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ARTICLE

From Service Quality to Loyalty: Understanding Rail Commuter Satisfaction in Greater Kuala Lumpur

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ABSTRACT

Rapid urbanization in Greater Kuala Lumpur has intensified automobile dependency, causing congestion and environmental concerns. Although urban rail systems are promoted as sustainable alternatives, their adoption remains limited. This study examines how service quality influences commuter loyalty and whether satisfaction mediates this relationship within Malaysia's urban rail context (KTM Komuter, LRT, MRT). A structured questionnaire yielded 218 valid responses analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Results show that service quality does not directly predict behavioural intention ($\beta = 0.07$, $t = 0.874$, $p > 0.05$). Instead, commuter satisfaction significantly predicts behavioural intention ($\beta = 0.728$, $t = 10.338$, $p < 0.001$) and fully mediates the link between service quality and behavioural intention ($\beta = 0.515$, $t = 8.53$, $p < 0.001$). Enhancing commuter satisfaction is therefore essential to increase rail usage, as improvements in service quality influence behaviour only when they raise satisfaction. Theoretically, the findings integrate the SERVQUAL model with the Theory of Planned Behaviour (TPB); practically, they guide policymakers in strengthening rail services to promote sustainable urban mobility.

Keywords: Urban Rail Transport; Service Quality; Customer Satisfaction; Behavioural Intention; PLS-SEM; Greater Kuala Lumpur

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1. Introduction

Both developed and developing nations increasingly face severe urban congestion due to rapid motorization and inadequate city planning. In the case of Greater Kuala Lumpur, the expansion of private automobile use has resulted in significant challenges, including traffic congestion, environmental pollution, and loss of productivity^[1-3]. The excessive dependence on cars and motorcycles has also contributed to higher fuel consumption, infrastructure deterioration, and public health concerns. Previous studies have shown that improving the quality of public transport services, particularly rail, plays a vital role in retaining existing commuters and attracting new users^[4]. In recent years, several researchers have examined how service quality and commuter satisfaction influence travel behaviour and loyalty toward public transportation^[5-7].

The Greater Kuala Lumpur region, also known as the Klang Valley, is Malaysia's largest metropolitan area, encompassing multiple municipalities that border the Federal Territory of Kuala Lumpur. It serves as a central hub for the nation's economic and social activities. Urban mo-

bility management authorities have made major efforts to establish an integrated rail transit system to enhance connectivity and sustainability. Currently, the region operates eleven rail transit lines, including two commuter networks (KTM Komuter), five rapid transit lines (LRT, MRT, and KL Monorail), and two airport rail links (KLIA Transit and KLIA Express)^[1]. The LRT, introduced in 1996, was Malaysia's first urban rail service connecting Ampang and Sentul to the city centre, symbolizing a major shift toward modern urban mobility.

Figure 1 presents the annual ridership for four main categories of urban rail services in Greater Kuala Lumpur from 2020 to 2023. Both the LRT Kelana Jaya and LRT Ampang/Sri Petaling Lines showed significant drops in 2021, reflecting pandemic-related travel restrictions, followed by steady growth in 2022 and strong recovery in 2023. KL Monorail and other feeder or integrated services show smaller absolute volumes but similar recovery patterns. The data underscores the resilience of rail ridership and the role of service continuity in regaining passenger trust.

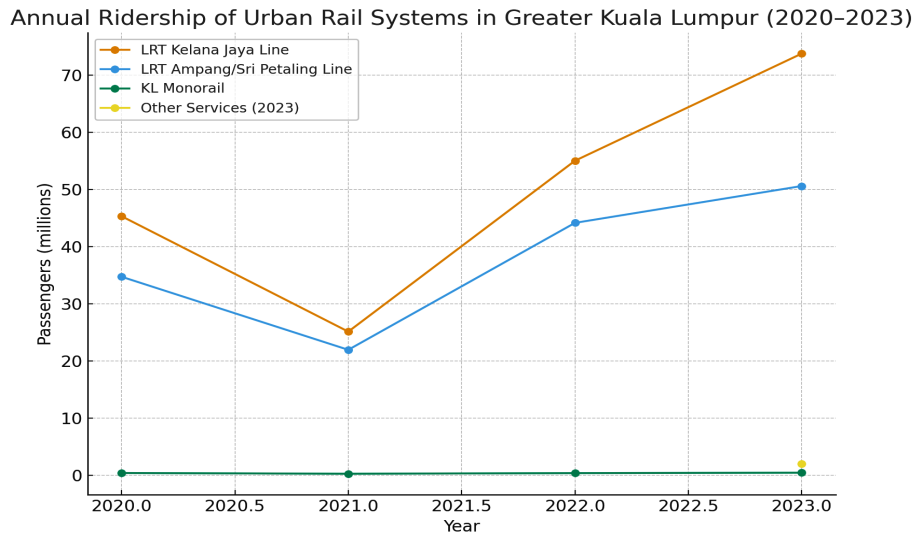


Figure 1. Annual ridership trends of four main urban rail services in Greater Kuala Lumpur (2020–2023)^[4-6], showing the pandemic-induced decline in 2021 and strong recovery by 2023 across LRT Kelana Jaya, LRT Ampang/Sri Petaling, KL Monorail, and other feeder services.

Despite the availability of modern rail systems, commuter satisfaction in Greater Kuala Lumpur remains low. Many citizens continue to prefer private vehicles due to perceptions of unreliable schedules, limited accessibility, and inconsistent service quality. This shift toward private

transport has worsened congestion, increased travel time, and negatively affected economic efficiency and environmental sustainability^[1]. Enhancing rail service quality is therefore a strategic priority for policymakers seeking to encourage a modal shift from private cars to public trans-

portation. Applying the SERVQUAL framework ^[8] can help identify key service quality dimensions i.e., tangibility, reliability, assurance, empathy, and responsiveness that influence commuters' perceptions and satisfaction ^[9,10].

Many recent studies have been conducted ^[11,12], to find the relationship between service quality, behavior, and intentions in different contexts. Most of the studies ^[13,14] in the literature review exhibit that if a company wants to increase re-use intention, they must provide customers with high-quality services, through this people are more satisfied and show positive behavior in their social circle towards the usage intention ^[15].

