The Assessment of Behaviour Intention to Use High Speed Rail (HSR) Service in Johor Among Generations Z: The Integration of PLS Structural Modelling

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Abstract

The Kuala Lumpur-Singapore High-Speed Rail (KL-SG HSR) is a significant infrastructure project with the potential to transform regional connectivity. However, the current study of generation Z ridership in high-speed rail (HSR) services reveals a complex interplay of preferences, behaviours and socio-economic factors that influence their travel choices. While generation Z is generally characterized by a preference for sustainable and technology-integrated transport options, these trends vary significantly across different countries. This nuanced understanding is essential for optimizing HSR services to cater to this demographic. Therefore, this study aimed to identify the influences of attitudes, subjective norms, perceived behaviour control, trust, and external influences towards behaviour intention to use high speed rail services among Generation Z in Johor. A total of 1845 respondents were collected using online survey. Partial Least Squares Structural Equation Modelling (PLS-SEM) was employed to validate the hypotheses generated based on the fundamental theory of Technology Acceptance Model and Theory of Planned Behaviour. Key findings revealed that attitude, perceived behavioural control, and trust were the most significant predictors of behavioural intention. All constructs were significant and all the hypotheses were accepted. The findings suggest that the variables of attitude, subjective norms, price, and perceived behavioural control as the most necessary condition to be meet by the HSR operator in future prior the establishment of HSR services and building trust in the HSR project to ensure its successful implementation and long-term sustainability.

1. Introduction

Fast trains, high-speed trains, are a modern engineering miracle that have altered the way we travel, bringing us rapid, efficient, and even comfortable travel experiences. The 20th century saw the inception of these technological wonders, with the world's first high-speed train arising from its mid-century peak in Japan. Launched in 1964, the Shinkansen, or "bullet train," accomplished in 24 years what the United States had failed to accomplish in the preceding 184 years: a level of speed and comfort in train travel that far outstripped anything we had ever experienced. With a virtually straight-line route, the Shinkansen linked two of Japan's most populous cities, the capital and Tokyo, and Osaka. Since the time of the bullet train, the Yanks have often referred to its

successors simply as 'high-speed trains.' But they also should refer to their recent predecessors more accurately as 'high-speed rail systems.' Like the first high-speed train, the Shinkansen, the next two trains in the story, the TGV and ICC, not only broke speed records but also did so in a way that offers some intriguing considerations for the design of rapid rail systems. And up to this time, with the CRH, China has extended that speed and efficiency across a more or less straight and clear path through its very huge territory.

Modern transportation systems especially in areas of high urban density now have something of a core element: high-speed rail (HSR). With the 1964 launch of the Shinkansen, which significantly shortened the journey among the biggest towns and established a global standard for rapidity, effectiveness, and safety, Japan gave birth to the idea of HSR (High-Speed Rail History, 2015). A number of European nations, including France, Germany, and Spain, were influenced by the achievements of Japan and established themselves with high-speed rail systems, most notably the TGV in France, the ICE in Germany, and the AVE in Spain (Permalu & Nagarajoo, 2023). These systems not only improved connectivity but also offered an environmentally friendly substitute for air travel, helping to boost economic growth and profound regional development.

An international leader in the construction of high-speed rail (HSR), China has a vast network which is also the largest in the world of HSR. The network aids rapid urbanization and economic growth throughout the nation, provides all terrain passenger transport to millions of people from all walks of life, and appears to pay for itself. It offered over thirty-one billion U.S. dollars in bond financing to connect over thirty-seven related segments in the first half of 2012 alone, and there is no evidence that it has suffered financially since (Y. Sun et al., 2022). The planned Kuala Lumpur-Singapore High-Speed Rail (KL-SG HSR) project is regarded as a crucial infrastructure project in Malaysia that aims to improve connection between Malaysia and Singapore, both of the majority of financially important cities in Southeast Asia. It is anticipated that the KL-SG HSR will drastically improve connectivity and promote economic growth by cutting the time required to travel among each of the capitals to only 90 minutes (Seven Consortia Interested in KL - Singapore High-Speed Project - Newsroom, 2024). This project, however, relies on comprehending public sentiment. That is especially true for the preferences of the younger generations, such as Generation Z, which is known for its robust digital and environmental consciousness.

The latest generation that has entered economic life, Gen Z, or those born between 1995 and 2015, is rapidly emerging as a significant population impacting several industries, including transportation. They represent the earliest generation to have grown up with cellphones, and nearly all that they're into involves technology. These teenagers have a significant preference for technologically integrated, sustainable services and goods (Fry & Parker, 2018). They provide special potential and difficulties for the adoption of HSR because of their preference for eco-friendly modes of transportation and their usage of online mediums for data and services.   According to earlier research, their choice of transportation is greatly influenced by elements including perceived utility, usability, and environmental sustainability (Grzesiuk et al., 2023).

The potential of HSR in Malaysia is highlighted by Generation Z's increasing desire for environmentally friendly modes of transportation. Since this generation is expected to make up a sizable amount of future ridership, it is imperative to comprehend their behavioural intentions towards HSR in order to ensure the achievement of the KL-SG HSR project. Though the advantages of HSR are well acknowledged, little study has been done on the precise elements that affect Generation Z's acceptance of HSR, especially in Malaysia, where the system remains in the stages of design and construction.   By investigating the effects of attitudes, subjective norms, perceived behavioural control, trust, and outside factors on Generation Z's desire to utilise HSR in Johor, Malaysia, this study seeks to close this gap. expectations.

