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The impact of perceived accessibility and its moderating effects

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Exploring the switch to urban train services: The impact of perceived accessibility and its moderating effects

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ABSTRACT

Perceived accessibility refers to individuals' subjective perception of how easy it is to reach destinations using a specific mode of transport. As such, understanding the effect of perceived accessibility on travel behavior is essential for creating transport systems and urban environments that are efficient, equitable, and sustainable. This study develops a new integrated model by combining the Norm Activation Model (NAM), the Theory of Planned Behavior (TPB), perceived risk, and perceived accessibility. This enhanced model offers a comprehensive understanding of the factors influencing individuals' intentions to switch to urban train systems. Additionally, the moderating effects of perceived accessibility on the link between personal, contextual factors and switching intention are also explored. The model developed is tested using data obtained from a sample of 535 individuals in Hanoi, Vietnam. This is particularly important because more research in low- and middle-income countries (LMICs) is needed to address the sustainability challenges these nations face due to their dependency on motorized private transport. The findings show that subjective norms have the strongest effect on the intention, followed by personal norms, attitude, and perceived accessibility. This study also confirms the moderating role of perceived accessibility on the link between attitude and switching intention, while the other hypotheses regarding the moderating effects of perceived accessibility are not supported by the findings. These insights aim to inform policymakers and public transport authorities in developing targeted strategies to promote sustainable urban mobility in Vietnam.

1. Introduction

Perceived accessibility plays a crucial role in shaping transport choices, yet it remains an underexplored factor, particularly in low- and middle-income countries (LMICs), where sustainable transport options are vital to addressing the heavy reliance on motorized private vehicles. According to Lättman et al. (2018), perceived accessibility refers to the ease and convenience of using a transport

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system to lead a satisfactory life. In the context of public transport (PT), it encompasses individuals' perceptions of how easily they can access services, including the proximity of stations to their homes or workplaces, availability of parking, and the convenience of connections. Although perceived accessibility is increasingly recognized as a key determinant of transport behavior, research on this topic remains limited, especially within LMICs (Pot et al., 2021; Jamei et al., 2022). While transport planning often relies on objective metrics like distance to transit stations or service frequency, these measures fail to fully capture how individuals subjectively experience access to PT (Lättman et al., 2018). This distinction is significant because perceived accessibility can differ substantially from objective measures and exerts a stronger influence on decisions to shift from private vehicles to PT (Olsson et al., 2021). The existing literature has yet to thoroughly investigate how perceived accessibility affects modal shift behaviors and interacts with psychological factors like attitudes, social norms, and personal norms, particularly in LMICs. Closing this research gap is critical for developing effective strategies to promote sustainable transport modes in regions where public transport is often underutilized.

In urban cities across Vietnam, motorcycles have dominated the traffic flow, followed by private cars (Hoang and Okamura, 2015). PT is expected to play a crucial role in addressing the challenges of traffic congestion and enhancing mobility for residents (Aftabuzzaman et al., 2010; Nguyen-Phuoc et al., 2018). Historically, buses have been the primary mode of PT in urban areas in Vietnam. However, the quality and quantity of bus services in Vietnam are often perceived as relatively poor, characterized by issues such as overcrowding, irregular schedules, and inadequate infrastructure (Pham et al., 2021; Tran-Thi et al., 2024). In response to the growing demand for efficient and sustainable transport solutions, urban train systems have been developed and implemented over the past decade in Hanoi and Ho Chi Minh City (Fig. 1) (Tuong, 2024). While these rail networks hold promise for alleviating congestion and improving connectivity, their ridership levels have not met the authorities' expectations. As Vietnam continues to urbanize and grapple with ineffective transport management, exploring the influencing factors affecting the switching intention from private vehicles to urban train systems remains a critical consideration for policymakers and urban planners. Currently, there is little research on this topic in Asian LMIC, so Western-based findings cannot be entirely applied due to differences in national cultural values and socio-economic development levels. Few factors have been explored in separate studies without a comprehensive framework (Long et al., 2011; Ngoc and Ngoc, 2022).

To address the limitations in the existing literature and enhance the understanding of factors influencing the intention to switch to urban train services, this research aims to develop a comprehensive and contextually relevant model that integrates perceived accessibility with established behavioral frameworks. Specifically, the study combines the Norm Activation Model (NAM), the Theory of Planned Behavior (TPB), and perceived risk, focusing on how these elements collectively shape transport choices in low- and middle-income countries (LMICs), such as Vietnam. Additionally, the framework considers a comprehensive range of factors, such as contextual factors (e.g., perceived accessibility and perceived risk), personal factors (e.g., attitudes, personal norms), and social factors (e.g., subjective norms). This approach allows for a nuanced exploration of how these various factors interact and influence individuals' transport choices. By introducing perceived accessibility as both an antecedent and a moderator, the study evaluates not only how this factor directly impacts the intention to use urban train services but also how it moderates and shapes the influence of personal and social factors within the decision-making process. The research is structured around the following sub-objectives:

- To develop a comprehensive and contextually relevant model that examines how a combination of personal, social, and contextual factors influence the intention to switch to urban train services, specifically within the context of an Asian developing country like Vietnam.
- To analyze the moderating role of perceived accessibility in the relationships between personal, social, and contextual factors and the intention to switch to urban train services. This includes assessing how perceived accessibility impacts the strength of these associations and whether it facilitates or impedes the switching intention.

This study is expected to inform the development of effective policies and practical solutions for encouraging a shift toward more sustainable urban transport options. As such, the findings contribute to helping address real-life transport challenges, including

Fig. 1. Urban train systems in Hanoi, Vietnam.

reducing congestion, lowering emissions, and fostering a more cohesive urban environment. The structure of the paper is as follows: The second section provides an overview of the theoretical background. The third section outlines the development of the conceptual framework and research hypotheses. Next, the research methodology used to validate the proposed model and test the hypotheses is described. The subsequent section presents the results of the study, including a step-by-step data analysis using Partial Least Squares – Structural Equation Modelling (PLS-SEM). This is followed by a discussion of the theoretical and managerial implications, along with limitations and suggestions for future research. Finally, the paper concludes with a final summary.

2. Theoretical background

2.1. Norm activation model (NAM)

The Norm Activation Model (NAM), as proposed by Schwartz (1977), provides a robust framework for understanding prosocial behaviors (Han, 2014; Kim & Hwang, 2020; Onwezen et al., 2013). The model is predicated on three core constructs: personal norms (PEN), awareness of consequences (AWC), and ascription of responsibility (ASR). These constructs are crucial in shaping an individual's prosocial behavioral intentions and have been explored across various settings such as green electricity participation (Clark et al., 2003), vehicle ownership and usage (Flamm, 2009), organic food consumption (Le & Nguyen, 2022), environmental policies (Fang et al., 2019), waste separation behavior (S. Wang et al., 2019), and responsible tourism (Gao et al., 2017).

Specifically, PEN is individuals' self-expectations tied to behavior and values, impacting guilt and pride (Pires et al., 2019). Awareness of consequences involves understanding the potential harm to others or valued things, triggering the activation of PEN (Schwartz, 1977). ASR refers to feeling responsible for negative outcomes, leading to the activation of personal norms (De Groot & Steg, 2009). Different interpretations of how these components interact have been proposed in the literature. While some researchers argue that AWC and ASR sequentially influence PEN, which in turn affects behavior (De Ruyter & Wetzels, 2000; Radic et al., 2021; Zhang et al., 2013), others suggest a more intertwined relationship where PEN can moderate the effects of AWC on behavior (Oh & Ki, 2023). This study adopts the view that ASR mediates between AWC and PEN, aligning with recent findings that emphasize the role of responsibility in activating personal norms (Savari et al., 2023; Wang et al., 2019).

Despite being applied to various pro-environmental behaviors, less attention has been paid to apply NAM in urban transport contexts, particularly in developing settings like Vietnam, where personal vehicle use predominates. In urban train services, the interaction of AWC, ASR, and PEN can critically influence commuters' choices. By understanding how individuals become aware of the environmental consequences of car use, feel responsible for these impacts, and internalize norms that favor train services, the switch to more sustainable transport options can be encouraged.

2.2. Theory of planned behavior (TPB)

The TPB, introduced by Ajzen in 1991, is a widely used social-psychological theory for understanding human behavior (Ajzen, 1991). It builds upon the Theory of Reasoned Action (TRA) proposed by Ajzen and Fishbein (1975) and incorporates the concept of perceived behavioral control (PBC) to address a perceived limitation in the previous model (Ajzen, 1991). The TRA is more effective for predicting behaviors within an individual's direct control, so the TPB addresses this limitation by considering perceived behavioral control, making it better suited for predicting behaviors as human behavior is not always under a person's total control (Park & Ha, 2014). The core of the TPB is the concept of intention, which represents an individual's conscious decision or plan (Ajzen, 1991; Conner & Armitage, 1998).