However, further empirical research helps to increase commuters' satisfaction as one of the significant factors in service industries. It offers a more positive, direct, and indirect relationship with the customer's behavior. SERVQUAL model ^[8,16] has been successfully used in the developed world's education, hospital, and food sectors ^[17]. This study focused on analyzing the commuters' satisfaction through service quality specifically considering the technology usage in the dimensions of tangibility, reliability, assurance, empathy, and responsiveness, to find the loyalty to keep attracting the public for increased rail transport usage.

In response to persistent automobile dependence and the need for sustainable mobility in Greater Kuala Lumpur, this study examines how perceived service quality shapes commuter intentions through customer satisfaction. The next section reviews recent evidence on the service quality-satisfaction-loyalty pathway and clarifies how technology-enabled attributes align with SERVQUAL.

Role of Technology and Improved Service Quality

The expansion of public transportation significantly enhances the quality of urban life and supports long-term economic growth. Efficient and reliable public transit systems not only improve mobility but also reduce traffic congestion, lower carbon emissions, and promote sustainable urban development. In Malaysia, the government has prioritized the modernization of its transport sector through the integration of advanced technologies and digital infrastructure. The launch of a fully automated driverless bus system in Iskandar, Johor, in April 2022 exemplifies the nation's commitment to smart and sustainable mobility ^[18].

Many developed countries have already adopted In-

telligent and Autonomous Transportation Systems (IATS) to address congestion, safety, and environmental challenges caused by heavy automobile dependence. Similarly, Malaysia is introducing Intelligent Public Transportation Systems (IPTS) that employ Internet of Things (IoT) technologies, artificial intelligence, and real-time communication tools to optimize urban mobility and improve commuter experience ^[18,19]. These innovations help transport operators deliver more reliable, responsive, and user-centred services that align with modern urban needs.

Smart transport infrastructure relies on several enabling technologies, including IoT, wireless communication, GPS, sensing devices, and cloud-based data systems. IoT applications allow vehicles and transport infrastructure to connect through the internet, enabling continuous monitoring of routes, passenger flow, and service performance ^[18]. Wireless technologies such as Wi-Fi and Bluetooth enhance data transfer, digital ticketing, and passenger navigation, while RFID (Radio Frequency Identification) systems facilitate automated fare collection and access control, reducing waiting time and operational inefficiency ^[19].

In addition, intelligent and autonomous systems employ vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, which supports safer driving environments and reduces the likelihood of collisions. Malaysia's government has also expanded the installation of charging infrastructure for electric vehicles, providing accessible charging points in both public and residential areas. This initiative supports the transition toward energy-efficient and low-emission public transport modes ^[20].

By integrating GPS, IoT, and real-time data analytics, Malaysia's urban rail and bus systems can offer improved punctuality, safety, and passenger satisfaction. These technologies not only enhance service reliability but also build commuter trust by providing accurate travel information and seamless digital transactions. Consequently, technology-driven service improvements are vital to strengthening the relationship between service quality and commuter satisfaction, as emphasized in studies on smart transportation and rail performance ^[21]. The adoption of these innovative solutions positions Malaysia to achieve a more sustainable, efficient, and passenger-focused urban mobility system.

2. Literature Review

This section reviews prior studies on service quality, satisfaction, and loyalty in urban rail transportation, emphasizing their interrelationships and the mediating role of commuter satisfaction. The review first outlines the SERVQUAL model and its application to urban rail systems and then connects these dimensions with commuter loyalty and behavioural intention.

2.1. SERVQUAL in Urban Rail and the Satisfaction–Loyalty Pathway

The SERVQUAL model, developed by Parasuraman et al. [8], remains one of the most widely used frameworks for evaluating service quality across industries. It identifies five dimensions i.e., tangibility, reliability, assurance, empathy, and responsiveness that together determine how customers perceive service performance. In public transport research, SERVQUAL has been applied extensively to measure perceived service quality and its influence on satisfaction and behavioural intention [22–24].

Recent studies on metro and rail services consistently demonstrate that perceived service quality (SQ) positively influences both satisfaction and post-use behavioural intentions. Multicity research across Europe and Asia shows a strong sequential relationship of SQ → satisfaction → loyalty, where satisfaction acts as a key mediator between service quality and behavioural intention [25]. In Kuala Lumpur, studies have confirmed that improved service quality enhances switching intention (from private car to public rail) and positive word-of-mouth behaviour, primarily through satisfaction mechanisms [25]. Similar results have been reported for Malaysia's KTM Komuter, LRT, and Monorail systems, where attributes such as reliability, cleanliness, and staff assurance significantly affect satisfaction and, subsequently, commuter loyalty [26,27].

Therefore, existing evidence reinforces the notion that commuter satisfaction is the critical link that translates service quality improvements into behavioural outcomes. A deeper understanding of this relationship is essential for policymakers to promote sustainable urban transport usage.

2.2. Connecting Technology to SERVQUAL Dimensions

The rise of smart transportation has expanded the scope of the SERVQUAL framework to include technology-enabled attributes. Today, urban rail users interact with services through mobile applications, real-time information systems, and contactless payment methods. These technological advancements directly align with SERVQUAL's RATER dimensions: reliability, assurance, tangibility, empathy, and responsiveness, by improving communication, convenience, and passenger experience [28,29].

For instance, real-time passenger information (RTI) and transit mobile apps enhance perceived reliability and responsiveness by reducing uncertainty about wait times and service delays. Empirical research across major cities indicates that RTI contributes to higher satisfaction levels when combined with consistent operational performance [30]. Digital tangibles such as e-signage, app interfaces, and automated ticketing also shape commuters' perceptions of service modernity and professionalism, thus reinforcing assurance and tangibility [31].

Moreover, contactless payment technologies and mobile ticketing systems simplify boarding and fare transactions, thereby improving convenience and accessibility [32]. These features foster trust and a sense of control, strengthening commuter satisfaction [33–35]. Collectively, these findings demonstrate that technological innovation operationalizes SERVQUAL dimensions rather than replacing them, illustrating how digital solutions enhance traditional service quality measures in public transportation systems.

