



Spatial Tenure Conflicts in First-Mile Infrastructure: Evaluating the Implementation Gap of Transit Facility Standards in Surabaya's Wirawiri Suroboyo Feeder Service

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Abstract

The integration of formal feeder services into high-density urban settlements often encounters spatial constraints that challenge the implementation of standardized transport infrastructure. This study evaluates the implementation of the Wirawiri Suroboyo feeder service in Surabaya by examining the gap between the National Minimum Service Standards (SPM) and the physical realities of dense urban kampungs. Using a mixed-method approach, the research combines a comprehensive physical audit of 277 feeder stopping points with a purposive user perception survey ($N = 49$) to assess infrastructure provision and user priorities. The findings reveal a pronounced implementation gap, where severely constrained rights-of-way and fragmented spatial conditions limit the provision of standard feeder infrastructure. Despite these constraints, user perceptions indicate that basic safety and comfort attributes remain critical, with lighting ($\bar{x} = 4.92$) and roofed shelter ($\bar{x} = 4.90$) identified as non-negotiable needs among transit-dependent users. This condition highlights a structural mismatch between land-based service standards and the spatial contexts in which feeder services operate. Rather than framing the issue as a technical design deficiency, the study positions feeder infrastructure provision as a planning and governance challenge shaped by spatial tenure and implementation capacity. The findings contribute to urban transport planning discourse by emphasizing the need for adaptive, context-sensitive approaches to service standard implementation in dense urban environments, particularly within cities of the Global South.

Keywords: *First-Mile Connectivity; Feeder Transport Planning; Service Standard Implementation; Spatial Constraints; Spatial Governance*

1. Introduction

Surabaya, as the second-largest metropolitan area in Indonesia, faces complex urban mobility challenges characterized by severe traffic congestion, reflecting broader structural limitations in urban transport planning. The Global Traffic Scorecard has identified Surabaya as one of the most congested cities in the country, underscoring the urgency of strengthening mass transit systems and their supporting components (Hadi & Arif, 2024). Addressing congestion in such metropolitan contexts requires not only the

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expansion of public transport services but also the effective integration of these services within existing urban spatial structures.

Within contemporary transport planning, feeder systems play a strategic role in strengthening first-mile and last-mile connectivity by linking residential areas to primary transit corridors and terminals. The quality of first- and last-mile connections is widely recognized as a determinant of public transit performance, as such connections extend the catchment area of transit systems and bridge gaps in existing networks (Shaheen & Chan, 2016). In response to these challenges, the Surabaya City Government launched the "Wirawiri Suroboyo" feeder service in 2023 as part of its broader mass transit strategy (Zaky & Taufiq, 2025). Unlike trunk services such as the Suroboyo Bus, this feeder system is designed to penetrate high-density residential areas (*kampungs*) and narrow neighborhood streets that are inaccessible to larger vehicles, thereby extending public transport coverage to areas that have historically been underserved (Hamida & Kurniawan, 2023). From a planning perspective, the performance of such feeder services is closely tied to how well they can be accommodated within constrained and heterogeneous urban environments.

The sustainability and effectiveness of feeder services depend not only on fleet operations but also on the provision of adequate supporting infrastructure. Previous studies indicate that public transport performance in developing countries is frequently undermined by limited road infrastructure and weak physical integration between transport modes (Budiprasetya & Farghani, 2024). Empirical evidence further suggests that the quality of bus stop facilities plays a substantial role in shaping public transport usage, influencing up to 46.4% of users' decisions to shift to public transport (Affif, 2021). In Indonesia, these infrastructure requirements are formalized through the Ministry of Transportation Regulation Number PM 10 of 2012 concerning Minimum Service Standards (*Standar Pelayanan Minimal* or SPM), which mandates the provision of basic physical elements such as shelters and seating to ensure safety, comfort, and protection from weather conditions (Ministry of Transportation, 2012). Although the regulation formally governs road-based mass transport, it is applied in this study as the normative benchmark because the Wirawiri Suroboyo is designed as a feeder integrated with the Suroboyo Bus mass transit corridors, so its stopping points are expected to meet the service standard of the system they serve. These standards represent an important policy instrument intended to guarantee a minimum level of service quality across urban transport systems.

