An Empirical Study on Demand-Supply Imbalances of Intercity Public Transportation: Evidence from Gorontalo Province

Merlyn Fransisca Rassa[1]; Anton Kaharu[2*]; Mohammad Yusuf Tuloli[3]

[1]Civil Engineering Graduates, Department of Civil Engineering, State University of Gorontalo, Indonesia
[2,3]Associate Professor, Department of Civil Engineering, State University of Gorontalo, Indonesia

Corresponding Author: Anton Kaharu[2*]

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Abstract: This study investigates the structural imbalances between demand and supply in intercity public transportation (locally known as AKDP paratransit) across Gorontalo Province, Indonesia. Utilizing an empirical approach, field data were collected through comprehensive passenger counts and vehicle tracking across five major intercity routes connecting Gorontalo City with surrounding regencies. The results reveal a severe state of over-supply across the transit network: while the total daily regional supply reached 720 available seats, the actual daily passenger demand peaked at only 287 individuals, generating a critical supply-to-demand mismatch. On a corridor level, the high-frequency Kota–Isimu route exhibited the lowest efficiency with a 28% average load factor due to uncoordinated headway distributions (averaging 8.5 minutes) among 37 actively competing fleets. Conversely, peripheral corridors like Kota–Taludaa suffered from operational scarcity, recording an unviable frequency of 0.8 vehicles/hour despite holding latent demand. These temporal and spatial mismatches underscore how unregulated paratransit operations lead to destructive competition and low asset utilization. This study concludes that the current supply-driven model is unsustainable. We propose a data-driven route restructuring framework and a transition toward a regulated headway system to optimize load factors and stabilize regional transit economics in emerging provinces.

Keywords: *Demand-Supply Imbalance; Intercity Paratransit; Load Factor; Headway Optimization; Gorontalo Province.*

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I. INTRODUCTION

In developing economies, informal and semi-formal public transportation systems commonly referred to as paratransit play a pivotal role in sustaining regional mobility and connecting peripheral areas to urban economic centers [2]. Unlike institutionalized mass transit systems observed in developed nations, paratransit networks typically operate under a decentralized, supply-driven model characterized by individual vehicle ownership, flexible scheduling, and market-driven route competition [1], [11]. While this operational flexibility offers high adaptability to fluctuating spatial demands, it frequently introduces severe systemic inefficiencies [4]. Unregulated market entry and the absence of synchronized scheduling often culminate in acute demand-supply imbalances. In many emerging regions, these imbalances manifest either as catastrophic over-supply along lucrative urban corridors, which induces destructive economic competition among operators, or as severe under-supply along peripheral routes, which isolates vulnerable rural populations [11]. Understanding the empirical dynamics of these mismatches is crucial for developing sustainable regional transit policies, yet quantitative assessments of intercity paratransit performance in rapidly urbanizing secondary provinces remain noticeably scarce in the current literature [9].

In the context of Indonesia, regional connectivity relies heavily on Angkutan Kota Dalam Provinsi (AKDP), a provincial intercity paratransit mode predominantly served by sub-15-passenger microbuses. Following decentralization reforms, the management and regulation of AKDP networks were transferred to provincial transportation authorities under national legislative guidelines [7]. However, infrastructure planning in many outer provinces has historically favored private vehicle infrastructure, sidelining public transit frameworks. This policy mismatch has triggered a rapid surge in private motorcycle and automobile ownership, causing a structural contraction in public transit patronage [5]. Despite this declining demand, the volume of registered paratransit permits often remains static or continues to grow due to a lack

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of data-driven supply calibration. Consequently, operators are forced to navigate a shrinking market, leading to highly volatile vehicle headways, compromised service quality, and critically low vehicle utilization rates that threaten the socioeconomic viability of the entire regional transport sector [6].

Gorontalo Province, situated in the northern peninsula of Sulawesi, serves as an ideal empirical laboratory to investigate these structural demand-supply configurations. As an emerging secondary province with a developing urban core and extensive agrarian hinterlands, Gorontalo's regional mobility is dependent on its five primary AKDP corridors that link Gorontalo City to surrounding regencies. Preliminary observations suggest a profound disconnect between state-sanctioned transit supply and the actual mobility requirements of the population [3]. While transport authorities issue permits based on historical capacities, shifting demographic patterns, spatial economic reconfigurations, and the proliferation of app-based ride-hailing services have radically altered the regional demand landscape. Existing localized transport reports often rely on static, aggregated annual data [3], failing to capture the real-time operational metrics such as route-specific load factors, temporal passenger fluctuations, and headway distributions that directly govern the efficiency of paratransit networks [8].

