JIPE Journal of Infrastructure Planning and Engineering

Journal of Infrastructure Planning and Engineering

Journal homepage: https://ejournal.warmadewa.ac.id/index.php/jipe

Evaluation of multimodal transportation integration facilities at Serang station

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Received on 29 May 2025, accepted on 20 September 2025, published on 31 October 2025

ABSTRACT

This study aims to evaluate the performance of multimodal transportation integration facilities at Serang Station, a major transportation hub in the Jakarta-Merak corridor serving 15,000 passengers per day. Key issues identified include fragmented pedestrian paths, a 450 m intermodal distance exceeding the 300 m TOD standard (SNI 03-7065-2005), limited covered waiting areas, and a lack of directional signs. This evaluation addresses the urgent need to improve travel efficiency and user satisfaction, contributing to sustainable urban development and reducing economic losses due to congestion. The Customer Satisfaction Index (CSI) was used to measure user perceptions of 16 facility attributes, and Importance-Performance Analysis (IPA) was used to prioritize improvements based on the gap between expectations and performance. The results showed very low levels of satisfaction with disabled access (CSI = 20%), lighting, zebra crossings, and bus stops (CSI = 20–46%), far below the average CSI of 52.52%, making them top priorities for improvement. Meanwhile, cleanliness, public restrooms, and gentle slopes meet user expectations. Recommendations include improved lighting, a microtransit hub within a 500-meter radius, additional trash bins, improved access for the disabled, improved markings/signage, and the construction of protected bus stops to support equitable, efficient, and sustainable urban mobility.

Keywords: mode integration, multimodal transportation, serang station, travel efficiency

1 Introduction

Public transportation plays a role in supporting community mobility [1] requires multimodal transportation integration facilities are critical enablers of seamless urban mobility, directly influencing travel efficiency and user satisfaction. This can be achieved through adjacent and easily accessible bus stops. Public transport stops should be comfortable, safe, and protected from the weather, with seating, adequate lighting, and schedule information, as well as safe and comfortable pedestrian paths between stations equipped with accessibility features for people with disabilities [2].

However, despite the clear importance of such facilities, their quality and integration remain inconsistent in many urban areas, particularly in developing countries. In Indonesia, where congestion-induced economic losses exceed Rp 100 trillion annually [3] and transportation contributes 23% of carbon emissions [4], optimizing these facilities is pivotal for sustainable development. While global examples like Tokyo and Singapore demonstrate that Transit-Oriented Development (TOD) can boost public transport usage by 40% [5], Indonesian secondary cities such as Serang face persistent challenges in harmonizing infrastructure, operations, and user-centric design. Serang Station, a key transit hub serving 15,000 daily passengers [6], epitomizes these struggles, with fragmented facilities exacerbating inefficiencies and discouraging modal shifts.

The core problem addressed in this study is the low quality of integration facilities at Serang Station particularly pedestrian pathways, disability access, and bus stops which leads to low user satisfaction, limited modal shift rates, and reduced travel efficiency. This issue not only hinders accessibility for vulnerable groups but also undermines the potential for emissions reduction and equitable urban mobility. Despite its significance, such facility-specific integration problems have not been comprehensively examined in the context of Indonesian secondary cities, creating a clear research gap that this study aims to address.

Existing studies highlight systemic gaps: disjointed infrastructure (e.g., 450-meter inter-stop distances vs. the 300-meter TOD standard; SNI 03-7065-2005), poor coordination between transport modes, and inadequate accessibility features [7]. For instance, 68% of Bogor Station users resist mode-switching due to subpar transit facilities [8], underscoring the need for facility-driven reforms. Findings from Jakarta and Bogor further indicate persistent deficiencies in integration facilities particularly disability access, pedestrian pathways, and information elements making facility-based reforms a priority to encourage modal shift and improve user satisfaction [9] [10] [11].

This study addresses this gap by evaluating the performance of multimodal integration facilities at Serang Station through a dual-method approach:

1. Customer Satisfaction Index (CSI) to quantify user perceptions of 16 facility attributes, including pedestrian paths, lighting, disability access, and bus stops.
2. Importance-Performance Analysis (IPA) to prioritize improvements based on discrepancies between user expectations and current conditions.

Unlike previous research that focused mainly on operational or ticketing integration, this study combines technical measurements with user perception-based insights in a facility-specific context, offering a more holistic understanding of multimodal integration challenges. This methodological combination is novelty in Indonesian secondary cities and allows for both diagnosis and actionable recommendations. The objectives of this research are:

1. To identify the condition and needs of multimodal integration facilities available at Serang Station, including pedestrian paths, disability accessibility, bus stops, and other supporting facilities.
2. To evaluate and analyze the performance of multimodal integration facilities based on user perceptions and applicable technical standards, using the Customer Satisfaction Index (CSI) and Importance-Performance Analysis (IPA) methods.

This study contributes to smart mobility policy in three ways:

1. Replicable framework for evaluating transport infrastructure through combined CSI-IPA methodologies.
2. Practical innovations, including real-time Mobility-as-a-Service (MaaS) prototypes and public-private partnerships (PPP), tailored to address governance and infrastructural fragmentation.
3. By aligning facility design with user needs, this work advances Indonesia's agenda for equitable, efficient, and sustainable urban mobility.

2 Data and Methods

2.1 Research Design

This study uses a mixed-methods approach that combines quantitative and qualitative data to evaluate the performance and user perception of multimodal integration facilities at Serang Station. The methodology is designed to ensure both statistical rigor and contextual understanding through triangulation as shown in **Figure 1**.