2.3. Positioning and Contribution

This study builds on prior evidence by explicitly positioning commuter satisfaction as the mediating mechanism that connects service quality with loyalty and behavioural intention in Malaysia's urban rail network [36]. By integrating technology-driven attributes within the SERVQUAL framework and combining them with the Theory of Planned Behaviour (TPB), this research provides a holistic understanding of how modern commuters form intentions to use rail transport.

The proposed model extends existing literature by

testing this theoretical integration in the Greater Kuala Lumpur context ^[37], where rapid urbanization and increasing car ownership continue to challenge sustainable mobility ^[38]. Unlike previous single-mode analyses, this study encompasses multiple rail systems i.e., KTM Komuter, LRT, and MRT, to provide a broader and more representative assessment of commuter perceptions and satisfaction ^[39–41]. Through this integrated approach, the study offers both theoretical and practical contributions to improving Malaysia's public transport service quality and policy design.

2.4. Commuters' Satisfaction, Commuter Loyalty

Commuter satisfaction refers to the extent to which a traveller's expectations are fulfilled by the performance of a public transport service. It represents an emotional response, positive or negative, that arises from the comparison between the service a commuter expects, and the one experienced ^[42,43]. In public transport research, satisfaction is a key measure of the effectiveness and quality of services delivered by rail systems, buses, and other modes of transit. When passengers perceive that services are reliable, safe, comfortable, and accessible, their satisfaction levels increase, leading to favourable attitudes and repeat usage intentions ^[44].

Within the context of urban rail, commuter satisfaction plays a dual role: it directly influences behavioural intention and indirectly affects loyalty through psychological commitment. de Oña ^[12,35] highlighted that satisfaction and behavioural intention are closely related constructs that reflect users' willingness to reuse or recommend public transportation. Thus, commuter loyalty, often used interchangeably with behavioural intention represents the continued preference and commitment of passengers to use public transit regularly ^[45]. Satisfied commuters are more likely to engage in positive behaviours, such as advocating for the service, accepting fare adjustments, and remaining consistent users, which ultimately benefit transport operators and policymakers.

Numerous studies confirm the positive link between satisfaction and loyalty. For example, Wang et al. ^[46] found that higher satisfaction among public bus users significantly enhances loyalty and retention levels. Similarly, Ansoy & Safira ^[47] demonstrated that commuter satisfaction

strongly predicts long-term use intentions and word-of-mouth promotion across European cities. Satisfaction not only reflects the functional quality of service (e.g., punctuality, cleanliness, safety) but also the emotional aspects of the commuter experience, such as comfort, trust, and empathy from staff.

In the Malaysian context, ensuring commuter satisfaction is essential for increasing the attractiveness of public transport and achieving sustainable mobility goals. When service quality dimensions: tangibility, reliability, responsiveness, assurance, and empathy are effectively managed, they strengthen commuter satisfaction and, consequently, loyalty. Therefore, this study positions satisfaction as a core construct linking service quality and behavioural intention in Greater Kuala Lumpur's rail systems, consistent with global empirical findings on public transportation satisfaction and loyalty dynamics ^[47].

2.5. Hypotheses Development

Satisfaction is the most crucial factor for increasing the general usage intention of public transport ^[48]. Isai et al. ^[11] studied the relationship between services and commuter satisfaction for KTM Komuter services in Malaysia and revealed that transportation industry ignored the customer loyalty ^[49]. The effect of the services quality in the context of usage behavior has been used till present ^[20] commuter's satisfaction ^[50] and loyalty to the usage of public transport and customer loyalty ^[13,51].

Several researchers, consumer loyalty is strongly predicted by perceived service quality ^[52]. For instance, La and Cho ^[53] discovered in a study on the Indian banking industry that better service quality increases customer loyalty as well as complaints are decreased, and customer retention is enhanced.

In the past, researchers have looked at service quality and travel behaviour across age groups ^[23,54], gender ^[55], and geographical.

Another study conducted on the five megacities of Europe, i.e., London, Lisbon, Madrid, and Berlin, analysed the data set of about 2579 responses demonstrated that services quality provided in public transport is a significant predictor of the commuters' satisfaction, as well as the behavioural intention or customers loyalty. Several studies ^[56–58] performed SEM (Structural Equation Modelling)

analysis, and the result showed that service quality increases the usage intention of public transport. Thus, it is to hypothesize that:

H1: *Service quality is positively associated with Customer Loyalty.*

It has been shown that onsite surveys can provide more accurate assessments of transit customers' happiness and perceived service quality^[59]. The difference between what clients expect from a service and what they receive is what is known as service quality^[23]. Commuter satisfaction may possibly be used as a determinant to describe how customers perceive a service^[14], and customer satisfaction surveys (CSS) are frequently utilized to gather passenger impressions^[60].

Studies^[11,12] revealed that services quality is positively associated with customer's satisfaction. Another study^[61,62] also stated that services quality has a strong connection with customer satisfaction. If service providers want to retain and attract commuters, they must consider consumer satisfaction as the priority. Therefore, it is to hypothesize that:

H2: *Service quality is positively associated with commuter satisfaction.*

Customer demands are closely tied to customer satisfaction. Because customer satisfaction affects the interest in repurchasing, the company must improve both product and service quality to satisfy customers. Customers have a high repurchase intention on product purchases because they are satisfied with the provider, both in terms of their products and services. According to research^[63,64] commuter satisfaction has a substantial and beneficial effect in influencing consumers' propensity to repurchase products.

The service quality is the factor highlighted in several studies to determine commuter's satisfaction and the customer's loyalty. Kalhor et al.,^[65] also analyzed the data set of 3211 and found that customer satisfaction and customer loyalty are significantly associated. Ingvardson & Nielsen^[63] investigated the direct and positive effect of the commuter's delight and loyalty; thus, the following statement is developed below:

H3: *There is a significant relationship between Commuters' Satisfaction and Customer Loyalty.*

Several studies have confirmed a direct effect of the commuter's satisfaction on loyalty. However, there is still a shortage to finding the indirect relationship of customer satisfaction for service quality and customer's loyalty to the public transport mode^[66].