While previous scholarship in transport geography has extensively explored demand-supply elasticities in metropolitan bus rapid transit (BRT) networks and urban rail systems, significant knowledge gaps persist regarding intercity paratransit dynamics in non-metropolitan, developing archipelagic regions. Most paratransit literature focuses on high-density urban micro-mobility (e.g., Angkot in Jakarta or Jeepneys in Manila) [5], [6], leaving the spatial-temporal imbalances of intercity paratransit systems in lower-density secondary provinces largely under-researched. This study directly addresses this empirical and geographical gap [8]. By conducting synchronized, route-specific passenger counts and high-resolution vehicle tracking across the entire AKDP network of Gorontalo Province, this paper presents a granular, empirical diagnosis of regional transit performance.

The primary objective of this study is to quantify and evaluate the spatial and temporal imbalances between public transit demand and supply across the five major intercity corridors in Gorontalo Province. Specifically, this paper evaluates empirical indicators including passenger volume fluctuations, vehicle headways, and operational load factors to map structural inefficiencies. Beyond its localized empirical contributions, this study provides a generalizable methodological framework for transportation planners in developing regions to recalibrate paratransit supply, transition from supply-driven to demand-responsive governance, and safeguard the economic sustainability of regional public transport systems [10].

II. METHODOLOGY

A. Research Design and Study Area

This study employs a quantitative, empirical approach leveraging synchronized field observations to evaluate the spatial-temporal performance of intercity paratransit networks. The empirical investigation was executed across the entire registered Angkutan Kota Dalam Provinsi (AKDP) network in Gorontalo Province, Indonesia [8]. Gorontalo presents a critical case study due to its geographical configuration as an emerging secondary province in the northern peninsula of Sulawesi.

The scope of this empirical assessment encompasses the five primary intercity corridors connecting the urban hub of Gorontalo City to regional hinterlands and administrative centers [3]:

- Route 1 (Kota Gorontalo – Isimu): Serving as the high-density commuter spine corridor.
- Route 2 (Kota Gorontalo – Suwawa): Linking the urban core to eastern administrative extensions.
- Route 3 (Kota Gorontalo – Limboto): Connecting the provincial capital to the secondary urban cluster.
- Route 4 (Kota Gorontalo – Tilamuta): Executing long-distance regional connectivity westward.
- Route 5 (Kota Gorontalo – Taludaa): Providing peripheral coastal transit access.

B. Data Collection Protocols

To capture granular operational dynamics and mitigate temporal biases, a dual-pronged field data collection framework was deployed simultaneously over a designated multi-day observation window, capturing both peak weekdays and typical weekend transit behaviors.

➢ *Dynamic Passenger On-Board Counts*

Trained field observers were stationed on-board a representative sample of active paratransit fleets across all five routes. Observers recorded:

- The exact number of passengers boarding and alighting at designated terminals and informal curbside transit stops.
- The cumulative daily ridership profiles partitioned into distinct temporal windows: Morning Peak (06:00–09:00), Off-Peak midday intervals, and Afternoon/Evening Peak (15:00–18:00).

➢ *Static Roadside Screenline and Headway Surveys*

Simultaneously, static screenline surveys were established at critical gateway cross-sections for each route. Surveyors utilized high-precision digital stopwatches and synchronized mobile logging applications to record the exact timestamp (t_i) of every AKDP vehicle passing the screenline boundary, alongside its registered license plates to monitor fleet replication and active operational volumes.

C. Analytical Indicators and Operational Metrics

The quantitative appraisal of the demand-supply imbalance relies on three primary standardized public transit performance indicators, calculated as follows:

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➢ *Fleet Headway and Service Frequency*

Vehicle headway (H), defined as the time interval between successive transit vehicles arriving at a specific spatial reference point, was calculated using Equation 1:

$$H_i = t_i - t_{i-1}$$

Where t_i represents the arrival timestamp of vehicle i, and t_{i-1} is the arrival timestamp of the immediate preceding vehicle. The hourly service frequency (f), denoting the density of available transit supply per hour, is derived via Equation 2:

$$f = \frac{60}{\overline{H}}$$

Where $\overline{H}$ represents the mean route headway expressed in minutes.

