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Exploring User Experience of Medan's Electric Bus Services: The Mediating Role of Customer Satisfaction in Smart Mobility and Service Quality

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ABSTRACT

This study examines the relationships between smart mobility, service quality, customer satisfaction, and user experience among users of the K1 Electric Bus in Medan. A quantitative explanatory approach was employed, involving 187 respondents selected through purposive sampling. Data were analyzed using partial least squares structural equation modeling (PLS-SEM) with SmartPLS 4. The results indicate that smart mobility positively influences customer satisfaction (β = 0.320, t = 2.254, p = 0.024), as does service quality (β = 0.585, t = 4.374, p < 0.001). Customer satisfaction also positively influences user experience (β = 0.681, t = 6.895, p < 0.001). However, the direct effects of smart mobility (β = 0.042, p = 0.748) and service quality (β = 0.209, p = 0.241) on user experience are not statistically significant. Customer satisfaction significantly mediates the relationships between smart mobility and user experience (β = 0.218, p = 0.032) and between service quality and user experience (β = 0.398, p < 0.001). The model explains 78.4% of the variance in customer satisfaction and 82.2% of the variance in user experience. These findings highlight the importance of customer satisfaction in connecting smart mobility and service quality with users' overall travel experience.

Keywords: Customer Satisfaction; Electric Bus; Service Quality; Smart Mobility; User Experience.

INTRODUCTION

Public transportation supports urban mobility and economic activity. Smart mobility uses technology to improve accessibility, information, connectivity, and sustainability, while electric buses can reduce transport emissions (Matubatuba & De Meyer-Heydenrych, 2022; Ribeiro et al., 2024; Vătămănescu et al., 2023).

Electric buses support lower-emission transport and modernize public services through technological integration (Ashraf & Idrisi, 2024; Moon et al., 2020; Ye et al., 2024). Their benefits also depend on users' perceptions of the service.

Medan operated 60 electric buses in 2024. Throughout 2025, the electric bus service recorded approximately 2.74 million passengers, averaging more than 200,000 passengers per month, with a peak of 279,732 passengers in October 2025. As of early 2026, the service was supported by 60 buses, consisting of 55 operational units and 5 reserve units, serving five main corridors in Medan City (Dinas Kominfo Kota Medan, 2026). By its second year of operation, Medan's electric bus services had served millions of passengers and generated steadily increasing revenue (Leandha, 2026). These

figures provide an overview of the development and utilization of electric bus services at the city level, still they should not be interpreted as passenger or fleet statistics specific to the K1 route. Therefore, this study focuses on K1 Electric Bus users (Amplas–Pinang Baris) to examine how Smart Mobility and Service Quality relate to Customer Satisfaction and User Experience.

Public transport performance depends not only on ridership and fleet size but also on users' comfort, convenience, accessibility, safety, and perceived service quality (Friman & Fellesson, 2009; van Lierop & El-Geneidy, 2016). Transport innovation can improve mobility efficiency and convenience, but travel experience also depends on service characteristics encountered during the journey (Carreira et al., 2013; Ittamalla & Srinivas Kumar, 2021). Smart mobility research often emphasizes technology adoption, while service-quality studies commonly examine satisfaction and loyalty. Research jointly examining Smart Mobility and Service Quality in relation to User Experience through Customer Satisfaction, especially for Indonesian electric buses, remains limited (Matubatuba & De Meyer-Heydenrych, 2022; van Lierop & El-Geneidy, 2016). This study examines relationships among Smart Mobility, Service Quality, Customer Satisfaction, and User Experience among K1 Electric Bus users in Medan, contributing evidence from an emerging urban transport context.

LITERATURE REVIEW

Smart Mobility

Smart mobility integrates technology into transportation to improve accessibility, information availability, connectivity, and sustainability. In this study, five indicators were conceptually adapted from previous research for the K1 Electric Bus context, rather than adopted directly from a single measurement scale. Technology integration draws on Matubatuba & De Meyer-Heydenrych (2022) and Vătămănescu et al. (2023), while accessibility and connectivity are informed by Ali (2021).