2.2 Data Types

The study collected both primary and secondary data. Primary data were obtained from respondents and field observations, while secondary data were sourced from relevant institutions, previous research studies, books, and other pertinent information [12].

Primary data included:

- Survey responses from 300 users (quantitative)
- Field observation data (qualitative)
- Interviews with selected users (qualitative)

Secondary data included:

- Transportation regulations
- Design standards
- Previous studies.

2.3 Data Collection

Data were collection over a two-week period during peak travel times (7–9 AM and 4–6 PM). Surveys were distributed via Google Forms and printed questionnaires with respondents selected using stratified random sampling to diversity in age, occupation, and distance to the station. Field oservations validated the physical conditions of facilities, while interviews explored user experiences and priorities.

2.4 Evaluation Criteria adn Benchmark

The evaluation criteria serve as the foundation for assessing the quality and effectiveness of multimodal transportation integration facilities at Serang Station. This assessment is based on 16 key attributes that reflect comfort, safety, accessibility, and user convenience.

These attributes were carefully selected based on the following considerations:

- Indonesian National Standard (SNI) 03-7065-2005, which stipulates a maximum walking distance of 300 meters between transport modes to facilitate smooth modal transfer. This standard serves as a critical benchmark for assessing pedestrian path adequacy and intermodal connectivity.
- Ministry of Transportation Regulation No. PM 46/2014 concerning transportation integration, which provides regulatory requirements for coordination among transport modes and facilities to support seamless multimodal travel.
- Transit-Oriented Development (TOD) principles, emphasizing accessibility, proximity, and integration among transit facilities to encourage public transport use and reduce reliance on private vehicles. Transit-Oriented Development is a pattern or concept of urban planning with synergistic and integrated transportation,

accommodating new growth, strengthening the environment, and expanding choices and benefits through optimizing the public transportation network, thus facilitating residents' access to city resources, creating an efficient city [13].

- Universal Design Guidelines, ensuring accessibility features meet the needs of persons with disabilities, promoting inclusivity in public transportation infrastructure.

The 16 evaluated attributes are as follow:

1. Cleanliness – maintaining a hygienic and pleasant environment.
2. Pedestrian path condition – ensuring safe and continuous walkways.
3. Lighting – providing adequate illumination for safety and comfort.
4. Public toilets – availability and cleanliness for user convenience.
5. Seating – sufficient and comfortable waiting areas.
6. Trash bins – proper waste management facilities.
7. Walking obstacles (e.g., street vendors, gates) – minimizing barriers that disrupt pedestrian flow.
8. Distance to boarding point – proximity to reduce transfer time.
9. Comfort during boarding – ease and safety when boarding vehicles.
10. Walking duration to boarding point – reasonable walking times between modes.
11. Accessibility for persons with disabilities – inclusive design for all users.
12. Bicycle lanes – facilitating multimodal trips involving cycling.
13. Slope conditions (ramps, elevation) – manageable gradients for ease of movement.
14. Zebra crossings – safe pedestrian crossing points.
15. Signage and road markings – clear directions and information.
16. Bus stops (halte) – protected and accessible waiting areas for bus users.

These criteria not only reflect national standards and user priorities but also serve as benchmarks for evaluating the performance of integration facilities, ensuring they meet both regulatory requirements and user expectations.

2.5 Analytical Methods: IPA and CSI

Two main analytical methods were used to evaluate user satisfaction and priority of improvements:

a. Importance-Performance Analysis (IPA)

- Purpose

  IPA is a two-dimensional evaluation method used to determine the priority for improving facility attributes based on users' perceived *importance* and *actual performance* [14]. This allows researchers to pinpoint which attributes require urgent attention and which are performing satisfactorily.

- Data Collection

  Respondents rate each facility attribute based on its Importance Score (IS) – how important the attribute is to them and Performance Score (PS) – how well attribute is currently performing. Both are measured on a 5-point Likert scale (1 = very low, 5 = very high).

- Calculation

  The total performance score (PS) and importance score (IS) assessment is obtained by summing the assessment scores given by respondents as users. The calculation results are depicted in a Cartesian diagram. Each attribute is positioned in the diagram based on its average score. The average performance assessment score (X) indicates the attribute's position on the X-axis, while the attribute's position on the Y-axis is indicated by the average importance score (Y) [14].

$$X = \frac{n_{i=1}\, Y_i}{n} \quad (1)$$

$$Y = \frac{n_{i=1}\, X_i}{n} \quad (2)$$

Description:

X = Average performance score
Y = Average importance score
N = Number of consumer data

- Plotting onto the IPA Grid

  Each attribute is plotted into one of four quadrants:

  1. Quadrant I (Top Priority): High importance, low performance – requires immediate improvement.
  2. Quadrant II (Keep Up the Good Work): High importance, high performance – should be maintained.
  3. Quadrant III (Low Priority): Low importance, low performance – not a current priority.
  4. Quadrant IV (Possible Overkill): Low importance, high performance – resources may be reallocated.

The crosshair lines in the IPA diagram were positioned based on the mean values of all attributes. The vertical axis (importance threshold) was set at the average Importance Score ($\bar{IS}$), and the horizontal axis (performance threshold) was set at the average Performance Score ($\bar{PS}$). Attributes were then classified into quadrants as follows:

1. Quadrant I (*Top Priority*): $IS \geq \bar{IS}$ and $PS < \bar{PS}$
2. Quadrant II (*Maintain Achievements*): $IS \geq \bar{IS}$ and $PS \geq \bar{PS}$
3. Quadrant III (*Low Priority*): $IS < \bar{IS}$ and $PS < \bar{PS}$
4. Quadrant IV (*Possible Overkill*): $IS < \bar{IS}$ and $PS \geq \bar{PS}$

This systematic approach ensures transparency in quadrant allocation and allows for accurate replication of the analysis.

