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Modelling of Passenger Satisfaction and Reuse Intention with Monorail Services in Kuala Lumpur, Malaysia: A Hybrid SEM-ANN Approach

Ahmad Nazrul Hakimi Ibrahim [1,2,3,*], Muhamad Nazri Borhan [1,2,3,*], Muhamad Razuhanafi Mat Yazid [1,2,3], Sitti Asmah Hassan [4], Ahmad Firdhaus Arham [5] and Sharizal Hashim [6]

1 Department of Civil Engineering, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia; razuhanafi@ukm.edu.my
2 Sustainable Urban Transport Research Centre, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia
3 Resilient Advanced Infrastructure & Structure (RAISe), Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia
4 Department of Geotechnics & Transportation, Faculty of Civil Engineering, Universiti Teknologi Malaysia, Skudai 81310, Johor, Malaysia; sasmah@utm.my
5 School of Liberal Studies (CITRA UKM), Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia; benferdaoz@ukm.edu.my
6 Center for Global Business and Digital Economy Studies, Faculty of Economics and Management, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia; hsharizal@ukm.edu.my
* Correspondence: nazrulhakimi@ukm.edu.my (A.N.H.I.); mnazri_borhan@ukm.edu.my (M.N.B.)

Abstract: This study employs the fundamental concept of the American Customer Satisfaction Index (ACSI) model to explore the factors influencing passengers' satisfaction with monorail service in Kuala Lumpur, Malaysia and their reuse intention. The study tests the hypotheses on 417 monorail passengers using a hybrid structural equation modelling based on parameter estimation of partial least squares (PLS-SEM) and an artificial neural network (ANN) method to estimate the proposed model. The results showed that the proposed model explains 70.4% and 59.5% of the variance in passenger satisfaction with the monorail service and reuse intention. The PLS-SEM results for Stage 1 showed that perceived quality and perceived value have a statistically significant influence on passenger satisfaction. Furthermore, all critical factors in the output from Stage 1 were used as the input in the ANN model to overcome the simplistic nature of the SEM model. The results for the ANN model (Stage 2) showed that perceived quality is the most crucial predictor of passenger satisfaction with the monorail service, followed by perceived quality. The outcomes of this study can help service providers, policymakers, and planners develop effective strategies for enhancing user satisfaction and improving monorail ridership.

Keywords: railway; monorail; railway transit; urban transit; hybrid method; sustainable transport

MSC: 68T07; 62P25

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1. Introduction

Sustainable transportation is one of the components of the Sustainable Development Goals (SDGs), particularly Goal 11: Sustainable Cities and Communities. It recognises the significance of creating environmentally friendly, socially inclusive, economically viable and safe transportation systems [1]. Sustainable transportation addresses the negative impacts of conventional transportation systems, such as air pollution, greenhouse gas emissions, traffic congestion, and social inequalities [2,3]. It is a cleaner and more efficient mode of transportation and comprises, among others, public transport, cycling, walking, and electric or hybrid vehicles [4].

Public transport is a critical component of a sustainable agenda. It plays a crucial role in modern societies and is an essential part of the lives of urban and rural dwellers. Many countries, including Malaysia, have been shifting towards limiting dependence on private vehicles by prioritising the development of public transportation networks that focus on, for instance, bus, train, metro or monorail services. The dependency on private transport is the primary factor contributing to congested roads and accidents and environmental, air and noise pollution [5–7]. Even though there are various ways to achieve more sustainable lifestyles, the critical component of these approaches is limiting private vehicle usage by providing effective public transport systems.

Despite the many measures governments implement to develop public transportation services rapidly, the public seems to lack interest in using such facilities. According to Van Lierop et al. [8], in many countries, the use of private vehicles is far higher than public transport usage. Masirin et al. [9] stated that the ridership of railway transit in Kuala Lumpur, Malaysia is still low. Studies in other Asian countries, such as Zulkifli et al. [10], Ibrahim et al. [11,12], and Yusoff et al. [13], yielded similar results. The annual ridership of the Kuala Lumpur monorail service declined by 54.8% from 2013 to 2022 [14]. People are more inclined to use private vehicles, such as cars, because they are faster, more reliable and better-suited for fast-paced lifestyles and provide privacy, flexibility, comfort, convenience and independence [15,16].

The COVID-19 pandemic significantly reduced the ridership of the Kuala Lumpur monorail service to 4,226,329 in 2021 and 7,143,534 in 2022 [14]. The movement restriction, Conditional Movement Control Order (CMCO) and Recovery Movement Control Order (RMCO) implemented by governments across the globe to prevent the spread of the virus transmission during the COVID-19 pandemic had a similar impact on public transport performance in other countries, such as Italy [17], Slovakia [18,19], Thailand [20], Bangladesh [21], and others [22]. The public avoided crowded spaces, including public transport, due to the fear of contracting the illness. Remote working also contributed to reduced usage of public transport [18]. The ridership statistics and reported findings of previous studies revealed that the primary concern in this research area was the low rate of railway ridership.

Therefore, we must develop novel strategies to persuade the public to use railway transit. The ridership of railway transit will increase if the service providers address the current problems concerning retaining existing users while attracting new users. The primary concern is offering efficient, high-quality services that fulfil user expectations and ensure user satisfaction, which convinces them to continue using the railway network services. Users satisfied with the provided services are more likely to continue using the railway transit and recommend it to others [8,16], thus attracting new users and increasing ridership.

Service providers and policymakers must determine the factors influencing user satisfaction and reuse intention before formulating broad-scale measures to increase railway ridership [23]. Researchers have extensively explored the factors influencing user satisfaction with rail-based public transportation services globally. Among others, Yanık et al. [24] and Yilmaz and Ari [25] studied the metro and high-speed rail service in Turkey, Shen et al. [26] reported user satisfaction with the urban rail transit in China, and Lai and Chen [27] conducted a case study on the Kaohsiung Mass Transit (KMRT) in Taiwan. Researchers in Malaysia focused on user satisfaction with rail transit, primarily the commuter service [28–30] and light rail transit [6,31,32].

To the best of the authors' knowledge, there is scarce research in Malaysia on factors affecting railway transit in general and users of monorail services specifically. Previous studies on the monorail service in Malaysia by Das et al. [33] and Ibrahim et al. [34] focused only on the influence of service quality. This gap justifies the present study to determine other factors influencing the user satisfaction and reuse intention of those using monorail service and thus help in ensuring the retention of current monorail users and attracting future users. Therefore, the authors conducted this research to identify the factors influenc-

ing the satisfaction and reuse intention of users of Kuala Lumpur's monorail service using the American Customer Satisfaction Index (ACSI) model, which is widely used to measure customer satisfaction in various industries [35,36], including transportation [26,37,38]. The fundamentals of the study are two well-established theories, the quality, satisfaction, and performance (QSP) paradigm and Hirschman's voice-out theory [39,40]. The model measures the cause-and-effect relationship established from the antecedents of consumer satisfaction (consumer expectations, perceived quality and perceived value) to its effects (behaviour intention such as passenger complaint and reuse intention). Including perceived quality and perceived value in the ACSI model has provided pivotal diagnostic information concerning passenger satisfaction and passenger behavioural intention [41,42].

