Volume 4, No. 8 August 2026
p-ISSN 3032-3037 | e-ISSN 3031-5786

ADVANCES IN SOCIAL HUMANITIES RESEARCH

Analysis of Intermodal Service Performance Integration Between LRT and Musi Emas Feeder Based on Physical Facilities and User Perception in Palembang City

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Keywords: Intermodal Integration; Palembang LRT; Musi Emas Feeder; Servqual; Customer Satisfaction Index

Abstract

This study evaluated the actual condition of physical facilities, identified service-quality bottlenecks, and formulated strategic interventions to improve intermodal integration performance between the South Sumatra Light Rail Transit (LRT) and the Musi Emas feeder service in Palembang City, with Asrama Haji Station and Polrestabes Station serving as case studies. Primary data were collected through field observations based on national regulations (Ministry of Transportation Regulation No. PM 41/2015 and No. PM 29/2019, and Ministry of Public Works Regulation No. 14/PRT/M/2017) and through a questionnaire distributed to 374 respondents selected using probability sampling. The data were analyzed using a combination of multivariate methods, including SERVQUAL gap analysis, the Customer Satisfaction Index (CSI), Importance–Performance Analysis (IPA), and Partial Least Squares Structural Equation Modeling (PLS-SEM), with data processing conducted using SmartPLS 4 and SPSS. The overall evaluation indicated a high level of commuter satisfaction, with an overall CSI score of 87.8%, categorized as “Very Satisfied.” The IPA Cartesian diagram showed that most of the 18 service attributes were distributed across Quadrants I and IV, indicating that core physical infrastructure and LRT operational punctuality generally performed well, although attributes in Quadrant I still required priority improvement because of their high importance and comparatively lower performance. The structural model assessment ($R^2 = 0.639$ for the Performance model and $R^2 = 0.831$ for the Satisfaction model) indicated that satisfaction was influenced not only by physical infrastructure but also by interpersonal and nonphysical service performance. The Empathy dimension (X5) demonstrated the strongest effect, with a path coefficient of 0.390, followed by Comfort and Safety (X4 = 0.276) and the Information System (X3 = 0.272).

INTRODUCTION

Palembang, as one of the metropolitan cities in South Sumatra, continues to experience population growth and increasing economic activity, which directly increase mobility demand and require an efficient and sustainable transportation system (Romdhoni et al., 2023). Traffic congestion has become a critical problem that must be addressed to support sustainable urban activity. In response to this issue, the Palembang City Government has developed an integrated public transportation system, most notably the Light Rail Transit (LRT), which has operated since the 2018 Asian Games (Anggraini et al., 2023). Alongside the LRT, the city also operates the Musi Emas feeder service to complement the public transportation network (Agustien et al., 2025; Huang et al., 2021). Effective intermodal integration is expected to improve efficiency, accessibility, and comfort for public transport users while reducing dependence on private vehicles (Anisah et al., 2020).

The importance of intermodal integration is further reinforced by the Transit-Oriented Development (TOD) concept, which aims to increase public transport ridership (Agustin, 2022). The application of TOD to the Palembang LRT is intended to maximize the development potential of areas surrounding stations, strengthen connectivity, and support sustainable urban development (Romdhoni et al., 2023); effective integration between the LRT and its feeder service is therefore a key factor in the successful implementation of TOD in Palembang. However, successful intermodal integration depends not only on the availability of physical infrastructure but also on service quality and user perceptions (Anisah et al., 2020; Ratnasari, 2020). Adequate physical facilities—such as comfortable stops, clear information, and convenient access—are essential for creating a positive travel experience (Isradi et al., 2021), while users' perceptions of service quality, including safety, reliability, responsiveness, and staff friendliness, play an important role in determining satisfaction and continued willingness to use public transportation (Obsie & Woldeamanuel, 2020).

Several critical issues motivated this research. Physical facilities at intermodal transfer points may not yet fully support smooth, safe, and comfortable passenger movement because of issues such as confusing layouts, insufficient shelter, limited accessibility, and unclear route signage. User perceptions of service quality may also vary considerably and may not correspond to the standards expected by operators and government authorities (Al-Neyadi et al., 2018; Pataraia et al., 2025; Zhang et al., 2022). Furthermore, the effectiveness of existing physical facility designs in facilitating fast, safe, and comfortable passenger transfers—particularly during peak passenger periods—has not been comprehensively evaluated. The factors that most strongly influence user satisfaction during intermodal transfers at the two stations have also not been clearly identified. In addition, there remains a lack of concrete, evidence-based policy recommendations derived from comprehensive empirical evaluations of intermodal service performance in Palembang (Alhadi et al., 2026; Megawati et al., 2026; Timperio, 2024).

Based on this background, the research addressed four main issues: (1) the condition of physical facilities at Asrama Haji and Polrestabes LRT Stations in supporting LRT–feeder intermodal integration; (2) the factors influencing user satisfaction with intermodal integration services at both stations; (3) users' perceptions of intermodal service quality at both stations; and (4) strategies for improving intermodal service performance based on evaluations of physical facilities and user perceptions.