According to the TPB, behavioral intentions are influenced by attitude (ATT), subjective norms (SUN), and perceived behavior control (PBC) (Ajzen, 1991). ATT refers to an individual's evaluation or appraisal of the behavior, including the positive or negative outcomes associated with it (Bamberg and Möser 2007). SUN reflects the perceived social pressure to engage in or avoid a behavior. PBC encompasses beliefs about the availability of resources and opportunities necessary for the behavior and an individual's self-confidence in their ability to perform it (De Groot & Steg, 2009). The TPB has been applied to study factors influencing the intention to use public transport (Ali et al., 2023; Borhan et al., 2019), electric vehicles (Nguyen-Phuoc et al., 2022a), and alternative transport modes like ride-hailing (Nguyen-Phuoc et al., 2022b), cycling (Ali et al., 2023; Lois et al., 2015; Warner et al., 2021) and walking (Rod et al., 2023). Positive attitudes, strong subjective norms favoring sustainable transport options, and a high perceived behavioral control over using them are associated with a higher likelihood of choosing sustainable travel modes (Bamberg et al., 2007). By considering the components, the adoption of train services in Vietnam can be enhanced by promoting positive attitudes toward train usage and addressing social norms to facilitate a shift toward sustainable transport.

2.3. Perceived risk

The concept of quantifying risk gained traction in economics during the 1920 s (Knight, 1921), becoming foundational in decision-making theories across various fields such as finance, engineering, healthcare, and environmental management (Dowling & Staelin, 1994). However, the examination of safety and security in the transport sector, especially in developing nations, has been limited (Kacharo et al., 2022; Taniguchi et al., 2013). Risk assessment and management are critical in the transport sector, particularly for urban train services. Early models relied on statistical approaches, using historical data to estimate the frequency of risk events (Kaplan & Garrick, 1981). As the field matured, more sophisticated techniques emerged, incorporating expert judgment, fuzzy logic, and Bayesian inference to account for uncertainty and incomplete information (Abrahamse et al., 2009; Clemen & Winkler, 1993).

Perceived risk holds particular significance due to its potential impact on health protection, the demand for risk mitigation measures, and its role in informing policy decisions concerning hazards (Barbieri et al., 2021; Slovic, 2016; Wang et al., 2019). It represents an individual's subjective assessment of a threatening situation based on its characteristics and severity (Slovic, 1988), varying depending on personal attributes, social structures, and cultural beliefs (Neuburger & Egger, 2021). When individuals perceive risks as likely or severe, they prioritize self-protection, leading to actions like canceling trips or altering travel modes (Wang et al., 2024). Consequently, in this paper, perceived risks have a considerable influence on the selection of transport modes. However, even with objective security measures in place, passengers may not necessarily feel secure. Various factors contribute to feelings of insecurity, such as poorly maintained stations, pickpocketing, limited visibility, the presence of intimidating individuals, and a sense of isolation (Delbosc and Currie, 2012; Reichow and Friemel, 2020).

2.4. Perceived accessibility

Accessibility is a complex concept that has been extensively studied and defined in numerous ways. According to Burns (1979) and Weibull (1980), accessibility refers to the freedom individuals have to engage in various activities. While being recognized for a long time, there is still a scarcity of research on understanding perceptions of accessibility (Van Wee, 2016). Objective data alone cannot explain unknown components of individual perceptions (De Vos et al., 2023). Hence, recent research has turned its attention to perceived accessibility, exploring its role in understanding the subjective experiences of individuals (Curl, 2018; Curl et al., 2011; Lättman et al., 2016, 2018).

Although perceived accessibility was first recognized in the 1970 s (Morris et al. 1979), studies of perceived accessibility have only recently gained traction in the field of PT (De Vos et al., 2023; Olsson et al., 2021). Perceived accessibility is defined as the ease of leading a satisfactory life with the assistance of the transport system (Lättman et al., 2018). It is influenced not only by environmental conditions and the transport system but also by individual prerequisites and preferences that shape overall accessibility experiences (Pot et al., 2021). Perceived accessibility goes beyond traditional measurements and focuses on what individuals find significant. Various approaches, including quantitative survey measurements such as the Perceived Accessibility Scale, as well as qualitative and mixed methods, have been employed to assess perceived accessibility (De Vos et al., 2023).

Perceived accessibility is likely to play a critical role in influencing intentions to switch to public transport (Vafeiadis and Elldér, 2024). In this paper, we employ perceived accessibility as a predictive and moderating factor through a quantitative approach. Particularly, perceived accessibility might moderate the relationship between the components of the NAM, TPB, and risk model and switching intention to train services. Under the NAM, perceived accessibility can enhance personal norms by making individuals more aware of the environmental and social consequences of their travel choices, thus increasing their sense of responsibility toward choosing eco-friendlier options like urban trains. In the framework of the TPB, it might strengthen perceived behavioral control, enhancing individuals' confidence in using urban train services thereby positively influencing their intentions. In terms of perceived risk, an increased sense of accessibility can boost confidence and comfort, alleviating concerns about potential safety risks. As a result, improved perceived accessibility can make the perceived risks less significant in their decision-making process, thereby increasing their intention to switch to public transport. Thus, integrating perceived accessibility into urban train service planning and promotion can enhance user confidence and address barriers, thereby encouraging greater adoption of public transport.

3. Hypothesis development

3.1. Norm activation model (NAM) and switching intention to urban train services

Regarding personal norms (PEN), research conducted in Queenstown, New Zealand, found that PEN was strongly associated with the decision to choose eco-friendly travel options (Doran and Larsen, 2016). Previous studies have also demonstrated the significant role of PEN in influencing pro-environmental behaviors, including the intentions to use PT (De Groot & Steg, 2009; Lind et al., 2015; Liu, Sheng, Mundorf, Redding, & Ye, 2017; Nordfjærn & Rundmo, 2019). Thus, it is expected that personal norms will influence the switching intention to public train services.

As for awareness of consequences (AWC), previous research has shown that it plays a substantial role in shaping PEN (De Groot & Steg, 2009; Han, 2014; Lind et al., 2015; Trinh & Le, 2018). Hence, when individuals become aware of a problem (which in this case, the consequences of using private vehicles), they are inclined to responsible actions. The extent to which they contemplate resolving the issue subsequently triggers their personal beliefs of switching to train services and dictates the level of activation. Therefore, it is proposed that AWC will influence PEN and ASR.

The feeling of ascription of responsibility ASR also influences PEN (De Groot & Steg, 2009; Fang et al., 2019; Han, 2014; Javid et al., 2021; Lind et al., 2015; Trinh & Le, 2018). It is important to note that individuals are unlikely to feel a sense of responsibility unless they are aware of the potential issues associated with not acting responsibly (De Groot & Steg, 2009). Thus, it is expected that ASR influences the adoption of public train services. Therefore, a set of hypotheses are developed:

H1: AWC has a positive effect on PEN
H2: AWC has a positive effect on ASR
H3: ASR has a positive effect on PEN
H4: PEN has a positive effect on switching intention to urban train services

3.2. Theory of planned behavior (TPB) and switching intention to urban train services

As for attitude (ATT), in the context of PT, individuals' intentions to switch to train services depend on their belief in the usefulness, benefits, and positive outcomes of such practices (Rezaei et al., 2019; Yadav & Pathak, 2017). Recent research conducted in Kanazawa, Japan, by Ali et al. (2023) shows that ATT, SUN, PBC, and PEN have a significant and positive relationship with individuals' intentions to use PT. Other studies by Borhan et al. (2019), Saleh et al. (2023), Hou et al. (2021), and Javid et al. (2021) found a direct and positive relationship between ATT and the intention to take the train for intercity travel. Hence, in this paper, it is also expected ATT influences the switching intentions to urban train services.

PBC, in the context of this study, refers to the individual's perception of the ease or difficulty in switching to train services. Previous literature has also shown that PBC directly and positively influences individuals' intention to use PT (Hou et al., 2021; Onwezen et al., 2013; Saleh et al., 2023; Zailani et al., 2016). For instance, Zailani et al. (2016) examined people's intentions to use PT in the central parts of Kuala Lumpur in Malaysia and showed that PBC is a significant predictor of the intention to use PT.

Lastly, SUN, in this paper, pertains to the influence of others' approval or disapproval on the switching to train services. Previous studies have confirmed the positive and direct relationship between SUN and PT intention (Hou et al., 2021; Liu, Sheng, Mundorf, Redding, & Ye, 2017; Onwezen et al., 2013). Aligning with these studies, the role of SUN on switching intention to urban train services is explored. Hence, this study developed hypotheses as follows.

H5: ATT has a positive effect on switching intention to urban train services
H6: PBC has a positive effect on switching intention to urban train services
H7: SUN has a positive effect on switching intention to urban train services

3.3. Integrating NAM and TPB model

NAM and TPB are two empirically supported but distinct frameworks utilized to elucidate prosocial behaviors. However, the sufficiency and effectiveness of each theory individually have been subjects of debate (Bamberg & Möser, 2007). To address this, researchers have combined the NAM and TPB to enhance the explanatory power of eco-friendly behavioral intentions (Onwezen et al., 2013; Park & Ha, 2014; Rezaei et al., 2019). Incorporating personal norms into the TPB framework has also been shown to improve the predictive power of behavioral intentions and actual behavior (Harland et al., 1999). In many instances, the decision to change modes of transport is influenced by a combination of self-interest and prosocial considerations (Liu, Sheng, Mundorf, Redding, & Ye, 2017). Thus, combining these two can provide complementary viewpoints to better understand the behavior of reducing car transport.

