang, S. & Liu, M., 2011, 'Travel mode choice of high-speed railway passenger modeling with support vector machines', *Advances in Information Sciences and Service Sciences* 3(6), 334–340. https://doi.org/10.4156/aiss.vol3.issue6.42

Liu, F., Yun, M., Liu, G., 2016, 'Will motorcyclist shift to bus or car in commuting: a case study of Zhongshan, China', in *Proceedings of Transportation Research Board 95th Annual Meeting*, January 2016, Washington, D.C.

Liu, J. & Zhang, N., 2012, 'Empirical research of intercity high speed rail passengers' travel behavior based on fuzzy clustering model', *Journal of Transportation Systems Engineering and Information Technology* 12(6), 100–105. https://doi.org/10.1016/S1570-6672(11)60236-5

Louviere, J., 1988, 'Conjoint analysis modelling of stated preferences: A review of theory, methods, recent developments and external validity', *Journal of Transport Economics and Policy* 22, 93–119.

McFadden, D., 1974, 'Conditional logit analysis of qualitative choice behavior', in P. Zarembka (ed.), *Frontiers of econometrics*, Academic Press, New York, NY, pp. 105–142.

Ngene 1.1.2 user manual, 2014.

Orme B., 2001, 'Sawtooth Software research paper series: Hierarchical Bayes: Why all the attention?', *Sawtooth Software, Sequim*, Washington, D.C., 98382(360).

Ortúzar, J.D. & Willumsen, L.G., 2011, *Modelling transport*, 4th edition, John Wiley & Sons, ISBN: 978-0-470-76039-0.

Pagliara, F. & Mauriello, F., 2022, 'Modelling the impact of high-speed rail on tourists with geographically weighted Poisson regression', *Transportation Research Part A* 132, 780–790. https://doi.org/10.1016/j.tra.2019.12.025

Pagliara, F., Pietra, A.L., Gomez, J. & Vassallo, J.M., 2015, 'High-speed rail and the tourism market: Evidence from the Madrid case study', *Transport Policy* 37, 187–194. https://doi.org/10.1016/j.tranpol.2014.10.015

Pagliara, F., Vassallo, J. M. & Román, C., 2012, 'High-speed rail versus air transportation' *Transportation Research Record: Journal of the Transportation Research Board* 2289(1), 10–17. https://doi.org/10.3141/2289-02

Park Y. & Ha H.-K., 2006, 'Analysis of the impact of high-speed railroad service on air transport demand', *Transportation Research E* 42 (2), 95–104. https://doi.org/10.1016/j.tre.2005.09.003

Rao, V.R., 2014, *Applied conjoint analysis*, Springer, Heidelberg, New York, Dordrecht, London.

Ren, Z., Chen, Z., Wang, F., Dan, T., Wang, W., Guo, X. et al., 2020, 'Impact of high-speed rail on social equity in China: Evidence from a mode choice survey, *Transportation Research Part A* 138, 422–441. https://doi.org/10.1016/j.tra.2020.05.018

Sperry, B.R., Burris, M. & Woosnam, K.M., 2017, 'Investigating the impact of high-speed rail equipment visualization on mode choice modes: Case study in central Texas', *Case Study on Transport Policy* 5(4), 560–572. https://doi.org/10.1016/j.cstp.2017.10.004

Train, K. E., 2009, *Discrete choice methods with simulation*, Cambridge University Press, United Kingdom.

Valeri, E., 2014, 'Competition between air and high-speed rail: The case of the RomeMilan corridor', *FSR Transport* 1, 8–9.

Wang, F., Wei, X., Liu, J., He, L. & Gao, M., 2019, 'Impact of high-speed rail on population mobility and urbanisation: A case study on Yangtze River Delta urban agglomeration, China', *Transportation Research Part A* 127, 99–114. https://doi.org/10.1016/j.tra.2019.06.018

Wang, Y., Li, L., Wang, L., Moore, A., Staley, S. & Li, Z., 2014, 'Modeling traveler mode choice behavior of a new high-speed rail corridor in China', *Transportation Planning and Technology* 37(5), 466–483. https://doi.org/10.1080/03081060.2014.912420

Yin, P., Pagliara, F. & Wilson, A., 2019, 'How does high-speed rail affect tourism? A case study of the capital region of China', *Sustainability* 11(2), 1–16. https://doi.org/10.3390/su11020472

Yu, P.J., 2017, 'Investigation of passengers' intentions to use high-speed rail and low-cost carriers in China', *Dissertations and Theses* 348.

Zhan, S., Wong, S.C. & Lo, S.M., 2020, 'Social equity-based timetabling and ticket pricing for high-speed railways', *Transportation Research Part A* 137, 165–186. https://doi.org/10.1016/j.tra.2020.04.018

Zhang, K.Y. & Meng, X.C., 2016, '"Involuntary high-speed railway travel": A case study based on the Beijing-Shanghai high-speed railway', *Progress Geography* 35(4), 496–504.

Zhao, F., Li, M.T., Chow, L.F., Gan, A. & Shen, D., 2002, 'FSUTMS mode choice modelling: Factors affecting transit use and access', Final Report, National Center for Transit Research (NCTR), University of South Florida and Florida Department of Transportation, Miami, FL.

Zhou, Z. & Zhang, A., 2021, 'High-speed rail and industrial developments: Evidence from house prices and city-level GDP in China', *Transportation Research Part A* 149, 98–113. https://doi.org/10.1016/j.tra.2021.05.001