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Provision of Urban Public Transport in the Samarinda Kutai Kartanegara Agglomeration: Current Landscape and Future Directions

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Abstract: Public transportation is a vital component of city development, influencing economic, social, and environmental aspects of urban life. The Samarinda–Kutai Kartanegara agglomeration in East Kalimantan, Indonesia, is experiencing rapid growth in travel demand, especially with the designation of the new national capital in its vicinity. However, the current public transport system in this region is underdeveloped and struggles with integration, resulting in a heavy reliance on private vehicles and associated issues of congestion and pollution. This study aims to evaluate the performance of the existing urban public transport services in the Samarinda–Kutai Kartanegara agglomeration (current landscape) and to forecast future travel demand and service needs (future directions). It seeks to identify areas for improvement in service quality and to provide strategic recommendations for developing an integrated, efficient public transport system for the region. A quantitative descriptive approach was employed. The study delineated five key zones at the interface of Samarinda City and Kutai Kartanegara Regency using land use and administrative boundary overlays. Primary data were collected through field observations and a user survey (questionnaires) focusing on service performance indicators such as travel time, frequency, capacity, and accessibility. Secondary data, including public transport route maps, fleet size, and ridership statistics, were obtained from relevant agencies. The service performance was analyzed using descriptive statistics and compared against standards. Additionally, a transport modeling exercise was conducted: trip generation was estimated using trip rates (from Institute of Transportation Engineers guidelines) based on population and land-use data, and future trip demand was forecasted for 5, 7, and 12 years ahead (2022, 2026, 2031) using a geometric growth model of population. A trip distribution analysis was then performed to predict future origin–destination patterns among the defined zones. The existing service performance is suboptimal – survey results indicate low user satisfaction, particularly regarding punctuality (on-time performance) and comfort (crowding and vehicle conditions). Average satisfaction scores for travel time reliability and comfort were below 3 on a 5-point scale, suggesting dissatisfaction. Operational aspects such as frequency and accessibility scored slightly higher (around the midpoint), but still leave room for improvement. The dominance of private vehicles is evident: an estimated 15% of commuters use public transport versus 85% using private modes currently. The modeling results show that daily trip volumes in the agglomeration are substantial and projected to increase by approximately 30–40% over the next decade. In 2019, the total daily trips in the five-zone area were about 59,000; this is expected to grow to ~85,000 by 2031, assuming current trends. Trip distribution forecasts suggest that certain zones (especially the one encompassing Samarinda's urban core) will attract a disproportionately large share of trips in the future, underscoring the need for robust inter-zone transport links. The study concludes that significant improvements in the public transport system are required to meet current and future mobility needs. Key recommendations include better integration of routes across city-regency boundaries, increased fleet size and service frequency to reduce waiting times, adoption of technology (such as transit scheduling apps and GPS tracking) to enhance reliability, and improvements in vehicle quality and comfort. These measures, aligned with national transport policy and sustainable transport principles, are essential for shifting commuters from private to public transport and for supporting the region's growth. The findings provide a data-driven basis for local authorities and stakeholders to plan an integrated urban transport network that can ensure efficient, accessible, and sustainable mobility in the Samarinda–Kutai Kartanegara agglomeration.

Keywords: Agglomeration; Public Transportation; Samarinda; Service Performance; Urban Transport Planning

1. Introduction

Public transportation plays a crucial role in urban and regional development, serving not only as a means of mobility but also as a driver of economic growth, social equity, and environmental sustainability (Bruschi & Gelli, 2025; Pyrialakou et al., 2016; Sze & Christensen, 2017). A well-integrated transport system can enhance accessibility to education, employment, and services, thereby improving quality of life for urban residents (Pyrialakou et al., 2016; Roslan et al., 2025). Conversely, an inefficient transport system incurs high socio-economic (Chatziioannou et al., 2020; Gutman & Malashenko, 2025) costs due to congestion, pollution, and unequal access to mobility (Afrin & Yodo, 2020; Fattah et al., 2022). In the context of Indonesia, national regulations mandate that governments at all levels plan and manage transportation infrastructure and services to meet community needs (Ministry of Transportation, 2009). This includes the obligation to establish transportation networks and service coverage that are integrated across regions and modes, as outlined in the Regulation of the Minister of Transportation No. 15/2009 (Ministry of Transportation, 2009).