The relationships between variables within an integrative NAM-TPB model are examined in this study. Given that subjective norms (SUN) rationalize specific behaviors within society, they have the potential to become internalized as personal norms (PEN) (Joo et al. 2022). Likewise, SUN precedes personal norms as it confirms whether a specific behavior is socially acceptable, guiding individuals to form their beliefs about the correctness of behaviors (Nguyen, 2022). Previous research consistently supports a positive relationship between SUN and PEN (Han et al. 2019; Park & Ha, 2014). Particularly, Rezaei et al. (2019) proposed that SUN, which establishes societal standards and perceived importance, influences PEN. Therefore, if individuals perceive that switching to urban train services is socially acceptable, they may feel a personal obligation to switch. Based on these, it is proposed:

H8: SUN has a positive effect on PEN

3.4. Perceived risk and NAM and TPB model

Risk perception refers to an individual's subjective evaluation of a potential threat, considering its attributes and seriousness (Slovic, 1988). It can vary based on personal traits, social dynamics, and cultural beliefs (Wang et al., 2024). Differences in risk perception based on transport mode usage have been observed, suggesting its relevance in transport decisions (Rundmo et al. 2011). Train stations and onboard trains may be perceived as potential public locations for security threats, such as theft, vandalism, or harassment (Delbosc and Currie, 2012; Currie et al. 2015). Train services may also pose health risks, especially in situations such as the spread of infectious diseases or exposure to pollutants (Hu et al. 2021). Thus, perceived risk, as a contextual factor reflecting individuals' evaluations of security concerns and health hazards, might has significant influence on PT mode choice. According to Phun et al. (2018), perceived risks negatively influenced customers' intention to switch to other transport modes. Additionally, understanding individuals' perceptions of safety and security is recognized to be crucial since their attitudes are indicative of their beliefs (Joewono and Kubota 2006). In Vietnam, Nguyen-Phuoc et al. (2021) found that perceived vehicle and driver-related risks as well as booking app-related risks directly influenced ride-hailling passengers' satisfaction and loyalty significantly. Additionally, the relationship between perceived risk and personal norms has been confirmed in the context of sustainability and consumer behavior (Hein, 2022). There has been limited research examining the direct relationship between perceived risk and assumption of responsibility. Liobikienė and Juknys (2016) have established a connection between risk perception and assumption of responsibility in a study exploring the impact of values on environmentally-friendly behavior. As such, the following hypotheses are proposed:

H9: PER has a negative effect on switching intention to urban train services
H10: PER has a negative effect on ASR
H11: PER has a negative effect on PEN

H12: PER has a positive effect on ATT

3.5. Perceived accessibility as a moderator and predictor

Despite extensive research conducted on accessibility in recent decades (El-Geneidy et al., 2016), limited studies have focused on the predictive role of perceived accessibility (PEA) in relation to public transportation usage (Lättman et al., 2018; Olfindo 2021), and its role as a moderator has been largely overlooked. As a predictor, there exists a divergence in scholarly discourse regarding the impact of PEA on the intention to switch. While some studies suggest a positive relationship between PEA and travel mode choice (Ingvardson and Nielsen, 2022; Olsson et al., 2021), others argue that such perceptions may not wield significant influence over transport choices (Olfindo, 2021). Particularly, Leng and Corman (2022) revealed that perceived accessibility influences not only satisfaction but also the choice of transport mode. Ingvardson and Nielsen (2022)- extend this discussion by demonstrating that proximity to well-serviced stations significantly enhances public transport utilization in Copenhagen. However, Olfindo (2021) found that while high perceived bus stop accessibility correlates with greater residential satisfaction, this perception does not necessarily incite moving intention. Despite these, the majority of evidence supports the positive role of enhancing PEA. In this study, we rest on the assumption that improved perceptions of ease of access to train services will effectively motivate switching intention to urban train services. Hence, it is hypothesized:

H13: PEA has a positive effect on switching intention to urban train services

As a moderator, while existing studies have highlighted the direct impact of PEA on mode choice decisions, the potential moderating role of perceived accessibility in shaping the relationship between other key variables and switching intentions has yet to be extensively examined. The TPB incorporates perceived behavioral control (PBC), which can be significantly influenced by accessibility. Studies by Doll and Ajzen (1992) and Liu et al. (2017) demonstrate that enhanced accessibility can substantially improve PBC, thereby positively affecting intentions to use public transport. This is particularly pertinent in Vietnam, where improving the perceived ease of accessing urban trains could lead to substantial shifts in travel behavior. Rocha et al. (2023) proposed an integrated model that

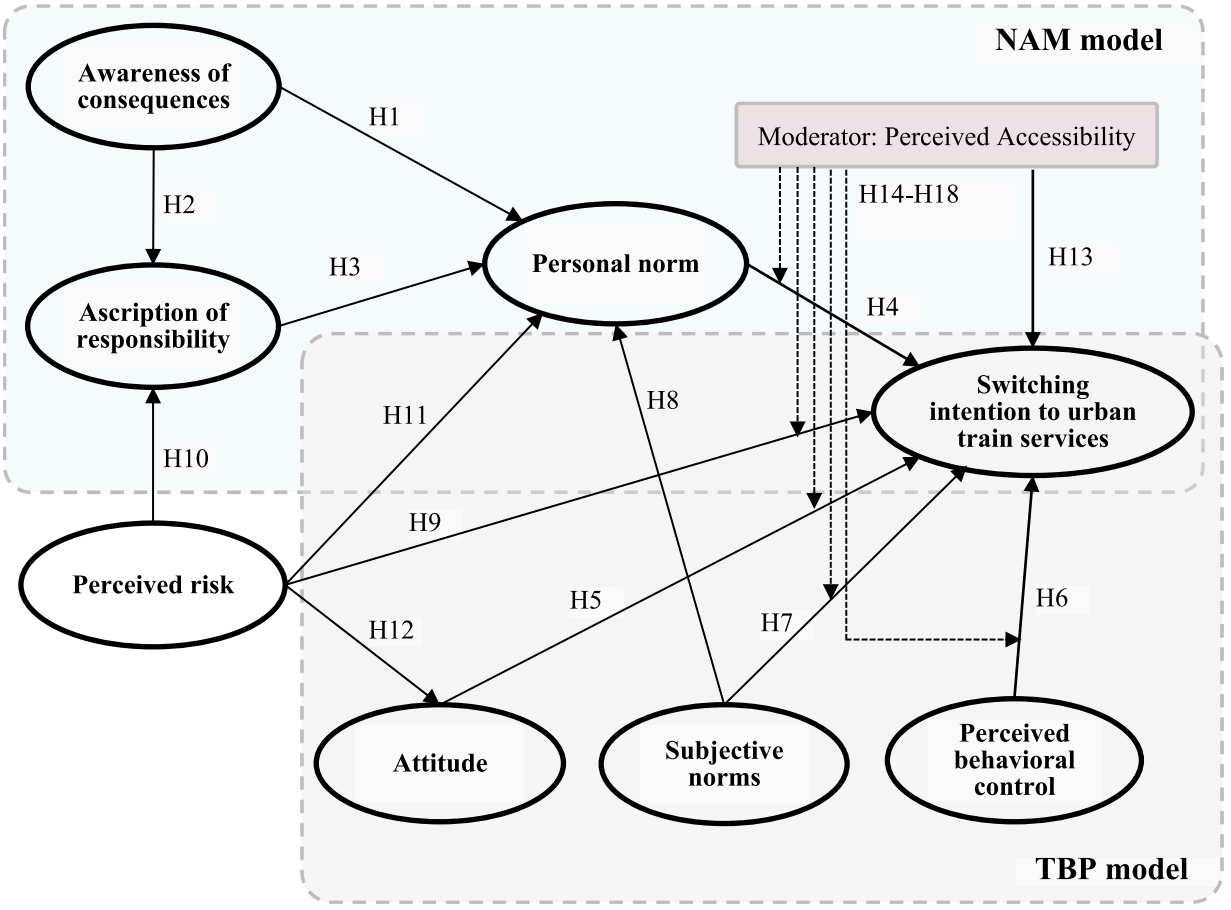

Fig. 2. Proposed conceptual model.

combines the NAM, the TPB, and social marketing, suggesting that PEA can influence intentions through both PEN and PBC. This framework can be extended to the context of urban train services, emphasizing how PEA shapes PEN and PBC. Furthermore, perceived risk can deter individuals from adopting more sustainable travel options. Wang et al. (2019) investigated the willingness to engage in ride-sharing and found that while perceived value positively affects willingness, perceived risk negatively impacts it. Based on such insights, improved PEA might moderate the relationship between perceived risk and the intention to switch to this transport mode. Individuals who perceive urban train services as accessible are likely to perceive less risk, thus fostering more favorable intentions to use trains. By elucidating the moderating role of PEA, this research aims to provide a comprehensive framework that captures the multifaceted influences that shape individuals' intentions. Hence, the following hypotheses are posited:

H14: PEA moderates the relationship between PEN and switching intention to urban train services
H15: PEA moderates the relationship between PER and switching intention to urban train services
H16: PEA moderates the relationship between ATT and switching intention to urban train services
H17: PEA moderates the relationship between SUN and switching intention to urban train services
H18: PEA moderates the relationship between PBC and switching intention to urban train services

The proposed model was illustrated in Fig. 2, where continuous arrows denoted direct effects, and dotted arrows represented moderating effects.