Accordingly, this study aimed to assess and analyze the condition of physical facilities at both stations, identify the factors influencing user satisfaction, evaluate users' perceptions of service quality, and formulate strategies for improving intermodal service performance (Adamos & Nathanail, 2022; Fang et al., 2020; Paraskevadakis et al., 2021; Salisu et al., 2024; Saputra et al., 2024). Academically, the study is expected to contribute to the literature on public transportation intermodal integration and service-performance evaluation. Practically, it is expected to provide strategic recommendations for local government, transportation authorities, and other stakeholders seeking to improve the quality of public transportation services in Palembang.

The novelty of this research lies in its integrated evaluation of intermodal service performance within the LRT and Musi Emas feeder system by combining physical facility assessment with user-perception analysis at Asrama Haji and Polrestabes Stations in 2025. Specifically, the study jointly applies SERVQUAL, the Customer Satisfaction Index (CSI), Importance–Performance Analysis (IPA), and Partial Least Squares Structural Equation Modeling (PLS-SEM), thereby integrating service-quality measurement, satisfaction assessment, priority mapping, and structural relationship analysis within a single empirical framework. This combination of research locus, intermodal context, and analytical methods has not previously been examined comprehensively within the Palembang public transportation setting.

METHOD

This research employed a mixed-methods design combining quantitative and qualitative approaches. The quantitative approach measured and analyzed users' perceptions of service quality and satisfaction through questionnaire surveys and statistical analysis, while the qualitative approach used interviews and direct observations to explore user experiences, factors influencing satisfaction, and strategies for improving service performance. The integration of both approaches supported data triangulation and provided a more comprehensive understanding of intermodal service performance. The overall research process is presented in Figure 1.

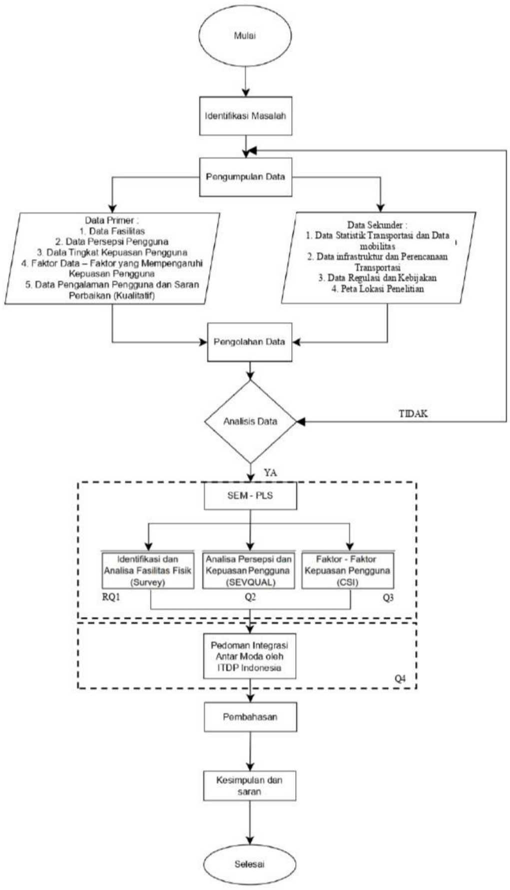

Figure 1. Research Flow Diagram

Source: Author's compilation (2025)

Data Collection and Analysis Techniques

Data were collected through four complementary methods: (1) a structured user survey administered to LRT and Musi Emas feeder users at Asrama Haji and Polrestabes Stations, covering perceived service performance, quality, satisfaction, physical facilities, and user experience across access, comfort, security, reliability, information, and intermodal integration; (2) structured field observation of physical facilities, user behaviour, and service operation, focusing on facility condition (cleanliness, lighting, signage), information availability, and staff-user interaction; (3) semi-structured in-depth interviews with key stakeholders, including the operator of the LRT and Musi Emas feeder, regional transport planners, and user representatives; and (4) secondary data collection from transport performance reports, ridership data, facility data, transport policy, and planning documents.

The collected data were analyzed using several complementary techniques. Descriptive analysis summarized respondent characteristics, user perception, and facility conditions using frequency, percentage, mean, and standard deviation. Service-quality analysis applied an adaptation of the SERVQUAL model across five dimensions-Reliability, Responsiveness, Assurance, Empathy, and Tangibles-each measured on a five-point Likert scale, from which a Performance (P) score and an

Expectation/Satisfaction (E) score were computed for every item, and the service-quality Gap (Gap = P - E) was derived; a negative gap indicates an area performing below user expectation and therefore a priority for improvement. Overall user satisfaction was measured with the Customer Satisfaction Index (CSI), computed from the weighted average of user satisfaction ratings across all relevant service and facility attributes, producing a single, easily interpretable satisfaction indicator. Attribute prioritization was performed with Importance-Performance Analysis (IPA), in which each attribute's importance and performance ratings were plotted on a two-dimensional cartesian matrix split by the grand-mean values on the Performance (X) and Importance (Y) axes into four quadrants: Quadrant I (Keep Up the Good Work), Quadrant II (Concentrate Here / main priority), Quadrant III (Low Priority), and Quadrant IV (Possible Overkill).