1.1 Problem Statements

Past studies have combined two influential models which are Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM) to explore the factors influencing behavioural intention towards HSR adoption (Mahardika et al., 2022). TPB, which emerged from the Theory of Reasoned Action, emphasizes the role of attitudes, subjective norms, and perceived behavioural control in shaping behavioural intention (Wong et al., 2024). It also highlights the importance of factors like trust and external influences, which have been integrated into TPB by recent research. Trust impacts attitudes and perceived behavioural control, while external factors, such as mass media campaigns, influence behaviour intention indirectly (Hsiao & Yang, 2010) (Madha et al., 2016) (Borhan et al., 2017). Understanding the factors that influence individuals' intentions to use this mode of transport is essential for successful implementation and widespread acceptance. While previous research abroad has explored the effects of attitudes, subjective norms, and perceived behavioural control in TPB and TAM on HSR usage intentions, a comprehensive understanding of the interactions between these factors is also needed in Malaysia. To fill in this research gap, researchers need to learn more about how psychological, social, and outside factors affect people's decisions to adopt HSR. Next, TAM, developed to understand technology acceptance, posits that user behaviour is strongly driven by attitudes towards technology (Davis et al., 1989). Users are more likely to adopt technology they perceive as useful and easy to use. The study applies TAM to assess passenger acceptance of HSR, showing that perceived usefulness, ease of use, and attitudes towards technology are crucial in shaping

behavioural intention (Wong et al., 2024). TAM's reliability in predicting technology adoption, including in Advanced Driver Assistance Systems, reinforces its applicability to HSR adoption (Damsara & De Barros, 2023). The previous research also identifies several variables that affect HSR adoption, such as service quality, safety, comfort, cost, and convenience. Perceived benefits and costs, both monetary and non-monetary, also influence passengers'decisions (Hortelano et al., 2016).

Research indicates that price, in conjunction with journey time, comfort, regularity, and timeliness, can affect the decision to utilise train travel (Hortelano et al., 2016). Research repeatedly indicates that multiple factors substantially affect an individual's choice of train travel. The factors encompass pricing competition, trip time efficiency, journey comfort, service frequency, and rail timetable punctuality. (Alfonso et al., 2015) said the harmful emissions caused by extra traffic brought on by high-speed rail could not be sufficiently offset by the environmental benefits of switching from air travel to HSR, a 2010 study by the Universidad Politécnica de Valencia concluded. Its authors deplored what they considered a major shortcoming in not just the ecological evaluations of high-speed rail but also in the kind of environmental impact statement that is often drawn up for this sort of project. According to their calculations, HSR may prompt more travel and thus more emissions than would occur in the absence of HSR, even if one employs the sort of methodology that U.P.V. did to arrive at that conclusion. Demographics related to the distinct attributes present in certain groups of people, encompassing factors such as age, income level, and geographic region. The past research opined that research studies should, at the very least, provide details regarding age, gender identity, sex assigned at birth, ethnicity, race, socioeconomic status (SES), and social class (Hughes et al., 2022). The behaviour intention of high-speed rail services indeed differs generation. HSR services tend to attract higher-income, well-educated individuals, raising concerns about social exclusivity and accessibility for lower-income generation Z members (Dobruszkes et al., 2022). Generation Z shows a strong inclination towards sustainable travel options, often favouring public transport over private vehicles (Fisu et al., 2024). Their travel behaviour is influenced by technological integration, with a preference for mobile apps and digital ticketing systems (Grzesiuk et al., 2023). Despite the promising trends in generation Z's sustainable travel preference, the social inequalities associated with

Table 1 *Constructs and problem statement of high speed rail*

Constructs	Problem Statements
Attitude (AT)	• Limited understanding of whether Generation Z perceives HSR as useful, safe, or environmentally friendly, and how this influences their usage intention.
Subjective Norms (SN)	• There is a need to assess how social influences (e.g., family, media, peers) affect Generation Z's intention to adopt new public transport options like HSR.
Perceived Behavioral Control (PBC)	• Lack of insight into whether Generation Z feels capable of using HSR given financial, time, and travel convenience constraints.
Trust (TR)	• Existing concerns over HSR reliability and safety may hinder Generation Z's acceptance; trust needs to be established as a determinant of intention.
External Influences (EI)	• Previous research lacks investigation into how media exposure and societal trends shape public trust and interest in adopting HSR in the Malaysian context.
Price (P)	• Affordability is a key concern among younger users; it's unclear how price perception affects their willingness to switch from existing transport modes to HSR.
Perceived Sustainability (PS)	• Need to determine whether sustainability awareness among Generation Z translates into higher intention to adopt HSR over less eco-friendly options.
Behavioral Intention (BI)	• The central issue of the study: what drives or hinders Generation Z's intention to adopt HSR services in Johor, given psychological, social, and practical considerations.