However, the implementation of such standards faces significant challenges in dense urban settlements, where spatial conditions differ markedly from those assumed in formal planning frameworks. In high-density *kampungs* with limited pedestrian paths, narrow sidewalks, and fragmented land ownership, the provision of standardized transport infrastructure is constrained by the availability and control of public space. Built-environment research indicates that density, land-use diversity, and pedestrian-oriented design influence trip rates and non-auto travel, albeit with modest to moderate effects (Cervero & Kockelman, 1997), underscoring that the physical setting conditions how transit can be accessed. Existing literature highlights that in spatially constrained environments, transport facilities must operate within extremely limited footprints and cannot be implemented through conventional approaches without disrupting pedestrian circulation or everyday neighborhood activities (Maksić-Mulalić, 2023). In addition, logistical and construction constraints in narrow neighborhood roads further complicate infrastructure provision, often requiring adaptive approaches to address land limitations and construction feasibility (Ibrahim et al., 2022). The operational characteristics of feeder services, which involve shorter dwell times and more flexible stopping patterns than trunk services, further accentuate the need for infrastructure provision models that differ from conventional large-scale bus shelters (Rinaldi et al., 2025).

Empirical conditions in Surabaya reveal a pronounced gap between regulatory standards and on-the-ground realities. Preliminary observations across 277 stopping points along four Wirawiri Suroboyo routes indicate that feeder infrastructure is predominantly minimal, with 51.3% of stops marked only by signage poles without pavement and 36.1% located on sidewalks without any supporting facilities. These conditions point to the presence of spatial tenure conflicts, in which the provision of public transport infrastructure is constrained by critically narrow sidewalks, limited right-of-way width, and friction with adjacent private property (*persil*). In such contexts, planning standards that rely on ground-level space allocation become difficult to implement, resulting in selective or symbolic compliance rather than substantive infrastructure provision.

This study aims to evaluate the spatial constraints that hinder the fulfillment of Minimum Service Standards (SPM) for feeder transport infrastructure in Surabaya from a planning and spatial governance perspective. Unlike previous studies that have primarily focused on fleet performance and service operations, this research emphasizes the implementation of planning standards within the spatial realities of dense urban settlements. By examining the gap between regulatory requirements, existing physical conditions, and user priorities, the study seeks to contribute to urban planning discourse by reframing feeder stop provision as an implementation challenge shaped by spatial tenure and governance conditions. The

findings are expected to inform more adaptive planning approaches and technical policy considerations for resolving infrastructure provision challenges in dense urban environments.

2. Methods

2.1. Research Design and Conceptual Framework

This study adopts an evaluative planning research design with a mixed-method approach to examine the implementation of feeder transport infrastructure standards within spatially constrained urban environments. The research is situated in Surabaya City, using the Wirawiri Suroboyo feeder service as a case study due to its role in serving high-density residential areas with heterogeneous urban morphology.

The study is conceptually grounded in the interaction between three key dimensions: regulatory standards, spatial conditions, and user priorities. The Minimum Service Standards (*Standar Pelayanan Minimal* or SPM) serve as the normative benchmark and are operationalized into observable physical indicators, including lighting, shelter, seating, accessibility, and service information.

These indicators are assessed through field observation to evaluate their implementation under existing spatial constraints, while user perception data are collected to identify priority needs from the perspective of active users. The analysis integrates these dimensions using a gap analysis approach, comparing regulatory requirements, observed conditions, and user priorities to identify mismatches between expected standards and actual provision.

By structuring the analysis in this way, the study frames feeder infrastructure provision as an implementation challenge shaped by spatial and governance constraints rather than solely a technical design issue. The conceptual relationship between regulatory standards, empirical observations, and analytical processes is summarized in Table 1.