To test the theoretical model and the complex relationships among variables, Structural Equation Modeling-Partial Least Squares (SEM-PLS) was applied using SmartPLS 4. SEM-PLS is well suited to research involving latent theoretical constructs (such as service quality and satisfaction) and enables simultaneous testing of direct and indirect effects; it was used to test whether physical-facility quality (independent variable) directly affects user satisfaction and/or transfer effectiveness (mediator), whether perceived service quality affects satisfaction, and whether perceived service quality mediates the relationship between physical-facility quality and satisfaction. SEM-PLS is particularly appropriate for moderate sample sizes and complex predictive models. In parallel, the study referred to the intermodal integration guideline published by ITDP Indonesia (Rakhmatulloh et al., 2022), which specifies components such as direct connection, direct crossing, and pedestrian facilities that must be met to achieve fast and easy passenger transfer within a public transport system; interview transcripts were analyzed using qualitative content analysis to identify themes, patterns, and stakeholder perspectives; and gap analysis was performed at both the conceptual level (the research gap identified in the literature review) and the empirical level (the SERVQUAL P-E gap computed from survey data), with negative or low gaps indicating priority areas for improvement.

Population, Sample, and Study Location

The study population comprises all individuals interacting with the LRT-Musi Emas feeder intermodal integration system at the two study locations during 2025, namely public-transport users transferring between the LRT and feeder services at Asrama Haji and Polrestabes Station areas; operational staff at the integration points (information officers, cleaning staff, security personnel, feeder crew); and institutional stakeholders relevant to integrated public transport provision in Palembang, including the Palembang City Transportation Agency, the South Sumatra Light Rail Management Agency (BPKARSS), and the Musi Emas feeder operator. Passengers recorded at the two LRT stations and the three feeder corridors (Corridor 2, 3, 4 and 8) during 2025 totalled 2,921,306 trips, averaging 8,004 passengers per day, as summarized in Table 3 below.

The sample size for the quantitative user survey was determined using the Slovin formula at a 90% confidence level: $n = N / (1 + N.e^2)$, where n is sample size, N is population size, and e is the margin of error (5%). Using the average of daily LRT and feeder ridership ($N \approx 4{,}002$), the minimum required sample was calculated at 363.65, rounded to 364 respondents. To improve precision, reduce the actual margin of error, and anticipate invalid questionnaires, data collection was extended in the field until 374 valid respondents were obtained-exceeding the Slovin minimum threshold and considered highly representative for the subsequent statistical modelling. For the qualitative component, purposive sampling was used to select 5-10 informants per stakeholder category (frequent daily intermodal users, station operational staff, and representatives of BPKARSS and the Musi Emas feeder operator), following the principle of data saturation.

The primary questionnaire instrument consisted of 18 items measuring paired Importance (Satisfaction/expectation) and Performance ratings across five service dimensions-X1 Accessibility and Transfer Facilities, X2 Reliability and Punctuality, X3 Information System and Navigation, X4 Comfort and Safety, and X5 Staff Service (Responsiveness and Empathy)-plus three items on Operational Integration (Y), covering payment integration, combined fare, and ease of transfer. Each item was rated on a five-point Likert scale (1 = strongly disagree/very dissatisfied to 5 = strongly agree/very satisfied).

The study was conducted in Palembang City, South Sumatra, focusing on the Asrama Haji and Polrestabes LRT Station areas during 2025, chosen because both stations are major intermodal transfer nodes serving distinct catchment typologies-Asrama Haji as the northern commuter/logistics/airport-gateway node, and Polrestabes as the southern administrative and public-service node-allowing an objective comparison of intermodal performance between two nodes with different passenger volumes and trip-generation backgrounds.

RESULTS AND DISCUSSION

General Overview of the Study Locations

Fieldwork was carried out throughout 2025-2026 at two purposively selected case-study locations representing distinct intermodal transfer typologies in Palembang. Asrama Haji Station, located on Jalan Letjen Harun Sohar, Sukarami Sub-district, sits within a dense residential area, functions as the main transit gateway from Sultan Mahmud Badaruddin II International Airport, and hosts regional logistics activity; throughout the observation period it remained the busiest station along the South Sumatra LRT corridor, with average daily ridership of approximately 2,494 passengers, served by the Musi Emas feeder Corridor 3 (Asrama Haji-Talang Betutu) and the newly opened Corridor 8 (Asrama Haji-Talang Jambe, inaugurated in the first quarter of 2025). Polrestabes Station, located in the Jakabaring area, is surrounded by government administration, public services, commercial activity, and developing suburban residential areas; unlike Asrama Haji, which is dominated by suburban and inter-city commuters, Polrestabes generates trips mainly from office workers and users of government services, and is served by feeder Corridor 4 (Polrestabes-Perumahan OPI). This choice of locations allows an objective comparison of intermodal integration performance between two nodes with different passenger volumes and trip-generation profiles, with pedestrian transition facilities, headway synchronization, signage legibility, and side-friction behaviour from surrounding traffic forming the observation focus for the IPA and SEM-PLS analyses that follow.