In this study, Smart Mobility on the K1 Electric Bus is measured through five indicators: technology integration, accessibility, information availability, sustainability, and connectivity. Information availability is based on Islam et al. (2020) who examined real-time bus passenger information, and sustainability is informed by Ribeiro et al. (2024), who studied bus electrification and decarbonization. The questionnaire items were tailored to assess users' perceptions of transport technology, ease of access, travel information, environmental benefits, and connections with other transport modes.

Service Quality

Service quality concerns how well a provider meets users' expectations. SERVQUAL identifies reliability, responsiveness, assurance, empathy, and tangibles as its five dimensions (Parasuraman et al., 1985, 1988), covering operational consistency, prompt assistance, trust, attention to user needs, and facilities.

Service quality shapes public transport users' evaluations and satisfaction (Friman & Fellesson, 2009; van Lierop & El-Geneidy, 2016). Studies also link reliability and service quality with public transport satisfaction (Alfando et al., 2023; Berggren et al., 2026; Fikri et al., 2025; Sham et al., 2024).

This study measures K1 Service Quality using the five SERVQUAL dimensions. While prior public transport research examines service quality and satisfaction, this study also tests User Experience as an outcome, both directly and through satisfaction.

Customer Satisfaction

Customer Satisfaction is users' evaluation of service performance against expectations (Oliver, 1980). Perceived service quality and value also shape satisfaction and subsequent responses (Zeithaml et al., 1996); transport reliability is associated with satisfaction (Berggren et al., 2026).

Customer Satisfaction is proposed as a mediator because users' evaluations may reflect whether mobility features and service quality meet their travel needs.

In this study, Customer Satisfaction is assessed through overall satisfaction, expectation fulfillment, perceived value, and likelihood to recommend. Overall satisfaction and expectation fulfillment reflect users' evaluations of their service experience, whereas perceived value concerns the benefits received relative to costs. Likelihood to recommend represents a behavioral intention that may follow satisfaction. These conceptual distinctions are acknowledged when interpreting the measurement of Customer Satisfaction in the K1 Electric Bus context.

User Experience

User Experience comprises users' cognitive and emotional responses to a service, including comfort, enjoyment, and journey evaluations in public transport (Bellone et al., 2021; Carreira et al., 2013; Ittamalla & Srinivas Kumar, 2021).

Customer Satisfaction evaluates service performance against expectations; User Experience focuses on how users perceive and respond to the journey itself.

User Experience is measured through enjoyment, comfort, perceived value, travel experience, and emotional experience. Perceived value under User Experience concerns whether the journey is worth the time and effort invested and whether it provides a quality travel experience. In contrast, perceived value under Customer Satisfaction concerns whether the fare paid is justified by the service benefits and is advantageous compared with alternative transport modes. Travel experience is defined in terms of journey continuity, smoothness from boarding to alighting, and the absence of significant disruptions. Although one questionnaire item uses the term "satisfying," the conceptual focus of this indicator is the continuity and smoothness of the journey rather than overall satisfaction with the service.

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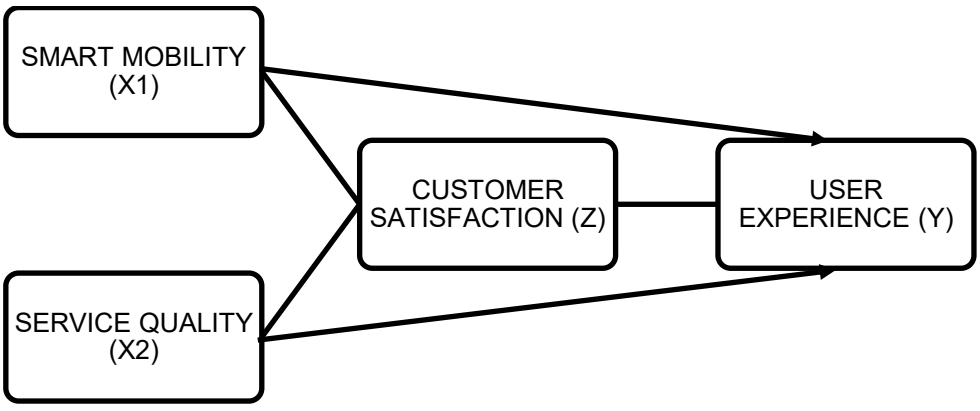