Table 1. Conceptual Framework Linking Theory, Variables, and Analysis

Component	Description	Operational Form	Role in Analysis
Regulatory Framework	Minimum Service Standards (SPM) as national policy guideline	Set of service dimensions (security, comfort, accessibility, etc.)	Defines expected level of infrastructure provision
Observed Conditions	Empirical data from field observation	277 feeder stopping points (census)	Represents actual infrastructure provision
User Perception	User-based evaluation of infrastructure needs	Survey responses ($N = 49$), Likert scale	Identifies priority attributes and perceived gaps
Analytical Approach	Comparative evaluation framework	Gap analysis (standard vs condition vs perception)	Identifies mismatches and critical intervention areas
Output	Planning interpretation	Implementation patterns and constraints	Forms basis for adaptive planning implications

Source: Author's analysis, 2025

2.2. Study Area and Case Selection

The Wirawiri Suroboyo feeder service was selected as the case study due to its strategic role in extending public transport coverage into high-density residential areas (*kampungs*) that are not accessible to larger transit modes. This characteristic makes the service particularly relevant for examining the implementation of feeder infrastructure within spatially constrained urban environments.

Four feeder corridors were selected using a purposive sampling strategy to capture variations in urban morphology, land-use context, and spatial governance conditions. Rather than aiming for statistical representation, the selection is intended to ensure analytical diversity across different planning environments, allowing comparison of how infrastructure standards are implemented.

Table 2. Analytical Characteristics of Selected Feeder Routes

Route	Route Trajectory	Area Typology	Spatial Characteristics	Planning Relevance
FD02	PNR Mayjend–Balai Kota	CBD and Protocol Road	Wide right-of-way, formal pedestrian infrastructure, and high land control	Represents areas with feasibility of standard implementation
FD04	RS Royal SIER–Kota Lama	Industrial and Transit Area	Moderate to wide roads and limited pedestrian prioritization	Tests whether space availability translates into infrastructure
FD10	Terminal Keputih–Pasar Atom	Education and Trade Route	Strong contrast between institutional land and <i>kampung</i> areas	Captures “institutional enclave effect” in infrastructure provision
FD11	Terminal Bratang–Shelter Bulak	Coastal and Residential Area	Narrow streets, informal settlements, and limited right-of-way	Represents highly constrained environments

Source: Author's analysis, 2025

As shown in Table 2, each selected corridor represents a distinct combination of spatial conditions and planning contexts. This variation enables the study to examine how differences in right-of-way availability, land control, and urban form influence the implementation of feeder infrastructure standards. By comparing these contrasting environments, the research aims to identify patterns of spatial selectivity and the underlying constraints that shape infrastructure provision across the feeder network.

2.3. Variables and Indicators

To ensure conceptual consistency between regulatory standards and empirical observation, this study operationalizes the Minimum Service Standards (*Standar Pelayanan Minimal* or SPM) into a set of measurable physical indicators. These indicators are selected based on two main criteria: (1) their direct relevance to feeder-scale infrastructure, and (2) their observability under field conditions. This approach allows the study to translate normative planning standards into empirically verifiable variables.

While the SPM framework includes a broad range of service components, this study focuses specifically on physical infrastructure indicators that influence user safety, comfort, accessibility, and information provision at stopping points. Indicators related to operational management or onboard service quality are excluded to maintain analytical focus on spatial and infrastructure conditions. Each variable is defined in operational terms and linked to a specific measurement method to ensure consistency during field observation and analysis. In addition, each indicator is assigned an analytical role to clarify its contribution to the gap analysis framework. The operationalization of variables is summarized in Table 3.

Table 3. Operationalization of Variables Based on Minimum Service Standards (SPM)

Dimension	Indicator	Operational Definition	Measurement Method	Analytical Role
Security	Lighting	Availability of functioning lighting to ensure user safety at night	Binary observation	Identifies safety-related infrastructure gaps
	Emergency Information	Availability of complaint/contact information	Visual verification	Assesses provision of basic security communication
Safety	Signage or Marking	Presence of stop signage and road marking	Visual observation	Determines formal recognition of stop location
Comfort	Shelter	Presence of roofed structure protecting users from weather	Visual observation	Evaluates protection against environmental exposure
	Seating	Availability of seating facilities	Visual observation	Assesses waiting comfort level
	Cleanliness	Availability of waste bins	Visual observation	Indicates maintenance and usability of space
Equality	Accessibility Features	Presence of ramps or tactile paving	Visual observation	Evaluates inclusivity for disabled users
	Stop Access	Adequate space for boarding and alighting	Qualitative spatial assessment	Identifies physical usability constraints
Regularity	Service Information	Availability of route, schedule, or stop information	Visual observation	Assesses informational accessibility