Physical Facility Condition of Intermodal Integration

Physical facility conditions at both stations were evaluated through structured field observation benchmarked against national technical standards, covering pedestrian paths and transition connectivity, facilities for vulnerable/disabled users, public sanitation, waiting and drop-off areas, and the traveller information (signage) system. The evaluation results are summarized in Table 1.

Table 1. Physical Facility Condition of Intermodal Integration

Facility Component	Ideal Standard (National Regulation)	Asrama Haji Station: Condition - Status	Polrestabes Station: Condition - Status
Pedestrian path & connectivity	Must be safe, comfortable, and covered by a weather canopy along the whole transfer corridor (PM Hub 41/2015)	Physical connection protected by a skywalk and permanent canopy along the route to the feeder stop - Compliant	Open pedestrian transition area, most of the pavement not fully covered by a canopy - Not compliant
Facilities for vulnerable users / disability	Tactile paving free of damage (PM PUPR 14/2017); wheelchair ramp gradient max. 1:12 (4.76°)	Tactile paving present from the platform to the outer stairs, but the guide tiles show physical damage from elevated-structure maintenance loads - Not compliant	Steep pavement elevation difference (>20 cm); no standard 1:12 wheelchair ramp available - Not compliant
Sanitation (public toilets)	Main station: min. 3 male, 3 female, 1 disabled unit; secondary station: min. 2 male, 2 female (PM Hub 41/2015)	3 male units, 3 female units, and 1 disabled-accessible unit, clean with continuous water supply - Compliant	2 male and 2 female units; functional quantity met, but the disabled unit lacks a handrail - Compliant
Waiting area & drop-off	Must provide vehicle circulation space and a waiting area free of roadside side friction (PM Hub 29/2019)	Narrow drop-off area beneath the station, causing traffic conflict from ride-hailing/private vehicles idling on the road shoulder - Not compliant	Waiting area merges with open public space without clear vehicle circulation markings - Not compliant
Information system (signage)	Must provide clear, real-time, easily accessible schedule and route integration information (PM Hub 41/2015)	Static directional signage for feeder routes available at several strategic points, with periodic digital schedule updates - Compliant	Real-time route and arrival information for onward transport is still very limited - Not compliant

Source: Field observation data (2025)

The infrastructure audit shows that, of the five components evaluated, Asrama Haji Station (main typology) meets three: it excels in weather-protected skywalk coverage

(PM Hub 41/2015) and sanitation adequacy, but still shows a deficit in disabled-guide-tile condition (PM PUPR 14/2017) and congestion caused by the narrow vehicle circulation space at the drop-off area. Polrestabes Station (secondary typology) shows weaker performance, meeting only one component (sanitation), while the remaining four are not compliant: the absence of a continuous weather canopy, a steep pavement elevation difference (>20 cm) without a standard 1:12 wheelchair ramp, the absence of firm vehicle-circulation boundary markings, and limited real-time travel information signage.

Population, Sample, and Respondent Characteristics

The study population was defined as all LRT passengers at Asrama Haji and Polrestabes Stations together with feeder passengers on Corridors 2, 3, 4, and 8; LRT staff and feeder drivers were excluded as they are considered part of the service provider rather than service-satisfaction respondents. Passenger volume data are summarized in Table 2.

Table 2. Passenger Volume Data

Location	Total Passengers	Passengers / Day
Asrama Haji LRT Station	910,156	2,494
Polrestabes LRT Station	345,530	947
Feeder Corridor 2, Asrama Haji - Sematang Borang	877,604	2,404
Feeder Corridor 3, Asrama Haji - Talang Betutu	260,637	714
Feeder Corridor 8, Asrama Haji - Talang Jambe	223,634	613
Feeder Corridor 4, Polrestabes - Perumahan OPI	303,634	832
Total	**2,921,306**	**8,004**

Source: BPKARSS data (2025)

Applying the Slovin formula with a 90% confidence level (e = 5%) to the average LRT-feeder ridership (N ≈ 4,002) yields a minimum sample of 364 respondents; the study collected, validated, and processed 374 valid respondents, exceeding this threshold. Table 3 summarizes the demographic and travel-behaviour profile of the 374 respondents.

Table 3. Respondent Profile (n = 374)

Category	Frequency (persons)	Percentage (%)
Gender		
Male	226	58%
Female	148	42%
Age Group		
< 17 years	30	8%
17 - 25 years	106	29%
26 - 40 years	132	35%
> 40 years	106	28%
Occupation		
Student	69	18%

Category	Frequency (persons)	Percentage (%)
Private/State-owned enterprise employee / civil servant / military-police	183	49%
Self-employed / trader	55	15%
Not employed	67	18%
Weekly Usage Frequency		
1 time	88	24%
2 times	53	14%
3 times	44	12%
4 times	69	18%
5 or more times	120	32%
Total respondents	**374**	**100%**

Source: Primary data processed (2025)

Instrument Validity and Reliability

Before proceeding to inferential analysis, all primary data from the 374 respondents were subjected to validity and reliability testing to ensure the accuracy and statistical consistency of the questionnaire instrument. Structural model (inner model) testing was carried out separately for the Performance construct and the Satisfaction construct using the PLS-SEM algorithm in SmartPLS 4, shown respectively in Figure 3 and Figure 4, and reliability testing used Cronbach's Alpha (threshold ≥ 0.70) computed both in SmartPLS 4 and in SPSS; results are summarized in Table 4.