- Interpretation
  The resulting quadrant placements guide the prioritization of facility improvements based on user perception.

b. Customer Satisfaction Index (CSI)

- Purpose
  Customer Satisfaction Index (CSI) method quantitatively measures the overall satisfaction level of users for each facility attribute [14]. The result is expressed as a percentage, making it easy to interpret and compare.
- Steps for CSI Calculation

1. Weight Factor (WF)
   Calculated based on the proportion of the importance score [14]
   $$WFi = \frac{ISi}{\sum IS} \quad (3)$$
2. Weighted Score (WS)
   Calculated by multiplying the weight factor with the performance score [14].
   $$WSi = WFi \times PSi \quad (4)$$
3. CSI Total Score
   The final CSI score is computed as [14].
   $$CSI = \left(\frac{\sum WSi}{5}\right) \times 100 \quad (5)$$
   CSI Score Interpretation:
   >80% = Very Satisfied
   >60%-80% = Satisfied
   >40%-60% = Moderately Satisfied
   <40% = Dissatisfied

c. Integration of IPA and CSI in This Study

- CSI provides a numeric satisfaction benchmark for each facility attribute.
- IPA places these attributes in a strategic priority map.
- Combined, they ensure both quantitative and strategic clarity for decision-making regarding facility improvements.

2.6 Planning Method Rationale

The proposed development plan for Serang Station facilities was formulated through an integrated process combining IPA and CSI analytical results, direct field observations, and compliance with national regulations and universal design principles. The rationale for prioritization is based on three key considerations:

- Urgency based on IPA–CSI outcomes : Attributes located in Quadrant I (high importance, low performance) were given highest priority, as these directly affect safety, accessibility, and service quality.
- Observed physical and operational constraints : Field verification identified specific deficiencies and feasibility challenges that shaped the scope of proposed interventions.
- Regulatory compliance and inclusivity : All proposals align with the Indonesian Ministry of Transportation's technical guidelines, relevant SNI standards, and universal design requirements to ensure equitable access.

Analytical methods applied include:

- Gap Analysis : Calculating the difference between importance and performance scores (Gap = IS – PS) for each attribute to rank urgency. Larger positive gaps indicated greater need for improvement.
- Spatial Mapping : Identifying pedestrian movement flows, connectivity points, and conflict zones to guide placement of facilities.
- Accessibility Audits : Assessing usability for diverse user groups, including persons with disabilities, to identify barriers and recommend targeted enhancements.

This combined approach ensures that facility planning is data-driven, technically feasible, and aligned with both user expectations and statutory requirements.

This triangulated approach ensures that planned interventions align with user needs and government standards for sustainable and inclusive transport hubs.

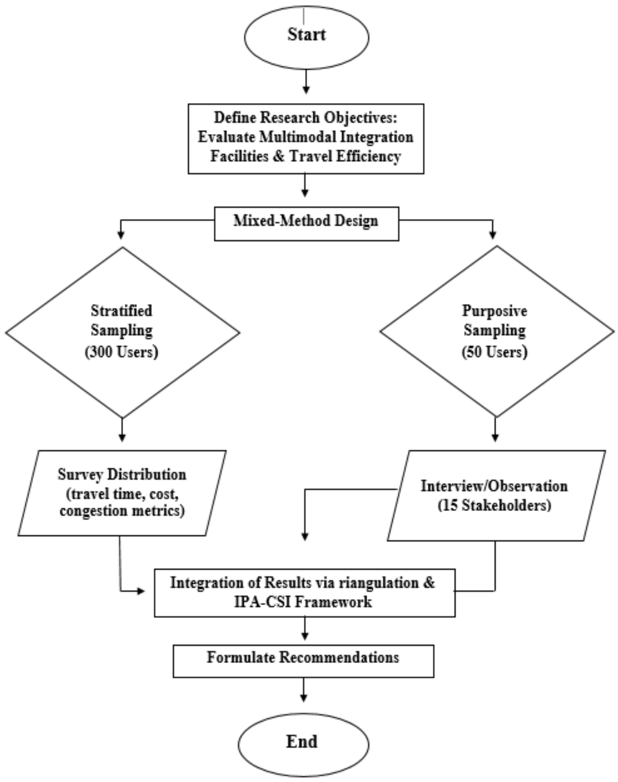

Figure 1. Flowchart

3 Results and Discussion

3.1 The image below displays the personal characteristics of the respondents as follows.

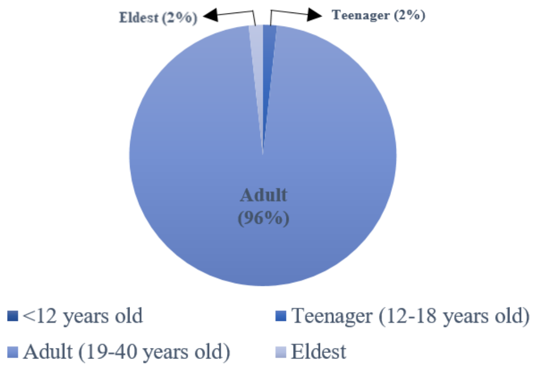

Figure 2. Age Characteristics of Respondents

Based on **Figure 2**, the vast majority (96%) of Serang Station users are adults (19-40 years old), indicating that the productive age group dominates transportation use there. Other age groups have minimal representation. Transportation development in this area should primarily focus on the needs of adult users.