Source: Author's analysis, 2025

By structuring the variables in this way, the study establishes a clear linkage between regulatory expectations and field-based evidence. This operational framework enables a systematic comparison between required standards, existing infrastructure conditions, and user priorities, forming the basis for the subsequent gap analysis.

2.4. Data Collection Methods

Data collection was conducted in October 2025 using two complementary methods: (1) a comprehensive field observation of feeder stopping points, and (2) a user perception survey. These methods were designed to capture both the physical implementation of infrastructure standards and user priorities, enabling triangulation between regulatory expectations, observed conditions, and user experiences.

2.4.1. Field Observation (Census Approach)

A census-based field observation was conducted to document all feeder stopping points along the four selected corridors. A total of 277 stopping points were systematically recorded to provide a comprehensive representation of infrastructure conditions across different spatial contexts.

Data collection was carried out through direct on-site visits, where each stopping point was assessed using a standardized observation checklist derived from the operationalized SPM indicators (Table 3). The checklist ensured consistency in recording the presence or absence of each infrastructure element, including lighting, shelter, seating, accessibility features, and service information.

Each location was documented using photographic records to ensure spatial accuracy and enable cross-verification. Observations were conducted during daytime conditions to ensure visibility of physical attributes, while infrastructure such as lighting was evaluated based on the presence of fixtures rather than operational performance.

To support comparative analysis, stopping points were further classified into four infrastructure typologies: (1) signage only without pavement, (2) signage located on sidewalks, (3) stops equipped with shelter and seating, and (4) locations without physical markers. This classification enables the identification of patterns in infrastructure provision and levels of compliance with planning standards across the network.

2.4.2. User Perception Survey

To complement the spatial audit, a user perception survey was conducted to capture user priorities and perceived deficiencies in feeder stop infrastructure. A purposive sampling strategy was employed to ensure that respondents were active users of the Wirawiri Suroboyo feeder service, aligning the data with the study's planning focus.

The questionnaire was distributed online through targeted channels, including student networks and local user communities associated with the feeder service. Screening questions were applied to confirm that respondents had prior experience using the service, ensuring the relevance of responses.

A total of 49 valid responses were collected. While the sample size is not intended for statistical generalization, it is considered sufficient for exploratory analysis and design-related research, as suggested by Roscoe (1975). The survey utilized a five-point Likert scale to measure user perceptions related to safety, comfort, accessibility, and information provision, corresponding to the dimensions of the Minimum Service Standards (SPM). The collected data were used to identify priority attributes and to support the evaluation of infrastructure gaps from a user-centered perspective. A summary of the data collection methods, including both the field observation and the user perception survey, is presented in Table 4.

Table 4. Summary of Data Collection Methods

Method	Data Source	Instrument	Sample Size	Output
Field Observation (Census)	Feeder stopping points	Standardized checklist and camera	277 stops	Inventory of infrastructure conditions and typology classification
User Perception Survey	Active feeder users	Online questionnaire (Likert scale)	49 respondents	User priority data and perceived infrastructure gaps

Source: Author's analysis, 2025

2.5. Data Analysis

Data analysis was conducted using a gap analysis framework to evaluate discrepancies between regulatory standards, observed infrastructure conditions, and user priorities. This approach enables a

structured comparison between what is required (SPM), what is implemented in the field, and what is perceived as important by users.

The analysis consists of three main components. First, observational data from 277 stopping points were analyzed using descriptive statistics, primarily frequency distributions, to identify dominant infrastructure conditions and typological patterns across corridors.

Second, user perception data were analyzed using mean scores derived from the five-point Likert scale to determine the relative priority of each infrastructure attribute. Higher mean values indicate greater perceived importance and urgency from the user perspective.