4. Methodology

4.1. Questionnaire design

The survey data were obtained through a structured questionnaire divided into three sections. The introduction at the beginning outlined the research scope and objectives. The second part included measurement items for latent constructs within the theoretical framework (refer to Fig. 1), which were adapted from relevant previous studies to ensure content validity (Table A1). Specifically, three constructs from the Norm Activation Model (NAM), including awareness of consequences (AWC), ascription of responsibility (ASR), and personal norm (PEN), were measured using eight items adapted from the studies by Huang et al. (2020), Abrahamse et al. (2009), and De Groot & Steg (2007). The three constructs from the Theory of Planned Behavior (TPB) were assessed through ten items adapted from Dirgahayani and Sutanto, 2020; Bamberg et al., 2003, and Liu et al. (2017). Perceived risk was evaluated using four items, while perceived accessibility was measured with three items adapted from Chowdhury et al. (2016), Cheng and Chen (2015), and Brons et al. (2009). Finally, switching intention was gauged using three statements adapted from Wang et al. (2021) and Nguyen-Phuoc et al. (2023).

A 7-point Likert scale (ranging from 1 = "strongly disagree" to 7 = "strongly agree") was utilized to assess the indicators. The final section collected background information on respondents, including gender, age, educational level, occupation and income. The questionnaire was initially created in English and subsequently translated into Vietnamese to gather feedback from five transport experts. The revised version addressed wording and semantic issues and adjusted the questionnaire structure based on the received feedback. Before conducting the main survey, pilot tests involving 30 undergraduate students and five urban rail passengers were conducted to assess the questionnaire's validity and reliability.

4.2. Data collection

Data collection took place through a self-administered questionnaire over a two-week period in January 2024 in Hanoi city, the capital of Vietnam, where the urban rail line 2A commenced commercial operations in November 2021. Despite other routes being in pilot operation in Hanoi and Ho Chi Minh City, route 2A stands as the sole urban rail line in Vietnam, spanning 13.5 km with 12 modern stations and convenient interchanges with bus services, BRT, and interregional coaches (Tuong, 2024). Operating at an average commercial speed of 35 km/h, the urban rail service proves to be an efficient solution to alleviate traffic congestion, particularly during peak hours in the 9-million-inhabitant megacity.

Six undergraduate students were recruited to conduct face-to-face surveys at strategic locations, including areas near train stations and popular gathering spots such as bus terminals, parks, and supermarkets. Before beginning their fieldwork, the survey teams participated in a comprehensive training session led by the research team. This training was designed to ensure that the students fully understood the study's objectives, the importance of accurate data collection, and the proper procedures for administering the survey. Participants were randomly selected from among passersby and were invited to take part in the survey if they confirmed that they rarely or never used the urban train system. This selection criterion was crucial, as the study focused on understanding factors influencing the intention to switch to urban train services. Surveys were conducted during both peak and off-peak hours, spanning weekdays and weekends, to capture a diverse range of responses.

Each participant who agreed to take part in the study was given a pen and a paper-based questionnaire to fill out. The research assistants remained on hand to answer any questions and assist as needed. For participants who had difficulty reading or writing, such as elderly individuals, the research assistants read the questions aloud and recorded the participants' responses. This approach ensured inclusivity and accuracy in data collection. Upon completion, the research assistants collected the questionnaires. Participants were thanked for their time and effort with a small token of appreciation—a prepaid mobile phone card valued at approximately USD $1. According to the research assistants, about one in five people invited to participate agreed to take the survey. Ultimately, 551

questionnaires were gathered. After a careful review to remove any incomplete or unreliable responses, such as those with consistent answers across a large number of consecutive questions, the final sample consisted of 535 valid responses, which were then used for further analysis.

4.3. Descriptive statistics

The demographic profile of survey participants is presented in Table 1. Gender distribution reveals a near-even split, with 48.2% male and 51.8% female participants. Education levels vary, with 3.7% completing middle school, 29.2% achieving high school education, 15.0% attending college, and the majority (43.7%) possessing a university degree. The mean age of participants stands at 40.33 years, with a standard deviation of 16.28. Regarding marital status, 68.6% of participants are married, while 31.4% are single. Monthly income distribution illustrates diversity, with 18.5% earning below 5 million VND, 20.4% earning between 5 to less than 10 million VND, 26.9% earning between 10 to less than 15 million VND, and 34.2% earning 15 million VND and higher. Diverse job types are represented, with 67.1% employed full-time and 2.1% working part-time. Additionally, 18.1% identify as students, 7.7% as retired, and 5.0% are engaged in other occupations. This rich dataset lays the foundation for in-depth analyses, enabling a nuanced understanding of the study's participants. Table A2 displays the outcome of the chi-squared test, which aimed to compare the gender and age distribution between the sample and the Hanoi population as per the 2019 Census. The test results indicate that the sample accurately represents the broader Hanoi population.

4.4. Data analysis

The study utilized the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique to evaluate the fit of the data with the proposed conceptual framework and to validate the research hypotheses. PLS-SEM was selected due to its suitability for testing complex extensions of established theories involving numerous constructs and links (Hair et al., 2019). Its effectiveness and reliability persist even with small sample sizes or a lack of normal data distribution (Akter et al., 2017). However, traditional fit indices like Root Mean Square Error of Approximation (RMSEA) or Comparative Fit Index (CFI) are not applicable in PLS-SEM. Instead, PLS-SEM focuses on maximizing the explained variance in the dependent variables, which aligns with its exploratory and predictive nature. The absence of traditional fit indices in PLS-SEM is often viewed as a limitation because it makes it more challenging to assess the overall fit of the model in the same way as with Covariance-Based SEM (CB-SEM). The primary fit index used in PLS-SEM is the Standardized Root Mean Square Residual (SRMR), which provides an approximate measure of the model fit. While PLS-SEM is powerful for exploratory research, the results should be interpreted cautiously, considering potential limitations in model fit and parameter accuracy. Future studies could benefit from combining PLS-SEM with other techniques to ensure more robust conclusions. Currently, PLS-SEM's increasing use in the transport sector has been evident for the last decade (Mandhani et al., 2020; Su et al., 2023).

In this study, three analytical techniques were employed to assess and interpret the structural relationships within the developed model, following the guidelines of Hair et al. (2017). The evaluation of measurement models focused on internal consistency reliability, convergent validity, and discriminant validity. Internal consistency reliability was assessed using the outer loadings of the constructs' measurement items, along with Composite Reliability and Cronbach's Alpha values. Convergent validity was determined by examining the Average Variance Extracted (AVE) values, while discriminant validity was evaluated using the Heterotrait-Monotrait (HTMT) ratio. The evaluation of the structural model involved analyzing path coefficients, including direct, indirect, and total effects, to assess the strength, direction, and significance of the relationships between latent constructs, as well as the model's explanatory and predictive power. Additionally, a moderation analysis was conducted to assess interaction effects, examining how the strength or direction of the relationship between two constructs varies depending on the level of a moderator. SmartPLS 4.1 was utilized to evaluate the measurement model, analyze the structural equation model, and conduct the moderation analysis. The subsequent sections present the outcomes of these analytical steps.

Table 1
Demographic profile of survey participants.

	n	**%**		***n***	**%**
Gender			*Level of education*		
Male	258	48.2	Middle school	20	3.7
Female	277	51.8	High school	156	29.2
Age			College	80	15.0
Mean (Standard Deviation)	40.33 (16.28)		University	234	43.7
Marital status			Above university	45	8.4
Single	168	31.4	*Job type*		
Married	367	68.6	Full-time	359	67.1
Monthly income (million VND)*			Part-time	11	2.1
< 5	99	18.5	Students	97	18.1
5 − <10	109	20.4	Retired	41	7.7
10 − <15	144	26.9	Others	27	5.0
15 and higher	183	34.2			

Note: *1 USD=24,500VND.

5. Results

5.1. Measurement model evaluation

All constructs in this study were considered reflective constructs, and their evaluation followed the reflective measurement model procedure, as per the approach outlined by (Hair et al. 2021). This examination encompasses three crucial aspects: internal consistency reliability, convergent validity, and discriminant validity.

The outer loadings of constructs' measurement items were examined, and the findings revealed a range from 0.712 to 0.949 (Table 2). These outer loadings surpassed the recommended threshold of 0.708, indicating a satisfactory relationship between the measurement items and their respective latent variables. Internal consistency reliability, assessed using Cronbach's Alpha (CA), Composite Reliability (rho_a & rho_c), exceeded the benchmark of 0.7 for all latent variables. This implies that the measurement items consistently measure the underlying constructs, ensuring acceptable internal consistency for each latent variable.