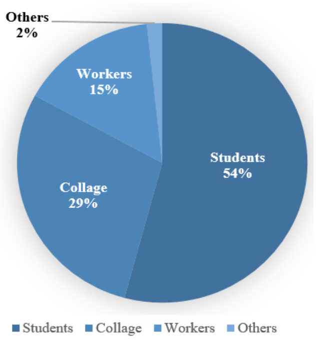

Figure 3. Occupation Characteristics of Respondents

Based on **Figure 3**, the majority of Serang Station users are students (54%) and college (29%), followed by workers (15%). This indicates that transportation services there are heavily utilized by students.

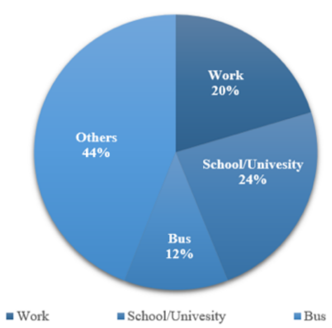

Figure 4. Types of Locations Adjacent to Serang Station

Based on **Figure 4,** The majority of locations around Serang Station fall into the "Other" category (44%), Bus stop(12%), schools/university (24%), and workplaces (20%) are also significant. The station area has diverse functions (transportation, education, commercial, residential), so multimodal development needs to consider various user needs.

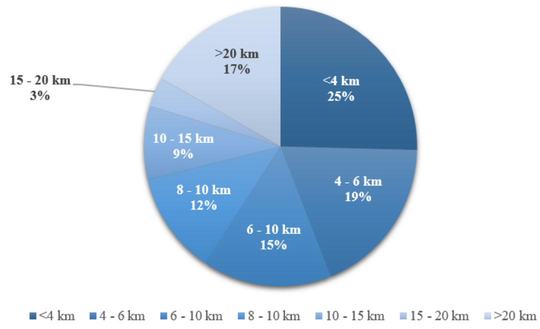

Figure 5. Distance to Serang Station

Based on **Figure 5**, the largest group of respondents lives within 4 km of Serang Station (25%). Significant proportions also reside 4-6 km (19% each) and > 20 km away (17% each). The varied residential distances of respondents indicate that Serang Station serves a wide area, making last-mile integration important.

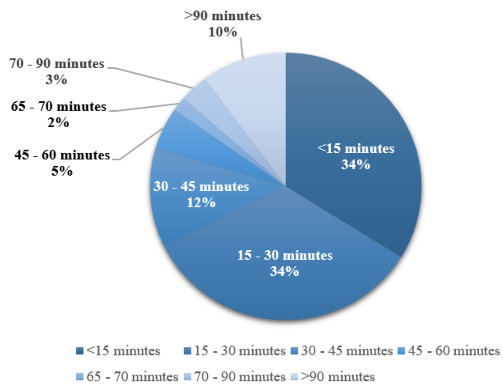

Figure 6. Travel duration to the station

Based on **Figure 6**, most Serang Station users wait less than 30 minutes for connecting transport (34% for <15 minutes and 15 - 30 minutes). A small portion waits longer, indicating a need for improved transfer efficiency.

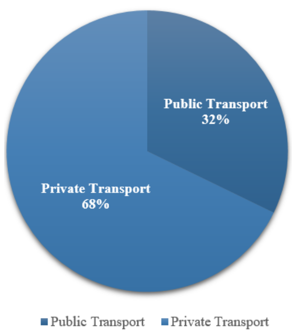

Figure 7. Characteristics of Transportation Used by Respondents

Based on **Figure 7**, it is shown that the number of respondents using Private Transportation is 68%, and those using Public Transportation is 32%. This indicates a high dependence on private vehicles to reach the station.

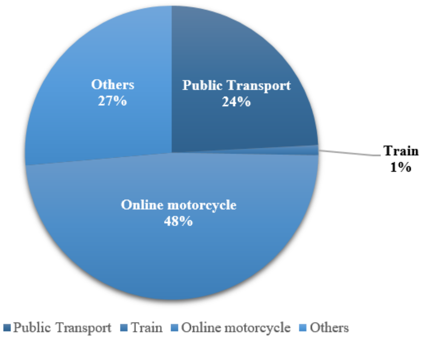

Figure 8. Characteristics of public transportation used by respondents

Based on **Figure 8**, online motorcycle taxis (ojek *online*) are the most frequently used onward transportation mode at Serang Station (48%), followed by public minivans (angkot) at 24%. This indicates the important role of ojek online for first/last-mile connectivity.

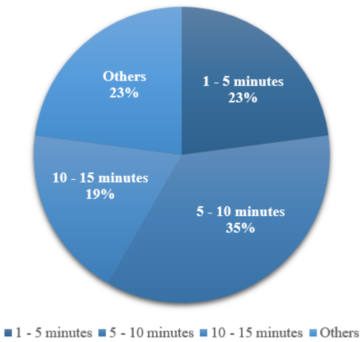

Figure 9. Waiting time for public transportation

Based on **Figure 9**, most respondents (35%) reach Serang Station within 5-10 minutes, indicating close proximity to the station. A large portion of the remainder also have travel times under 15 minutes.

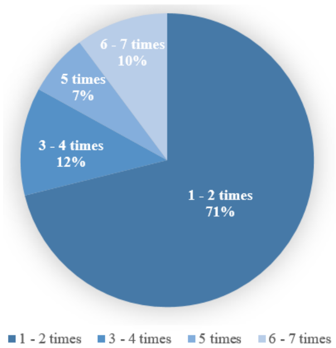

Figure 10. Number of trips from/to Serang Station in a week

Based on **Figure 10**, most respondents travel to Serang Station 1-2 times per week, accounting for 75%.