The remainder of this paper is structured as follows. The Section 2 presents the literature review and proposes the conceptual framework. The Section 3 describes the adopted methodology, which comprises the design of the questionnaire, the data collection process and data analysis. Section 4 presents the case study of the Kuala Lumpur monorail service, Section 5 presents the results of the two stages of the data analysis, and Section 6 discusses the study results. The final section concludes the study.

2. Literature Review and Conceptual Framework

Passenger satisfaction is the user-wide experience with a service compared to their predefined expectations [43]. Since 1990, the adoption of marketing techniques has provided transport researchers with directions and guidance in studying the travel satisfaction factor [41,44]. Researchers have shown increasing interest in passenger satisfaction with travel. Since the beginning of the 21st century, several studies have focused on understanding the factors influencing passengers' satisfaction with public transport [2,37,45–47].

2.1. Passenger Expectations

Previous studies have shown that passenger expectations are one of the antecedents of passenger satisfaction. Customer expectations are shaped by their experience with a product or service provider and the ability of the companies to supply products or services in the future [41,42]. Fornell et al. [41] contended that passenger expectations have a positive and direct relationship with perceived performance, namely service quality, perceived value and passenger satisfaction. Oliver [48,49] supported this view based on the framework of the expectation-uncertainty model, which argues that expectations are one of the critical antecedents in passenger satisfaction.

A review of the transport literature showed that researchers had examined the relationship between passenger expectations and passenger satisfaction. Hussain et al. [50] conducted a case study in the United Arab Emirates (UAE) concerning airline passenger satisfaction and reported that passenger satisfaction was positively and directly determined by their expectations. This finding is similar to that of Fu et al. [51], who conducted a case study of public transport in Suzhou, China. Shen et al. [26] have shown that passenger expectations toward urban rail transit influenced their perceived value and passenger satisfaction. The literature review showed that, in Malaysia, passenger expectations might influence their satisfaction with the monorail service. Therefore, this study proposes the following hypothesis.

Hypothesis 1. *Passenger expectations have a direct positive influence on passengers' satisfaction with the monorail service.*

2.2. Perceived Quality

Another factor which could influence passenger satisfaction is perceived quality. Zeithaml [52] contended that perceived quality shapes perceived value and, by extension, passenger satisfaction, which means there is an indirect relationship between perceived quality and satisfaction through perceived value. Shen et al. [26] have proven this indirect relationship in a case study of city rail transit service in Suzhou, China.

There is ample evidence, especially in the marketing literature, of perceived quality having a strong influence and a direct relationship with consumer satisfaction [53–56]. These findings are in line with the previous studies of rail-based public transport. Lai and Chen [27] conducted a case study on the Kaohsiung Mass Transit (KMRT) in Taiwan and found that quality responses were statistically significant in determining KMRT's passenger satisfaction.

Other studies in the rail-based public transport literature (e.g., [26,33,57–61]) reported similar findings. In addition, the studies conducted in Turkey by Yanık et al. [24] and Yilmaz and Ari [25] showed that the quality of Metro and high-speed rail services was directly proportional to passenger satisfaction. In another area of public transport, a recent study by Boubker and Naoui [62] reported similar findings on how perceived quality influenced passengers' satisfaction with the Royal Air Maroc in Morocco. Therefore, this study proposes that there exists a relationship between perceived quality and passenger satisfaction.

Hypothesis 2. *Perceived quality directly and positively influences passengers' satisfaction with the monorail service.*

2.3. Perceived Value

The service marketing literature often debates the relationship between perceived value and passenger satisfaction. Perceived value is one of the factors influencing consumer satisfaction and intent consumer behaviour, as proven by Cronin et al. [63] and Petrick [64]. Zeithaml [52] reported that users were more satisfied when they believed they received value for money, unlike those who did not. In other words, consumers expect to make small monetary investments in each product or service. This finding is similar to Konuk [65], who reported that the consumer's impression of the value of products is high when the offered price is low. There is plenty of evidence in the marketing literature of the relationship between perceived value and consumer satisfaction [66–68].

Transport researchers have reported the positive influence of perceived value on passenger satisfaction. Shen et al. [26] conducted a questionnaire study and identified a positive and direct relationship between perceived value and passengers' satisfaction with the Suzhou urban rail transit system. Irtema et al. [69] used the feedback from 412 public transport users in Kuala Lumpur, Malaysia, to formulate a structural equation model, which revealed a significant statistical correlation of perceived value with passenger satisfaction. Lai and Chen's [27] case study of the Taiwan KMRT revealed a significant perceived value–passenger satisfaction correlation. A ridesharing study in Malaysia concluded that perceived value, namely price, had a statistically significant influence on passenger satisfaction [70]. These findings are consistent with various studies in other public transport contexts [45,71–73]. There is clear evidence from the relevant literature that perceived value influences the satisfaction of monorail passengers. Therefore, the authors propose the following hypothesis.

Hypothesis 3. *Perceived value has a direct positive influence on the passenger satisfaction of monorail users.*

2.4. Corporate Image

Flavian et al. [74] contended that corporate image is complex. Corporate image is the general outcome of the interactions of a company's experiences, impressions, beliefs, feelings and human knowledge [75]. Consumers are more likely to perceive that companies with a good image, instead of their products or services, provide superior quality. Consumers who have a good impression of the corporate image of a particular company expect products or services with better quality. Consumer satisfaction is higher when the quality of products or services provided by companies exceeds consumer expectations, and as a result, they are often more loyal to the product or service.

There are many reports of a corporate image having a profound positive influence on passenger satisfaction in the transport literature. The case studies by Chou and Kim [76] in Taiwan and South Korea and Kuo and Tang [77] in Taiwan on high-speed trains revealed that the corporate image has a strong positive and direct influence on passenger satisfaction. Hussain et al. [50] conducted an aviation industry case study in the United Arab Emirates (UAE) and found that corporate image has a direct and significant relationship with consumer satisfaction, value and expectations. In addition, the 2017 studies on city bus services [78] and high-speed rail [25] showed a positive, direct and significant influence of corporate image on consumer satisfaction. Fu et al. [51] recently reported similar findings for public transport in Suzhou, China. Shamsudin et al. [70] found that brand image had a significant, positive influence on ridesharing passengers' satisfaction. The literature review on corporate image indicated that corporate image positively influences passenger satisfaction. Therefore, this paper proposes the following hypothesis.

Hypothesis 4. *Corporate image has a direct positive influence on the satisfaction of monorail passengers*.