Convergent validity was then assessed using the Average Variance Extracted (AVE) value, with a minimum required threshold of 0.5. AVE evaluates the proportion of variance captured by the latent construct relative to the variance attributed to measurement error, providing evidence of effective convergence between each latent variable and its indicators. The results indicated that all latent constructs met this criterion, confirming their convergent validity. In summary, the assessments affirm the suitability of the modified measurement items and the robustness of the overall measurement model structure.

Ultimately, the examination includes an evaluation of discriminant via the Heterotrait-Monotrait (HTMT) ratio. This ratio is determined by contrasting correlations across distinct constructs (heterotrait correlations) with correlations within the same construct (monotrait correlations). The outcomes presented in Table 3 demonstrate that all HTMT ratio values (ranging from 0.051 to 0.605) fall below the threshold of 0.85, as recommended by Henseler et al. (2015), thereby satisfying the criterion for discriminant validity. Consequently, the measurement model employed in this study aligns with well-established standards for reliability and validity.

Table 2
The evaluation of the first-order model.

Latent constructs	Items	Loadings	CA	CR (rho_a)	CR (rho_c)	AVE
Awareness of Consequences	**AWC**		0.831	0.832	0.922	0.855
(AWC)	AWC1	0.921				
	AWC2	0.929				
Ascription of Responsibility	**ASR**		0.821	0.822	0.894	0.738
(ASR)	ASR1	0.814				
	ASR2	0.874				
	ASR3	0.887				
Personal Norm	**PEN**		0.717	0.720	0.840	0.637
(PEN)	PEN1	0.801				
	PEN2	0.793				
	PEN3	0.800				
Perceived Behavioral Control	**PBC**		0.872	0.926	0.919	0.791
(PBC)	PBC1	0.910				
	PBC2	0.851				
	PBC3	0.905				
Attitude	**ATT**		0.896	0.905	0.935	0.828
(ATT)	ATT1	0.916				
	ATT2	0.916				
	ATT3	0.897				
Subjective Norms	**SUN**		0.935	0.937	0.954	0.837
(SUN)	SUN1	0.871				
	SUN2	0.923				
	SUN3	0.949				
	SUN4	0.916				
Perceived Risk	**PRI**		0.875	1.416	0.879	0.646
(PER)	PRI1	0.921				
	PRI2	0.786				
	PRI3	0.751				
	PRI4	0.744				
Perceived Accessibility	**PEA**		0.795	0.872	0.867	0.688
(PEA)	PEA1	0.712				
	PEA2	0.883				
	PEA3	0.881				
Swiching Intention to Urban Train Services	**SWI**		0.901	0.902	0.938	0.835
(SWI)	SWI1	0.908				
	SWI2	0.941				
	SWI3	0.891				

Table 3
Heterotrait-Monotrait ratio results.

Variables	PEA	ASR	ATT	AWC	PBC	PER	PEN	SUN	SWI
PEA									
ASR	0.055								
ATT	0.051	0.384							
AWC	0.051	0.605	0.501						
PBC	0.137	0.156	0.416	0.381					
PER	0.078	0.077	0.126	0.082	0.090				
PEN	0.098	0.573	0.503	0.409	0.069	0.104			
SUN	0.093	0.260	0.539	0.330	0.107	0.126	0.468		
SWI	0.116	0.129	0.334	0.184	0.066	0.067	0.393	0.361	

5.2. Structural model evaluation

5.2.1. Direct effects

The table presents the direct effects among latent constructs in the study, including their coefficients (ß), standard deviations (SD), *t*-values, *p*-values, and the support for each hypothesis. Notably, each hypothesis corresponds to a specific relationship between two constructs. Table 4 illustrates that eight out of 13 proposed hypotheses (i.e., H2, H3, H4, H5, H7, H8, H12 and H13) receive positive support at the 1% and 5% significance level. Concerning the correlation between switching intention (SWI) and its influencing factors, it is observed that subjective norms (SUN) exhibits the most substantial impact on SWI ($ß_{SUN \rightarrow SWI} = 0.213$, $p < 0.001$), followed by personal norm (PEN) ($ß_{PEN \rightarrow SWI} = 0.181$, $p < 0.001$) and attitude (ATT) ($ß_{ATT \rightarrow SWI} = 0.135$, $p < 0.015$). Additionally, perceived accessibility (PEA) exhibits a statistically significant positive influence on SWI ($ß_{PEA \rightarrow SWI} = 0.131$, $p < 0.010$).

5.2.2. Indirect effects

A bootstrapping test, as recommended by Zhao et al. (2010), is employed to investigate the mediating effect of personal norm (PEN), ascription of responsibility (ASR) and attitude (ATT) in the associations among the studied constructs. Table 5 presents the outcomes of six indirect paths encompassing path coefficient values, standard deviations (SD), t-values and p-values. Three out of four indirect path associations are found to be empirically supported at a significance level of 1%. The findings also suggest that PEN operates as a mediator in the link between ASR and SWI ($ß'_{ASR \rightarrow PEN \rightarrow SWI} = 0.064$, $t = 3.615$, $p < 0.001$) as well as between SUN and SWI ($ß'_{SUN \rightarrow PEN \rightarrow SWI} = 0.052$, $t = 3.205$, $p < 0.001$). Furthermore, the mediating role of ASR in the connection between AWC and SWI is also affirmed ($ß'_{AWC \rightarrow ASR \rightarrow SWI} = 0.032$, $t = 3.383$, $p < 0.001$).

5.2.3. Total effects

The total effects of various latent constructs on SWI are presented in Table 6. Notably, SUN exerts the most significant influence on SWI ($ß_{SUN \rightarrow SWI} = 0.135$, followed by PEN ($ß_{PEN \rightarrow SWI} = 0.181$), ATT ($ß_{ATT \rightarrow SWI} = 0.135$) and PEA ($ß_{PEA \rightarrow SWI} = 0.131$). Conversely, AWC emerges as the least significant influential determinant of SWI ($ß_{AWC \rightarrow SWI} = 0.043$). PBC and PER are determined to have no significant impact on SWI.

5.2.4. Predictive capability evaluation

The coefficient of determination (R^2) and the Stone-Geisser Q^2 (cross-validated redundancy) are two criteria commonly used to assess the predictive capability of an SEM model. Following the guideline proposed by Chin (1998), R^2 values of 0.67, 0.33, and 0.19 for endogenous constructs are considered substantial, moderate, and weak, respectively. Thus, the R^2 value of SWI, which is reported as 0.211, suggests a weak level of predictive accuracy. Following the Blindfolding test in SmartPLS 4.1, Q^2 values are greater than 0,

Table 4
Direct effects.

Direct effects	ß	SD	*t*-value	*p*-value	Support
H1: AWC→PEN	0.063^{ns}	0.045	1.392	0.164	No
H2: AWC→ASR	0.496^{***}	0.038	13.122	<0.001	Yes
H3: ASR→PEN	0.353^{***}	0.050	7.029	<0.001	Yes
H4: PEN→SWI	0.181^{***}	0.047	3.893	<0.001	Yes
H5: ATT→SWI	0.135^{**}	0.055	2.434	0.015	Yes
H6: PBC→SWI	-0.017^{ns}	0.048	0.348	0.728	No
H7: SUN→SWI	0.213^{***}	0.047	4.521	<0.001	Yes
H8: SUN→PEN	0.287^{***}	0.041	6.985	<0.001	Yes
H9: PER→SWI	0.010^{ns}	0.047	0.205	0.838	No
H10: PER→ASR	-0.028^{ns}	0.052	0.538	0.590	No
H11: PER→PEN	0.010^{ns}	0.060	0.168	0.867	No
H12: PER→ATT	-0.141^{**}	0.066	2.123	0.034	Yes
H13: PEA→SWI	0.131^{***}	0.051	2.565	0.010	Yes

Notes: *** $p < 0.01$, ** $p < 0.05$, ^{ns} non-significant.

Table 5
Indirect effects.

Indirect effects	ß'	SD	*t*-value	*p*-value
ASR→PEN→SWI	0.064***	0.018	3.615	<0.001
AWC→PEN→SWI	0.010ns	0.009	1.275	0.203
AWC→ASR→SWI	0.032***	0.009	3.383	<0.001
PER→PEN→SWI	0.002ns	0.011	0.161	0.872
PER→ATT→SWI	−0.019ns	0.012	1.616	0.106
SUN→PEN→SWI	0.052***	0.016	3.205	<0.001

Notes: ns non-significant, *** $p < 0.01$, ** $p < 0.05$.

Table 6
Total effects.