Figure 1. Conceptual Framework of the Effect of Smart Mobility, Service Quality, and User Experience Through Customer Satisfaction as a Mediator

Relationship Between Smart Mobility and Customer Satisfaction
Smart Mobility and Customer Satisfaction
Smart Mobility can increase customer satisfaction when users perceive the benefits of technology, ease of access, information availability, connectivity, efficiency, and sustainability in transportation services. Matubatuba & De Meyer-Heydenrych (2022) serta Vătămănescu et al. (2023) show that the application of technology and smart mobility characteristics can shape positive user evaluations of transportation services. In the context of the K1 Electric Bus, these benefits can increase satisfaction when users perceive the service as meeting their travel needs.
H1: Smart Mobility has a positive and significant effect on Customer Satisfaction.

Relationship Between Service Quality and Customer Satisfaction
Service Quality plays a role in shaping customer satisfaction because users evaluate the alignment between the quality of service received and their expectations. Friman & Fellesson (2009) and van Lierop & El-Geneidy (2016) highlight the importance of service quality in public transportation users' evaluations. The findings of Berggren et al. (2026) also indicate a relationship between service reliability and customer satisfaction. Therefore, consistent, responsive, and safe services, supported by adequate facilities, can increase K1 Electric Bus users' satisfaction.
H2: Service Quality Has a Positive and Significant Effect on Customer Satisfaction of K1 Electric Bus Users in Medan.

Relationship Between Customer Satisfaction and User Experience
Customer satisfaction reflects users' evaluations of service performance in relation to their expectations (Oliver, 1980), whereas user experience encompasses users' cognitive and emotional responses throughout their interactions with a service (Bellone et al., 2021; Carreira et al., 2013). Although previous studies have commonly examined user experience as an antecedent of customer satisfaction (The et al., 2025), this study proposes customer satisfaction as a predictor of user experience in the K1 Electric Bus context. This approach examines whether users' satisfaction with the service is associated with their overall evaluation of the travel experience. The proposed relationship is tested empirically, although the cross-sectional design does not establish causality.
H3: Customer Satisfaction Has a Positive and Significant Effect on the User Experience of K1 Electric Bus Users In Medan.

Relationship Between Smart Mobility and User Experience
Smart mobility relates not only to technology use but also to how users experience the service's convenience, efficiency, connectivity, and benefits during their journey. These characteristics can shape user experience through interactions with the transportation system and the information available (Vătămănescu et al., 2023). Therefore, implementing smart mobility on the K1 Electric Bus is expected to improve user experience.
H4: Smart Mobility Has a Positive and Significant Effect on User Experience of K1 Electric Bus Users In Medan.

Relationship Between Service Quality and User Experience
Service quality is part of the experience users perceive while using public transportation. Reliable, responsive, safe, and empathetic services, supported by adequate facilities, can lead to a more positive evaluation of the travel experience. Carreira et al. (2013) and Ittamalla & Srinivas Kumar (2021) show that service characteristics and travel experiences are important aspects in shaping user experience in public transportation.
H5: Service Quality Has A Positive And Significant Effect On User Experience Of K1 Electric Bus Users In Medan.

Smart mobility features, such as accessibility, information availability, connectivity, and technology integration, may contribute to customer satisfaction by improving users' perceptions of transportation services (Ali, 2021; Matubatuba & De Meyer-Heydenrych, 2022). When these features meet users' travel needs and expectations, satisfaction may serve as a link between smart mobility and their overall user experience. Therefore, customer satisfaction is expected to mediate the relationship between Smart Mobility and User Experience in the K1 Electric Bus service as follows:

H6a: Customer Satisfaction mediates the effect of Smart Mobility on User Experience among K1 Electric Bus users in Medan.

Service quality dimensions, including reliability, responsiveness, assurance, empathy, and tangibles, are important in shaping users' evaluations of public transportation services (Friman & Fellesson, 2009; Parasuraman et al., 1988). When users perceive the K1 Electric Bus service as reliable and responsive to their needs, they may develop greater satisfaction, which may be associated with a more positive overall user experience. Therefore, customer satisfaction is expected to mediate the relationship between Service Quality and User Experience.