Samarinda City and Kutai Kartanegara Regency (Kukar) in East Kalimantan have emerged as a continuous urban agglomeration with strategic importance. Samarinda, the provincial capital, and its neighboring areas in Kukar function as a unified economic zone, especially with the Indonesian government's decision to locate the new national capital (Ibu Kota Nusantara, IKN) in the wider region. This development has accelerated urban growth and inter-regional travel. Daily activities of residents increasingly transcend administrative boundaries, leading to a metropolitan area that requires coordinated transport solutions (Setiawan et al., 2022). Traffic volumes in this agglomeration have surged in recent years, intensifying the strain on existing infrastructure and services. The urban expansion into peri-urban and rural fringes mirrors patterns observed in other Indonesian cities (Jati & Christanto, 2012), where formerly separate settlements coalesce into larger metropolitan regions. Such growth often outpaces transport infrastructure development, resulting in imbalances and inefficiencies in the transportation system.

Currently, the public transport system in the Samarinda–Kukar agglomeration is characterized by fragmented and inadequate services. The available public transport (mainly small vans or minibuses known as angkot) operates on fixed routes but with poor integration between the city and regency routes. Service schedules are inconsistent and infrequent, and the fleet is aging and insufficient to meet demand**.** There is minimal use of technology in operations – for instance, no real-time tracking or reliable timetable information is available to passengers (Priyanta & Zulkarnain, 2023). This situation has led to a strong preference for private vehicles (cars and motorcycles) as the primary mode of transport. The dominance of private transport has several negative consequences: increased road congestion, longer travel times, higher accident risk, and growing carbon emissions and air pollution in the urban area. Additionally, vulnerable groups such as low-income residents are disproportionately affected; with limited affordable public transport options, their accessibility to jobs, education, and healthcare is hindered. These challenges highlight the urgency of improving public transportation to ensure inclusive and sustainable urban mobility (Suharjo et al., 2024).

Recognizing these issues, this research undertakes a comprehensive evaluation of the current public transport performance in the Samarinda–Kukar urban agglomeration. The goal is to provide evidence-based insights for policymakers in designing strategies to revitalize and integrate the public transport system. Previous studies in Indonesia have emphasized the importance of integrated transport networks for regional connectivity (Aksa, 2014) and the adoption of sustainable transport practices to reduce environmental

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impact (Andriani & Yuliastuti, 2013). In line with these perspectives, this study addresses both the present service performance (the "current landscape") and future transportation needs in the agglomeration (the "future directions"). By analyzing user satisfaction and operational efficiency of existing services, the research identifies specific performance gaps – for example, issues with punctuality and comfort – that require attention. At the same time, by forecasting travel demand and patterns for the coming decade, the study anticipates where and how transport services must expand or adapt.

In summary, the Introduction establishes the context and importance of public transport improvement in the Samarinda–Kutai Kartanegara agglomeration. It underlines that a reliable and efficient public transit system is critical for managing urban growth and ensuring equitable access to opportunities (Hermansyah et al., 2024). The introduction also frames the research objectives: to evaluate current public transport performance and to develop future demand projections to guide strategic planning. The subsequent sections of this paper will detail the methodology used for this analysis, present the key findings on service performance and travel demand, and discuss their implications in light of broader urban transport strategies and policies. By doing so, the paper contributes to the body of knowledge on urban transport planning in emerging Indonesian metropolitan areas and offers practical recommendations for achieving an integrated and sustainable transport system in the Samarinda–Kukar region.