2.5. Passengers' Reuse Intention

Researchers in various fields have shown keen interest and investigated the concept of consumer loyalty [65,66]. The transport literature contains empirical evidence that passengers' satisfaction with public transport is an influential determinant of the intention to reuse or recommend the service to others [25,26,76,79,80]. In a case study of the Kaohsiung mass flow transit (KMRT) in Taiwan, the researchers employed a structural equation model and found that user satisfaction had a clear and positive effect on passenger reuse intention. This finding is similar to the results of the study by Kuo and Tang [77], investigating the relationship between several antecedents, such as quality of service, corporate image, passenger satisfaction and intent of senior passengers towards Taiwan high-speed rail services (THSR), and the study by Chou et al. [81] on THSR users. Furthermore, the studies in Malaysia [69,70], Turkey [24], Morocco [62] and Spain [82] reported that passenger satisfaction influenced the reuse intention of public transport passengers.

Based on the findings of the studies reported in the transport literature, it is apparent that consumer satisfaction is a critical determinant of the reuse intention of passengers of the monorail service. Therefore, the researchers put forth the following hypothesis.

Hypothesis 5. *Passenger satisfaction has a positive and direct influence on the reuse intention of monorail passengers*.

2.6. Conceptual Framework

Based on the comprehensive review of previous transport literature, this study proposes a framework for a study model that incorporates the above hypotheses, as shown in Figure 1. This study will comprehensively examine the effects and relationships between passenger expectations, perceived quality, perceived value, corporate image, passenger satisfaction and passenger loyalty to the monorail service.

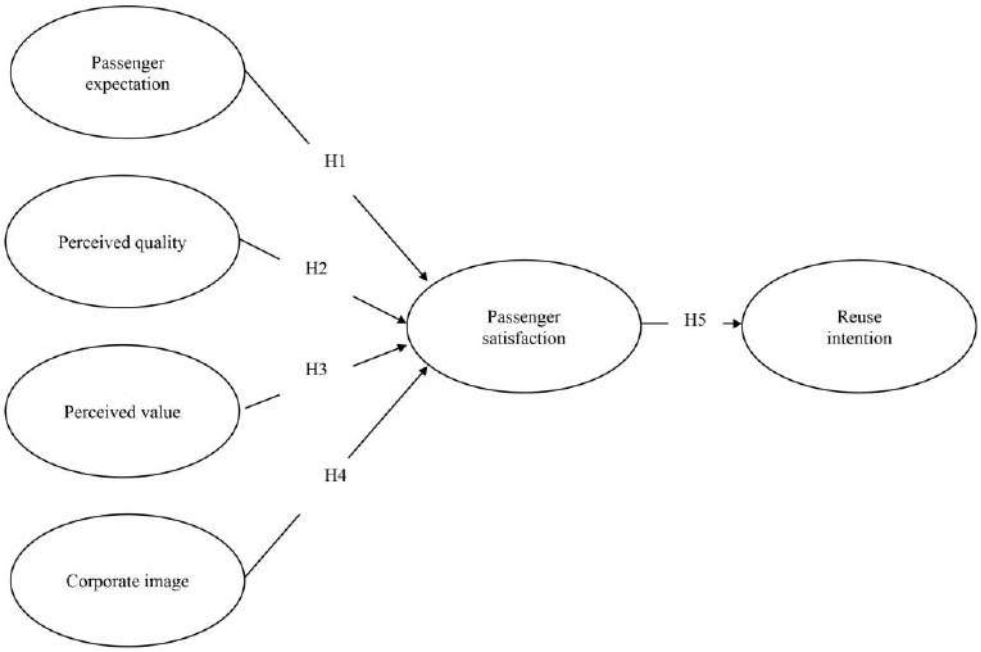

Figure 1. Conceptual framework.

3. Methodology

3.1. Survey Design

This study adopted a quantitative approach using a cross-sectional questionnaire design to gather data from respondents to test the validity of the research hypotheses and model. The questionnaire was adapted from previous transportation studies, including Irtema et al. [69], Kuo and Tang [77], Shen et al. [26] and Yilmaz and Ari [25]. The researchers performed a back-to-back translation of the questionnaire and modified it to fit the Malaysian economic, social and cultural context. The questionnaire consist of two sections, respondent demographics characteristics and the constructs measuring the factors influencing passenger satisfaction and intention to reuse the monorail service. The items for all constructs in Section 2 were measured using a five-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). A higher score indicated higher interest in a particular measure.

3.2. Data Collection

Before the full-scale data collection, the researchers conducted a pilot study on 50 randomly selected respondents from Bandar Baru Bangi, Selangor. The pilot study aimed to identify and improve the weaknesses in the questionnaire design [34,83]. Based on the feedback from the pilot samples, some items were omitted from the questionnaires, while others were modified to improve clarity and reliability. Table 1 presents the results of the reliability test of the pilot samples.

Table 1. Results of the reliability analysis of the pilot test (n = 50).

Variable	No. of Items	Cronbach's Alpha (α)
Passenger expectation	3	0.871
Perceived quality	5	0.931
Perceived value	5	0.905
Corporate image	5	0.792
Passenger satisfaction	4	0.870
Reuse intention	5	0.872

The full-scale data collection was carried out between September 2019 and December 2019 at the monorail stations with the highest numbers of users, such as the Kuala Lumpur Sentral and Hang Tuan stations. This study appointed and trained three enumerators to gather the data. The enumerators randomly selected potential respondents and screened them to ensure they were Malaysian and had used the monorail service within the last 6 months. The enumerators asked those respondents who fulfilled the criteria if they were willing to participate in the survey. Respondents who agreed to participate were given a set of questionnaires and briefed on the purpose of the study. A previous study had shown that this approach would increase the response rate and accuracy of the feedback. Respondents were given a token of appreciation upon completing the survey.

Five hundred questionnaires were distributed to respondents via a convenience sampling approach. In this sampling approach, everyone in a population has an equal chance of being selected. The respondents were randomly selected to participate in the study. Previous transport studies have employed this sampling technique [84–86]. Saunders et al. [87] and Sekaran and Bougie [88] stated that this sampling technique is simple and inexpensive. Of the returned questionnaires, 83 were excluded from the analysis due to invalid or incomplete responses, such as straight lines and missing data. Table 2 presents the 417 samples with an effective response rate of 83.40%.

Table 2. Demographic characteristics of the respondents (n = 417).

	Frequency (*n*)	**Percentage (%)**
Gender		
Male	212	50.8
Female	205	49.2
Age group (Years)		
≤20	38	9.1
21 to 30	182	43.6
31 to 40	156	37.4
≥40	41	9.8
Education level		
Non-degree holder	106	25.42
Degree holder	311	74.58
Employment status		
Employed	256	61.39
Unemployed	26	6.24
Student	135	32.37
Driving license ownership		
Yes	356	85.37
No	61	14.62
Car ownership		
Yes	301	72.18
No	116	27.81

3.3. Data Analysis

The 417 valid surveys were analysed using a two-stage data analysis, namely structural equation modelling based on the parameter estimation of partial least squares (PLS-SEM) method for stage one and artificial neural network for stage two. The researchers used SmartPLS version 3.0 software to conduct the analysis and the PLS-SEM and Statistical Package for Social Sciences Software (SPSS) version 26 to perform the ANN analysis.