Both the theory of planned behaviour^[67,68] and the customer satisfaction study^[69] widely used to predict intention and actual behaviour of using public transportation. To the best of our knowledge, however, very little work has been done to really accomplish the fusion of the two theories, which is likely to give further psychological insight into transit use behaviour. This model will be based on a systematic integration of the customer satisfaction theory and the TPB^[70]. A study of Kalhor et al.^[71] which states that consumer happiness has a considerable impact on repurchase intention.

Furthermore Kalhor et al.^[71] analysed the direct and positive effect of commuters' satisfaction and Behavioural Intention. Likewise, they also found a mediating product of the customer's satisfaction which makes the strong relationship between the services quality and behavioural intention/Commuter's loyalty. Study^[72-74] observed through the analysis of the 4702 sample and during the PLS-SEM test that commuter's satisfaction and behavioural Intention have a high correlation of (0.95). In contrast, commuters' satisfaction has the full mediation effect on the service quality and behavioural intention/Loyalty. A study of Kalhor et al.^[71] found a partial mediating result of satisfaction on services quality and traveller's loyalty/ behavioural intention. Consequently, the statement is to hypothesize as follows:

H4: *The commuters' satisfaction has mediated the effect on services quality and Customer Loyalty.*

2.6. Conceptual Framework

The extensive literature review constructed the research framework based on different variables, as shown in **Figure 2**. To understand the synergistic effects on city rail use behaviour, complex relationships between the SERVQUAL- commuter satisfaction along with TPB theory's constructs are investigated^[11,75,76]. This approach is anticipated to be helpful in creating appropriate policies and interventions to maintain current transit users and draw in

new ones by providing more insight into respondents' decision-making processes. The figure shows a clearer view of the relationships among the variables. The five significant dimensional effect on service quality-customer satisfaction

plays the mediator between service quality and customer loyalty. Thus, service quality provision extends the passengers' positive intention, which increases the usage of city rail transport.

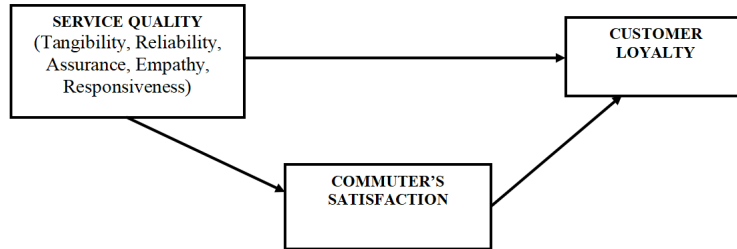


Figure 2. The Conceptual Framework.

Building on these theoretical links and recent applications in Asian metro systems, research is designed a cross-sectional survey and tested the conceptual model using PLS-SEM.

3. Method

Following the Saunders's Research Onion, the present research adopted the quantitative strategy (deductive approach). The researchers conducted an offline and online survey to collect the responses conveniently^[72] as the cross-sectional patterns from the citizens who are the users of the city rail transport in Greater Kuala Lumpur, Malaysia. Later, Google forms a closed-end questionnaire distributed among the targeted respondents through social platforms (officially and confidentially).

3.1. Sampling Procedure and Justification

A convenience sampling technique was employed due to the practical challenges of approaching a large and diverse commuter population, as well as restrictions during the COVID-19 period which limited full access to stations. To address potential limitations, the final sample size exceeded the minimum threshold required for PLS-SEM analysis ($n \geq 138$), thus enhancing the robustness of the findings^[73].

3.2. Sample Size and Response Rate

A total of 230 questionnaires were distributed, of which all were returned. After screening, 218 valid re-

sponses were retained for analysis. This sample size meets the requirements for SEM analysis and provides reliable insights into the commuter population^[74,75]. Thus, from 230 filled questionnaires around 218 appropriate questionnaires were processed in Smart PLS to perform the Structural Equation Modelling (SEM) analysis. This study adopted the reflective-reflective model analysis. It assesses the Reliability, Discriminant validity, CR, AVE, and direct and indirect effects of the loading's coefficients^[75].

3.3. Inclusion and Exclusion Criteria

Inclusion criteria were (i) respondents aged 18 years and above, (ii) commuters who had used KTM Komuter, LRT, or MRT at least once in the last three months, and (iii) residents of Greater Kuala Lumpur. Exclusion criteria were incomplete responses and non-users of urban rail.

3.4. Instrument Development

The closed-end questionnaire was developed based on two sections, i.e., the demographic profile of the respondents and variables items. Different factors used: Customer satisfaction as the mediator and customer loyalty as the dependent variable in the study. The items adopted from different studies were rephrased and edited based on the objectives of this research. The comprehensive research adopted seven items for customer loyalty by de Oña,^[76] and eight commuter satisfaction items by Nayum and Nordfjærn^[15] and de Oña,^[76]. There are twenty-three service quality items adopted from the study of Ibrahim et al.^[32] to know consumer's expectation and perception

and their intention from the quality service provided by the public transport. The variables' items were assessed on a five-point Likert scale, in which 1 = Strongly Disagree, 3 = Neither Agree nor Disagree, and 5 = Strongly Agree.

The following section reports measurement and structural results, followed by tests of mediation to evaluate whether satisfaction transmits the effect of service quality to behavioural intention.

4. Analysis & Results

For demographic analysis (see **Table 1**), 96.2% of the respondents were regular users of rail, while the rest refused to participate. The Federal Territory of Kuala Lumpur (39.2%) provided the most responses, followed by Selangor (33.9%) and Negeri Sembilan (26.9%). Male respondents constituted 60.8% of the total. The 21–30 years (35.7%) age group was the biggest, followed by 31–40

years (29%). By ethnicity, the sample was dominated by Malay (31.6%) and Chinese (31%) respondents. In terms of marital status, 45.6% were married and 33.9% were single.

By education, 40.4% had a bachelor's degree and 22.8% had postgraduate qualifications, while the remaining had lower levels. By employment status, 35.7% were self-employed, 25% were students, 23.4% were employed in the private sector, and 17% were government employees. Income distribution indicated that 24% of them earned less than RM2000, 22.2% earned RM2001–3000, while only small percentage recorded earnings exceeding RM7000. For the use of the rail system, 40.4% used the LRT, 39.2% the MRT, and 19.3% the KTM Komuter. The principal reasons for using the rail were social/recreation (38.6%) and education (22.2%), followed by employment as well, as indicated in **Table 1**.