2. Materials and Methods

2.1. Study Area and Zoning

The study was conducted in the metropolitan area encompassing Samarinda City and adjacent parts of Kutai Kartanegara (Kukar) Regency in East Kalimantan, Indonesia. This area forms a contiguous urban agglomeration where daily commuting flows occur between the city and the regency. To facilitate focused analysis, the research delineated the agglomeration into five zones representing key origin-destination areas of trips. Each zone corresponds to a border area between Samarinda and Kukar, defined based on homogeneity of land use and administrative boundaries. The delineation process utilized geospatial data: land use maps and administrative boundary maps of Samarinda and Kutai Kartanegara were overlaid to identify clusters of continuous urbanized land that straddle the city-regency boundary. These clusters form the five zones used in the study, ensuring that each zone has relatively uniform land-use characteristics (e.g., residential, commercial mix) and aligns with a logical travel shed.

Table 1 summarizes the zonation scheme and the constituent districts on each side of the city-regency border. As shown, Zone 1 lies at the northern boundary of Samarinda (Samarinda Utara District) adjoining Muara Badak District of Kukar. Zone 2 covers the western boundary around Samarinda Ulu (an urban district of the city) bordering Tenggarong Seberang in Kukar. Zone 3 is in the southwest, linking Samarinda's Loa Janan Ilir with Kukar's Loa Janan District. Zone 4 is at the eastern fringe, connecting Samarinda's Sambutan area with Anggana District (a part of the Mahakam River delta region in Kukar). Zone 5 is at the southern boundary, where Palaran District of Samarinda meets Sanga Sanga District of Kukar. These zones effectively capture the main interface points between the city and regency where urban public transport services either operate or are needed. By structuring the study area into these zones, we can analyze travel demand and service provision in a spatially disaggregated manner, which is useful for identifying which corridors or border areas have the highest needs or gaps in transport service.

Table 1. Zonation of Trip Generation and Attraction Areas in Samarinda–Kukar Agglomeration

Zone No.	Samarinda City District	Kutai Kartanegara District
1	North Samarinda (Utara)	Muara Badak
2	Samarinda Ulu	Tenggarong Seberang
3	Loa Janan Ilir	Loa Janan
4	Sambutan	Anggana
5	Palaran	Sanga Sanga

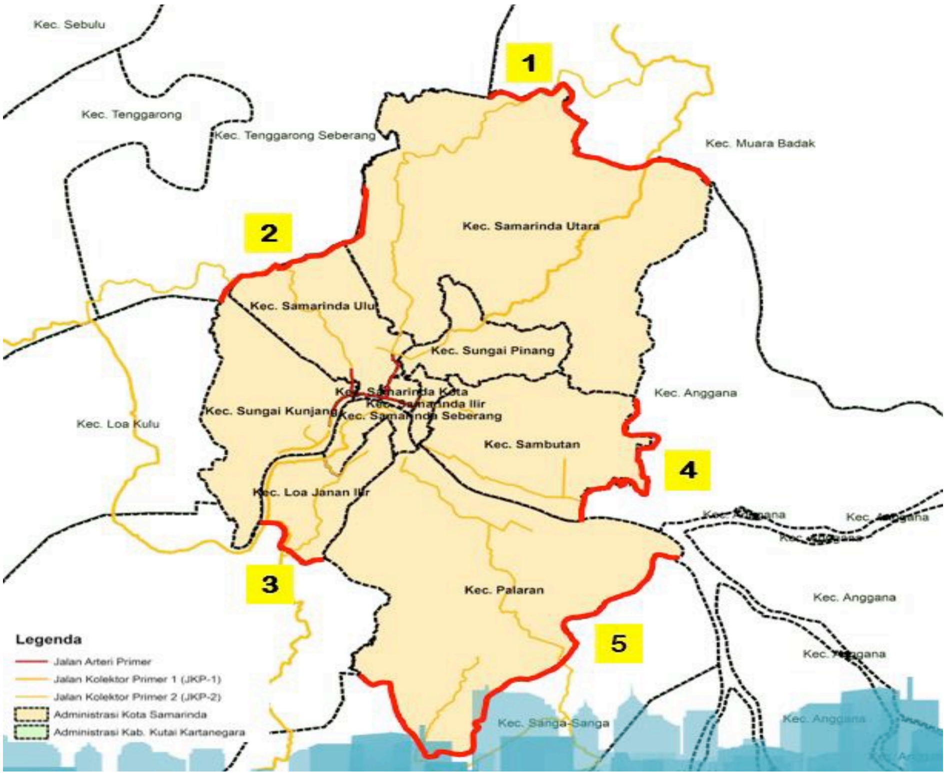

Figure 1. Conceptual map of the five study zones in the Samarinda–Kutai Kartanegara agglomeration.