4. The Case Study

The Kuala Lumpur monorail service is one of the components of the Klang Valley Integrated Transit System; it operates as a part of the RapidKL system managed by Rapid Rail, a subsidiary of Prasarana Malaysia [33]. It is a single-rail, fully elevated railway system, thus the name monorail. The system is designed to provide efficient and convenient transportation for daily commuters and tourists by connecting the inner areas of Kuala

Lumpur not serviced by other rail transport, such as the Mass Rapid Transit (MRT), Light Rail Transit (LRT) and KTM Komuter [9].

Monorail systems offer several advantages, including minimal operating space and interference with existing traffic flow, cost-effectiveness, and short foundation and rail construction time compared to conventional runways. The monorail network in Kuala Lumpur spans approximately 8.6 kilometres (5.3 miles) and has 11 stations [33]. It runs from the Titiwangsa station to the northwest of the KL Sentral station in the south and passes through popular areas such as Bukit Bintang, Imbi and Chow Kit. The monorail route intersects with other public transportation systems, including the Kelana Jaya LRT Line (Light Rail Transit) at the KL Sentral station, as shown in Figure 2.

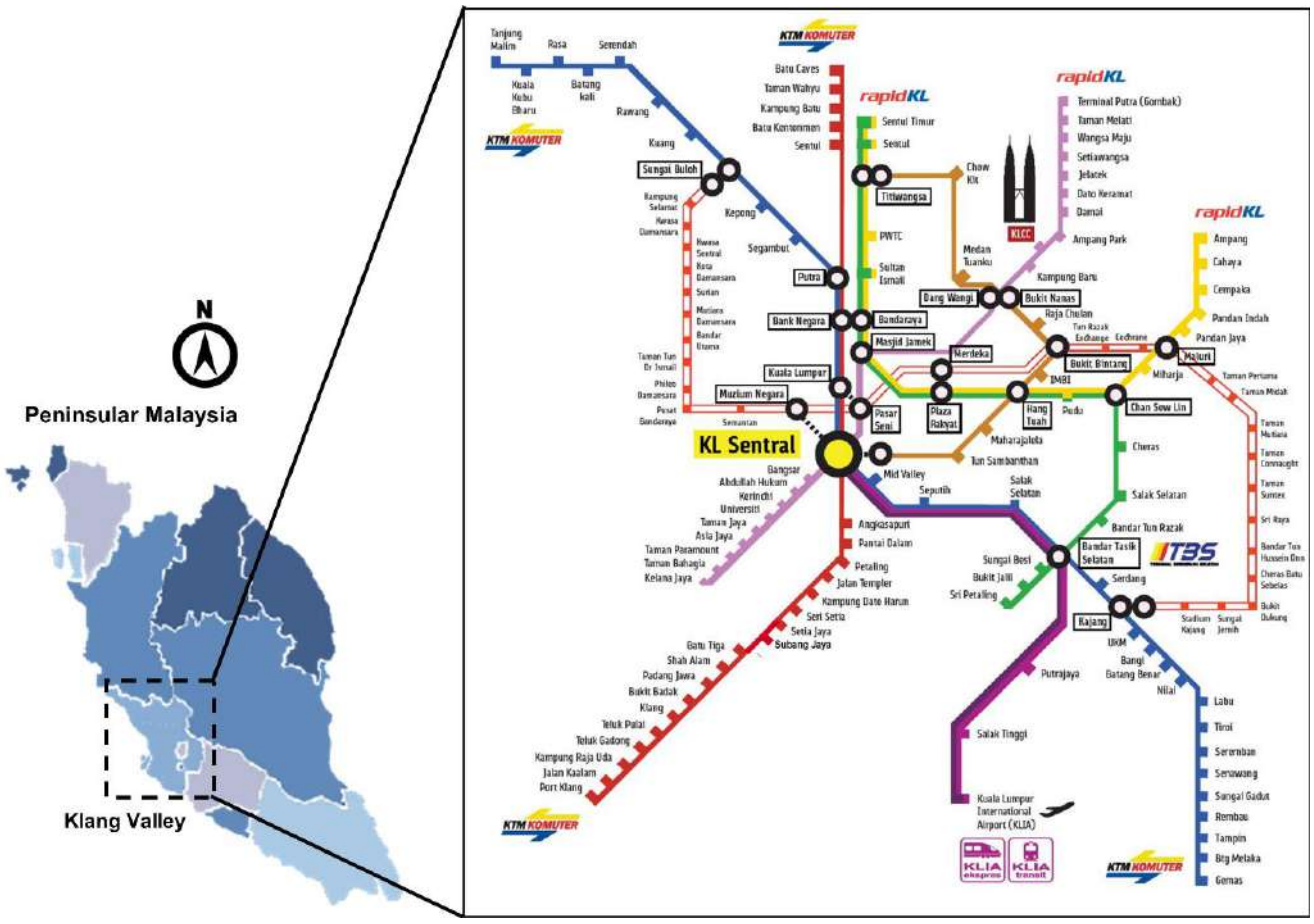

Figure 2. The monorail line (brown) in Kuala Lumpur, Malaysia.

The current rolling stock of KL Monorail is four-car trains that can accommodate 430 passengers with each train trip. The monorail trains are sleek, modern and equipped with air conditioning to ensure passenger comfort. The train frequency varies depending on the time of day, where the frequency during regular hours is every ten minutes and every seven minutes during peak hours. The monorail operates from 6:00 am to midnight. Passengers must purchase a token or use contactless payment methods, such as the Touch n Go card, which can be topped up with credit, to access the monorail service. The stations have ticket vending machines and clear signage providing information about fares, routes and station facilities.

One of the key advantages of the monorail is that it avoids daily traffic congestion when navigating congested urban areas, thus ensuring a shorter travel time. It is popular among commuters travelling to commercial and shopping districts, such as Bukit Bintang, where traffic congestion is often a nightmare. Figure 3 presents the annual monorail ridership. It shows that, since 2013, the monorail ridership has decreased gradually from

25.4 million to 11.5 million in 2022. The lowest ridership was 7.1 million in 2020 and 4.2 million in 2021 due to the COVID-19 pandemic. The considerable reduction in monorail ridership was due to the movement restrictions implemented by the government, namely the Movement Control Order (MCO), Conditional Movement Control Order (CMCO) and Recovery Movement Control Order (RMCO), to contain the transmission of COVID-19. The movement restrictions changed the travel behaviour of the public and reduced the number of passengers using public transport.