Total effects	ß	SD	*t*-value	*p*-value
SUN→SWI	0.265***	0.047	5.674	<0.001
PEN→SWI	0.181***	0.047	3.893	<0.001
ATT→SWI	0.135**	0.055	2.434	0.015
PEA→SWI	0.131***	0.051	2.565	0.009
ASR→SWI	0.064***	0.018	3.615	<0.001
AWC→SWI	0.043***	0.013	3.323	0.001
PBC→SWI	−0.017ns	0.048	0.348	0.728
PER→SWI	−0.009ns	0.051	0.185	0.853

Notes: ns non-significant, *** $p < 0.01$, ** $p < 0.05$.

indicating the model's capacity for predictive relevance. Hair et al. (2016) suggest that Q^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large levels of predictive relevance, respectively, for a specific endogenous variable. Specifically, the Q^2 value for SWI is determined to be 0.167, surpassing the threshold of 0.15, thus confirming a medium predictive relevance for this endogenous latent construct. Consequently, based on R^2 and Q^2 value, it can be concluded that the suggested model possesses sufficient predictive capability (See Table 7).

5.3. Moderation effect

This current research examines the moderating influence of perceived accessibility (PEA) to urban train services on the link between PEN, PER, ATT, SUN, PBC and SWI. Table 8 reveals that a significant negative moderating effect of PEA on the relationship between ATT and SWI (ß = −0.164, t = 2.555, p = 0.011) has been confirmed, supporting hypothesis H16. This indicates that the positive correlation between ATT and SWI weakens and reverses as the level of PEA increases. Moreover, the interaction plotted in Fig. 3 demonstrates that the positive relationship between ATT and SWI is more pronounced at lower levels of PEA (simple slope = 0.135), while the negative relationship is confirmed at higher levels of PEA (simple slope = -0.029).

Additionally, the inclusion of the moderating effect increases the value of R^2 for SWI from 17.3 % to 21.1 %. Considering the f^2 impact magnitude of the moderating effect, Hair et al. (2021) suggest that a value of 0.020 indicates a medium moderation effect of PEA on the link between ATT and SWI. This is in line with Kenny (2018) standards for small, medium, and large impact sizes of moderation (0.005, 0.01, and 0.025, respectively).

6. Discussion

The current study presents a comprehensive framework to explore the factors influencing individuals' intention to switch to urban train services in a low- and middle-income country where motorcycle dominates the traffic flow. By integrating the Norm Activation Model (NAM), the Theory of Planned Behavior (TPB), and perceived risk, this research places a particular emphasis on the critical role of perceived accessibility. Perceived accessibility, which reflects how easy and convenient individuals find using a transport system to lead a satisfactory life, is highlighted for its significant direct and moderating effects on the intention to use urban train services. Incorporating perceived accessibility into the developed model allows for a deeper examination of the interactions between various factors influencing the adoption of urban train systems. This inclusion helps in identifying which factors – whether personal, social, or

Table 7
Predictive capability.

Constructs	R^2	Q^2
Ascription of Responsibility	0.250	0.182
Attitude	0.020	0.015
Personal Norm	0.288	0.176
Switching Intention	0.211	0.167

Table 8
Moderating effects of perceived accessibility.

Path	Coefficient (ß)	Standard Deviation	*t*-value	*p*-value	f^2
H_{14}: (PEN* PEA) → SWI	0.027^{ns}	0.053	0.514	0.607	0.001
H_{15}: (PER* PEA) → SWI	-0.051^{ns}	0.045	1.137	0.256	0.004
H_{16}: (ATT* PEA) → SWI	-0.164^{**}	0.064	2.555	0.011	0.020
H_{17}: (SUN* PEA) → SWI	-0.046^{ns}	0.055	0.834	0.404	0.002
H_{18}: (PBC* PEA) → SWI	-0.028^{ns}	0.049	0.570	0.569	0.001

Notes: ** $p < 0.05$, ^{ns} non-significant.

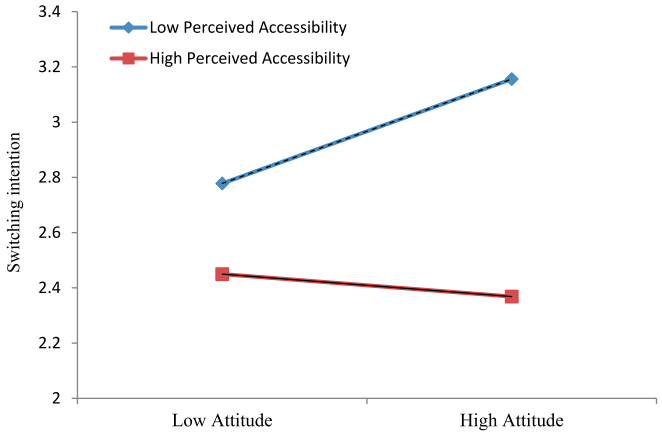

Fig. 3. Moderating effect of perceived accessibility.

contextual – are more influential and should be targeted for effective intervention. This approach not only enhances the model's comprehensiveness but also provides valuable insights for designing tailored strategies that address the most significant barriers and motivators for adopting urban train systems.

6.1. *Theoretical implications*

The research model's hypotheses about direct effects were tested, except for H1 (the link between awareness of consequences and personal norm), H6 (the link between perceived behavioral control and switching intention), H9 (the relationship between perceived risk and switching intention), H10 (the relationship between perceived risk and ascription of responsibility), and H11 (the link between perceived risk and personal norm). Additionally, except for H16, which confirmed the moderating role of perceived accessibility on the relationship between attitude and switching intention, the other hypotheses regarding the moderating effects of perceived accessibility were not supported by the findings. This highlights the complexity of factors influencing the decision to switch to urban train systems, indicating that while some relationships are strongly supported, others may be influenced by variables not captured in the current framework, reflecting the multifaceted nature of transport choices.

The findings of this study enhance the research on urban train adoption by merging the TPB and the NAM to investigate the determinants of switching intention to urban train systems. This research extends beyond previous studies that have examined NAM and TPB factors in isolation, such as those by Zhang et al. (2013) focusing on NAM factors and those by Liao et al. (2023) and Nguyen et al. (2023) on TPB factors. Importantly, Ma et al. (2022) and Sheng and Zhang (2022) have called for more explorations into the combined TPB and NAM framework concerning the adoption intention of PT, based on their limited previous attempts. For example, Ma et al. (2022) infused personal norms within the TPB context and assessed their impact in relation to public trust. Additionally, Sheng and Zhang (2022) combined TPB and NAM factors but specifically through the lens of awareness of consequences and personal norm, whereas the current study adds perceived risk and perceived accessibility to the integration.

Despite its critical role in facilitating access to activities and opportunities within the urban train context, perceived accessibility has rarely been investigated from a user-centered perspective in relation to the intention to use public transport (Cheng and Chen (2015)). Although some studies have explored how perceptions of accessibility predict transport use (Lättman et al., 2018; Olfindo, 2021), its role as a moderating factor has been largely overlooked. This study advances the literature on public transport (PT) usage by introducing perceived accessibility as both an antecedent (H13) and a moderating mechanism (H14 - H18) within the integrated TPB-NAM model. The findings reveal that perceived accessibility significantly predicts the intention to switch to urban train systems (H13) and acts as a moderator that strengthens the positive relationship between attitude and the intention to switch (H16). This underscores the importance of considering perceived accessibility not only as a key factor influencing transport choices but also as a crucial moderator in theories related to PT usage. By highlighting these roles, the study provides a more nuanced understanding of how

perceived accessibility impacts commuter behavior and offers valuable insights for designing strategies to enhance the adoption of urban train services.

A key insight from the study's findings reveals a complex relationship where perceived accessibility significantly moderates the impact of attitudes toward urban train services on the intention to switch. It highlights that even in areas with high accessibility, individuals may not show a stronger intention to switch despite positive attitudes. This suggests that merely enhancing attitudes or accessibility might not be sufficient to transition behavior from private vehicle use to train systems. In regions where train services are highly accessible, these areas are often also high-income neighborhoods where the comfort and convenience of private cars are readily available. This accessibility to private vehicles may reduce the appeal of trains, even among individuals with positive attitudes toward public transport. High-income areas have generally higher accessibility in the global south countries such as Colombia (Guzman et al. 2017). In contrast, in regions where train services are less accessible, positive attitudes toward train systems tend to have a more substantial influence on the intention to switch. Individuals who hold favorable views of urban trains may be more willing to transition, driven by a desire for better mobility options, environmental concerns, or the recognition of long-term benefits associated with urban train use. This indicates that in lower-accessibility areas, attitudes can be a powerful lever for change, particularly if accompanied by incremental improvements in accessibility. This approach should address the broader barriers, tailoring strategies to the specific needs and perceptions of different community segments to effectively encourage the adoption of sustainable transport habits.