Table 4. Reliability Test Results (Cronbach's Alpha)

Variable	Dimension	N Items	Alpha - Performance	Alpha - Satisfaction	Remark
X1	Accessibility & Transfer Facilities	3	0.735 / 0.736	0.862	Reliable
X2	Reliability & Punctuality	3	0.800	0.860	Reliable
X3	Information System & Navigation	3	0.734 / 0.727	0.834	Reliable
X4	Comfort & Safety	3	0.706	0.844	Reliable
X5	Staff Service (Responsiveness & Empathy)	3	0.816 / 0.815	0.908	Reliable
Y	Operational Integration	3	0.639 / 0.637	0.832	Below 0.70 but accepted (Hair et al., 2019)

Source: SmartPLS 4 and SPSS output, processed (2025)

All five performance/perception dimensions (X1-X5) recorded Cronbach's Alpha values above the 0.70 threshold in both software packages, ranging from 0.706 to 0.908, indicating that the questionnaire used to measure physical and operational facility performance, as well as user expectation, is highly reliable and internally consistent. The

Operational Integration construct (Y) recorded values of 0.637-0.639 in the SmartPLS models (below 0.70) but 0.832 under SPSS; the SmartPLS values, although below the strict threshold, remain valid and acceptable for field transportation research according to Hair et al. (2019), since the outer loadings of its constituent indicators in the SmartPLS 4 model were shown to be strong.

Structural Model Assessment (SEM-PLS)

Structural (inner) model testing evaluated the simultaneous and partial contribution of the five quality dimensions to commuter satisfaction, first for the actual field Performance construct (Figure 3) and then for the user Satisfaction/expectation construct (Figure 4). Path-coefficient and R^2 results for both models are summarized in Table 6.

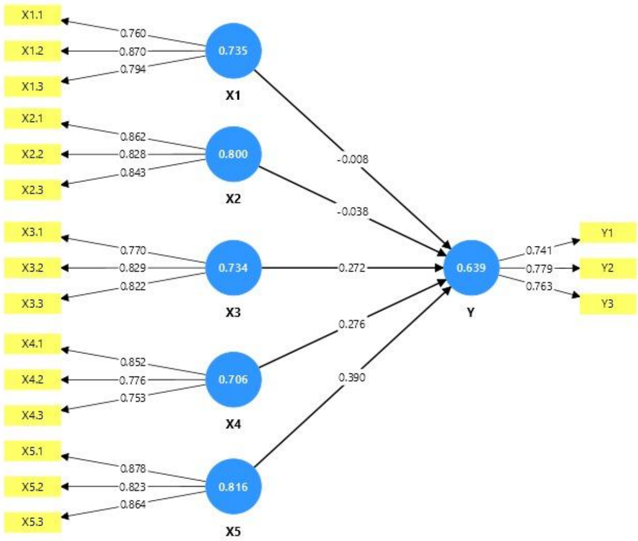

Figure 3. Structural Model (Outer Model) of the Performance Variable

Source: PLS-SEM algorithm computation in SmartPLS 4 (2025)

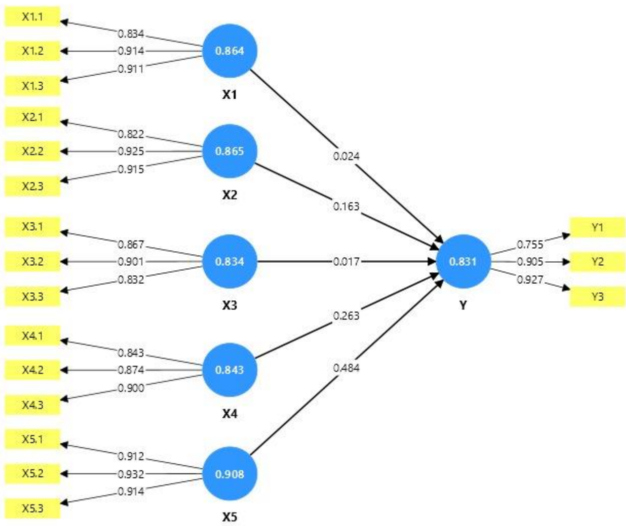

Figure 4. Structural Model (Outer Model) of the Satisfaction Variable

Source: PLS-SEM algorithm computation in SmartPLS 4 (2025)

Table 5. Structural Model Path Coefficients (Performance and Satisfaction Models)