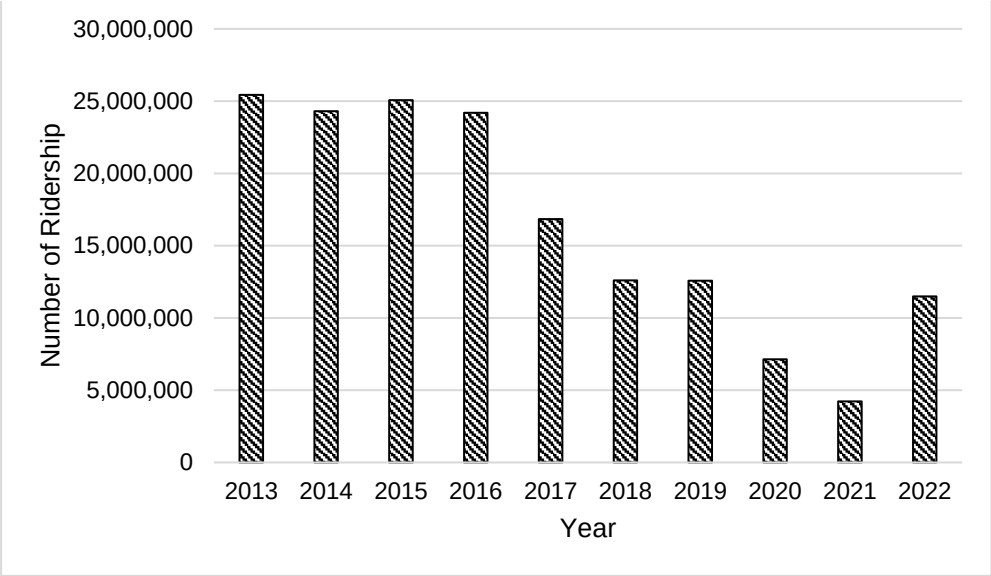

Figure 3. The annual ridership of the KL Monorail [14].

5. Results

5.1. Stage 1: Structural Equation Model

The analysis of the results of this study followed the PLS-SEM analysis protocol recommended by Hair et al. [89], including the evaluation of the measurement model and assessment of the structural model.

5.1.1. Measurement Model

The measurement model was evaluated based on reliability and validity [90]. This study used composite reliability to determine the measurement model's reliability, also known as internal consistency reliability, and convergent and discriminant validities to test the measurement model's validity [91,92].

Internal Consistency Reliability

The reliability and validity were used to evaluate the measurement model [90], where the composite reliability was employed to test the former (also known as internal consistency reliability), while the convergent and discriminant validity were used to test the latter [91,92].

Based on the PLS-SEM method, the researchers first used the composite reliability and Cronbach's alpha to measure the internal consistency reliability. Table 3 shows that the composite reliability was between 0.944 and 0.974, while Cronbach's alpha ranged between 0.910 and 0.972, which exceeded the recommended 0.7 cut-off value [93,94]. Thus, these results satisfy the reliability of the measures.

Table 3. Results for the internal consistency, measurement reliability and convergent validity.

Construct	No. of Items	Outer Loading	Cronbach's Alpha (α)	rho_A	Composite Reliability (CR)	AVE
Passenger expectation (JP)	3	0.908–0.952	0.926	0.928	0.953	0.871
Perceived quality (KT)	8	0.673–0.814	0.972	0.973	0.974	0.555
Perceived value (NT)	3	0.885–0.944	0.91	0.917	0.944	0.848
Corporate image (KI)	3	0.914–0.942	0.923	0.924	0.951	0.867
Passenger satisfaction (KPP)	3	0.923–0.932	0.917	0.917	0.947	0.857
Reuse intention (KSP)	6	0.823–0.901	0.935	0.938	0.949	0.756

Note: rho_A: Dijkstra–Henseler's rho; AVE: Average variance extracted.

Convergent Validity

Convergent validity is the degree of positive correlation between one measure of a given construct and a different measure of the construct [90]. This study assessed the convergent validity using two criteria, the outer loading and average variance extracted (AVE). Table 3 shows that most of the model's items had outer loading values higher than the 0.7 threshold value recommended by Hulland [95]. The AVE values ranged from 0.555 (perceived quality) to 0.871 (user expectations) for six constructs, thus fulfilling the normal 0.5 AVE value rule of thumb [96–99].

Discriminant Validity

Discriminant validity is the degree one construct is empirically different from the others [90]. This study used the Fornell–Larcker criterion [96] and the Heterotrait-Monotrait ratio (HTMT) to evaluate the discriminant validity [100], where the former was used to determine the square root of the AVE values for all constructs and then compared to the cross-loading for different constructs. Table 4 shows that the findings meet the values recommended by Fornell and Larcker [96], where the appropriate discriminant validity rule of thumb is that the square root of a construct's AVE value should be higher than its highest squared correlation with the remaining constructs. Table 5 shows that the HTMT ratios were considerably lower than the 0.85 threshold value recommended by past researchers [6,98,100]. Based on these tests, the results for the Fornell–Larcker criterion (Table 4) and HTMT (Table 5) confirmed the discriminant validity of all constructs in the proposed model.

Table 4. The Fornall–Larcker criterion for discriminant validity.

Construct	KI	JP	KPP	KSP	KT	NT
Corporate image (KI)	**0.931**					
Passenger expectation (JP)	0.717	**0.933**				
Passenger satisfaction (KPP)	0.68	0.677	**0.926**			
Reuse intention (KSP)	0.689	0.653	0.772	**0.869**		
Perceived quality (KT)	0.602	0.761	0.819	0.793	**0.87**	
Perceived value (NT)	0.621	0.64	0.743	0.681	0.777	**0.921**

Note: The numbers in bold are the square root of the AVE value.

Table 5. The HTMT criterion for discriminant validity.

Construct	KI	JP	KPP	KSP	KT	NT
Corporate image (KI)						
Passenger expectation (JP)	0.776					
Passenger satisfaction (KPP)	0.739	0.734				
Reuse intention (KSP)	0.741	0.699	0.831			
Perceived quality (KT)	0.846	0.801	0.825	0.83		
Perceived value (NT)	0.675	0.693	0.811	0.734	0.822	

5.1.2. Structural Model

Evaluation of the Path Relationships

Table 6 presents the results for the direct path relationships among six constructs, namely passenger expectation (JP), perceived quality (KT), perceived value (NT), corporate image (KI), passenger satisfaction (KPP) and reuse intention (KPS). They show strong empirical support for most of the hypothesised direct effects between the constructs. Except for Hypotheses 1 and 4, all t-values were higher than the critical 1.96 value at a 5% level of significance. Therefore, this study confirmed that user satisfaction with the monorail service in Kuala Lumpur is significantly and positively influenced by perceived quality ($\beta_{KT \rightarrow KPP} = 0.522$, t = 7.092, $\rho < 0.001$) and perceived value ($\beta_{NT \rightarrow KPP} = 0.259$, t = 4.052, $\rho < 0.001$), thus, supporting Hypotheses 2 and 3. Similarly, passenger satisfaction is a significant and positive determinant of reuse intention ($\beta_{KPP \rightarrow KPS} = 0.772$, t = 30.149, $\rho < 0.001$), which supports Hypothesis 5. Table 6 also shows that the direct relationship between passenger expectation ($\beta_{JP \rightarrow KPP} = 0.086$, t = 1.786, $\rho < 0.074$) and corporate image ($\beta_{KI \rightarrow KPP} = 0.039$, t = 0.657, $\rho < 0.511$) with passenger satisfaction was not significant, and, therefore, Hypothesis 1 and Hypothesis 4 are rejected.