The study has three main goals, which are listed below:
- To identify the differences of high-speed rail behaviour intention to use between gender among generation Z in Johor.
- To identify the influences of attitudes, subjective norms, perceived behaviour control, trust, and external influences towards behaviour intention to use high speed rail services in Johor.
- To identify the influence of price towards perceived sustainability and behaviour intention to use high speed rail services in Johor.

1.2 Significant of the Study

The The Malaysian government agreed to build the KL-SG HSR development project in Malaysia, which will connect the railway from Malaysia to Singapore. Therefore, this study will be of importance to the Malaysian government because the purpose of this study is to study the behaviour intention of the local community in Johor regarding the KL-SG HSR project that will have a station built in Johor. By exploring community perspectives, the research can help bridge the gap between policymakers and the public regarding HSR development. This fosters a more collaborative approach to infrastructure projects. Positive perception from the local community can provide benefits to KL-SG HSR. The research can highlight the importance of environmental sustainability in gaining community support for KL-SG HSR projects. This can influence policymakers to prioritise these elements during project development. By identifying factors that influence community behaviour intention, the study can help planners design KL-SG HSR projects that maximise positive social and economic impacts for local communities. The KL-SG HSR project's success hinges on whether local communities are willing to use this technology in the best way. The significance of the study is to contribute to a smoother and more successful implementation of HSR projects by addressing community concerns early on. Influence policies and practices that ensure HSR development benefits both local communities and broader society. Advance public understanding of HSR technology and its potential impact on communities.

2. Theories Justification

2.1 The Study of HSR

Malaysia has been actively exploring the development of a HSR system to enhance connectivity between major cities and boost economic growth. The proposed HSR line would significantly reduce travel time between Kuala Lumpur and Singapore, fostering closer economic ties and promoting regional development. Several factors contribute to the success of this high-tech project. The obvious factor is population density. Since HSR necessitates high urban densities, especially those concentrated near major stations, extending HSR to areas lacking the ability or desire to foster high densities is unlikely to yield success. Furthermore, the success of high-speed rail is contingent upon the presence of large urban populations clustered around the citycentre's rail terminals, as well as extensive public transport systems that facilitate easy journey completion (Aleksander Purba et al., 2019). Indonesia should recognize the tangible benefits of HSR, such as time savings and environmental advantages, which foster strong public acceptance. In order to make this HSR project a success, research on the behaviour intention of the ridership is important. According to the (Aleksander Purba et al., 2019) that is since public transport usage is one of the greatest indicators for rail success, ridership is important.

The success of HSR stems from the correlation between the population in a place and their behavioural intentions in the area. The interplay between a large population and supportive behavioural intentions significantly impacts the success of a HSR system in several ways. However, we must acknowledge that Indonesia lacks certain factors that enable the successful implementation of HSR in other nations. For starters, Indonesia has neither the population density nor the land use regulations necessary to support the development of high-speed rail. It lacks a pre-existing, successful passenger rail system and has far less urban public transport usage than Tokyo and Seoul (Aleksander Purba et al., 2019). The existence of this HSR frees it from traffic, and the train also relieves traffic jams on the highway. Switching to trains can significantly reduce the number of motor vehicles, which in turn reduces the road load. Besides, it will save time, be cost-effective, and be space-saving because HSR can carry a huge number of passengers, even exceeding the number of passengers on a plane. Other benefits include environmental friendliness, convenient mass transit, and increased safety compared to road travel. Train passengers will exhibit greater discipline due to the necessity of adhering to the train schedule, which is crucial for success (Aleksander Purba et al., 2019).

2.2 The Different Between Gender

Comprehending the demographic attributes of HSR passengers is crucial for the efficient planning, implementation, and administration of these systems. The demographic profile remains ambiguous about the persistence of social injustice in relation to HSR travel. There are a minimum of three justifications for addressing this matter. In some countries, regional (and perhaps long-distance) classical rail services are linked to subsidized public services, resulting in travellers paying fares that are considerably lower than the actual cost. Secondly, high-speed rail initiatives and the HSR system, in general, are frequently presented as beneficial for all, (Dobruszkes et al., 2022). The prior study indicates that, regarding the age component, those under 50 years exhibit a negative correlation, suggesting they are more inclined to utilize HSR for travel.

The predicted parameters for age and gender as socioeconomic determinants are substantial, suggesting a connection between HSR usage and these variables. A negative correlation with gender suggests that women are more inclined to utilizeHSR, as they view HSR travel to be safer than car travel on toll roads. This outcome aligns

with the findings of comparable intercity travel studies in Indonesia, including those by (Muhammad Zudhy Irawan, Nurvita I.M. Simanjuntak, Faza Fawzan Bastarianto, Reslyana Dwitasari, 2020), which indicated that females are more inclined to utilize airplanes rather than cars on toll roads (Mahardika et al., 2022). This study provides fresh insights into HSR in the US, contrasting with earlier research that emphasized the significance of demographic characteristics as gender and age in pro environmental activities (Vicente-Molina et al., 2018).

Numerous demographic factors, particularly gender, age, education, wealth, and ethnicity, exhibited patterns analogous to those of the respondents (Yu Pan, 2024). University graduates constitute a significant proportion of HSR passengers relative to the general population, with specificity indices frequently exceeding 5 and even surpassing 20 in China. By identifying key demographic segments, governments and transport operators can tailor services, pricing strategies, and marketing initiatives to effectively attract riders and maximize the social and economic benefits of HSR.