Table 1. Demographic Profile.

No.	Question	Description	Percentage
1	States	Kuala Lumpur	48.5
		Selangor	30.1
		N. Sembilan	21.4
2	Gender	Male	64.1
		Female	35.9
3	Age group	18 to 20 years old	4.9
		21 to 30 years old	33
		31 to 40 years old	33.1
		41 to 50 years old	22.3
		51 years old and above	8.7
4	Ethnicity	Malay	29.1
		Chinese	23.3
		Indian	27.2
		Others	20.4
5	Marital status	Single	36.9
		Married	43.7
		Divorced	14.6
		Widowed	4.8
6	Education level	Primary	1.9
		Secondary/SPM/O-Level	9.7
		STPM/Certificate/Diploma	14.6
		Bachelor	43.7
		Postgraduate	30.1
7	Occupation	Govt/Public employee	20.4
		Private sector employee	12.6
		Self-employed	38.8
		Student	28.2
8	Income per month in (RM)	Below RM2000	22.3
		RM2001 to RM3000	23.3
		RM3001 to RM4000	12.6
		RM4001 to RM5000	13.6
		RM5001 to RM6000	11.7
		RM6001 to RM 7000	12
		RM7001 and above	4.5

Table 1. Cont.

No.	Question	Description	Percentage
9	Usage	KTM Komuter	19.4
		Mass Rail Transit (MRT)	35
		Light Rail Transit	43.7
		KL (Monorail)	7.8
		KLIA (express/ transit)	1.9
10	Purpose of Usage	For work	20.4
		For education	33
		For social activities	45.6
		Others	1

Analysis of the data was carried out utilizing Smart PLS for Structural Equation Modelling (SEM). This entails testing Cronbach's Alpha reliability ($\alpha \geq 0.70$), Composite Reliability (CR ≥ 0.70), Average Variance Extracted (AVE ≥ 0.40), and model fit indicators to test the significance of hypotheses. Modelling measurement entailed inspection of factor loading, construct validity, and reliability testing. A reflective–reflective model was used. During stage one, the reliability of the lower-order constructs (reliability, tangibility, assurance, empathy, and responsiveness) was examined. During stage two, higher-order construct service quality was tested to test

the hypotheses.

4.1. Construct Validity and Reliability for Lower-Order Constructs

Reliability is the consistency of a scale. Two frequent indicators are Cronbach's Alpha and Composite Reliability (CR). From **Table 2**, Cronbach's Alpha was between 0.771 to 0.950, whereas CR was between 0.619 to 0.856. Both were greater than the acceptable cut-off value of >0.70 [75–77]. Cross-loadings and exact CR values are described below. Summary statistics are given in **Table 2** (indices of reliability).

Table 2. Reliability of Lower Order Constructs.

	Cronbach's Alpha	Composite Reliability
RLBT	0.619	0.752
ASSU	0.66	0.814
RES	0.73	0.832
TAN	0.789	0.855
EMP	0.791	0.856
BI	0.793	0.849
CS	0.803	0.855

Note. ASSU = Assurance, BI = Behavioral Intention/customers' loyalty, CS = Consumers' Satisfaction, RLBT = Reliability, RES = Responsibility, TAN = Tangibility.

Cross-loadings indicate that all items exceeded the standard of 0.50 [72], except for two (RLBT2 and RLBT4) that were below the cut-off. Factor loadings are given in **Table 3**.

Table 3. Discriminant Validity Cross Loading.

	ASSU	BI	CS	EMP	RLBT	RES	TAN
ASSU1	0.826	0.34	0.434	0.627	0.47	0.547	0.576
ASSU2	0.75	0.291	0.351	0.553	0.46	0.451	0.496
ASSU3	0.734	0.264	0.337	0.517	0.404	0.506	0.494
BI1	0.118	0.673	0.554	0.25	0.295	0.323	0.287
BI2	0.25	0.587	0.473	0.252	0.323	0.356	0.277
BI3	0.293	0.703	0.544	0.413	0.32	0.393	0.414
BI4	0.326	0.689	0.516	0.403	0.353	0.394	0.428
BI5	0.254	0.72	0.542	0.346	0.308	0.369	0.389
BI6	0.289	0.642	0.478	0.376	0.305	0.331	0.349
BI7	0.27	0.656	0.511	0.278	0.291	0.286	0.348
CS1	0.249	0.596	0.693	0.325	0.42	0.363	0.434

Table 3. Cont.

	ASSU	BI	CS	EMP	RLBT	RES	TAN
CS2	0.423	0.567	0.722	0.466	0.439	0.476	0.512
CS3	0.29	0.59	0.655	0.396	0.371	0.334	0.491
CS4	0.391	0.58	0.731	0.466	0.39	0.466	0.446
CS5	0.263	0.389	0.618	0.357	0.356	0.332	0.424
CS6	0.327	0.467	0.673	0.471	0.413	0.451	0.416
CS7	0.351	0.453	0.642	0.396	0.379	0.397	0.382
EMP1	0.569	0.463	0.607	0.837	0.579	0.558	0.706
EMP2	0.584	0.319	0.386	0.708	0.464	0.532	0.562
EMP3	0.514	0.391	0.448	0.723	0.386	0.493	0.523
EMP4	0.512	0.364	0.356	0.669	0.465	0.566	0.522
EMP5	0.561	0.279	0.394	0.74	0.476	0.565	0.532
RLBT1	0.526	0.464	0.553	0.51	0.774	0.522	0.584
RLBT2	0.319	0.101	0.243	0.376	0.467	0.273	0.325
RLBT3	0.258	0.202	0.231	0.305	0.554	0.318	0.239
RLBT4	0.233	0.184	0.235	0.28	0.49	0.284	0.27
RLBT5	0.371	0.336	0.403	0.492	0.758	0.383	0.439
RES1	0.471	0.433	0.441	0.615	0.442	0.703	0.477
RES2	0.498	0.332	0.437	0.512	0.468	0.716	0.463
RES3	0.451	0.415	0.47	0.5	0.432	0.759	0.421
RES4	0.522	0.378	0.431	0.535	0.432	0.794	0.421
TAN1	0.506	0.487	0.55	0.584	0.515	0.469	0.828
TAN2	0.521	0.462	0.553	0.653	0.431	0.47	0.757
TAN3	0.476	0.355	0.495	0.611	0.471	0.502	0.704
TAN4	0.513	0.312	0.401	0.529	0.559	0.37	0.707
TAN5	0.502	0.326	0.377	0.473	0.39	0.378	0.676

Note. ASSU = Assurance, BI = Behavioural Intention/ customers' loyalty, CS = Consumers' Satisfaction, RLBT = Reliability, RES = Responsibility, TAN = Tangibility.