Table 6. Results of the direct effect.

Hypothesis	Path Relation	Path Coefficient (β)	Confidence Intervals Bias Corrected (95%)	t-Value	ρ-Value	Result
H1	Passenger expectation → Passenger satisfaction	0.086	[−0.005, 0.184]	1.786	0.074	Rejected
H2	Perceived quality → Passenger satisfaction	0.522	[0.372, 0.661]	7.092	0.000	Supported
H3	Perceived value → Passenger satisfaction	0.259	[0.139, 0.389]	4.052	0.000	Supported
H4	Corporate image → Passenger satisfaction	0.039	[−0.070, 0.163]	0.657	0.511	Rejected
H5	Passenger satisfaction → Reuse intention	0.772	[0.715, 0.817]	30.149	0.000	Supported

Evaluation of the Predictive Capability

In SEM modelling, the predictive capability of a model is based on two criteria, predictive accuracy and predictive relevance. Hair et al. [90] elucidated how the former assesses each endogenous construct's amount of explained variance based on the coefficient of determination (R^2). High R^2 values (close to 1) indicate the high predictive accuracy of a model [1,34]. The results of this study showed that user satisfaction and reuse intention had strong ($R^2 = 0.704$) and moderate ($R^2 = 0.595$) predictive accuracy [26,101].

The second criterion was evaluated based on the Q^2 calculated using the blindfolding approach in the SmartPLS 3.0 software. In their recommendation for a model, Henseler et al. [102] stated that positive Q^2 values indicate the endogenous constructs' predictive relevance. In the current model, the Q^2 value for user satisfaction was 0.598, while reuse intention had a Q^2 value of 0.446, indicating that the predictive relevance of the model was adequate.

Another criterion is the effect size (f^2). This study evaluated the effect size using the PLS-SEM approach to quantify the magnitude or strength of the relationship between variables. According to Ali et al. [103], an effect size of ≥0.02, ≥0.15 and ≥0.35 indicates small, moderate and significant effects. The results of this study showed that the 1.472 ($f^2 \geq 0.35$) effect size of passenger satisfaction on reuse intention (KPP → KSP) was significant, while the effect size of perceived quality on passenger satisfaction (KT → KPP) and perceived value on passenger satisfaction (NT → KPP) were moderate ($f^2 = 0.191$) and small ($f^2 = 0.088$).

This study also evaluated the goodness-of-fit (GoF). Wang et al. [104] classified GoF as weak (≥0.10), medium (≥0.25) and strong (≥0.36). The proposed model recorded a GoF value of 0.314, indicating a medium GoF (≥0.25), and the structural model could potentially better explain passenger satisfaction and reuse intention. In summary, the results for both criteria confirmed that the proposed model has predictive capability.

5.2. Stage 2: Artificial Neural Network

The second stage of this study developed an artificial neural network (ANN) model. The significant predictor factors identified in the first stage (PLS-SEM) were used as the input variables in the ANN model. This study employed a multi-layer perceptron (MLP) model with a feed-forward backpropagation algorithm, as recommended by previous studies on consumer behaviour modelling [105–107]. The models for passenger satisfaction with and intention to reuse the monorail service had two dependent variables. Therefore, the study model in Figure 1 was separated into the two ANN models (Models A and B) shown in Figures 4 and 5.

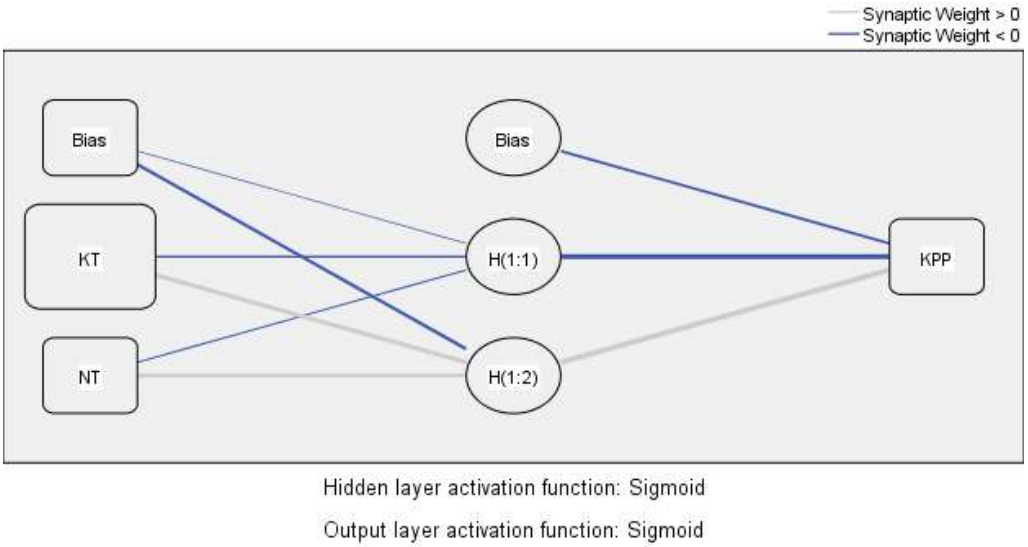

Figure 4. Model A.

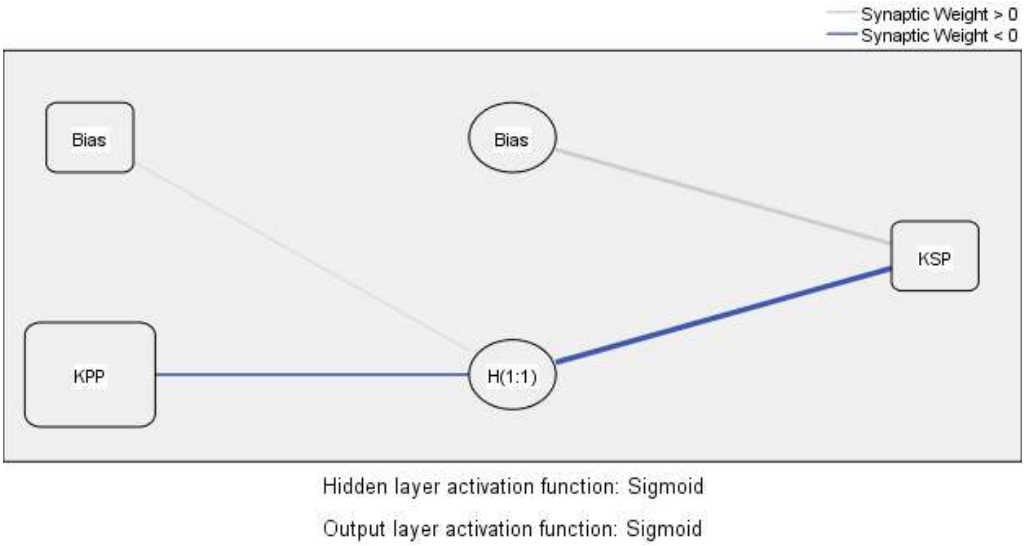

Figure 5. Model B.