2.3 The Development of the Hypotheses

The theory of planned behaviour (TPB) is a model that has been widely used in a variety of academic fields to predict and clarify human conduct (Lisa Beck, 1991). TPB, which builds from theory of reasoned action (TRA) in 1975, provides a useful paradigm for forecasting intentions and ultimately behaviours. TRA states that attitude and subjective norm are the functions that determine behavioural intention, an immediate predictor of behaviour. The TRA model has, however, been expanded to include the concept of perceived behavioural control, an antecedent variable that influences both intentions and behaviour (Hsiao & Yang, 2010). This previous theory has been improved with the addition of the latest factors by today's researchers in theory of planned behaviour. New constructions for TPB, including trust, external impact, and situational element, have been presented in several recent research (Hsiao & Yang, 2010)(Madha et al., 2016)(Borhan et al., 2017). Then, this study decides to take trust and external influences factors as additional variables to this researcher.

H1: Subjective norms (SN) have a positive effect on the high-speed rail use
behaviour intention (BI).
H2: Subjective norms (SN) have a positive effect on the high-speed rail use
behaviour intention (BI).

2.4 Generation Z

Generation Z include those born from 1995 to 2015 (Fry & Parker, 2018). Generation Z is the most ethnically diversified and technologically proficient generation (Harber, 2011). Generation Z is regarded as the inaugural generation born and nurtured in a technology environment, with their comprehension of information accessibility and perspectives evolving in ways that prior generations appear not to have (Davies & Eynon, 2018). Technology is a facet of their identity, and they possess technological proficiency; nonetheless, they exhibit deficiencies in problem-solving abilities and fail to contextualise situations, analyse them, and make informed judgements (Coombs,2013). Generation Z was raised in the era of the social web, making them digitally orientated and reliant on technology (Singh & Dangmei, 2016). Generation Z, characterized by their digital birth, has a unique perspective shaped by constant exposure to technology, influencing their communication, learning style and even their worldview. Generation Z's cognition, interaction, and learning have been altered by the digital landscape of limitless technological resources and interactions (Adamson et al., 2018).

Other than that, generation Z has significant awareness for environmental concerns and is acutely aware of impending shortages, particularly regarding water, which reflects their strong sense of duty towards natural resources (Tulgan, 2013). This generation values efficiency and sustainability, demonstrated by their preference for HSR as a mode of transportation that aligns with their environmental awareness and desire for a fast and seamless travel experience. Past research has indicated that sustainability and predictability substantially affect the social dimensions of rail travel, enhancing good experiences and relationships among young travellers in Romania (Nistoreanu et al., 2024). The research
conducted in Romania indicates that young travelers prioritise sustainability and reliability in their selection of rail travel. This emphasis on environmental accountability and dependable service cultivates favourable social relations and improves the entire travel experience for this population.

2.5 The Theoretical Framework

This study will evaluate eight factors. The variables will be categorized into two which are independent variables (IV) and dependent variables (DV). The IV for this research includes external influences, beliefs, attitudes, subjective norms, perceived behavioural control, and price, whereas the DV is behavioural intention and perceived sustainable HSR. The study theoretical framework is illustrated in Figure 3 below.
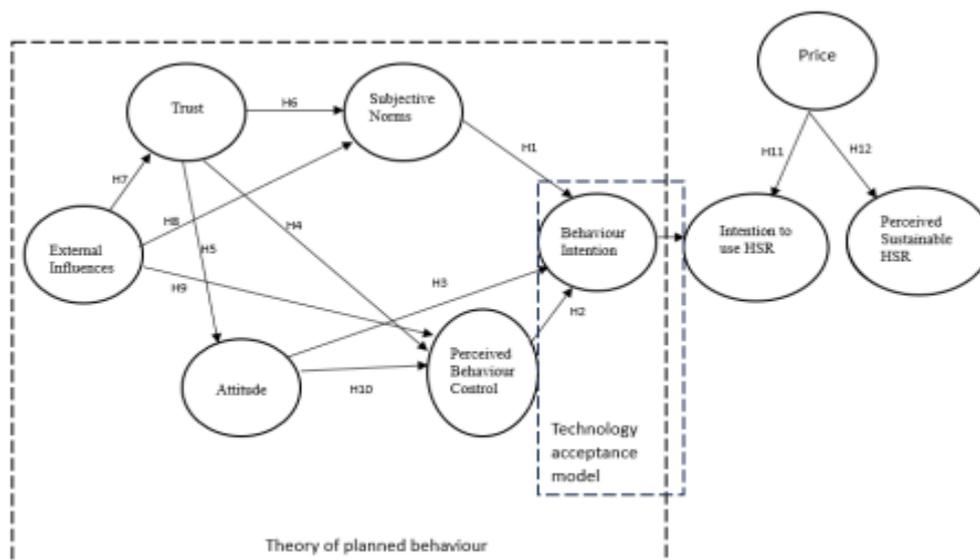
Fig. 1 *Theoretical framework*