➢ *Operational Load Factor.*

The Load Factor (LF), serving as the primary proxy for asset utilization and demand containment efficiency, represents the ratio of actual passenger volume to total physical vehicle capacity [2]. It was computed for each operational run using Equation 3:

$$LH = \frac{P_{max}}{C} x100\%$$

Where P_{max} is the peak passenger load recorded during a specific route leg, and C is the maximum legal seating capacity of the paratransit vehicle (standardized at 12 to 15 seats per microbus unit in the Gorontalo AKDP fleet framework [7]).

➢ *Demand-Supply Ratio (D/S Ratio)*

To model regional systemic imbalances, a spatial-temporal Supply-Demand index was constructed [10]. Total regional daily supply (S_{total}) was aggregated by multiplying total active daily fleet runs (N) by the standardized seating capacity (C):

$$S_{total} = NxC$$

The collective empirical demand (D_{total}) was derived from the total aggregated unique passenger counts across the observation timeline. The systemic mismatch is thus defined by the ratio index (R_{DS}):

$$R_{DS} = \frac{D_{total}}{S_{total}}$$

An R_{DS} < 1.0 statistically signals a structural state of over-supply, where regional transit investments and operator assets are systematically underutilized [10].

D. Data Processing and Triangulation

Field logs were digitized into structured spatial-temporal matrices. Outliers resulting from localized traffic congestion anomalies were filtered using a standard deviation threshold filter (2σ).To ensure analytical robustness, field demand data were cross-validated and triangulated against official operator registry databases provided by the provincial Department of Transportation (Dinas Perhubungan) [3]. This process guarantees that the empirical supply counts accurately reflect the active proportion of the legally permitted regional fleet.

III. RESULTS AND DISCUSSION

A. Regional Demand-Supply Mismatch and Systemic Over-Supply

The empirical aggregation of regional transit data reveals a severe structural imbalance between public transportation capacity and actual passenger patronage across Gorontalo Province [8]. Throughout the observed operational windows, the combined daily supply (S_{total}) across the five monitored intercity (AKDP) corridors reached a capacity of 720 available seats. Conversely, the cumulative daily passenger demand (D_{total}) peaked at only 287 individuals.Applying the demand-supply formulation established in the methodology yields a systemic mismatch index (R_{DS}) of:

$$R_{DS} = \frac{287}{720} \approx 0.40$$

An R_{DS} value of 0.40 indicates that approximately 60% of the daily transit seat capacity in Gorontalo Province is completely unutilized. This severe macro-level inefficiency demonstrates a highly unsustainable, supply-driven transit market. This imbalance is visually and structurally disaggregated by corridor in Table 1.

Table 1 Operational Performance Metrics Across Five Intercity Corridors

Route ID	Intercity Corridor	Active Fleet (Veh/Day)	Daily Seat Supply (Si)	Daily Passenger Demand (Di)	Mean Load Factor (LF%)	Mean Headway (Minutes)	Service Frequency (Veh/Hour)
Route 1	Kota Gorontalo – Isimu	37	222	100	28%	8.5	7.05
Route 2	Kota Gorontalo – Suwawa	12	72	45	42%	18.0	3.33
Route 3	Kota Gorontalo – Limboto	25	150	72	35%	11.2	5.35

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Route 4	Kota Gorontalo – Tilamuta	16	192	58	61%	45.0	1.33
Route 5	Kota Gorontalo – Taludaa	7	84	12	14%	75.0	0.80

B. Corridor-Level Analysis and Operational Inefficiencies

➤ *The Hyper-Congested Supply Spine: Kota Gorontalo – Isimu Koridor*

Route 1 (Kota Gorontalo – Isimu) represents the most critical case of operational inefficiency driven by destructive market competition [11]. This corridor captures the highest regional passenger volume with 100 passengers daily. To capture this market share, operators deploy a massive active fleet of 37 vehicles, generating a daily supply of 222 seats.This uncoordinated influx of vehicles creates an unsustainable over-saturation. The mean route headway drops to a tight 8.5 minutes, resulting in an hourly frequency of 7.05 vehicles. Because too many vehicles chase a finite pool of passengers simultaneously, Route 1 registers a critically low mean Load Factor (*LF*) of just 28%.