Model A for the monorail services (see Figure 4) had two significant inputs (perceived quality, KT, and perceived value, NT) and one output (passenger satisfaction, KPP). Model B (see Figure 5) had one significant input, passenger satisfaction (KPP), and one output, reuse intention (KPS). All models had one hidden layer, and the number of neurons in the hidden layers was produced spontaneously by the SPSS neural network module [106,108,109]. Model A had two hidden neurons, and model B had one. The sigmoid-type activation function was used in the hidden and input layers [105,110].

This study used a ten-fold cross-sectional validity approach to avoid over-fitting [107,111]. The data were divided into two, where 90% was used to train the models and 10% to test the models [105,110,112]. The predictive accuracy of the ANN model was assessed using the mean square root error (RMSE) value in the training and testing data sets [107,108,113]. According to Hyndman and Koehler [113], the RMSE value is always positive, and a value of 0 indicates perfect accuracy (almost unprecedented in predictive practice).

Table 7 presents the calculated average and standard deviation of the RMSE value for the ANN model (models A and B). The table shows that the average values and standard deviation of the RMSE were low and ranged between 0.104 and 0.119 (training) and 0.078 and 0.140 (testing). The small RMSE values proved that the ANN model had excellent predictive accuracy and matching, as suggested by Leong et al. [107,108] and Veerasamy et al. [114]. The RMSE value of the model developed in this study was lower than the values reported for the forecast models developed in previous studies, such as the case studies in Pakistan [115] and Malaysia [105]. The association of the predictors was confirmed by a quantity of non-zero synaptic weight associated with hidden neurons. In addition, the matching accuracy of the ANN model in this section was calculated using the determination coefficient (R^2). The R^2 value for the overall ANN model for monorail services ranged between 77.2% and 79.3%, indicating its high ability to predict the construct of a particular forecaster.

Table 7. RMSE value.

ANN Network	Model A		Model B	
	Training	Testing	Training	Testing
ANN 1	0.119	0.133	0.112	0.113
ANN 2	0.106	0.097	0.113	0.103
ANN 3	0.107	0.093	0.114	0.099
ANN 4	0.117	0.14	0.112	0.112
ANN 5	0.118	0.103	0.111	0.121
ANN 6	0.108	0.078	0.112	0.118
ANN 7	0.104	0.122	0.113	0.101
ANN 8	0.105	0.111	0.116	0.08
ANN 9	0.106	0.096	0.112	0.111
ANN 10	0.107	0.09	0.115	0.109
Mean	0.11	0.106	0.113	0.107
Standard deviation	0.006	0.02	0.001	0.012

Table 8 presents the sensitivity analysis results based on the average relative importance of the input variables in predicting the specific outputs of 10 networks [105]. The value of normalised relative importance was obtained by dividing the average value of relative importance for each independent variable by the average value of maximum importance and given as a percentage [115]. For ANN models with only one predictor variable (input) to predict a specific output, such as model B, the input from the model contributed exclusively (100%) to predicting a specific output (see Table 8). In addition, the sensitivity analysis for model A showed that the independent variable of perceived quality was more influential in predicting passenger satisfaction than perceived value. The results for the second stage based on the ANN model were consistent with those reported in the first stage obtained using the PLS-SEM technique.

Table 8. Sensitivity analysis.

ANN Network	Model A		Model B
	Perceived Quality	Perceived Value	Passenger Satisfaction
ANN 1	0.51	0.49	1
ANN 2	0.72	0.28	1
ANN 3	0.68	0.32	1
ANN 4	0.57	0.43	1
ANN 5	0.68	0.32	1
ANN 6	0.67	0.33	1
ANN 7	0.61	0.39	1
ANN 8	0.72	0.28	1
ANN 9	0.72	0.28	1
ANN 10	0.7	0.3	1
Average relative importance	0.66	0.34	1
Normalised relative importance (%)	100	51.65	100

6. Discussion and Implications

6.1. Theoretical Implications

In this study, the framework testing the American Consumer Satisfaction Index (ACSI) model used the passenger expectation, perceived quality and perceived value constructs as the predictor factors for passenger satisfaction and reuse intention as the consequence of passenger satisfaction. ACSI is a widely recognised model for measuring customer satisfaction in various industries [24,25], including transportation [15,26,27]. ACSI considers multiple factors when evaluating customer satisfaction in the transportation sector, such as passenger expectation, perceived quality, and perceived value, and thus provides a holistic overview of the formation of passenger satisfaction. The basic framework of the ACSI model was extended by adding a new construct predicted to have the potential to affect passenger satisfaction with the monorail service in Kuala Lumpur. The justification for using corporate image in the basic framework of the ACSI model was the strong influence of corporate image on consumer satisfaction based on the results of empirical studies in transport engineering reported in previous studies [25,51,76–78].

The relationships between the constructs in this model were tested using the feedback from 417 respondents obtained from a questionnaire on passenger satisfaction with the monorail service in Kuala Lumpur, which used the structural equation model technique based on the estimated partial smallest square parameter (PLS-SEM). The monorail passenger satisfaction and reuse intention prediction models were developed based on the conceptual framework of the advanced ACSI model describing 70.4% and 59.5% of the total variance for passenger satisfaction and reuse intention. The predictive accuracy value (R^2) for the model in this study was higher than that of previous studies which adopted the original ACSI model, such as Shen et al. [26], which reported the ACSI model explained 41.9% (satisfaction) and 20.9% (loyalty) of the variance in the case study of the rail transit system in Suzhou, China. The original ACSI model explained 47% and 15% of the total variance for satisfaction and loyalty to public bus services in Harbin, China, based on the views of senior citizens [37].

Passengers' perceived quality and perceived value of monorail services were the key predictors of their satisfaction with the provided services. As anticipated, perceived quality was the factor most influential on the other variables, namely, passenger expectations, perceived value and corporate image, which determined passenger satisfaction in the developed model. These results were congruent with previous studies, which reported that perceived quality is the primary predictor of consumer satisfaction with urban rail transit services [26], public transport [38,69] and public buses [37]. In addition, this study explained that passenger satisfaction has a significant, positive influence on passenger loyalty, as reported in previous transport studies [24,77,81,82].

This study also adopted a new methodological paradigm, a hybrid of structural equation models and artificial neural networks (SEM-ANN), to predict passengers' satisfaction with and intention to reuse the monorail service. This approach allowed the researchers to

use the SEM technique with PLS estimates (first stage) to identify the linear relationship between predictor factors and specific target factors and the ANN technique (second stage) to determine the nonlinear relationships. The SEM-ANN hybrid approach is appropriate in studies involving complex processes and data (human behaviour studies), such as the present study [105,108,111]. The results for the second stage, which used the ANN technique, were consistent with those from the first stage, which used the PLS-SEM technique. The outcomes clearly showed that the linear relationship identified in the first stage was supported by the results of the nonlinear relationships obtained in the second stage. The findings of this study are more significant than the previous studies that identified only a linear relationship between the constructs in those studies [25,26,37,38,69].