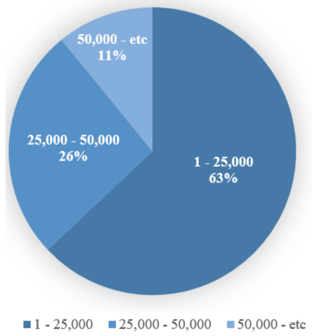

Figure 11. One-way trip cost to Serang Station using public transportation

Based on **Figures 11**, the most frequent expenditure for public transportation users at Serang Station is in the range of Rp 1–25,000, accounting for 63% of the total. This is followed by expenditures in the range of Rp 25,000–50,000 at 26%, while the smallest proportion is expenditures above Rp 50,000 at 11%.

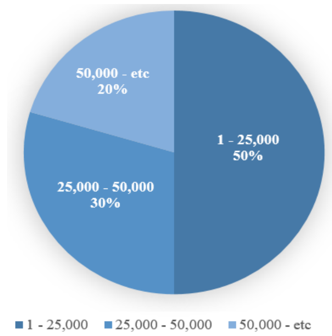

Figure 12. One-way trip cost to Serang Station using private transportation

Based on **Figures 12**, the most frequent expenditure made by users of the multimodal transportation integration facilities at Serang Station is in the range of Rp 1–25,000, accounting for 50% of the total. This is followed by expenditures in the range of Rp 25,000–50,000 at 30%, while the smallest proportion is expenditures above Rp 50,000 at 20%.

Based on the comparison between the figures 11 and 12, public transportation users at Serang Station tend to spend less than private transportation users. The majority of public transportation expenditures are in the range of Rp 1–25,000 (63%), with only 11% spending more than Rp 50,000. In contrast, private transportation users have a lower proportion in the Rp 1–25,000 range (50%) and a higher share of expenditures above Rp 50,000 (20%). This indicates that public transportation is generally more cost-efficient compared to private transportation.

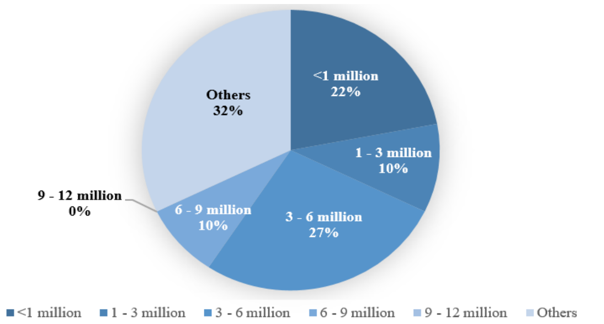

Figure 13. Respondent's income

Based on **Figure 13**, it is stated that the majority of respondent income is >12 million, amounting to 32%, while the smallest average income ranges from 6-9 million, at 8.9%.

Table 1. Respondents' Personal Characteristics

Characteristics	Inf.	Public Transport Driver	Private Transport Driver
Age	<12 years	10%	-
	12-18 years	20%	20%
	19-40 years	10%	30%
	Elderly	-	10%
Work	Students	10%	40%
	Worker	10%	30%
	Other	5%	5%

Based on **Table 1**, it is known that the age distribution tends to be higher in the 19-40 year age group. It can be seen in the table above that employees tend to bring private vehicles and use online motorcycle taxis to get to the station. Almost half of the users of public transportation and drop-off/taxi/online motorcycle taxis are students.

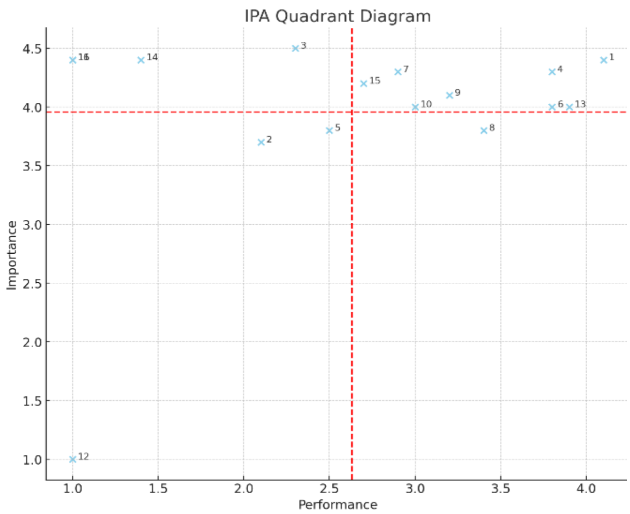

Figure 14. Diagram of calculation results using the IPA method

Based on **Figure 14** presents the results of the Importance–Performance Analysis (IPA), mapping 16 facility attributes of Serang Station based on user ratings of importance and performance. The results show that key facilities such as lighting, disability access, zebra crossings, and bus stops are located in Quadrant I (Top Priority), reflecting high importance but low performance. These facilities are directly related to safety, accessibility, and overall user satisfaction, making them urgent targets for improvement.

Meanwhile, facilities such as cleanliness, public toilets, trash bins, and pathway slopes fall into Quadrant II (Maintain Performance), indicating that their performance currently meets user expectations and should be maintained to prevent service degradation. Quadrant III (Low Priority) contains facilities like pedestrian conditions, bicycle lanes, and seating, suggesting that improvements in these areas are less urgent given their lower perceived importance.

Figure 14 highlights the most pressing service gaps in essential facilities, emphasizing the need for targeted upgrades in safety and accessibility to create a more inclusive and efficient multimodal transport environment at Serang Station. The IPA results provide clear, data-driven guidance for decision-makers in prioritizing investments where they will have the most significant impact on passenger experience.