Third, a comparative analysis was conducted by aligning the three dimensions: (1) SPM indicators as regulatory benchmarks, (2) observed field conditions, and (3) user priority scores. The gap was identified where critical indicators show low levels of physical provision but high user priority, indicating areas of significant mismatch.

Rather than producing prescriptive design solutions, the analysis focuses on interpreting patterns of implementation and identifying structural constraints related to spatial conditions and governance. The findings are then used to formulate planning-oriented implications for adaptive feeder infrastructure provision in dense urban environments.

3. Results and Discussion

This section presents the empirical findings of the study and discusses their implications for the implementation of feeder transport planning standards in dense urban environments. Rather than treating results and discussion as separate components, the analysis is integrated to highlight how observed infrastructure conditions reflect broader planning, spatial governance, and implementation challenges.

3.1. Implementation Gap of Feeder Infrastructure Standards

The census of 277 stopping points across four Wirawiri Suroboyo feeder corridors reveals a substantial gap between the Minimum Service Standards (SPM) and actual infrastructure provision. Unlike trunk public transport services that typically operate along arterial roads with established right-of-way, feeder services are embedded within heterogeneous urban fabrics where spatial conditions vary significantly. This results in uneven implementation of planning standards across the network.

Figure 1 illustrates the distribution of feeder stop infrastructure typologies by route, showing that minimal infrastructure dominates across all corridors. The findings confirm that the majority of feeder stops do not function as formal transit nodes as envisioned by regulatory standards, but rather as informal or semi-formal stopping locations shaped by local spatial constraints. In this context, stops are often reduced to basic markers of service presence rather than fully equipped facilities.

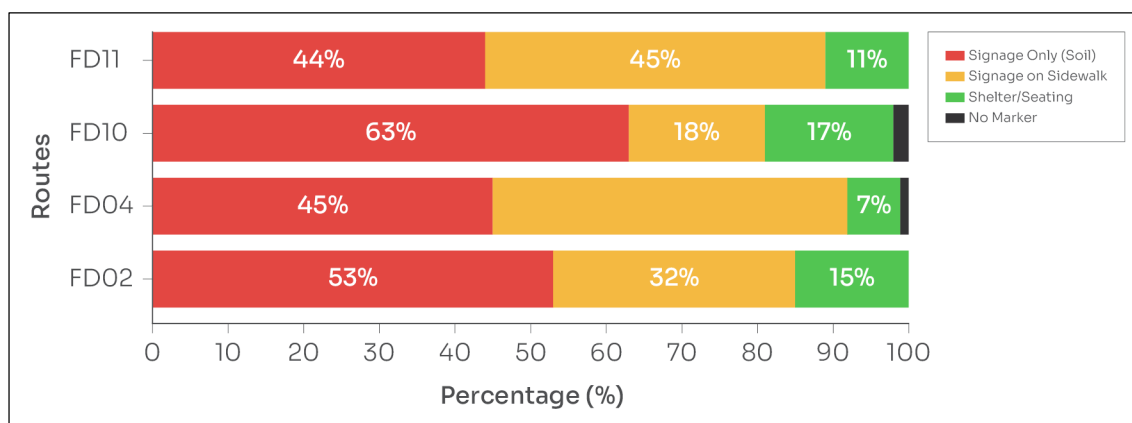


*Figure 1. Distribution of Infrastructure Typologies by Route
(Source: Author's analysis, 2025)*

The predominance of minimal infrastructure indicates that standard implementation is driven more by spatial feasibility than by service demand. Similar tendencies have been noted in spatially constrained environments, where infrastructure adapts to limited space rather than formal standards (Maksić-Mulalić, 2023). However, this study suggests that the issue extends beyond design adaptation, reflecting a mismatch between land-based regulatory standards and the spatial realities of feeder service environments.

3.2. Typology of Feeder Stop Conditions and Spatial Selectivity

Based on field observation, feeder stops were classified into four typologies reflecting varying degrees of compliance with planning standards. Figure 2 presents the overall distribution of these typologies.