Attribute	Quality Dimension	Path Coef. - Performance model (R^2 = 0.639)	Path Coef. - Satisfaction model (R^2 = 0.831)	Interpretation
X5	Staff Service (Responsiveness & Empathy)	0.390	0.484	Dominant driver: satisfaction is most sensitive to staff friendliness and assistance for elderly/disabled users.
X4	Comfort & Safety	0.276	0.263	Strong positive influence: passengers feel satisfied because the station is free of crime and well-lit at night.
X3	Information System & Navigation	0.272	0.017	Strong in the Performance model (staff promptness in clearing ride-hailing congestion at drop-off), minimal in the Satisfaction model (existing signage already meets baseline expectations).
X2	Reliability & Punctuality	-0.038	0.163	Near-zero in the Performance model since the LRT and feeder are already punctual; moderate supporting effect in the Satisfaction model through headway certainty.
X1	Accessibility & Transfer Facilities	-0.008	0.024	Minimal/baseline in both models: the physical condition of the station building is already considered very good and clean.

Source: SmartPLS 4 output, processed (2025)

The Performance model records $R^2 = 0.639$ for the satisfaction construct, while the Satisfaction (expectation) model records a stronger $R^2 = 0.831$. In both models, the Empathy/staff-service dimension (X5) is the leading driver of satisfaction, with the highest path coefficients (0.390 and 0.484 respectively), followed by Comfort and Safety (X4). This indicates a clear shift in satisfaction sensitivity: away from physical infrastructure, which is already considered a baseline standard, toward the interpersonal, non-physical performance of station staff.

User Perception of Service Quality (SERVQUAL Gap Analysis)

SERVQUAL gap analysis measures the difference between actual service performance (P) and user expectation/satisfaction (E). Service quality is considered ideal when the gap value is positive or zero (≥ 0); a negative gap (< 0) indicates a service deficit requiring improvement. The full gap calculation across the 18 attributes is presented in Table 6.

Table 6. SERVQUAL Gap Analysis (18 Attributes)

Code	Attribute	P (Performance)	E (Expectation)	Gap (P-E)	Remark
X1.1	Walking distance when transferring between modes is short and not tiring	4.2	4.3	0.2	Fulfilled
X1.2	Pedestrian path to the integration point is level, non-slip, and safe	4.3	4.3	0.0	Fulfilled
X1.3	Pedestrian safety is protected by dedicated crossings (zebra cross / pedestrian bridge)	4.4	4.4	0.1	Fulfilled
X2.1	Feeder / Trans Musi headway at the station is short (under 10-15 minutes)	4.3	4.2	-0.1	Priority for improvement
X2.2	Onward-mode arrival is certain and matches the informed schedule	4.2	4.5	0.2	Fulfilled
X2.3	Total transfer time between modes is efficient	4.3	4.4	0.1	Fulfilled
X3.1	Clear directional signage inside the station toward the transfer point	4.2	4.3	0.1	Fulfilled
X3.2	Feeder/BRT route and number information is clearly available at the integration area	4.3	4.4	0.1	Fulfilled
X3.3	Accurate digital/staff real-time vehicle-position information is available	4.3	4.3	0.1	Fulfilled
X4.1	Passengers feel safe from criminal acts while transferring at the station area	4.3	4.4	0.1	Fulfilled
X4.2	Integration waiting area (stop) is clean and has adequate seating	4.4	4.3	-0.1	Priority for improvement
X4.3	Lighting along the transfer corridor at night is good and feels safe	4.1	4.4	0.3	Fulfilled
X5.1	Staff responsiveness in assisting passengers who face difficulties	4.4	4.4	0.0	Borderline
X5.2	Staff friendliness in listening to complaints or special needs	4.3	4.4	0.1	Fulfilled
X5.3	Staff initiative in offering help without being asked, especially when busy	4.4	4.5	0.1	Fulfilled
Y1	Payment system (card/QRIS/cash) is well integrated across modes	4.3	4.3	0.0	Fulfilled
Y2	Total fare using integrated modes (LRT+Feeder/BRT) is affordable	4.5	4.5	0.0	Borderline

Code	Attribute	P (Performance)	E (Expectation)	Gap (P-E)	Remark
Y3	Transfer between modes is easy and comfortable (walking distance, directional signage)	4.2	4.5	0.3	Fulfilled

Source: Primary data processed (2025)

Sixteen of the eighteen attributes recorded a positive or neutral gap (≥ 0), showing that most pedestrian transition infrastructure, route information clarity, integrated payment, and fares already meet or exceed commuter expectations. Two critical attributes show a negative gap and require immediate attention: X2.1 (feeder/Trans Musi headway), where passengers feel waiting time still exceeds the ideal 10-15-minute threshold; and X4.2 (integration stop facilities), where the waiting area beneath the station is considered insufficiently clean, with limited seating capacity for passenger comfort.

Customer Satisfaction Index (CSI)

Overall user satisfaction was measured with the Customer Satisfaction Index (CSI), which weights the importance of each of the 18 attributes (Weighting Factor) by its mean performance score (Weighted Score) and aggregates the result into a single index. Using the mean Performance and Satisfaction scores already presented in Table 7 for the same 18 attributes, the total weighted score sums to 4.4 (on a 5-point scale), giving a final CSI score, summarized in Table 7.