Based on **Table 2**, the IPA analysis shows that aspects of lighting, disability access, zebra crossings, and bus stops are the main priorities for improvement because their level of importance is high but their existing condition is still low, while other attributes such as cleanliness and travel access are already good and need to be maintained, and several other facilities are in a low priority for improvement. The calculation results are based on the IPA calculations listed in the Plotting to IPA Grid sub-chapter above.

Based on **Table 3**, The results of the Customer Satisfaction Index (CSI) analysis for 16 accessibility service attributes in the station area indicate that the average user satisfaction level is at 52.52%, suggesting that overall service is still at a moderate level and requires improvement. Several attributes with the highest CSI scores, such as cleanliness (81.82%) and inclines/declines to the station (77.5%), show good performance, while attributes like disability access, bicycle lanes, zebra crossings, and bus stops have very low scores (≤27.6%), signifying the need for immediate attention and improvement. These findings underscore the importance of improving basic facilities that support accessibility and safety as part of a service enhancement strategy for inclusive and sustainable multimodal transportation.

The combined analysis using the Importance-Performance Analysis (IPA) and the Customer Satisfaction Index (CSI) on 16 accessibility service attributes in the station area reveals a discrepancy between the level of importance to users and the actual condition of the available facilities. Based on the IPA results, attributes such as lighting, disability access, zebra crossings, and bus stops are in Quadrant I, meaning these attributes are very important to users but their performance is still low, making them a top priority for improvement. This finding aligns with the CSI analysis, which shows that these four attributes have the lowest CSI scores, ranging from 20% to 46%, well below the average CSI of 52.52%. Meanwhile, attributes like cleanliness, public toilets, and gently sloped pathways have high CSI values and are in Quadrant II of the IPA, indicating that their existing conditions meet user expectations and their quality needs to be maintained. The combination of results from both methods provides a clear mapping of priorities for facility improvement and maintenance, thus serving as a basis for strategic planning in developing a more user-responsive accessibility in the station area.

Table 2. Calculation results using the science method

Category	Attribute	Satisfaction	Interest	Quadrant
Comfort	Clean from trash, dirt and dust.	4.1	4.4	II (Maintain Achievements)
	Pedestrian Conditions	2.1	3.7	III (Low Priority)
Security	Lighting	2.3	4.5	I (Top Priority)
Supporting facilities	Public toilet	3.8	4.3	II (Maintain Achievements)
	Seat/reclining	2.5	3.8	III (Low Priority)
	Rubbish bin	3.8	4	II (Maintain Achievements)
Cycling and pedestrian infrastructure	Obstacles in walking (there are obstacles such as portals, the location of street vendors makes it difficult to walk)	2.9	4.3	II (Maintain Achievements)
	Travel distance to vehicle/Location of boarding mode (Halte)	3.4	3.8	II (Maintain Achievements)
	Convenience and comfort when getting on/off the vehicle	3.2	4.1	II (Maintain Achievements)
	Travel duration to vehicle/boarding location (Halte)	3	4	II (Maintain Achievements)
	The existence of a disability pathway	1	4.4	I (Top Priority)
	The existence of bicycle lanes	1	1	III (Low Priority)
	Ascent or descent (elevation while walking) to the station	3.9	4	II (Maintain Achievements)
	Zebra cross	1.4	4.4	I (Top Priority)
	Markings and signs	2.7	4.2	II (Maintain Achievements)
	Halte	1	4.4	I (Top Priority)

Table 3. Calculation results using the CSI method

No	Attribute	CSI(%)
1	Clean from trash, dirt and dust.	81.818
2	Pedestrian Conditions	41.622
3	Lighting	46.222
4	Public toilet	75.814
5	Seat/reclining	49.474
6	Rubbish bin	75
7	Obstacles in walking (there are obstacles such as portals, the location of street vendors makes it difficult to walk)	58.14
8	Travel distance to vehicle/Location of boarding mode (Halte)	68.421
9	Convenience and comfort when getting on/off the vehicle	64.39
10	Travel duration to vehicle/boarding location (Halte)	60
11	The existence of a disability pathway	20
12	The existence of bicycle lanes	20
13	Ascent or descent (elevation while walking) to the station	77.5
14	Zebra cross	27.619
15	Markings and signs	54.289
16	Halte	20
	Average	52.529

Based on **Table 3**, The results of the Customer Satisfaction Index (CSI) analysis for 16 accessibility service attributes in the station area indicate that the average user satisfaction level is at 52.52%, suggesting that overall service is still at a moderate level and requires improvement. Several attributes with the highest CSI scores, such as cleanliness (81.82%) and inclines/declines to the station (77.5%), show good performance, while attributes like disability access, bicycle lanes, zebra crossings, and bus stops have very low scores (≤27.6%), signifying the need for immediate attention and improvement. These findings underscore the importance of improving basic facilities that support accessibility and safety as part of a service enhancement strategy for inclusive and sustainable multimodal transportation.

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3.2 Planning of Serang Station Mode Integration Facilities

The proposed development plan for Serang Station mode integration facilities is grounded in a combined assessment of direct field observations, survey-based Importance–Performance Analysis (IPA), Customer Satisfaction Index (CSI) results, and applicable regulatory standards. Analytical methods applied include:

- Gap Analysis: Comparing expected (importance score) vs actual (performance score) conditions of each facility attribute. Larger positive gaps indicate greater urgency for improvement.
- Mapping: Identifying pedestrian flows and connectivity points to optimize circulation and integration between modes.
- Accessibility Audits: Assessing usability and inclusiveness for all user groups, particularly persons with disabilities.
- Regulatory Compliance Check: Ensuring all proposals align with the Regulation of the Minister of Transportation, national standards (SNI), Transit-Oriented Development (TOD) principles, and Universal Design Guidelines.