To verify multicollinearity, Variance Inflation Factor (VIF) was applied ^[73]. There is no issue of multicollinearity when VIF values are less than 5 ^[74]. Findings indicate that

all values were satisfactory, as depicted in **Table 4**.

Convergent validity indicates whether several items that measure one concept correlate with each other. Findings presented in **Table 5** reveal that variables showed convergent validity, assuring they measure the intended construct ^[75].

Table 4. Variance Inflation Factor.

	VIF
BI1	1.48
BI2	1.24
BI3	1.59
BI4	1.47
BI5	1.69
BI6	1.46
BI7	1.40
CS1	1.52
CS2	1.53
CS3	1.44
CS4	1.66
CS5	1.37
CS6	1.45
CS7	1.38
ASSU1	1.34
ASSU2	1.26
ASSU3	1.26
EMP1	1.78

Table 4. Cont.

	VIF
EMP2	1.50
EMP3	1.46
EMP4	1.36
EMP5	1.60
RES1	1.24
RES2	1.35
RES3	1.45
RES4	1.63
TAN1	1.83
TAN2	1.46
TAN3	1.42
TAN4	1.51
TAN5	1.39
RLBT1	1.18
RLBT2	1.11
RLBT3	1.26
RLBT4	1.11
RLBT 5	1.42

Note. ASSU = Assurance, BI = Behavioural Intention/customers' loyalty, CS = Consumers' Satisfaction, RLBT = Reliability, RES = Responsibility, TAN = Tangibility.

Table 5. Convergent Validity (AVE) Results.

Code	Sample Mean (M)	T Statistics (O/STDEV)	P Values
ASSU	0.593	20.007	0.000
BI	0.445	13.425	0.000
CS	0.457	18.069	0.000
EMP	0.542	20.206	0.000
RLBT	0.386	12.247	0.000
RES	0.552	17.946	0.000
TAN	0.54	20.93	0.000

Note. ASSU = Assurance, BI = Behavioural Intention/customers' loyalty, CS = Consumers' Satisfaction, RLBT = Reliability, RES = Responsibility, TAN = Tangibility.

Values of f^2 at 0.02, 0.15, and 0.35 correspond to small, medium, and large effects, respectively, according to Cohen's (1988) recommendations. The large effect of service quality on commuter satisfaction ($f^2 = 0.53$) and of satisfaction on loyalty ($f^2 = 0.42$) were observed in this research. The largest effect found was that of gamified elements on motivation ($f^2 = 2.06$), which is extremely large, indicating a strong contribution of this construct to the model.

4.2. Reliability and Validity of the Higher-Order Construct

For the second-order construct of service quality, Cronbach's Alpha and Composite Reliability were also

above the cut-off of ≥ 0.70 . Average Variance Extracted (AVE) was ≥ 0.50 , ensuring convergent validity^[72–75], as indicated in Table 6.

To test the Model Fit and Predictive Relevance, the Standardized Root Mean Square Residual (SRMR) of the model was 0.057, which was a good fit (< 0.08 ; Hairs et al. [72]). The Normed Fit Index (NFI) was 0.91, which is over the 0.90 cutoff. Blindfolding yielded positive Q^2 values for all endogenous constructs (Customer Satisfaction = 0.42; Behavioural Intention = 0.35), affirming predictive relevance^[73–75]. PLS-Predict also displayed greater predictive accuracy than the linear benchmark, affirming model robustness. Cross-loadings of the higher-order construct items were also more than 0.50^[76,77], as reported in Table 7.

Table 6. Convergent Validity (AVE) Results.

Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
0.908	0.914	0.931	0.731

Note. ASSU = Assurance, BI = Behavioural Intention/ customers' loyalty, CS = Consumers' Satisfaction, RLBT = Reliability, RES = Responsibility, TAN = Tangibility.

Table 7. Discriminant Validity Factor-Loading.

	BI	CS	Services Quality
BI1	0.693	0.558	0.334
BI2	0.586	0.47	0.348
BI3	0.701	0.547	0.446
BI4	0.675	0.518	0.457
BI5	0.722	0.544	0.409
BI6	0.635	0.48	0.394
BI7	0.66	0.515	0.349
CS1	0.601	0.705	0.446
CS2	0.566	0.717	0.548
CS3	0.59	0.665	0.462
CS4	0.58	0.729	0.512
CS5	0.389	0.614	0.426
CS6	0.469	0.667	0.505
CS7	0.454	0.636	0.449
EMP	0.496	0.608	0.912
RLBT	0.468	0.585	0.826
RES	0.524	0.597	0.844
TAN	0.534	0.657	0.878

Note. ASSU = Assurance, BI = Behavioural Intention/customers' loyalty, CS = Consumers' Satisfaction, RLBT = Reliability, RES = Responsibility, TAN = Tangibility.

4.3. Structural Model Testing

SEM was utilized to examine the relationships between variables and the hypotheses set.

4.3.1. Direct Relations

H1: Service quality (SQ) has a positive influence on customer loyalty (BI). Results indicated that SQ had no statistically significant direct effect ($\beta = 0.07$, $t = 0.874$, p

< 0.01). Therefore, H1 is not supported.

H2: Service quality (SQ) has a significant impact on commuter satisfaction (CS). Findings revealed a high correlation ($\beta = 0.708$, $t = 15.998$, $p < 0.01$). Thus, H2 is supported.

H3: Commuter satisfaction (CS) has a significant impact on loyalty (BI). Findings verified this connection ($\beta = 0.728$, $t = 10.338$, $p < 0.01$). Thus, H3 is supported.

Findings are illustrated in **Table 8** and **Figure 3**.

Table 8. Direct Relationship Results.