3. Research Methodology

3.1 Research Design

The research design for this study was quantitative survey research, deemed the most suitable approach to achieve the study's objectives. This study collected measurable data on people's behavioural intentions through surveys. This approach enabled the study to gather data from a large sample and statistically analyse responses to understand behavioural intentions among people. The quantitative survey research was used to align with the aims of this research. Objective 1 was to identify the differences of high-speed rail behaviour intention to use between gender among generation Z in Johor. The quantitative technique enables the analysis of variations in variable relationships across genders within the data set. The second objective was to identify the influences of attitudes, subjective norms, perceived behaviour control, trust, and external influences towards behaviour intention to use high speed rail services in Johor and the third objective was to identify the influence of price towards perceived sustainability and behaviour intention to use high speed rail services in Johor. The quantitative technique, emphasizing statistical analysis, is very appropriate for structural models, specifically for identifying the influences of independent variables on dependent variables. The research employs a quantitative technique to systematically gather and evaluate numerical data, facilitating the identification of patterns, trends, and statistically significant correlations among variables. This methodology establishes a robust foundation for deriving objective results on HSR usage intentions among Generation Z in Johor.

4. Results and Discussion

In this study, the researcher used a statistical tool known as SmartPLS 4 to conduct data analysis for statistical purposes. The method of analysis included measurement model and structural modeling, and through these two methods it was able to show the reliability and accuracy of the research data.

4.1 Demographic

From the data collected, Most respondents who answered the questionnaire were female, which was 86.3%. In addition, the age range of respondents who answered the questionnaire was 20–24 years old, which is 53.9%. Next, most respondents (93.2%) identified as Malay. Furthermore, 52.2% of the respondents were either unemployed, housewives, or students. Moreover, 51.9% of the respondents had a bachelor's degree as their level Of education. The travel frequency of respondents in a year by train was less than 1 time, which was 48.4%. Next, 41% of respondents reported traveling by train less than once in the past 5 years. Another point is 83.6% of the respondents reported using cars as their primary mode of transportation. Other than that, 64.2% of respondents primarily used the HSR for holiday or leisure trips. Then, 99.2% of the respondents were in favour of establishing HSR services in Johor. Apart from that, most respondents agreed that the benefits of HSR development in Johor can reduce road congestion by 75.9%.

4.2 Measurement Model

This study accepted to the suggestions of (Anderson et al., 1988) to evaluate the model utilising a two-step method. Initially, the study evaluated the measurement model to ascertain the validity and reliability of the instruments employed, adhering to the protocols established by (Hair et al., 2022) and (Ramayah et al., 2018). Subsequently, this study executed the structural model to examine the formulated hypotheses. The researcher evaluated the loadings, average variance extracted (AVE), and composite reliability (rho_a) and composite reliability (rho_c) for the measurement model. Loadings must be ≥0.5, AVE must be ≥0.5, and CR must be ≥0.7. Table 3 demonstrates that all AVEs exceed 0.5 and all CRs surpass 0.7.

Table 2 *Table measurement model*

Factors	Items	Loadings	AVE	Composite reliability (rho_a)	Composite reliability (rho_c)
Attitudes	ATI 1	0.819	0.678	0.842	0.894
	ATI 2	0.830			
	ATI 3	0.844			
	ATI 4	0.799			
Subjective norms	SN 1	0.850	0.777	0.905	0.933
	SN 2	0.891			
	SN 3	0.890			
	SN 4	0.895			
Perceived behavioural controls	PBC 1	0.725	0.630	0.812	0.872
	PBC 2	0.806			
	PBC 3	0.833			
	PBC 4	0.806			
Trust	TR 1	0.933	0.873	0.855	0.932
	TR 2	0.935			
External influence	E 11	0.705	0.623	0.863	0.891
	E 12	0.840			
	E 13	0.853			
	E 14	0.718			
	E 15	0.818			
Behaviour intention	B 11	0.801	0.630	0.709	0.836
	B 13	0.747			
	B 16	0.830			
Perceived sustainability	PS 1	0.855	0.714	0.927	0.937
	PS 2	0.737			
	PS 3	0.866			
	PS 4	0.868			
	PS 5	0.875			
	PS 6	0.861			
Price	P 1	0.807	0.729	0.908	0.931
	P 2	0.880			
	P 3	0.889			
	P 4	0.882			
	P 5	0.807			

4.3 Structural Model

In this study, the route coefficients, standard errors, t-values, and p-values for the structural model utilizing a 10,000-sample bootstrapping technique (Ramayah et al., 2018). (Hahn & Ang,2017) criticized p-values as inadequate criteria for assessing hypothesis significance and recommended employing a variety of criteria, including p-values, confidence intervals, and effect sizes. Table 12 presents an overview of the criteria employed in this study to evaluate the formulated hypotheses. This study analysed the impact of the four predictors which are subjective norms (SN), perceived behaviour control (BI). The R^2 value was 0.441, indicating that these

predictors accounted for 44.1% of the variance in behavioural intention (BI). SN (β = 0.258, p < 0.01), PBC (β = 0.254, p < 0.01), AT (β = 0.169, p < 0.01), and P (β = 0.084, p < 0.01) exhibited positive correlations with BI, hence substantiating H1, H2, H3, and H11. After that, examined the impact of trust (TR), external influence (EI), and attitude (AT) on perceived behavioural control (PBC), yielding a R^2 of 0.602. This implies that PBC accounts for 60.2% of the variance in TR, EI, and AT, hence supporting hypotheses H4, H9, and H10.