The present investigation found no support for the hypotheses concerning the moderating effects of perceived accessibility on the impacts of personal norm (H14), perceived risk (H15), subjective norms (H17), and perceived behavioral control (H19) on the intention to switch. Possible explanations for these nonsignificant results are as follows: Personal norm relates to individuals' self-expectations linked to their values (Pires et al., 2019), and subjective norms reflect the perceived social pressure to engage in behavior (Ajzen, 1991). As these norms exert strong intrinsic and extrinsic forces, respectively, which drive behavior, individuals with such strong motivational forces may be less influenced by an external factor like perceived accessibility. Consequently, the influences of personal norm (H14) and subjective norms (H17) on the intention to switch are minimally affected by perceived accessibility. Furthermore, because the effects of perceived behavioral control and perceived risk on the intention to switch are weak (nonsignificant) in this study ($\beta = -0.017$, p-value $= 0.728$; $\beta = 0.010$, p-value $= 0.838$, respectively), perceived accessibility does not exert a force strong enough to render these effects significant. These discussions offer potential explanations for the unsupported hypotheses H14, H15, H17, and H19. The overall theoretical implication is that perceived accessibility's role in influencing PT usage may be more limited than expected, especially when it comes to interacting with established intrinsic motivations like personal norms and extrinsic motivations like subjective norms. This suggests that the foundational elements of behavior change models, such as the TPB, may operate independently of contextual factors like accessibility. Consequently, this calls for a reassessment of how external factors are integrated into behavioral models and highlights the resilience of personal and social norms in the face of varying external conditions.

Results from the present investigation also demonstrated findings similar to those of previous research. Primarily, we observed a positive relationship between subjective norms and personal norm (H8), which finds parallels in the work of Ma et al. (2022) and Sheng and Zhang (2022). In alignment with the NAM framework, the study reveals a sequence starting from awareness of consequences, moving through ascription of responsibility and personal norm, and culminating in the intention to switch to urban train systems. This progression is in harmony with the findings of Nordfjærn and Rundmo (2019) and Sheng and Zhang (2022), supporting the hypotheses of the sequential path (H2: awareness of consequences → ascription of responsibility; H3: ascription of responsibility → personal norm; H4: personal norm → switching intention). However, unlike previous research (Kim et al., 2018; Singh et al. 2023; Zhang et al., 2016), which reported a positive link between awareness of consequences and personal norm, this connection (H1) is not corroborated in our study. Jakovcevic and Steg (2013) suggest that a personal norm is developed when individuals recognize that their lack of pro-environmental or pro-social action will result in negative outcomes for the environment or society, and they believe that their actions can mitigate these effects. Thus, a personal norm may not be triggered merely by awareness of the adverse social or environmental consequences of not switching to urban train systems. The theoretical implication is that frameworks for promoting urban train system adoption must blend awareness-raising with the cultivation of personal responsibility and efficacy. This suggests a nuanced approach in behavior change theories, emphasizing the interplay between cognitive awareness and motivational factors in fostering sustainable transport behaviors.

Findings regarding the positive impacts of attitude (H5) and subjective norms (H7) on the intention to switch align with previous TPB-based studies on PT use (e.g., Nguyen-Phuoc et al., 2022a; Sheng & Zhang, 2022). Particularly, the strongest total effect of subjective norms on the intention to switch to urban train systems reflects the deeply rooted cultural values of collectivism and social conformity in Vietnam (Lin et al. 2020). Unlike in many Western countries, where individualism and personal preference often drive decision-making (Hofstede, 2001), Vietnamese society places significant emphasis on community orientation and the influence of social networks. In this context, the behavior and opinions of peers, family, and community leaders can strongly sway an individual's choices, including their willingness to switch to new transport modes. This contrasts with findings from Western countries, where subjective norms tend to have a more moderate impact on transport decisions, with personal attitudes and perceived control often playing a more dominant role. The pronounced influence of subjective norms in Vietnam highlights the importance of aligning public transport initiatives with societal values and community expectations, suggesting that campaigns promoting urban train usage might be more effective if they emphasize social approval and collective benefits rather than just individual convenience or environmental impact. This cultural distinction underscores the need for tailored strategies that account for the unique social dynamics in different regions when promoting sustainable transport options.

However, while previous studies confirmed a positive relationship between perceived behavioral control and the intention to use PT, our study does not find evidence to support this relationship (H6). Schniederjans and Starkey (2014) suggest that the translation of perceived behavioral control into intention depends on individuals' awareness of the implications of transport means for social or

environmental sustainability. Given that passengers may not fully understand the significance of PT in mitigating environmental impacts compared to other eco-friendly practices, such as energy conservation and recycling, they might be less inclined to develop the intention to switch, even if they possess the necessary resources and ability to do so. The findings imply a refined application of the TPB in PT adoption, emphasizing that the impact of perceived behavioral control on intentions may hinge on awareness of public transport's environmental benefits. This underscores the importance of integrating sustainability awareness into TPB-based interventions to enhance their effectiveness in encouraging PT use.

Perceived risk was incorporated into the TPB-NAM model to enhance its explanatory power. This addition responds to Wang et al. (2024)'s call for more research into the role of perceived risk in changing travel modes and augments prior studies that seldom considered perceived risk in models of transport mode usage (Nguyen-Phuoc et al., 2022a), despite its significance (Rundmo et al., 2011; Rod et al., 2023). Specifically, our research found a negative influence of perceived risk on attitude (H12), diverging from Nguyen-Phuoc et al. (2022a), which reported no significant relationship between these two variables. However, our study did not find evidence of a negative impact of perceived risk on the intention to switch to urban train services (H9), contrasting with Featherman et al. (2021) and Nguyen-Phuoc et al. (2022a), who observed a negative effect. Moreover, we found no significant negative impact of perceived risk on the ascription of responsibility (H10) or personal norm (H11). These nonsignificant findings could be due to the possibility that while passengers perceive risks, these may not influence them if they feel a sense of obligation and responsibility to switch to urban train systems for the mitigation of environmental and social issues associated with the use of private vehicles. In essence, perceived risk may not have a significant negative influence on switching intention, ascription of responsibility, or personal norm, which includes moral obligation (H9, H10, H11, respectively).

6.2. *Practical implications*

Perceived accessibility is recognized as the most challenging dimension to measure, as it can be influenced by a variety of factors, including socio-demographic characteristics and environmental awareness (Cheng et al., 2015). Expanding network coverage is recognized as critical and should be prioritized in the short term to increase perceived accessibility to urban train services, as suggested by Cheng et al. (2015). However, in low- and middle-income countries like Vietnam, such expansion tends to be a long-term solution due to the high investment required. Consequently, measures focusing on the journey from origins to train stations might be more practical. For instance, developing comprehensive park-and-ride systems would allow motorcycle users to transition more easily to trains for their city commutes (Dtinews, 2021). This would not only improve access but also help reduce inner-city congestion and pollution caused by motorcycles. Additionally, implementing integrated ticketing systems could simplify the switch from motorcycles to trains, especially if combined with incentives like discounted fares for former motorcycle users or a rewards system for frequent train usage (VietNamNet, 2023). Enhancing digital tools by developing a mobile app compatible with smartphones and other devices could further assist passengers in checking train statuses, estimating travel times, locating train stations, and providing updates on possible delays (Cheng et al., 2015). Recent literature has increasingly focused on incorporating such features into mobility apps to promote positive changes in travel behavior (Casquero et al., 2022). By making the benefits of train travel more visible and the switch more seamless, the perceived accessibility toward urban train services could increase, potentially making the habitual use of motorcycles less appealing for urban commuting.

The findings of this study reveal a significant negative moderating effect of perceived accessibility on the relationship between individuals' attitudes toward urban train services and their intention to switch to such services. This has crucial practical implications for policymakers and urban planners aiming to promote the switching intention of urban train services. To effectively encourage a modal shift from private vehicles to urban train services, strategies should be tailored to the specific characteristics of different areas. In regions with low accessibility, awareness campaigns and incentives could boost positive attitudes toward PT, encouraging the switching intention despite existing limitations. In contrast, in high-accessibility areas where positive attitudes do not necessarily translate into higher usage, strategies should focus on enhancing the overall user experience, offering behavioral incentives, and engaging communities in service improvements to make PT more appealing compared to private vehicles.

Subjective norms, highlighted as the most potent driver for choosing urban train services, underscore the social influences on individual behavior. The current study reveals that subjective norms significantly impact users' intentions to switch, suggesting that when people perceive that important others favor the use of urban trains, they are more likely to do so themselves. To fortify these norms, transport authorities could collaborate with local businesses and institutions to create a 'commuter club' offering benefits to employees or students who travel by trains (Heath and Gifford 2002). Featuring local personalities in promotional material who share their positive experiences with urban transit can also help in shaping community attitudes. Additionally, this study points to the potential of PT providers to create and enhance social opportunities through PT, which could foster a sense of community and make urban spaces more cohesive and inclusive.

Personal norms significantly influence the decision to switch to urban train systems, closely intertwined with the impact of subjective norms. To leverage this, introducing incentives that resonate with individuals' values can make the choice of PT not just practical but personally rewarding. For instance, offering fare reductions for off-peak hours encourages travelers to utilize the train system during less congested times, aligning with personal commitments to reduce overcrowding and environmental strain. Similarly, rewards programs that acknowledge and celebrate consistent use of PT – such as monthly passes with decreasing rates for regular users or loyalty points that can be exchanged for free rides – serve to reinforce personal norms around sustainability and community-mindedness. These initiatives not only provide immediate, tangible benefits to commuters but also foster a deeper sense of contribution toward broader environmental goals, making the act of choosing PT a reflection of personal values and a step toward a more sustainable lifestyle. This aligns with the finding from Ben-Elia et al. (2011), who state that if a reward scheme aligns with an

individual's personal norms and expectations, it is more likely to encourage a change in behavior. Additionally, these programs also enhance attitudes toward PT, which has been found to significantly affect the choice to switch to urban train services. This is consistent with Health et al. (2002)'s findings who found that the universal bus pass (U-pass) program encouraged changes in attitudes and beliefs about transport modes, which in turn increased bus ridership. By embedding such incentives within the PT system, authorities can cultivate a culture where sustainable commuting is supported and seen as a rewarding and integral part of community participation.