Table 7. Customer Satisfaction Index (CSI) Summary

Parameter	Value
Sum of Mean Performance Scores (∑ MIS, 18 attributes)	77.6
Sum of Weighted Scores (∑ D)	4.4
Final CSI Score (∑D / 5 × 100)	87.8%
CSI Category (81% - 100% = Very Satisfied)	Very Satisfied

Source: Primary data processed (2025)

Against the standard CSI interpretation scale (51-65% Fairly Satisfied, 66-80% Satisfied, 81-100% Very Satisfied), the resulting CSI score of 87.8% places overall user perception of the intermodal integration facility and service performance in the Very Satisfied category.

Importance-Performance Analysis (IPA)

Attribute prioritization was mapped on a two-dimensional cartesian matrix using the grand-mean cut points of Performance (X-axis, grand mean = 4.45) and Importance/expectation (Y-axis, grand mean = 4.38), based on the same 18 mean Performance and Expectation values reported in Table 7. The resulting quadrant map is shown in Figure 5.

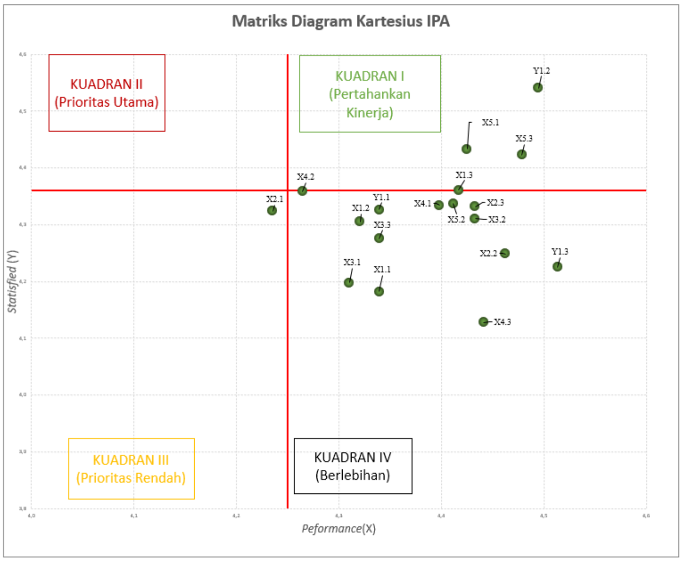

Figure 5. IPA Cartesian Quadrant Matrix

Source: Primary data processed (2025)

Quadrant I (Keep Up the Good Work) holds the majority of attributes (e.g., Y1.2, X5.3, X1.3, X4.2), showing that station management has successfully delivered physical facilities and service interactions of high quality that match passengers' high expectations. Quadrant II (Concentrate Here / main priority) is empty-no attribute falls into this region, indicating that basic infrastructure has already moved beyond the stage requiring radical, large-scale improvement. Quadrant III (Low Priority) contains a single attribute, X2.1 (headway), considered of relatively low importance by passengers with correspondingly average field performance, so it does not require disproportionate resource allocation beyond the targeted fix already noted. Quadrant IV (Possible Overkill) contains a large group of attributes (including X2.2, Y1.3, and X4.3), indicating that management delivers a level of service considered excellent and abundant, even though passengers regard the importance of these attributes as relatively ordinary.

Integration of Analytical Methods

To provide a comprehensive synthesis, the outputs of the structural model tests (SmartPLS 4, Satisfaction and Performance), the SERVQUAL gap values, and the IPA quadrant mapping were combined into a single integration matrix per indicator, presented in Table 8.

Table 8. Integration Matrix of Multivariate Analysis Results per Indicator

Var	Ind.	Outer Loading (Sat. / Perf.)	SERVQUAL Gap	IPA Quadrant	Field Condition & Recommended Solution
X1	X1.1	0.834 / 0.760	+0.2	IV	Inter-modal walking distance already short and not tiring for commuters.
	X1.2	0.914 / 0.870	0.0	IV	Pavement contour already level and continuous, giving consistent perceived safety.
	X1.3	0.911 / 0.794	0.1	I	Canopy shading is highly valued; performance must be maintained.
X2	X2.1	0.822 / 0.862	-0.1	III	Problem: feeder waiting time too long. Solution: evaluate and shorten fleet headway.
	X2.2	0.925 / 0.828	0.2	IV	Certainty of bus arrival schedule on information boards considered accurate.
	X2.3	0.915 / 0.843	0.1	IV	Total transit duration already very efficient.
X3	X3.1	0.867 / 0.770	0.1	IV	Legibility of station directional signage already very informative.
	X3.2	0.901 / 0.829	0.1	IV	Clarity of feeder route numbering at the integration area already ideal.
	X3.3	0.832 / 0.822	0.1	IV	Digital bus-position reporting service considered satisfactory.
X4	X4.1	0.843 / 0.852	0.1	IV	Passengers feel safe from theft/crime while transiting.
	X4.2	0.874 / 0.776	-0.1	I	Problem: stop is dirty and seating minimal. Solution: routine cleaning schedule and added seating.
	X4.3	0.900 / 0.753	0.3	IV	Night-time street-lighting system very bright and satisfactory.
X5	X5.1	0.912 / 0.878	0.0	I	Staff promptness in assisting commuters with difficulties must be maintained.
	X5.2	0.932 / 0.823	0.1	IV	Staff friendliness in hearing complaints already considered very good.
	X5.3	0.914 / 0.864	0.1	I	Staff initiative in proactively greeting and helping is very satisfactory.
Y	Y1	0.755 / 0.741	0.0	IV	Cashless payment integration (card/QRIS) considered smooth and practical.
	Y2	0.905 / 0.779	0.0	I	Combined LRT-feeder fare considered very affordable and must be maintained.
	Y3	0.927 / 0.763	0.3	IV	General ease of intermodal transfer considered very comfortable.