Table 3 *Structural model testing*

Hypoth esis	Constructs	Std dev	Std Bet	Interprenti ng *f²* effect size	t-values	p-values	*R²*	*f²*	Significance
H1	SN→BI	0.029	0.258	Small	8.845	0.000	0.439	0.056	Significant
H2	PBC→BI	0.032	0.254	Small	8.015	0.000	0.439	0.043	Significant
H3	AT→BI	0.028	0.169	Small	6.020	0.000	0.439	0.022	Significant
H4	TR→PBC	0.026	0.358	Small	14.028	0.000	0.601	0.147	Significant
H5	TR→AT	0.023	0.656	Large	28.048	0.000	0.430	0.757	Significant
H6	TR→SN	0.030	0.439	Medium	14.765	0.000	0.430	0.192	Significant
H7	EI→TR	0.022	0.658	Large	30.276	0.000	0.432	0.763	Significant
H8	EI→SN	0.030	0.278	Small	9.207	0.000	0.430	0.077	Significant
H9	EI→PBC	0.025	0.213	Small	8.567	0.000	0.601	0.060	Significant
H10	AT→PBC	0.026	0.316	Small	12.093	0.000	0.601	0.131	Significant
H11	P→BI	0.029	0.084	Negligible	2.945	0.000	0.439	0.006	Significant
H12	P→PS	0.018	0.753	Large	41.186	0.000	0.566	1.307	Significant

Subsequently, evaluated the influence of trust (TR) on attitude (AT), yielding an R2 of 0.431, signifying that AT accounts for 43.1% of TR, hence substantiating H5. Following that, evaluated the impact of trust (TR) on subjective norms (SN), yielding an R2 of 0.431, signifying that SN accounts for 43.1% of TR, hence corroborating H6. Then, examined the impact of external influence (EI) on trust (TR), subjective norms (SN), and perceived behavioural control (PBC), yielding R2 values of 0.433, 0.430, and 0.602, respectively. This indicates that EI accounts for 43.3%, 43.0%, and 60.2% of the variance in TR, SN, and PBC, thereby supporting hypotheses H7, H8, and H9. Finally, examined the influence of price (P) on perceived sustainability (PS), yielding a R^2 of 0.567, indicating that PS accounts for 56.7% of the variance in P, so supporting H12.

In Partial Least Squares Structural Equation Modelling (PLS-SEM), the f^2 effect size quantifies the influence of an external (independent) latent variable on an endogenous (dependent) latent variable. It aids in evaluating the contribution of a specific predictor variable to the explained variance (R squared) of the dependent variable. A low f^2 number signifies that the elimination of the associated exogenous variable would result in a minor decrease in the R Square value of the dependent variable. This indicates that the predictor variable possesses restricted explanatory capacity for the dependent variable in the model (Hair et al., 2022). (Cohen, 1988) criteria for interpreting f^2 effect sizes in PLS-SEM are as follows: $0.02 \leq f^2 < 0.15$ indicates a small effect size, $0.15 \leq f^2 < 0.35$ denotes a medium effect size, $f^2 \geq 0.35$ signifies a big effect size, and $f^2 < 0.02$ represents no or minimal effect size.

An f^2 value below 0.02 signifies a small impact size, implying that the variable may not substantially help to elucidating the variance in the dependent variable. This prompts inquiries on the variable's incorporation in the model. The determination to maintain or eliminate a variable should not rely exclusively on the statistical value of f^2. This selection should be informed by both theoretical and practical significance. The importance of an impact magnitude is contingent upon its context. Even modest f^2 values may hold significance in specific domains, especially in exploratory research.

Multiple factors may lead to diminutive effect sizes (f-squared) in Partial Least Squares Structural Equation Modelling (PLS-SEM). A tenuous theoretical connection between the exogenous and endogenous latent variables may yield a minimal observed effect magnitude. If the foundational theory does not robustly substantiate the relationship between these variables, the predicted effect size is likely to be minimal. Secondly, limited sample sizes frequently constrain statistical power, hindering the detection of significant effects. This may result in an underappreciation of effect sizes or the emergence of non-significant associations. Ultimately, poor data quality, characterized by outliers, missing values, or nonnormal distributions, might negatively impact the robustness of correlations. These difficulties may diminish the accuracy and robustness of the predicted parameters, ultimately leading to reduced effect sizes. Various tactics can be utilized to mitigate small impact sizes in research. Improving measurement using dependable and valid tools is essential for precisely capturing latent variables.