H6b: Customer Satisfaction mediates the effect of Service Quality on User Experience among K1 Electric Bus users in Medan.

RESEARCH METHOD

This quantitative explanatory study examined Smart Mobility, Service Quality, Customer Satisfaction, and User Experience among K1 Electric Bus users in Medan. Data were collected from July to August using a five-point Likert scale (1 = strongly disagree; 5 = strongly agree.

Purposive sampling required respondents to be at least 17, to have used the K1 Electric Bus on the Amplas–Pinang Baris route in the previous six months, and to complete the questionnaire. Of 276 responses, 89 responses were excluded, leaving 187 valid responses for analysis. Three negatively worded questionnaire items—SM7 (difficulty obtaining schedule information), SQ5 (staff responsiveness), and CS5 (fulfillment of travel expectations)—were reverse-coded, to align their scoring direction with the positively worded items. For the five-point Likert scale, the recoded score was calculated as 6 minus the original score: 1 was converted to 5, 2 to 4, 3 remained unchanged, 4 was converted to 2, and 5 to 1.

Data were analyzed with PLS-SEM in SmartPLS 4. The measurement model used outer loadings, reliability, and convergent validity; the structural model used R^2, effect sizes, predictive relevance, and fit measures. Bootstrapping tested direct and indirect relationships at 5% significance (Hair et al., 2022)..

RESULTS

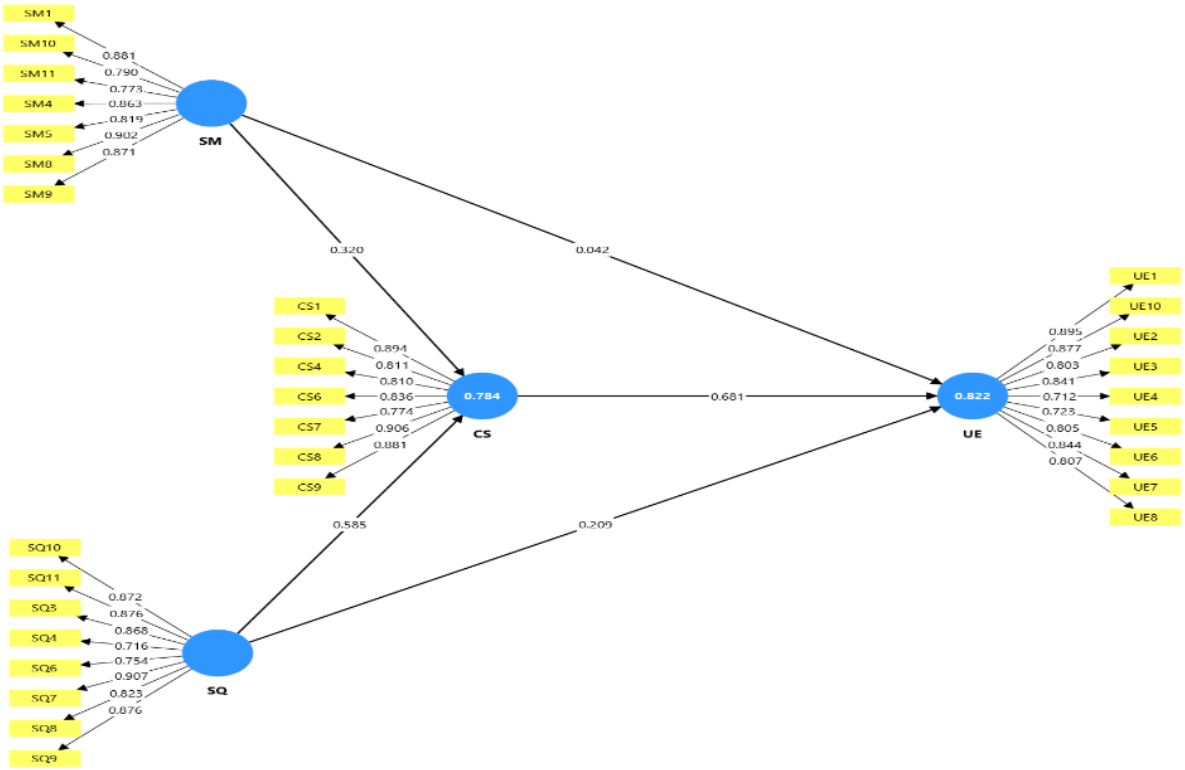


Figure 2. Overview Result

The 187 respondents met the eligibility criteria; their characteristics are summarized below.