Samarinda City (grey area) is at the center, and Zones 1–5 (blue circles) represent boundary areas between the city and the regency. Each zone comprises a pair of adjacent districts (one in Samarinda, one in Kukar) as listed in Table 1. Dashed lines illustrate the connectivity between the city center and these peripheral zones, indicating major travel corridors. This schematic highlights the spatial layout of the agglomeration and the importance of linking the city with its surrounding regions through reliable transport services.

2.2. Data Collection

The research utilized both primary data and secondary data sources. Primary data were collected to assess the current performance and user satisfaction of public transport services. This involved field observations and a questionnaire survey of public transport users. Field observations were conducted by the research team to qualitatively evaluate operational aspects such as vehicle conditions, route alignments, and schedule adherence. The survey targeted passengers of the urban public transport (e.g., angkot minibuses) across the different zones. Using a stratified sampling approach, questionnaires were distributed at key terminals and stops in each zone to capture a broad range of users (commuters, students, etc.). Respondents were asked to rate various service attributes – including travel time (duration and reliability of trips), service frequency (wait times between vehicles), vehicle capacity and comfort (crowding, seating availability, vehicle cleanliness), and accessibility (ease of reaching stops and coverage of routes) – typically on a Likert scale of 1 (very poor) to 5 (very good). The survey also gathered demographic information and travel behavior (e.g., trip purpose, frequency of public transport use) to provide context for satisfaction levels. A total of 200 responses were obtained, roughly evenly distributed among the five zones (around 40 per zone), which is a reasonable sample for descriptive analysis of satisfaction levels.

Secondary data were obtained from relevant government agencies and transport operators to complement the survey. Key secondary data included :

1. Route and Network Information

   Maps of existing public transport routes in Samarinda and the connections (if any) into Kutai Kartanegara were collected from the city's transportation office. These helped identify the current service coverage in the agglomeration.
2. Fleet and Operations Data

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Records of the number of public transport vehicles (angkot) operating on each route, their capacity, and schedule frequency were obtained. This included any recent data on ridership or load factor if available from the operators.

3. Travel Demand Data

   Traffic counts and origin-destination survey data from previous studies or the transportation agency were reviewed. In particular, the 2019 daily traffic (LHR 2019) data was used as a baseline for modeling (this likely included counts of vehicles or trips along major corridors between Samarinda and Kukar)

4. Socio-demographic and Land Use Data

   Population statistics for each zone (population of the districts) and land use information (e.g., locations of residential areas, commercial centers, schools, etc.) were compiled. These were important for estimating trip generation and attraction in the modeling phase.

All data were cross-checked for consistency. The primary survey data underwent cleaning to remove any responses with missing or obviously erroneous entries. The secondary data, such as route maps, were used to inform the interpretation of survey results (for example, identifying if low satisfaction in a zone correlates with fewer routes or lower frequency in that area).

2.3. Analytical Methods

The study applied a mix of descriptive analysis and transport modeling techniques to achieve the research objectives. The analytical approach can be divided into two main parts: service performance analysis (current landscape evaluation) and travel demand modeling (future projection).