Mitigating multicollinearity through the analysis of Variance Inflation Factor (VIF) values and the elimination of superfluous predictors can enhance model stability. Augmenting the sample size can yield more reliable estimates and improve the capacity to identify effects. Reevaluating the theoretical framework and exploring other paths or moderators might enhance the model and potentially fortify linkages. Ultimately, it is crucial to

acknowledge that minor effects might nonetheless possess practical significance. Consequently, researchers must assess effect sizes in relation to their research aims and domain expertise.
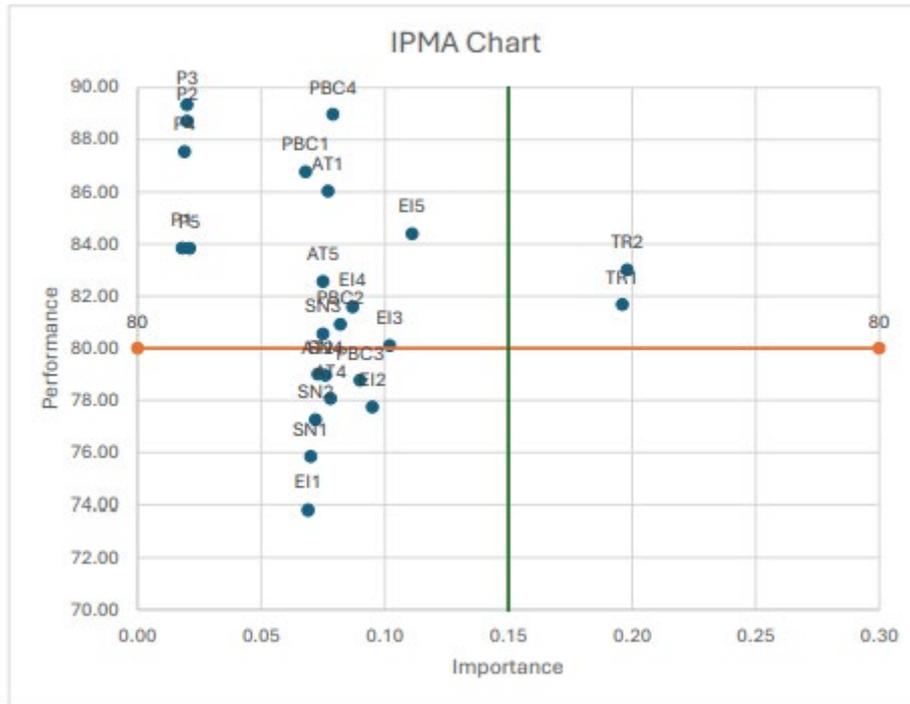

Fig. 2 *IPMA chart*

Additionally, Trust plays a crucial role in influencing Generation Z's willingness to use HSR. Factors such as TR1 and TR2 significantly impact their trust levels. To enhance trust, HSR operators can implement strategies that address these concerns effectively. Generation Z prioritizes safety and cleanliness, which are critical for their intention to use HSR services (Chuang et al., 2011). Trust in automated systems is vital; failures can rapidly diminish trust (J. Wang et al., 2021). High service quality, including efficient waiting areas and onboard experiences, is essential for building trust (Shu & Ran, 2023). Trust is significantly influenced by social factors, including reputation and social acceptance. HSR systems should focus on building a positive public image through community engagement and transparent communication about safety and efficiency. The HSR management should build upon this existing strength by strategically incorporating trust-building measures throughout the planning and development process to ensure sustained customer acceptance and utilization of the services.
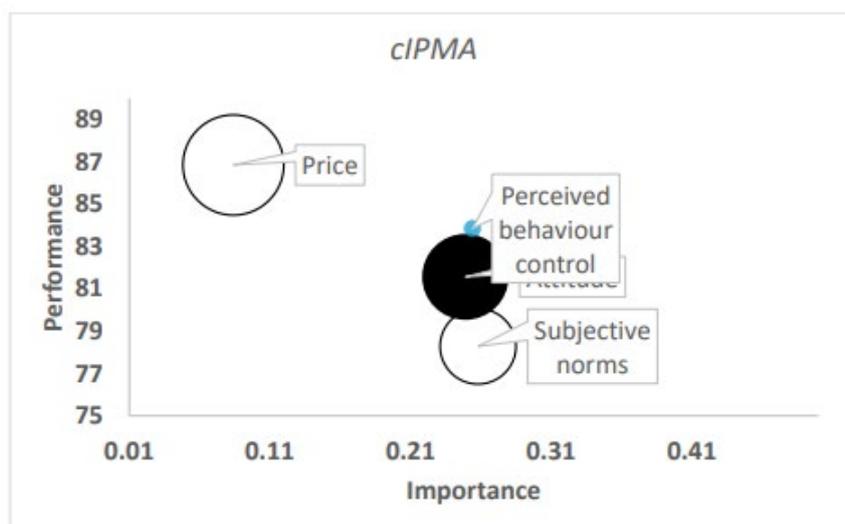

Fig. 3 *CIPMA chart*

Table 4 *Table effect size (CE-FDH celling line)*

Variable	Effect size d	p-value
Attitude	0.141	0.000
Price	0.230	0.000
Perceived Behaviour Control	0.287	0.000
Subjective Norms	0.103	0.000

4.4 Discussion

The study's conclusions provide important new information about the behavioral intentions of Generation Z in Johor to use High-Speed Rail (HSR) services as well as how these intentions are influenced by social, psychological, and economic factors. A strong foundation for comprehending the complex factors influencing adoption was made possible by the combination of the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB). In line with TPB (Ajzen, 2002), This study demonstrates that the intention to use HSR services is significantly predicted by attitudes, subjective norms, and perceived behavioral control (Madha et al., 2016). This result is consistent with earlier studies showing that behavioral intention to use public transportation is increased by positive views (Madha et al., 2016). Intention was also closely linked to perceived behavioral control. This implies that Generation Z believes they can use HSR, especially if the cost and ease of use meet their needs. This confirms the finding that people are more likely to embrace a behavior when they feel they have a lot of control over it (Borhan et al., 2017). The impact of social networks, or subjective norms, was notably beneficial. Encouragement of HSR use by family, friends, and esteemed individuals was associated with a higher desire to adopt, demonstrating the significance of the social component in transportation choices (Rivis & Sheeran, 2003). This supports the claim made by Rivis & Sheeran (2003) that intentions in environmental behavior can be strongly predicted by subjective standards.