Table 1.
Demographic Characteristic and Usage Frequency of Respondents

Characteristic	Category	n	%	n Total	Percentage Total
Gender	Male	73	39.04	187	100 %
	Female	114	60.96		
Age	17–25 years	109	58.29	187	100 %
	26–35 years	59	31.55		
	36–45 years	18	9.63		
	>45 years	1	0.53		
Education	SMP	9	4.81	187	100 %
	SMA/SMK	113	60.43		
	Diploma (D3)	8	4.28		
	S1	56	29.95		
	S2/S3	1	0.53		
Frequency of Use	1–2 times	24	12.83	187	100 %
	3–5 times	64	34.22		
	6–10 times	62	33.16		
	>10 times	37	19.79		

Most respondents were female (60.96%) and aged 17–25 (58.29%). SMA/SMK graduates formed the largest education group (60.43%); 3–5 trips was the most common usage frequency (34.22%).

Table 2.
Outer Loading of the Measurement Model

	CS	SM	SQ	UE
CS1	0.894			
CS2	0.811			
CS4	0.810			
CS6	0.836			
CS7	0.774			
CS8	0.906			
CS9	0.881			
SM1		0.881		
SM10		0.790		
SM11		0.773		
SM4		0.863		
SM5		0.819		
SM8		0.902		
SM9		0.871		
SQ10			0.872	
SQ11			0.876	
SQ3			0.868	
SQ4			0.716	
SQ6			0.754	
SQ7			0.907	
SQ8			0.823	
SQ9			0.876	
UE1				0.895
UE10				0.877
UE2				0.803
UE3				0.841
UE4				0.712
UE5				0.723
UE6				0.805
UE7				0.844
UE8				0.807

Source: *smartPLS4*

Outer loadings ranged from 0.712 to 0.907, exceeding the commonly used threshold of 0.70.

Table 3.
Construct Reliability and Convergent Validity

	Cronbach's alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
CS	0.933	0.936	0.946	0.715
SM	0.932	0.938	0.945	0.712
SQ	0.939	0.942	0.950	0.704
UE	0.936	0.941	0.946	0.663

Source: *smartPLS4*

All constructs had Cronbach's alpha, rho_A, and rho_C above 0.70 and AVE above 0.50, supporting reliability and convergent validity. Discriminant validity was assessed using the heterotrait–monotrait ratio (HTMT). To maintain a concise presentation in

accordance with the conference paper format, the HTMT matrix is not presented as a separate table in the main text. HTMT ranged from 0.860 to 0.961, with four of six pairs above 0.90. Service Quality–Smart Mobility (0.961) and Customer Satisfaction–User Experience (0.958) indicate possible construct overlap; discriminant validity is therefore not fully established, and findings require caution.

Table 4.
Coefficient of Determination (R^2)

	R-square	Adjusted R-square
CS	0.784	0.782
UE	0.822	0.819

Source: *smartPLS4*

The R^2 value for Customer Satisfaction was 0.784, indicating that Smart Mobility and Service Quality jointly explained 78.4% of its variance. The adjusted R^2 value was 0.782. For User Experience, the R^2 value was 0.822, indicating that Smart Mobility, Service Quality, and Customer Satisfaction jointly explained 82.2% of its variance, with an adjusted R^2 of 0.819. These results indicate substantial explanatory power within the study sample. Inner-model collinearity was assessed using variance inflation factor (VIF) values. The VIF values ranged from 4.633 to 7.281, with four of the five predictor relationships exceeding the commonly used threshold of 5. These results indicate potential collinearity among the structural predictors. Accordingly, the path coefficients and mediation findings should be interpreted cautiously, as collinearity may affect the stability of the estimated relationships.