Following direct observation at the study location and identification of mode integration facilities at Serang Station, a survey was conducted regarding passenger satisfaction and importance levels. The survey results indicate that several facilities are still inadequate and have low satisfaction levels, despite being considered very important by users. The main facilities of concern include the availability of pedestrian paths, lighting, litter bins, dedicated paths for persons with disabilities, markings and signs, and the presence of bus stops around the station area.

Based on these findings, and in accordance with the Regulation of the Minister of Transportation and the Technical Guidelines for the Provision of Integration, the planned facilities for Serang Station include [15]:

1. Improving the quality of pedestrian paths to be safer and more comfortable.
2. Providing adequate lighting to enhance security, especially at night.
3. Placing litter bins at strategic locations to maintain environmental cleanliness.
4. Providing more accessible paths for persons with disabilities, including ramps and tactile paving.
5. Installing clear traffic markings and signs to support the safety of road users.
6. Constructing bus stops as better transportation integration points.

The pedestrian paths available in the research area are generally sidewalks, which serve as the primary facility for pedestrians. The quality of pedestrian paths is assessed based on three main aspects: weather protection, accessibility for persons with disabilities, and adequate lighting. Weather protection can be realized by planting shade trees, installing canopies, or other protective elements. Accessibility for persons with disabilities is improved through the construction of ramps and tactile paving as guidance for users with visual impairments. Meanwhile, the lighting aspect is addressed by installing lights along pedestrian paths to maintain the safety and comfort of pedestrians, especially at night.

Figure 15. Top view of Serang Station area
Source; Gmaps, 2025

Based on **Figure 15**, from the entrance, the plan is to construct pedestrian facilities equipped with canopies for shelter and litter bins every 20 meters. This path is designed to be friendly for persons with disabilities and will include Green Open Space (RTH). In addition, a dedicated Drop Off and Pick Up area for online motorcycle taxis will be provided, with adequate lighting to ensure user comfort and safety, especially at night.

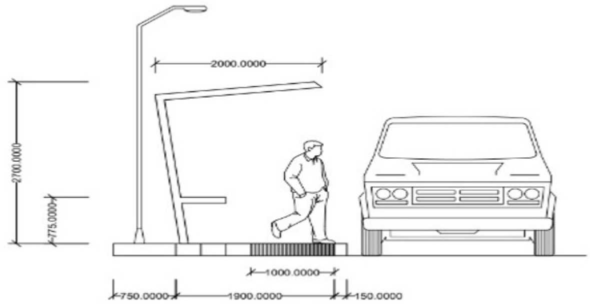

Figure 16. Facilities at Transportation Hubs

Based on **Figure 16**, shows facilities with canopies, lighting, tactile paving, and connection to the bus stop, indicating a focus on comfort, safety, and accessibility. The path width requires further review. This plan is a positive step towards an inclusive and integrated station area.

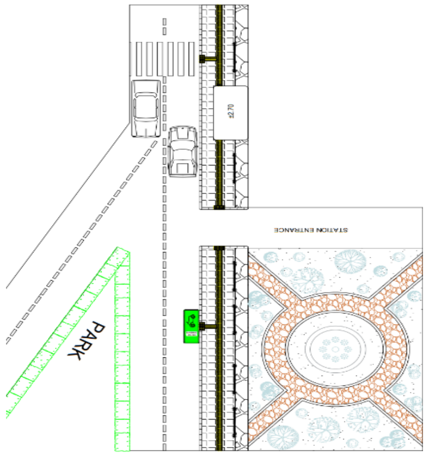

Figure 17. Top view of Serang Station Area Pedestrian Plan

Based on **Figure 17**, the top view of the Serang Station pedestrian plan shows integrated pedestrian paths to the entrance, park, and bus stop, with a zebra crossing for safety. The drop-off/pick-up area needs more detail. Overall, the proposed plan has strong potential to improve accessibility, safety, and comfort for all users.

4 Conclusion

Based on the analysis and discussion, This study evaluated the performance and user perception of multimodal integration facilities at Serang Station using a mixed-methods approach. The results indicate that while the integration of various modes has reduced user travel time and costs , significant challenges remain concerning limited infrastructure, inadequate supporting facilities, and insufficient coordination among transport service providers.

IPA and CSI analyses of 16 facility attributes revealed:

1. Top Priority (IPA Quadrant I): Lighting, disability access, zebra crossings, and bus stops are highly important to users but show low performance. These attributes have the lowest CSI scores (20%-46%), significantly below the average CSI of 52.52%.

2. Maintain Performance (IPA Quadrant II): Cleanliness, public toilets, and gentle slopes demonstrate good performance and meet user expectations.
3. Low Priority (IPA Quadrant III): Pedestrian conditions, bicycle lanes, and seating are less urgent for improvement.

Overall, Serang Station requires revitalization to better organize the terminal area and enhance comfort and convenience for public transportation users during mode transfers. Recommendations include improving pedestrian paths, lighting, waste bins, disability access, markings/signs, and constructing bus stops.

Limitations of the Study

1. Limited Geographical Scope: The study focused solely on Serang Station, which may limit the generalizability of findings to other stations or transit hubs.
2. Quantitative Sample Limitations: Although 300 survey respondents were included , the dominance of the productive age group (96.4%) and students (53.6%) might affect the broader demographic representation.
3. Depth of Qualitative Data: Interviews and observations, while conducted, might not have captured all nuances of user experiences in full depth.
4. Subjectivity of Likert Scale: The interpretation of IPA and CSI relies on respondent perceptions, which can vary.