Furthermore, attitudes and perceived behavioral control were both highly predicted by trust throughout the HSR system (Hsiao & Yang, 2010). Participants were more likely to use HSR if they thought the service would be dependable, attentive, and customer-focused. It is commonly known that trust shapes behavioral intention (Hsiao & Yang, 2010; Borhan et al., 2017) and emphasizes that successful implementation depends on fostering public trust via open communication and satisfying experiences. Price was also evaluated in the study as a factor influencing behavioral intention and perceived sustainability. More readiness to embrace HSR was linked to competitive and acceptable pricing. This result supports other studies that found price is essential for drawing travelers from other forms of transportation, like flying (Hu et al., 2024). Lastly, gender variations in behavior intention were found in the demographic analysis, with female respondents believing that HSR was safer. This finding is consistent with the findings of Mahardika et al. (2022) on gendered perceptions of transport safety. Overall, the findings support the majority of the hypothesized correlations between attitudes, subjective norms, perceived control, trust, external influence, and pricing, as well as validate the suggested model. This emphasizes the need for multifaceted approaches in pricing, marketing, and policy creation to encourage Generation Z in Johor to utilize HSR.

5. Recommendation and Conclusion

Employing All objectives have been accomplished, and all research enquiries have been addressed. Hypotheses are also corroborated by prior research. The variables of attitude, subjective norms, price, and perceived behavioural control must be considered critically in the establishment of HSR services. These characteristics substantially affect public acceptance and utilisation of the HSR system. Consequently, careful planning and execution techniques must be formulated to properly address these concerns. Besides that, targeted discounts such as offering discounts during off-peak hours or for specific demographic can attract more riders despite improving service quality alongside competitive pricing can further entice passengers to choose HSR over other modes of transportation. This includes offering reduced fares for students, senior citizens, and families. Collaborating with businesses to offer discounted travel for their employees can also encourage commuting by HSR and reduce traffic congestion. Other than that, to further entice passengers, HSR operators must prioritize enhancing service quality (Hu et al., 2024). This includes ensuring punctuality and reliability by maintaining consistent schedules and minimizing delays through robust maintenance programs and efficient traffic management systems. Providing accurate and up-to-date information on train schedules, delays, and disruptions through various channels like mobile apps, websites, and announcements is crucial for passenger convenience and reducing anxiety. By implementing these targeted strategies and enhancing service quality, HSR operators can effectively attract new riders, increase ridership, and establish HSR as a preferred mode of transport for both business and leisure travel.

By prioritising these characteristics, the HSR project can augment its attractiveness to prospective customers and guarantee enduring sustainability and success. The great performance yet low importance of these four variables in this study can likely be related to the absence of HSR services in Malaysia. This indicates that respondents may possess elevated overall expectations for these elements but lack direct experience to juxtapose them with real HSR services. Their evaluations lack empirical substantiation, rendering them predominantly speculative. Moreover, in the absence of HSR services, respondents may find it challenging to offer precise and quantifiable assessments of the significance of each element. Their responses are often more generalized and less specific. It is quite likely that additional undisclosed variables in this study exert a more substantial influence on individuals' interest in utilising future HSR services. These variables may only become evident if HSR services are fully functioning. Future research can be conducted once the HSR becomes operational, integrating real-world experiences. This may encompass surveys of actual passengers, focus groups with users, and observational studies at HSR stations to collect data on usage patterns and user satisfaction, as well as to investigate the impact of socioeconomic factors such as income, education level, and occupation on HSR acceptance and usage intentions in greater depth. This will facilitate comprehension of the varying effects of the HSR project on distinct demographic segments.

In conclusion, this study determines the factors that influence the behaviour intention of high-speed rail services among the generation Z in Johor. The findings consistent with past studies reported from the country such as Indonesia, Japan, France and Spain. Although past studies are lacking into the details on generation Z preferences. Hence, this current study has filled the gap especially from context of Malaysia. Technological advancements in HSR technology can improve efficiency, reduce costs, and make them a more attractive transportation option. By understanding these factors and incorporating theories such as TAM and TPB, policymakers and stakeholders can create a more favourable environment for the integration of HSR services. Future researchers can conduct continuous improvement studies about the acceptance of KL- SG HSR services. Conduct longitudinal studies to track changes in public perception over time as high-speed rail projects are developed and implemented. This can help evaluate the effectiveness of interventions and identify areas for further improvement.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors are responsible for the study conception, research design, data collection, data analysis, result interpretation and manuscript drafting.

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