Hence, this study identified the theoretical implication of using the SEM-ANN predictive analysis approach, which is a new methodological paradigm in the transport engineering literature. This study also identified a nonlinear relationship between the predictor constructs and a particular target construct, which supported the results of the first-stage analysis (the linear relationship). It is a new theoretical finding since no study on passenger satisfaction with and intention to reuse public transport services has confirmed a nonlinear relationship between the predictor and target construct. Therefore, researchers now have a new dimension to explore in this field. By performing ANN analysis, researchers can enhance the significance of normalised factors that are significant predictors of target constructs, such as consumer satisfaction. This approach differs from existing studies [25,37,69] that summarise the influence of predictor factors on the target factor based on the value of the beta coefficient (β) derived in the SEM analysis. In addition, the SEM-ANN hybrid techniques employed by this study provided a new methodological paradigm shift, where the researchers focused on testing the effects of linear relationships and the nonlinear relationship between the predictors and dependent variables.

6.2. Practical Implications

From a practical perspective, the findings of this study have significant implications for the service providers in formulating effective strategies to increase passenger satisfaction with the provided services, retaining existing users and attracting potential users of the monorail services for travelling in urban areas. As such, monorail services remain relevant in the competitive transportation markets in urban areas such as Kuala Lumpur. This finding is similar to the implications of previous studies, which reported that users satisfied with the provided services were more loyal and would promote the service to others [8,16,116].

In this context, service providers must ensure adequate and high-quality facilities at the stations and in the carriages (trains), such as a safe environment at the station and in the carriages, plenty of parking spaces, sufficient ticket vending machines and comfortable seats at the stations and handrails (strap hangers and poles in carriages) that are suitable for standing passengers. In addition, monorail service providers can enhance passenger satisfaction by providing timely and comfortable intermediate bus services from/to monorail stations to increase the number of monorail users in Kuala Lumpur. Chandra et al. [117] and Jain et al. [118] have proven that the convenience of first-mile and last-mile transport connections (intermediate buses) was a critical factor in increasing monorail ridership.

Service providers should give more importance to the ticketing service since providing various types of tickets, such as adequate self-service ticket machines and affordable ticket prices for specific target passengers, can improve service quality [11]. Other noteworthy factors are improving service quality and passenger satisfaction with the monorail service.

Ibrahim et al. [11] stated that customer service contributes to passenger satisfaction. All personnel in customer service must be equally committed to projecting a good corporate image. Therefore, monorail service providers must ensure their staff appropriately represent the services and company. Among the ways to improve staff professionalism and courtesy is training them to provide accurate, up-to-date and reliable information

about the provided services and providing them with better and more professional-looking uniforms to enhance their appearance. Service providers must convince customers that they are important to the organisation by maintaining a good corporate image. Monorail service providers can establish good relationships with users by offering loyalty bonuses and discounts to loyal users.

Záhumenská et al. [119] stated that the current trend aims to enhance connectivity in railway passenger transport by minimising transfer time from the beginning of the journey to the destination. Therefore, it is crucial to synchronise the arrivals and departures of all interconnected trains at the stations where passengers embark, disembark or switch vehicles. Minimising waiting time will enhance the overall quality of passenger transport [11,16]. Furthermore, market liberalisation offers an additional avenue to improve the performance of railway transport. As indicated by Záhumenská et al. [119] and Solina and Abramović [120], the growth in the market share of private transport companies is a direct outcome of liberalisation and is directly correlated with improved qualitative criteria and the increased attractiveness of railway passenger transport. Vojtek et al. [121] proposed an alternative method for enhancing the efficiency of railway transport which employs a mathematical approach to find optimal solutions for specific problems. This mathematical approach has several advantages, including more efficient and time-saving operational processes, more flexibility in decision-making at the operational and strategic levels, and lower costs that result primarily from enhanced operational efficiency while allowing individuals to focus on creative work since mechanical tasks are handled by software [121].

Based on the results of this study, monorail service providers should strive to increase passenger satisfaction with the provided services by increasing their value. This finding is congruent with previous studies that reported positive and significant direct effects of the high-value factors on passenger satisfaction. Among the measures that can enhance the value of monorail services is charging affordable fares for the provided services compared to fares charged by their competitors in the transportation services, such as buses, taxis and e-hailing services. Therefore, the researchers encourage the service providers to introduce several types of travel passes, such as daily, weekly and monthly passes, along with other fares and discount structures to particular groups of users, such as senior citizens, students, children and people with disabilities (PWD). In addition, service providers must not ignore non-monetary costs, such as effort, energy and time. In this context, providing high-quality services, such as timely, safe, clean and comfortable urban rail transit services and affordable travel costs, can enhance the estimated benefits, which partly contribute to the profitability and sustainability of urban rail transit services.

In summary, providing high-quality and high-value monorail services and having a good corporate image that fulfils passenger expectations will result in passenger satisfaction. The measures discussed in this section are among the methods that could increase passenger satisfaction with the provided services and thus retain the current users and attract new users. The conclusions drawn from this study offer service providers a compelling basis for devising strategies and making investments aimed at increasing ridership in urban rail transit. These initiatives align with the Malaysian government's agenda for establishing rail transit services as the fundamental infrastructure of the Greater Kuala Lumpur transportation network and achieving a target of 40% public transport mode share in urban areas by 2030 [122].

7. Conclusions and Recommendations for Future Studies

This study has increased the understanding of the factors influencing passenger satisfaction with and intention to reuse the Kuala Lumpur monorail service. Modifying the ACSI framework by considering the corporate image construct explained 70.4% and 59.5% of the total variance in passenger satisfaction and reuse intention. The research outcomes have proven that passenger satisfaction is a critical factor in persuading passengers to continue using the monorail service and that perceived quality is the most dominant factor

determining passengers' satisfaction with the monorail service. Another strong determinant of passenger satisfaction is perceived value. The results of this study give service providers, policymakers and planners the crucial insights required to develop competent strategies to increase user satisfaction and the ridership of monorail services.

Nevertheless, it is crucial to recognise the significant limitations of this paper to conduct more in-depth explorations in the future. The first limitation of the current study was its focus on the passengers of the monorail service in Kuala Lumpur, Malaysia. Future research should assess and validate the findings of this research in other countries to improve the generalisability of the study outcomes. Second, the sampling method in this study was a non-probability sampling method (convenience sampling approach) that did not generalise the results. Therefore, future research should employ a proper probability sampling method and increase the number of data collected to reduce bias and generalise the study outcomes. Third, this study did not consider the impacts of the COVID-19 pandemic on the performance of monorail services and passenger satisfaction and reuse intention since the data collection was carried out before the emergence of COVID-19. Thus, future research should consider the post-COVID-19 pandemic effects on passengers' satisfaction and reuse intention. Finally, since this research did not consider socio-demographic factors, such as gender and age of the respondents, as moderating factors, future research should do so to understand the factors shaping passenger satisfaction and reuse intention among different cohorts.

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