Table 5.
Effect Sizes (f^2)

	CS	SM	SQ	UE
CS				0.562
SM	0.083			0.002
SQ	0.278			0.034
UE				

Source: *smartPLS4*

Customer Satisfaction had a large effect on User Experience ($f^2 = 0.562$). Service Quality had a medium effect on Customer Satisfaction (0.278), and Smart Mobility a small effect (0.083). Effects on User Experience were small for Service Quality (0.034) and very small for Smart Mobility (0.002).

Table 6.
PLS-Predict Results

	Q²_predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE	IA_RMSE	IA_MAE
CS1	0.553	0.486	0.318	0.623	0.345	0.727	0.547
CS2	0.472	0.491	0.414	0.559	0.404	0.676	0.570
CS4	0.421	0.519	0.401	0.585	0.404	0.682	0.567
CS6	0.615	0.400	0.209	0.505	0.249	0.645	0.408
CS7	0.395	0.419	0.199	0.485	0.239	0.539	0.336
CS8	0.673	0.356	0.197	0.444	0.232	0.623	0.420
CS9	0.618	0.425	0.233	0.547	0.271	0.687	0.473

UE1	0.645	0.418	0.242	0.519	0.269	0.701	0.497
UE10	0.546	0.427	0.279	0.509	0.306	0.633	0.474
UE2	0.447	0.488	0.352	0.533	0.346	0.657	0.524
UE3	0.442	0.560	0.409	0.599	0.413	0.749	0.584
UE4	0.249	0.763	0.634	0.707	0.577	0.881	0.704
UE5	0.366	0.502	0.341	0.565	0.367	0.630	0.492
UE6	0.407	0.460	0.290	0.517	0.309	0.598	0.467
UE7	0.371	0.495	0.303	0.540	0.320	0.625	0.477
UE8	0.519	0.481	0.327	0.536	0.347	0.694	0.528

Source: *smartPLS4*

All Customer Satisfaction and User Experience indicators had positive Q^2_predict values. CVPAT supported overall predictive capability, although UE4 prediction errors were higher for PLS-SEM than for the linear model.

Table 7.
Model Fit Indices

	Saturated Model	**Estimated Model**
SRMR	0.064	0.064
d_ULS	2.046	2.046
d_G	1.959	1.959
Chi-square	1740.335	1740.335
NFI	0.747	0.747

Source: *smartPLS4*

SRMR was 0.064, below 0.080, while NFI was 0.747, indicating that model fit was not optimal on all measures.

Table 8.
Bootstrapping Results for Direct Effects

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
CS -> UE	0.681	0.683	0.099	6.895	<0.001
SM -> CS	0.320	0.295	0.142	2.254	0.024
SM -> UE	0.042	0.044	0.132	0.321	0.748
SQ -> CS	0.585	0.606	0.134	4.374	<0.001
SQ -> UE	0.209	0.206	0.178	1.172	0.241

Source: *smartPLS4*

Smart Mobility positively affected Customer Satisfaction ($\beta = 0.320$, $t = 2.254$, $p = 0.024$), as did Service Quality ($\beta = 0.585$, $t = 4.374$, $p < 0.001$). Customer Satisfaction positively related to User Experience ($\beta = 0.681$, $t = 6.895$, $p < 0.001$). Direct effects of Smart Mobility ($\beta = 0.042$, $p = 0.748$) and Service Quality ($\beta = 0.209$, $p = 0.241$) on User Experience were not significant.

Table 9.
Specific Indirect Effects and Mediation Results

Indirect Relationship	B	t-statistic	p-value	Bias-corrected 95% CI	Decision
SM → CS → UE	0.218	2.146	0.032	0.030–0.422	H6a supported
SQ → CS → UE	0.398	3.484	<0.001	0.215–0.658	H6b supported

Customer Satisfaction mediated Smart Mobility's (β = 0.218, t = 2.146, p = 0.032, 95% CI [0.030, 0.422]) and Service Quality's (β = 0.398, t = 3.484, p < 0.001, 95% CI [0.215, 0.658]) relationships with User Experience.