Figure 2. Typology of Existing Wirawiri Feeder Stops
(Source: Author's field documentation, 2025)

Type A stops, characterized by signage-only installations without pavement, constitute the majority at 51.3% (142 locations). These stops are typically located on road shoulders or unpaved surfaces, indicating the absence of formal space allocation for feeder infrastructure. From a planning perspective, this typology represents a form of minimal or symbolic compliance, where service presence is indicated without the provision of adequate facilities.

Type B stops, accounting for 36.1% (100 locations), are located on sidewalks but lack supporting amenities. While these locations provide relatively safer waiting areas, their limited facilities suggest partial implementation of planning standards constrained by narrow sidewalks and competing pedestrian uses. Only 11.9% (33 locations) fall under Type C, where shelters and seating are provided, predominantly in areas with stronger land control such as transit hubs or institutional environments. A small proportion (0.7%) of locations lack any physical marker (Type D), indicating gaps in spatial legibility within the feeder network.

This distribution demonstrates a clear pattern of spatial selectivity in infrastructure provision, where higher levels of compliance are concentrated in formally managed areas, while informal residential environments receive minimal intervention. Similar patterns have been observed in constrained urban contexts, where infrastructure provision is shaped by land control and spatial availability rather than uniform planning standards (Maksić-Mulalić, 2023). This suggests that feeder stop typologies are not merely physical variations, but reflect underlying spatial governance conditions that determine the extent to which planning standards can be implemented.

3.3. Spatial Variation Across Corridors and Urban Morphology

The implementation gap is not spatially uniform, but closely associated with corridor-specific urban morphologies and land governance contexts. The analysis reveals that infrastructure outcomes are shaped less by regulatory intent and more by the spatial structure in which feeder services operate.

Route FD10, serving education and trade areas, exhibits the most pronounced contrast. Within institutional environments such as university campuses, feeder stops are predominantly Type C, reflecting the feasibility of infrastructure provision under centralized land control. However, once the route enters adjacent kampung areas, the proportion of Type A stops increases sharply, reaching 63%. This contrast illustrates an "institutional enclave" effect, where planning standards are effectively implemented only within formally governed spatial domains.

In Route FD04, which traverses industrial and transit-oriented areas, a different pattern emerges. Despite relatively wider right-of-way and available space, 47% of stops are classified as Type B, while shelter provision remains limited. This suggests that spatial availability alone does not guarantee implementation, as planning priorities in industrial areas tend to favor vehicular movement over pedestrian-oriented infrastructure.

Route FD11, representing coastal and peri-urban residential areas, shows a gradual degradation of infrastructure quality as the feeder penetrates deeper into informal settlement areas. Type B stops dominate along arterial segments, while Type A stops prevail within interior residential zones. This pattern reflects a decline in planning control as feeder routes move away from formal road hierarchies.

Route FD02, located in the city center, demonstrates relatively higher compliance due to the presence of established pedestrian infrastructure. However, the persistence of minimal typologies even in central areas indicates that feeder services frequently operate within secondary street networks that fall outside the focus of conventional infrastructure planning.

These findings suggest that spatial variation in feeder infrastructure provision is fundamentally shaped by differences in land control, right-of-way conditions, and urban morphology. Rather than being uniformly applied, planning standards are mediated by localized governance contexts, reinforcing the argument that infrastructure implementation is contingent upon spatial and institutional conditions.

3.4. Infrastructure Deficits as Planning Constraints

3.4.1. Amenities and Security Deficits

Critical comfort facilities such as roofed shelters, seating, and dedicated lighting are absent in 88.1% of the Wirawiri Suroboyo stopping points. As a result, passengers are forced to rely on general street lighting for safety at night and remain exposed to direct sunlight and rain during the day. This condition significantly reduces the usability of feeder stops as public waiting spaces, particularly in a tropical urban context where environmental exposure directly affects user comfort and safety. Previous studies highlight that shelters function as essential micro-infrastructure to protect users from thermal stress and weather conditions (Briant et al., 2025), indicating that their absence represents not only a design limitation but a critical gap in basic service provision.