The finding that awareness of the consequences does not directly strengthen personal norms calls for a layered approach in public education and awareness campaigns, focusing not just on the downsides of personal vehicle use but also on celebrating the positive aspects of choosing PT, like urban trains. Such campaigns could vividly illustrate the lifestyle benefits of using urban train systems, like enjoying leisure time during the commute, avoiding traffic-related stress, and contributing to a cleaner environment. For instance, storytelling could be a powerful tool, featuring real commuters who share how switching to the train has improved their daily life, from reading more books to meeting new people and even lowering their carbon footprint (Brooks et al. 2022). Additionally, interactive online platforms could allow individuals to calculate the personal and environmental benefits of making the switch, such as time saved from traffic, money saved on gas and parking, and reduction in personal CO2 emissions. This positive framing, coupled with tangible examples and actionable insights, can shift the narrative from avoidance of negative outcomes to the pursuit of positive personal and collective benefits, making the choice to use PT more appealing and personally relevant.

Policymakers and service managers need to take these findings into account, recognizing their critical role in crafting and implementing strategies that can materially influence public perceptions and behaviors. They must not only oversee the operational aspects of urban train services but also steer the broader narrative around public transit, emphasizing its role in sustainable urban living.

6.3. Limitations and future research

While providing valuable insights, the study has certain limitations that must be acknowledged. Firstly, the limited sample size may not capture the full diversity of commuter experiences, given the rich and varied nature of human behavior. Particularly, the subjective nature of perceived accessibility may introduce biases in how individuals assess and report their experiences. Consequently, the findings may have limited generalizability to a broader population. Additionally, the context of the study, being situated in Vietnam, presents its own unique set of socio-cultural dynamics. Other geographical locations could present different challenges and behaviors in PT usage, which suggests that findings might differ across various cultural and urban contexts. Secondly, the constructs explored in the research do not encompass the entire spectrum of factors that can influence PT ridership since the human experience is multi-faceted and complex. This means there might be other influential variables that were not accounted for in this study. Lastly, the reliance on self-reported data in the study could introduce vulnerabilities such as bias and recall errors. Respondents' answers may be influenced by their desire to present themselves in a certain way or by their inability to accurately remember past behaviors or attitudes, which can affect the reliability of the data.

Future research could enhance the robustness of these findings by triangulating self-reported perceptions with objective measures of accessibility, providing a more balanced and comprehensive understanding of the factors influencing PT usage. Additionally, these findings suggest a need for research into the long-term efficacy of these norms and attitudes in predicting behavior. It's vital to understand how sustained behavior change can be achieved and what role evolving technologies may play in this. Moreover, with the impact of perceived accessibility (H13) on the intention to switch, future research should explore how infrastructure and information dissemination improvements can further facilitate PT use, especially in the face of rapid urban development and population growth.

7. Conclusion

This study explored the adoption of urban train systems by integrating TPB, NAM, and perceived risk, with a focus on perceived accessibility in Vietnam. The findings revealed that while perceived accessibility is a critical factor influencing the intention to switch to urban train services, it primarily moderates the relationship between attitudes and switching intentions. Other expected moderating effects of perceived accessibility were not supported, underscoring the complexity of factors involved in transport choices. Additionally, certain hypotheses, such as those linking awareness of consequences to personal norms and perceived behavioral control to switching intention, were not supported, suggesting that these factors may be influenced by variables beyond the current model's scope. The study successfully advanced the understanding of how personal, social, and contextual factors interact to shape intentions to switch to urban train systems, expanding the TPB-NAM framework to offer a more comprehensive view of transport behavior. These insights emphasize the need for tailored strategies that address both psychological and contextual elements to effectively promote sustainable urban transportation. Moving forward, policymakers and urban planners should prioritize enhancing perceived accessibility while considering the broader psychological factors that drive transport choices to foster a significant modal shift.

CRediT authorship contribution statement

Duy Quy Nguyen-Phuoc: Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Son Truong Pham:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Thao Phuong Thi Nguyen:** Writing – review & editing, Writing – original draft. **Diep Ngoc Su:** Writing – review & editing, Writing – original draft. **Tuan Trong Luu:** Writing – review & editing, Writing – original draft. **Oscar Oviedo-Trespalacios:** Writing –

review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Table A1
Measurement items.

Constructs	Code	Items	Sources
Awareness of Consequences (AWC)	AWC1	I think that using urban train services contributes to reducing traffic congestion	(Huang et al., 2020)
	AWC2	I think that using urban train services contributes to reducing resource consumption	(Huang et al., 2020)
Ascription of Responsibility (ASR)	ASR1	I feel personally responsible for the problems resulting from private vehicle use	(Abrahamse et al., 2009; De Groot et al. 2007)
	ASR2	I think that my private vehicle use contributes to environmental problems	(Abrahamse et al., 2009; De Groot & Steg, 2007)
	ASR3	I think that my private vehicle use constitutes problems for society	(Abrahamse et al., 2009; De Groot & Steg, 2007)
Personal Norm (PEN)	PEN1	I would become a better person if I consistently used urban train services instead of private vehicles	(Abrahamse et al., 2009; De Groot & Steg, 2007)
	PEN2	I feel guilty about driving/riding my private vehicle to work	(Abrahamse et al., 2009; De Groot & Steg, 2007)
	PEN3	I feel a moral obligation to conserve fossil fuel and protect environment no matter what other people do	(Huang et al., 2020)
Perceived Accessibility * (PEA)	PEA1	I can not use urban train services to reach recreational activities with ease.	(Chowdhury et al., 2016)
	PEA2	I can not use urban train services to reach work and/or education with ease	(Chowdhury et al., 2016)
	PEA3	My train station is not close enough to walk to	(Cheng et al., 2015; Brons et al., 2009)
Perceived Risk (PER)	PER1	I am worried that I could have possibility of contact with infected passengers when using urban train services	(Yıldırım et al., 2021; Zheng et al. 2021)
	PER2	I feel worried that I have possibility to being robbed when using urban train services	(Nguyen-Phuoc et al., 2021; Rundmo and Iversen, 2004
	PER3	I feel worried that I have possibility to become the victim of crime when using urban train services	(Jing et al. (2021))
	PER4	I feel worried about violence (assault) when using the urban train services	(Nguyen-Phuoc et al., 2021; Rundmo & Iversen, 2004)
Perceived Behavioral Control (PBC)	PBC1	I think using urban train services is entirely within my control	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
	PBC2	I think whether to use train services or not is completely depends on me	(Liu et al., 2017)
	PBC3	If I want, I can easily use urban train services	(Liu et al., 2017)
Attitude (ATT)	ATT1	I think using urban train services is a wise move	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
	ATT2	I think using urban train services is a good and positive thing	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
	ATT3	I think using urban train services is very beneficial	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
Subjective Norms (SUN)	SUN1	Most of people in my family think that I should use urban train services	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
	SUN2	Most of my friends and my co-workers think that I should use urban train services	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
	SUN3	Most of the people who are important to me think that I should use urban train services	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)
	SUN4	Most people I respect and admire think that I should use urban train services	(Bamberg et al., 2003; Dirgahayani & Sutanto, 2020)

(*continued on next page*)

Table A1 (*continued*)

Constructs	Code	Items	Sources
Switching Intention to Urban Train Services (SWI)	SWI1	There is a high probability that my transport will change to urban train services when I go to work in the next year	(Wang et al., 2021)
	SWI2	I will decide to change my current means of transport to urban train services in the next year.	(Wang et al., 2021)
	SWI3	I am likely to switch my main transport mode to urban train services in the next year.	(Nguyen-Phuoc et al., 2023)

* Reversed measurement items.

Table A2
Comparison of gender and age ratios between the sample and Hanoi population (2019).

Characteristics		Survey ($n = 535$)		Census		Chi-squared χ^2
		Number of respondents (n)	Proportion (%)	Expected value (n)	Proportion (%)	
Gender	Male	258	48.2	259	49.6	0.0018
	Female	277	51.8	276	50.4	0.0017
Age	16–24	99	18.5	101	18.9	0.0474
	25–34	126	23.6	126	23.6	0.0006
	35–44	104	19.4	106	19.8	0.0371
	45–54	76	14.2	73	13.7	0.1015
	55–64	74	13.8	70	13.1	0.2370
	64+	56	10.5	58	10.9	0.0944
Total		535	100	535	100	

$\chi^2_{Gender}(0.0035) < \chi^2_{Critical}(3.841)$; $\chi^2_{Age}(0.5179) < \chi^2_{Critical}(11.070)$
The level of significance for this test is $\alpha = 0.05$.

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