DISCUSSION

Smart Mobility and Customer Satisfaction

Smart Mobility positively related to Customer Satisfaction (β = 0.320, p = 0.024), supporting H1. This aligns with research linking technology, access, information, connectivity, and sustainability with positive transport-service evaluations (Matubatuba & De Meyer-Heydenrych, 2022; Vătămănescu et al., 2023).

Service Quality and Customer Satisfaction

Service Quality positively related to Customer Satisfaction (β = 0.585, p < 0.001), supporting H2 and showing a stronger relationship with satisfaction than Smart Mobility. This aligns with SERVQUAL and public transport studies (Friman & Fellesson, 2009; Parasuraman et al., 1988).

Customer Satisfaction and User Experience

Customer Satisfaction positively related to User Experience (β = 0.681, p < 0.001), supporting H3. Consistent with Oliver (1980), users' evaluations of whether service performance meets expectations may be associated with their overall journey evaluation. Cross-sectional data do not prove causality.

Smart Mobility and User Experience

Smart Mobility does not have a significant direct effect on User Experience (β = 0.042, t = 0.321, p = 0.748); therefore, H4 is not supported. This result differs from the broader smart mobility perspective discussed by Vătămănescu et al. (2023), whose study examined the factors influencing electric car-sharing adoption rather than user experience in public transportation. The difference may reflect the distinct research contexts and outcome variables. In the K1 Electric Bus context, smart mobility features may not be sufficient to shape users' overall experience directly. Instead, their relationship with User Experience may operate through Customer Satisfaction, as indicated by the significant indirect effect found in this study. This interpretation should be considered in the context of the present findings rather than as evidence that smart

mobility features are ineffective. Smart Mobility had no significant direct relationship with User Experience (β = 0.042, p = 0.748); H4 was not supported. In this sample, mobility features may relate to experience through satisfaction rather than directly.

Service Quality and User Experience

Service Quality does not have a significant direct effect on User Experience (β = 0.209, t = 1.172, p = 0.241). Therefore, H5 is not supported.

These results differ from several previous studies that have linked service quality to user experience in public transportation, such as van Lierop & El-Geneidy (2016), Sham et al. (2024), and Fikri et al. (2025). Service Quality had no significant direct relationship with User Experience (β = 0.209, p = 0.241); H5 was not supported. The findings suggest its relationship with experience may operate through satisfaction in this model.

The Role of Customer Satisfaction as a Mediator

The results show that Customer Satisfaction mediates the relationship between Smart Mobility and User Experience (β = 0.218; p = 0.032), as well as the relationship between Service Quality and User Experience (β = 0.398; p < 0.001). Because the direct effects on User Experience are not significant, while the indirect effects are, this pattern indicates indirect-only mediation.

Customer Satisfaction mediated the relationships of Smart Mobility (β = 0.218, p = 0.032) and Service Quality (β = 0.398, p < 0.001) with User Experience. Significant indirect effects alongside non-significant direct effects indicate indirect-only mediation. Potential construct overlap and collinearity require cautious interpretation.

CONCLUSION

Among 187 K1 Electric Bus users, Smart Mobility and Service Quality were positively associated with Customer Satisfaction, which was positively associated with User Experience. The direct relationships of Smart Mobility and Service Quality with User Experience were not significant, whereas both indirect relationships through satisfaction were significant. The model explained 78.4% of the variance in Customer Satisfaction and 82.2% of the variance in User Experience. The single-route, cross-sectional design and potential construct overlap and collinearity limit interpretation.

RECOMMENDATION

Operators should prioritize accessible and timely travel information, connectivity, service reliability, staff responsiveness, passenger comfort, and facility conditions. Because the direct relationships of Smart Mobility and Service Quality with User Experience were not significant while their indirect relationships through Customer Satisfaction were significant, operators should monitor whether service improvements are accompanied by higher satisfaction and better reported travel experiences. Future research should include multiple routes and data-collection periods and use measures that more clearly distinguish Customer Satisfaction from User Experience, particularly perceived value and travel experience; it should incorporate objective operational indicators where available. As this study is cross-sectional and limited to one route, its findings should not be interpreted causally or generalized to all electric-bus users without caution.

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