Recommendations for Future Research

1. Expanded Scope: Conduct similar studies at other stations/transit hubs to compare challenges and successes across different contexts.
2. More In-depth Qualitative Study: Increase the number and depth of interviews/observations for richer insights into user needs and hidden barriers.
3. Cost-Benefit Analysis: Perform detailed cost-benefit analyses for proposed facility improvements to aid policy-makers in resource allocation.
4. Smart Mobility Technology Implementation: Explore the potential of implementing *Mobility-as-a-Service* (MaaS), real-time information systems, and integrated ticketing.
5. Stakeholder Coordination Study: Analyze coordination mechanisms among PT KAI, local government, and transport service providers to identify best practices.
6. Long-term Impact Evaluation: Conduct follow-up studies post-implementation of facility development plans to assess long-term impacts on travel patterns and user satisfaction
7. Specific Demographic Focus: Conduct more targeted research on the needs and challenges of specific user groups, such as persons with disabilities or the elderly, to ensure greater inclusivity.

References

[1] L. Hevanda and M. O. Mahendra, “Pemilihan Moda Transportasi Umum Cilegon-Merak Menggunakan Metode Analytic Hierarchy Process”, doi: 10.33364/konstruksi/v.23-1.2288.

[2] W. Nopriyanto, S. W. Astuti, and P. Dewi, “Analysis of Mode Integration Facilities at Madiun Station Analysis of Mode Integration Facilities at Madiun Station”, doi: 10.32832/astonjadro.v13i12.

[3] Tim Redaksi, "Kerugian Akibat Macet di Jakarta Tembus Rp 100 Triliun per Tahun" CNBC Indonesia, July 05, 2024. [Online]. Available: CNBC Indonesia, https://cnbcindonesia.com/news/. [Accessed August 12, 2025].

[4] Liyantono, "Status Lingkungan Hidup Indonesia 2022," Kementrian Lingkungan Hidup dan Kehutanan Republik Indonesia, 2023. [Online]. Available: KLHK, https://menlhk.go.id/. [Accessed August 08, 2025].

[5] C. Robert, "Transit-Oriented Development's Ridership Bonus: A Product of Self- Selection and Public Policies," Environment and Planning A, vol. 39, pp. 2068-2085, September 2007.

[6] PT. Kereta Api Indonesia, PT. KAI Commuter Jabodetabek, "Jumlah Penumpang Kereta Api (Ribu Orang), 2023," Badan Pusat Statistik, July 10, 2025. [Online]. Available: BPS, https://bps.go.id/. [Accessed August 12, 2025]

[7] I. B. Alhassan, B. Matthews, J. P. Toner, and Y. O. Susilo, “Examining the effect of integrated ticketing on mode choice for interregional commuting: Studies among car commuters,” *Int J Sustain Transp*, vol. 17, no. 3, pp. 245–257, 2023, doi: 10.1080/15568318.2022.2029634.

[8] M. O. Mahendra and M. Djuneydi, “Commuter Trains in Merak-Rangkasbitung,” *U Karst*, vol. 9, no. 1, pp. 78–92, 2025, doi: 10.30737/ukarst.v9i1.6717.

[9] F. Fawwaz, A. R. Rakhmatulloh, "Analisis Pelayanan Integrasi Antarmoda Berdasarkan Persepsi Pengguna di KRL Stasiun Sudirman," Jurnal Pengembangan Kota, vol. 9, pp. 111-123, 2021. DOI: 10.14710/jpk.9.1.111-123

[10] S. D. Arianto, M. S. Roychansyah, "Walkability Kawasan Stasiun Bogor," Jurnal Planoearth, vol. 10, pp. 1-8, 2021.

[11] M. Hernawan, "Difable Perception For Accessibility and Information or Public Transport in Jakarta," Civil Engineering Forum, vol. 21, pp. 1311-1318 , September 2012.

[11] T. A. Ayu, L. N. L. Putu, N. W. N. Ketut, I. W. Runa, & P. Aryastana, "Infrastructure Development in Kendaran Village, Tegallang Sub-District, Gianyar Regency," *Journal of Infrastucture Planning and Engineering (JIPE),* vol. 02, pp. 10-15, October 2023.

[13] N. Asfarinal, L. S. Barus, and B. M. Djaja, “Strategi Pengembangan Sistem Transportasi dengan Pendekatan Transit Oriented Development (TOD) pada Kawasan Kota Tua,” *Jurnal Riset Jakarta*, vol. 15, no. 2, Jan. 2023, doi: 10.37439/jurnaldrd.v15i2.72.

[14] F. P. Sihotang and R. Oktarina, “Penggunaan Metode Importance Performance Analysis (IPA) dan Customer Satisfaction Index (CSI) Dalam Menganalisis Pengaruh Sistem E-Service Terhadap Tingkat Kepuasan Pelanggan The Use of Importance Performance Analysis (IPA) and Customer Satisfaction Index (CSI) Methods in Analyzing the Effect of the E-Service System on the Customer Level,” 2022.

[15] R. Amalia Fajar, T. Murtedjo, and Rulhendri, “Studi Perencanaan Fasilitas Integrasi Moda Pada Terminal Baranangsiang Kota Bogor,” *Journal of Applied Civil Engineering and Infrastructure Technology*, vol. 5, no. 1, pp. 2
4–30, Mar. 2024, doi: 10.52158/jaceit.v5i1.608.