3.4.2. Accessibility Constraints

The current infrastructure presents substantial barriers for passengers with disabilities. The absence of tactile paving and auditory information makes it difficult for visually impaired users to locate and identify stops independently, while the dominance of Type A stops, often situated on unpaved or roadside surfaces, prevents wheelchair users from accessing the service altogether. Although the existing feeder fleet provides limited accommodation for foldable wheelchairs, this provision becomes ineffective without accessible stop infrastructure. This indicates a systemic disconnection between transport services and pedestrian infrastructure, where accessibility is not addressed as an integrated component of planning. As a result, the system reinforces exclusion for vulnerable user groups, contradicting the equity principles embedded in the SPM framework.

3.4.3. Information Deficits

Most feeder stops lack essential service information such as route maps, stop identification, and schedules. This absence reduces the legibility of the transport system and increases uncertainty for users, particularly for first-time or occasional passengers. Previous studies have shown that the availability of clear information is a key determinant of perceived service quality and user satisfaction (Affif, 2021). In the context of Wirawiri Suroboyo, the lack of informational infrastructure further weakens the usability of feeder services, despite their intended role in improving accessibility and connectivity.

3.5. User Priorities and Equity Implications

To corroborate the physical audit findings presented in the section on the implementation gap of feeder infrastructure standards, a perception survey was conducted involving 49 respondents ($N = 49$) selected through a purposive sampling technique. Although limited in size, the survey functions as a needs assessment to identify dominant priorities among active users of the Wirawiri Suroboyo feeder service. The respondent profile, summarized in Table 5, indicates that the service primarily serves students (57.1%) within the productive age group of 18–30 years (79.6%). Economically, 71.4% of respondents report monthly incomes below Rp2,000,000 or have no fixed income, while 42.9% rely on the service for essential trips related to work and education.

This user composition confirms that Wirawiri Suroboyo predominantly serves captive riders with limited transportation alternatives. From a planning perspective, this condition reframes feeder infrastructure provision as an issue of social equity rather than discretionary service enhancement. This framing is consistent with the transport and social exclusion literature, which shows that transport, land-use planning, and service delivery decisions can create and reinforce poverty and social disadvantage (Lucas, 2012). In dense urban contexts where daily mobility is highly dependent on feeder services, the quality of waiting environments becomes a fundamental component of mobility access. In this regard, the promotion of inclusive urban furniture is relevant not as an aesthetic intervention, but as a means of supporting vulnerable user groups and fostering more equitable public spaces (Rinaldi et al., 2025).

Table 5. Demographic Profile of Respondents

Category	Segment	Percentage (%)
Gender	Male	59.2
	Female	40.8
Age Group	<18 Years	8.2
	18–30 Years	79.6
	31–55 Years	8.2
	>55 Years	4.1
Occupation	Student	57.1
	Employee	22.4
	Entrepreneur	12.2
	Others	8.2
Income	<Rp2,000,000/No Fixed Income	71.4
	Rp2,000,000–Rp5,000,000	18.4
	>Rp5,000,000	10.2
Trip Purpose	Work/School/Campus	42.9
	Recreation/Social	28.6
	Feeder to Main Transport	18.4
	Others	10.2

Source: Author's analysis, 2025

User perception analysis reveals a strong alignment between reported discomfort and the infrastructure deficiencies identified in the spatial audit. Respondents reported high levels of discomfort ($\bar{x} = 4.51$) and identified lighting ($\bar{x} = 4.92$), roofed shelter ($\bar{x} = 4.90$), and seating ($\bar{x} = 4.80$) as absolute priorities. These findings indicate that basic safety and comfort attributes are non-negotiable from the user perspective, particularly for vulnerable groups who rely on the system for routine mobility.

Table 6. User Needs Assessment based on SPM Dimensions

SPM Dimension	Indicator (Attribute)	Mean Score (1–5)	Interpretation
Security	Lighting	4.92	Absolute Priority
Comfort	Roofed Shelter	4.90	Absolute Priority
	Seating	4.80	Absolute Priority
Regularity	Route Information	4.78	High Priority
Equality	Ramp/Accessibility	4.57	High Priority
Perceived Condition	Discomfort Perception	4.51	Highly Uncomfortable
	Ease of Access	2.98	Difficult to Access
Design Preference	Aesthetic vs Functional	4.63	Prefer Functional

Source: Author's analysis, 2025

These results, as presented in Table 6, are consistent with previous studies showing that environmental attributes, especially lighting and visibility, are critical determinants of perceived safety and public transport use (Sethulakshmi & Mohan, 2024). However, in the context of Wirawiri Suroboyo, the absence of such basic amenities not only reduces comfort but also reinforces the vulnerability of transit-dependent users.