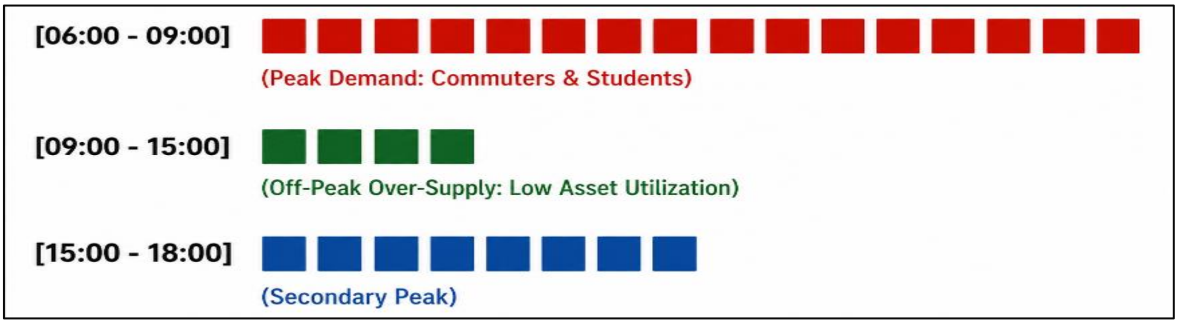

Fig 1 Teporal Distribution of Demand on Route 1 (Kota Gorontalo-Isimu)

Field observations indicate that during off-peak hours, vehicles frequently depart terminals near-empty, attempting to "race" competing microbuses along the highway to poach roadside passengers. This behavior compromises road safety and causes severe economic deficits for owner-operators.

➤ *Long-Distance Viability vs. Peripheral Deprivation (Tilamuta & Taludaa)*

In contrast to the urban spine, long-distance and peripheral routes exhibit entirely different structural crises:

- Route 4 (Kota Gorontalo – Tilamuta): This corridor achieves the highest operational efficiency in the province with a mean Load Factor of 61%. Because long-distance travel involves higher individual fares, operators tolerate a prolonged mean headway of 45.0 minutes. This spacing allows demand to consolidate effectively prior to dispatch, demonstrating a more stable operational equilibrium.
- Route 5 (Kota Gorontalo – Taludaa): This peripheral coastal route exhibits severe transit deprivation. It suffers from a critically low service frequency of 0.80 vehicles per hour (headway of 75 minutes), making the service highly unreliable. Because wait times are excessive and unpredictable, latent demand has completely abandoned public transit in favor of private motorized transport. This shift has collapsed the active daily demand to just 12 passengers, driving the Load Factor down to a disastrous 14%.

C. Discussion: Structural Drivers of Paratransit Inefficiency

The empirical findings from Gorontalo Province illustrate a classic paradox of informal transport sectors in developing economic landscapes, matching patterns identified in global paratransit literature [2]. The underlying driver of the R_{DS} = 0.40 macro-imbalance is not a fundamental lack of transit need, but a profound regulatory misalignment.The current governance model implemented by provincial transport authorities relies on static, permit-based licensing [3]. This mechanism distributes operating permits based on historical fleet allocations rather than dynamic, data-driven demand tracking.

Furthermore, the rapid proliferation of private motorcycles and app-based ride-hailing platforms (ojek online) in Gorontalo's urban core has dramatically altered the modal split [5]. Public paratransit (AKDP) has been relegated to a secondary choice, primarily serving lower-income demographics who lack access to private vehicles.When private vehicle ownership scales up without a corresponding contraction or structural optimization of paratransit supply, the system inevitably experiences a catastrophic drop in load factors. Operators respond to shrinking margins by delaying departures at terminal bays to maximize passenger loads. This practice increases wait times, destabilizes headways, and drives the remaining passenger base toward private alternatives [6].