Source: Primary data processed (2025)

The integration matrix confirms two critical micro-level priorities: feeder headway (X2.1, IPA Quadrant III, gap -0.1) and stop cleanliness/seating (X4.2, IPA Quadrant I, gap -0.1), both requiring immediate operational intervention. Conversely, the remaining sixteen indicators consistently record satisfactory-to-excellent performance with positive-to-neutral gaps, concentrated in Quadrant I and Quadrant IV, confirming that the station's basic physical connectivity chain, wayfinding system, fare integration, and staff interpersonal competence are already reliable and successfully meet Palembang LRT commuters' comfort expectations.

Strategy Formulation for Intermodal Service Performance Improvement

Based on the integration matrix, four strategic pillars are formulated to improve LRT-Musi Emas feeder intermodal service performance in Palembang City. First, a transit-flow operational management strategy (targeting attribute X2.1) through an integrated timetable that synchronizes Musi Emas feeder departure times with LRT arrival times, aiming to keep passenger headway consistently under 10-15 minutes during peak hours and close the -0.1 SERVQUAL gap identified in IPA Quadrant III. Second, a stop-facility revitalization and lane-sterilization strategy (targeting attribute X4.2) through additional ergonomic waiting seats, a routine stop-cleaning schedule, and clearly marked exclusive drop-off zone boundaries to control ride-hailing vehicles, aiming to remove side friction around the station integration node and resolve the cleanliness complaint recorded in IPA Quadrant I. Third, an outdoor inclusivity and pedestrian-rights strategy (targeting constructs X5 and X1) through the extension of continuous weather-protection canopies from the station exit to the onward feeder stop-prioritized at Polrestabes Station-and the repair of damaged tactile paving, aiming to meet the comfort and safety needs of vulnerable pedestrians (elderly/disabled users) while responding to the Empathy dimension, which recorded the highest sensitivity coefficient (0.390) in the SmartPLS 4 model. Fourth, a commuter travel-information digitalization strategy (targeting attribute X3.3) through digital Passenger Information System (PIS) monitors at station waiting areas displaying real-time GPS positions of feeder vehicles, aiming to increase the efficiency and certainty of transfer time for passengers before continuing onto road-based transport.

CONCLUSION

This study concluded that the physical facilities supporting intermodal integration between the Palembang LRT and the Musi Emas feeder service were generally adequate. Asrama Haji Station performed better than Polrestabes Station because of its permanent skywalk connection. However, both stations still exhibited deficiencies in outdoor accessibility, including damaged tactile paving and steep pavement elevations without standard wheelchair ramps. Polrestabes Station also lacked a continuous weather-protection canopy. The Partial Least Squares Structural Equation Modeling (PLS-SEM) results ($R^2 = 0.639$ for the Performance model and $R^2 = 0.831$ for the Satisfaction model) indicated that user satisfaction was influenced more strongly by the interpersonal performance of station staff than by physical infrastructure. The Empathy dimension showed the strongest effect, with a path coefficient of 0.390, followed by Comfort and Safety and the Information System. SERVQUAL gap analysis identified two service attributes with negative gaps that required priority improvement: feeder headway (X2.1, gap = −0.1) and stop cleanliness and seating (X4.2, gap = −0.1). Meanwhile, the Importance–Performance Analysis (IPA) matrix placed most of the 18 service attributes in Quadrants I and IV, indicating that several high-importance attributes required priority attention while other well-performing attributes should be maintained. The overall Customer Satisfaction Index (CSI) score of 87.8% indicated a "Very Satisfied" level of commuter satisfaction. In line with these findings and the Non-Motorized Transport (NMT) and Transit-Oriented Development (TOD) principles promoted by ITDP Indonesia, it is recommended that the LRT operators, PT KAI Divre III and BPKARSS, implement an integrated timetable to reduce feeder headways to less than 10–15 minutes and improve feeder-stop facilities by providing additional seating and more consistent cleaning. The Palembang City Transportation Agency should also provide continuous protective canopies, particularly at Polrestabes Station, and strengthen the management of designated drop-off zones to minimize conflicts caused by ride-hailing activities. Future research should incorporate additional constructs, such as perceptions of integrated ticketing and fares, and expand the study to intermodal nodes involving other transport modes, including water transportation at locations such as Ampera LRT Station.

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