Interestingly, respondents also expressed a strong preference for functional provision over aesthetic considerations. This suggests that users prioritize the fulfillment of minimum service standards rather than enhanced or decorative infrastructure. From a planning perspective, this reinforces the argument that the primary challenge lies not in design sophistication, but in ensuring the consistent provision of essential infrastructure within constrained spatial environments.

3.6. Implications for Adaptive Feeder Infrastructure Planning

The findings of this study demonstrate that the challenges associated with feeder stop provision in Surabaya extend beyond technical design limitations and are rooted in the interaction between planning standards and constrained urban spatial conditions. The dominance of minimal infrastructure typologies indicates that conventional, land-based standards assume spatial availability that does not exist within dense kampung environments. As a result, implementation becomes selective and contingent upon localized spatial feasibility rather than service necessity.

This condition reveals a structural limitation within the current planning framework, where feeder services are operationally expanded without corresponding adaptation in infrastructure planning logic. While routes successfully penetrate high-density residential areas, the standards governing stop provision remain oriented toward formal road hierarchies and stable land ownership. This creates a persistent mismatch between service expansion and infrastructure provision.

From a planning perspective, these findings suggest the need for more adaptive approaches to feeder infrastructure provision that recognize spatial tenure constraints. Rather than treating feeder stops as fixed infrastructure objects, they can be conceptualized as flexible public micro-spaces that can be accommodated within narrow and contested urban environments. This does not imply lowering service standards, but prioritizing essential elements such as shelter, lighting, and seating within minimal footprints.

More broadly, the study highlights the importance of integrating feeder infrastructure planning with neighborhood-scale spatial governance. Without mechanisms to address fragmented land ownership and limited public space, feeder systems risk reproducing spatial inequality despite their role in improving mobility access. These findings suggest that future planning approaches should move toward context-sensitive standards that balance regulatory intent with spatial feasibility.

4. Conclusion

This study examined the implementation of Minimum Service Standards (SPM) for feeder transport infrastructure in Surabaya, using the Wirawiri Suroboyo feeder service as a case study. The audit of 277 stops reveals a persistent gap between regulatory requirements and actual provision. Minimal typologies dominate, and most stops lack basic amenities such as shelters, seating, and dedicated lighting. Rather than reflecting service demand, implementation is largely determined by spatial feasibility and land control. Higher compliance is concentrated in formally managed or institutionally controlled areas, while informal settlements experience systematic under-provision. User perceptions reinforce these findings: the predominance of low-income, transit-dependent users makes feeder infrastructure a matter of social equity, and their priorities center on basic safety and comfort rather than enhanced facilities. The challenge is therefore structural rather than technical, since conventional land-based standards are difficult to implement where public space is limited and spatial tenure is contested.

Several policy directions follow from these findings. Transport authorities should develop adaptive design guidelines for feeder-scale infrastructure that allow flexibility in providing shelter, lighting, and seating within constrained spaces. Coordination between transport agencies and local spatial governance actors is needed to address land access and right-of-way limitations in dense kampung areas. Incremental or modular implementation can enable gradual upgrading of stops based on priority needs and spatial feasibility, keeping provision context-sensitive while maintaining minimum service quality. This study reframes feeder stop provision as a negotiated outcome shaped by spatial governance conditions rather than solely a design issue. Future research may explore the institutional mechanisms and policy instruments that support more flexible and equitable implementation of transport infrastructure standards in dense urban environments.

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the text. After using these tools, the authors reviewed and edited the content as needed and assume full responsibility for the published content.

6. Conflict of Interest Statement

The authors state that they have no conflicts of interest concerning the research, authorship, or publication of this manuscript.

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