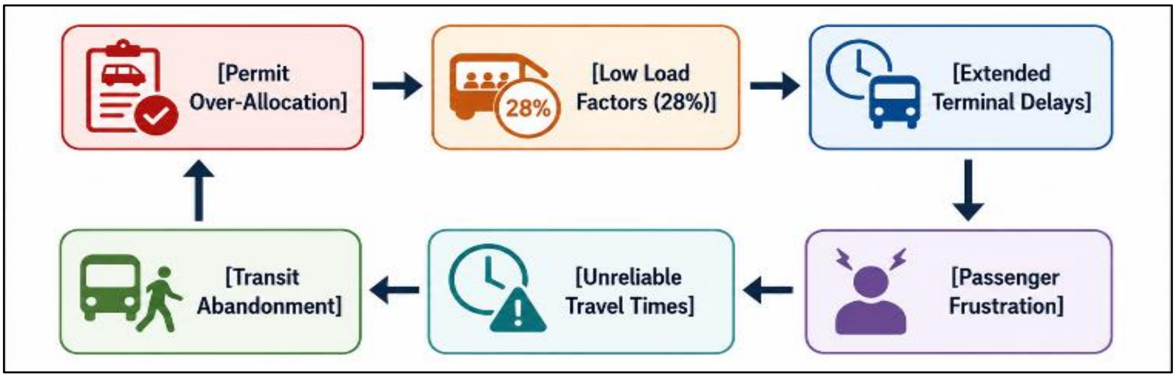

Fig 2 The Paratransit Vicious Cycle in Secondary Provinces

To break this vicious cycle, Gorontalo Province must transition from a fragmented, supply-driven individual operator framework toward a consolidated, headway-regulated transit management system.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

A. Conclusion

This empirical study provides quantitative evidence of severe structural demand-supply imbalances within the intercity paratransit (AKDP) network of Gorontalo Province. The investigation reveals a systemic regional mismatch index (R_{DS}) of 0.40, signifying that 60% of the provincial public transit seat capacity remains completely unutilized on a daily basis.The inefficiency is highly institutionalized and spatially polarized. Along the high-density urban spine (Kota Gorontalo–Isimu corridor), an over-allocation of 37 active fleets generates an aggressive vehicle frequency of 7.05 vehicles/hour and a tight headway of 8.5 minutes. This unstructured competition collapses the average vehicle Load Factor to a financially unviable 28%. Conversely, peripheral routes like Kota Gorontalo–Taludaa suffer from extreme transit deprivation, recording an unreliable frequency of 0.80 vehicles/hour and an average Load Factor of just 14%, which drives localized captive riders to abandon public transit entirely.These findings indicate that Gorontalo's current supply-driven, uncoordinated licensing framework is unsustainable. Without direct policy intervention, the combination of declining passenger patronage, rising private vehicle ownership, and unregulated fleet competition will lead to the total economic collapse of the regional public transportation ecosystem.

B. Policy Recommendations

To mitigate these systemic imbalances and transition toward a resilient, demand-responsive regional transit network, this study proposes three integrated policy frameworks for provincial transportation authorities:

➢ *Data-Driven Fleet Rationalization and Quota Recalibration*

The provincial Department of Transportation (Dinas Perhubungan) must freeze the issuance of new AKDP permits along saturated routes, specifically the Kota Gorontalo–Isimu and Kota Gorontalo–Limboto corridors. Operating licenses should be dynamically downscaled to match the empirical peak daily demand of 287 passengers. Surplus vehicles from these corridors should be systematically reallocated to underserved peripheral routes, such as the Taludaa corridor, backed by fiscal incentives to guarantee operational viability during the market rebuilding phase.

➢ *Transition to a Regulated Headway and Dispatch System*

Authorities must dismantle the fragmented individual-operator management model and enforce a centralized dispatch system. Instead of allowing operators to wait indefinitely at terminals to maximize individual vehicle loads, which destabilizes arrival reliability, transit agencies should enforce a strictly scheduled, headway-regulated framework. For the high-density Isimu corridor, the headway should be expanded and stabilized from 8.5 minutes to an optimized 15-minute interval during off-peak hours to artificially raise passenger aggregation and stabilize individual vehicle Load Factors above the 50% economic break-even threshold.

➢ *Institutionalization of Operator Cooperatives*

To eliminate destructive curbside passenger poaching, individual vehicle owners should be integrated into formal, route-specific transport cooperatives. This institutional shift allows for the pooling of financial resources, standardized vehicle maintenance, and the future implementation of a gross-cost service contract mechanism (e.g., a "buy-the-service" scheme paid per kilometer operated rather than per passenger carried). This model decouples operator revenue from immediate passenger volume, directly eliminating aggressive driving behaviors and stabilizing public transit quality in emerging secondary provinces.

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