Hypotheses	Original Sample (O)	T Statistics (O/STDEV)	P Values	Decision
H1: SQ -> BI	0.07	0.874	0.383	Not Supported
H2: SQ -> CS	0.708	15.998	0.000	Supported
H3: CS -> BI	0.728	10.336	0.000	Supported

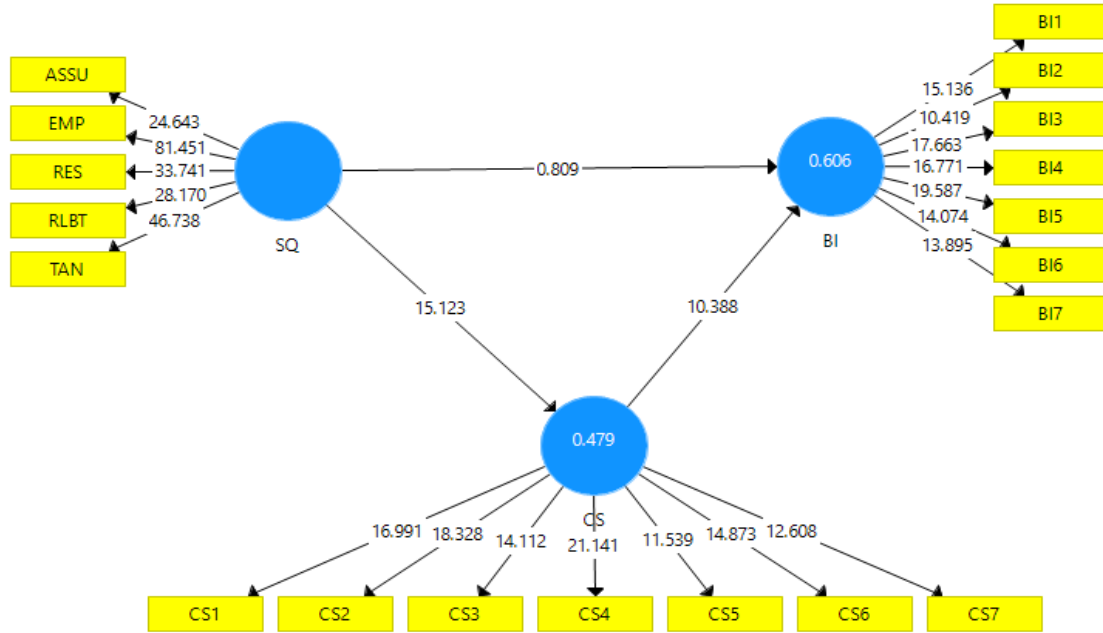


Figure 3. Structural Equation Modeling results showing standardized loadings and reliability indices for SERVQUAL, satisfaction, and Customer Loyalty constructs.

4.3.2. Indirect Relationship (Mediator Effect)

Hypotheses four identifies that customer satisfaction mediates significant effect of service quality and behavioural intention. The result in table shows strong indirect effect of customer satisfaction (beta = 0.515, $t = 8.53$, $p < 0.01$). Hence hypothesis has the full mediation effect, and results supported H4 (referred in **Table 9**).

As shown in results, the direct effect of service quality on behavioural intention was not significant ($\beta = 0.07$,

$p > 0.05$). However, the indirect path through customer satisfaction was significant and strong ($\beta = 0.515$, $t = 8.53$, $p < 0.001$), indicating full mediation. This suggests that improvements in service quality translate into greater behavioural intention only when they enhance customer satisfaction.

Having established full mediation, study now interpret these findings in Malaysia's policy, cultural, and technology context.

Table 9. Direct Relationship Results.

Hypothesis	Original Sample (O)	T Statistics (O/STDEV)	P Values	Decision
H4: SQ -> CS -> BI	0.515	8.53	0.000	Supported

Note. BI = Behavioural Intention.

5. Discussion and Implications

This study is to analyze service quality, customer satisfaction, and loyalty toward city rail transport in Greater Kuala Lumpur is the point of view of regular private automobile users using surveys and a structural equation modelling approach.

The SERVQUAL-customer satisfaction^[78] and TPB dimensions^[79,80] that are applicable to customers to use city rail transport. The respondents considered, tangibility,

reliability, responsiveness, empathy, and assurance to be significant factors influencing service quality towards the city rail transportation usage behaviour^[81]. The results of this study demonstrate that technology usage with consideration of the service quality dimensions is crucial in the case city rail passengers' satisfaction.

The structural equation modeling shows that service quality and commuters' satisfaction portrayed the consumer's loyalty towards city rail transport in Greater Kuala Lumpur, Malaysia. The results reflect that modern rail of

LRT, MRT, and KTM Komuter should use the services quality dimensions for higher satisfaction. The results (i.e., $\beta = 0.515$, $t = 0.829$, $p < 0.01$) for hypothesis (services quality is significantly related loyalty) ^[82–84]. The citizens' response shows that they have positive expectations from the public transport services with the perception of high accessibility, space, time punctuality, accuracy, security, safety, etc. ^[85]. The responses given on the Likert scale for services quality show positive results during the assessment. However, findings suggest the more improvements required in assurance, empathy, and tangibility services by the city rail transit in Malaysia.

This research contributes to the literature of the customer satisfaction and to their loyalty in context of the Malaysian city rail transport. The customers' loyalty towards rail transportation also strengthens the environmental sustainability in Greater Kuala Lumpur. This study helps to enhance the knowledge for increasing the usage behaviour for rail transport in metropolitan cities. The literature review also supported partial and complete mediation ^[86–88]. This research contributes to the literature by increasing the core focus of the service quality to enhance the commuters' satisfaction for the customers' loyalty. Hypothesis four shows that complete mediation of customer satisfaction affects the relationship between service quality and behavioural intention ^[89–92].

City rail transport service quality assumes as the critical component to enhancing the quality of life ^[93,94]. The lack of service quality in the context of tangibility, reliability, assurance, empathy, and assurance improves the hindrances for the public to participate actively in the daily routine activities, which ultimately results in the reduction in commuter satisfaction ^[95]. Results of the PLS-SEM show that services quality is associated with customer satisfaction. Lower order constructs of services quality also show a positive association with service quality.

Additionally, this study found that service quality is significantly related to the commuters' loyalty for the LRT, MRT, and KTM Komuter ^[96]. The results also help the government and transportation agencies to reduce congestion and pollution in Klang Valley, Malaysia. It also contributes to the Sustainable Development Goals 2030 i.e., good health & well-being, affordable & clean energy, sustainable cities & communities, and climate

action. In 2018, the world bank forecasted that almost every person living in the urban region of Malaysia has a car ^[97]. The study improves awareness among the public and supports the activities which stimulate positive behavior among the public to enhance rail transportation and alleviate traffic congestion, but it also saves money, improves security, reduces pollution, and improves efficiency and quality of life ^[98].

The 2020–2023 ridership trends illustrate the disruptive effect of COVID-19 on urban rail usage, with 2021 marking the lowest recorded volumes across all lines. The LRT Kelana Jaya Line experienced a 44.5% drop between 2020 and 2021, while the LRT Ampang/Sri Petaling Line saw a 36.8% decline in the same period. KL Monorail and other services recorded similar proportional decreases. However, the rebound in 2022 and 2023 was substantial, particularly for the LRT Kelana Jaya and Ampang/Sri Petaling Lines, both of which recovered to well above 50 million passengers by 2023 ^[80]. This rebound reflects increased public confidence, operational stability, and gradual restoration of normal travel demand. The patterns further indicate that targeted service quality improvements especially in reliability, safety, and accessibility are essential to sustaining recovery in the post-pandemic period.

Implications for Policy and Planning

The results have policy and rail expansion implications for urban transport policy in Greater Kuala Lumpur. The assurance that commuter satisfaction completely mediates the service quality–intention relationship implies that investments in infrastructure alone will not bring modal shift from private cars to rail. For commuter behavior to be affected, policymakers need to ensure that investments in operations and technology are converted into tangible changes in passenger experience.

Planning wise, the authorities need to give priority to real-time service observation, precise passenger information systems, upgraded station facilities, and expert staff training. These create commuter confidence, promote loyalty, and win new passengers, thus optimizing the social rate of return from rail investments. Management approaches need to concentrate resources on user values most prized, including punctuality, cleanliness, effective crowd management, and smooth first- and last-mile links.

In addition, as part of Sustainable Development Goal

11 (Sustainable Cities and Communities), improving urban rail decreases congestion, reduces greenhouse gas emissions, and increases overall liveability of cities. The resilience in ridership recovery post-pandemic also underscores the need for constructing backup-capable systems with the ability to continue service through disruptions. Lastly, consistent with Malaysia's National Transport Policy, improvements in service need to be paired with commuter-facing results to realize behavioural influence, in addition to backend upgrades.

6. Limitations and Future Research

Although this research brings new insights into the interplay of service quality, satisfaction, and behavioural intention in Greater Kuala Lumpur's rail industry, some caveats need to be acknowledged:

Geographical Scope – The sample was confined to Klang Valley, making generalizability to other areas of Malaysia or another international settings problematic.

Sample Size – While sufficient for PLS-SEM, the sample of 218 respondents is unlikely to represent the full heterogeneity of urban rail passengers.

Cross-sectional Design – Measures were taken at a single point in time, constraining causal inference and excluding consideration of seasonal or long-term changes in behavior.

Variable Coverage – The model did not consider variables like fare policy, alternative transport modes, reliability of travel time, and socio-psychological factors that can shape satisfaction and intention.

COVID-19 Context – Some of the data capture pandemic realities, which might have changed commuter behavior on a temporary basis.

Future Research Directions

Future research must increase the sample size and geography, use multiple Malaysian cities or make cross-country comparisons. A longitudinal study would register changes in attitudes and ridership over time, while mixed methods would complement understanding through combining quantitative and qualitative information. The inclusion of attitudinal and policy variables like safety perceptions, environmental awareness, fare encouragement, and equity would yield a more complete picture of

rail usage. Sophisticated model forms like artificial neural networks or SEM-ANN hybrids would promise better predictability and usability in practice.

7. Recommendations

From the findings, the following are advocated strategies to operators and transport authorities to increase satisfaction and divert travelers to rail:

Improve Reliability and Punctuality – Install sophisticated monitoring and real-time information systems to reduce delays and enhance schedule compliance.

Improve Safety and Security – Effectively implement strong safety measures, enhance the visibility of staff, and offer open communication during accidents in order to increase passenger confidence.

Upgrade Passenger Amenities – Keep facilities clean and offer contemporary amenities like Wi-Fi, charging points, and accessible infrastructure for passengers with disabilities.

Improve First- and Last-Mile Connectivity – Increase feeder bus services, integrate micromobility, and improve pedestrian access to stations.

Introduce Fare Incentives and Loyalty Schemes – Provide targeted discounts and loyalty incentives, especially for off-peak travelers, to drive more ridership and reduce peak-time congestion.

8. Conclusions

This research confirms that commuter satisfaction is the primary mediator of service quality and commuter behavioural intention on Greater Kuala Lumpur's rail network. Theoretically, it develops SERVQUAL uses further by incorporating technology-facilitated attributes (real-time information, contactless payments, station tangibles) into service quality to demonstrate that such innovations enact the traditional dimensions. Practically, it emphasizes that policy and management need to be directed at satisfaction-enhancing features, not just infrastructure improvement. By so doing, rail systems can be more competitive, sustainable, and resilient, thus promoting more modal shifts away from private cars and towards public transport.

Author Contributions

First author M.K. highlighted the problem statement, set the hypotheses, and executed the research process. Second author H.N.A.Y. was supervising, correcting the manuscript. The third author, C.R.S., conceived the whole project idea. All authors combined perform the data collection and analysis process with the help of software. In the end, all are agreed, read, and approved of the final manuscript.

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Institutional Review Board Statement

This study involved human participants who voluntarily responded to a structured survey. All participants were informed of the study's objectives, the voluntary nature of their participation, and their right to withdraw at any time without penalty. The study protocol was reviewed and approved by the UTAR Scientific and Ethical Review Committee under reference number Re: U/SERC/191/2020.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

More data related to this study will be made available on demand.

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Conflicts of Interest

The authors declare no conflict of interest.

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