1. Service Performance Analysis

   Survey results on user satisfaction were analyzed using descriptive statistics. For each service attribute (punctuality, frequency, comfort, accessibility), mean satisfaction scores were calculated across respondents, and the distribution of responses was examined. These scores were then interpreted against qualitative categories (e.g., a mean score below three suggests generally poor perception). To provide a structured view, an index of overall service performance was not directly provided by agencies, but we constructed a simple composite indicator by averaging the scores of the four key attributes for each respondent, then taking the mean. This offered an overall satisfaction level for public transport in each zone, which could be compared. We also identified which attributes were rated lowest; this pointed to punctuality (on-time performance) and comfort as the weakest aspects according to users. Where applicable, one-sample t-tests were performed to check if satisfaction scores were significantly different from a neutral midpoint (3), using standard statistical procedures (Riduwan & Sunarto, 2009). Although detailed inferential statistics are not the focus of this study, this basic test helps confirm that the dissatisfaction was statistically significant rather than due to random variation. In addition to user perceptions, operational data (from observations and secondary sources) were analyzed: for example, average headways (time between vehicles) on key routes, average travel speeds, and vehicle load factors. These measures were compared with recommended service standards or findings from similar studies in other cities. For instance, Pradana (2017) provides a reference point from Tangerang City, where a performance evaluation of urban transport indicated the need for additional vehicles to meet frequency standards. Such comparisons offer context on whether Samarinda's public transport performance is atypical or in line with known issues elsewhere.

2. Travel Demand Modeling

   To project future travel needs, a simplified four-step transport modeling approach was employed up to the trip distribution stage (mode choice and route assignment were beyond the scope given the data constraints). The steps were as follows :

   a. Trip Generation

      We estimated the number of trips generated and attracted by each zone. Using the socio-demographic data, the trip generation was calculated based on trip rates. For residential trip generation, we applied trip rates per person or per household from the Institute of Transportation Engineers (ITE) Trip Generation Manual (2012 edition) as a guideline. For example, if the standard trip production rate is X trips per person per day, and Zone 2 has Y population, then Zone 2's daily trip generation is approximated as X*Y (adjusted for local context as needed). Similarly, trip attraction was estimated using land use data; e.g., commercial floor area or number

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of jobs in a zone multiplied by a standard trip attraction rate. While these standards are based on typical North American contexts, they provide a starting point; local calibration was not possible due to limited detailed data, so results are interpreted cautiously. The base year for trip calculations was 2019, aligning with available traffic data.

b. Forecasting Future Trips

We projected trip generation and attraction for future years using a geometric growth model of population increase. The annual population growth rate for Samarinda and Kukar (around 3% per annum in recent years, according to regional statistics) was applied to the base trip figures. The formula used is the standard geometric growth: *Future Trips = Base Trips × (1 + r)^n*, where *r* is the annual growth rate and *n* is the number of years into the future (Pamuji & Rustiadi, 2012). Projections were made for three future points: 2022 (approximately a short-term 3-year horizon from 2019), 2026 (medium-term, ~7 years), and 2031 (long-term, ~12 years). These intervals were chosen to capture short- and mid-term planning horizons and a long-term scenario about a decade into the future. Table 2, Table 3, and Table 4 present the projected trip generation and attraction for each zone in 2022, 2026, and 2031 respectively. Notably, the model assumes a "business-as-usual" scenario of growth – i.e., it does not yet factor in any major policy changes or new transit interventions that could alter travel behavior, which will be addressed qualitatively in the discussion.

Table 2. Projected Trip Generation and Attraction per Zone (2022) (in Daily Trips per Zone)

Zone	Trip Generation (2022)	Trip Attraction (2022)
1	9,900	9,700
2	19,800	22,800
3	15,400	13,000
4	7,700	9,700
5	12,100	9,700
Total	**64,900**	**64,900**

Table 3. Projected Trip Generation and Attraction per Zone (2026) (in Daily Trips per Zone)

Zone	Trip Generation (2026)	Trip Attraction (2026)
1	11,200	11,100
2	22,500	25,700
3	17,500	14,800
4	8,800	11,100
5	13,800	11,100
Total	**73,800**	**73,800**

Table 4. Projected Trip Generation and Attraction per Zone (2031) (in Daily Trips per Zone)

Zone	Trip Generation (2031)	Trip Attraction (2031)
1	13,000	12,800
2	26,100	30,100
3	20,300	17,100
4	10,200	12,800
5	16,000	12,800
Total	**85,600**	**85,600**

The projected figures (Tables 2–4) were cross-validated by comparing the total growth with known trends, such as urban population growth and vehicle count increases. The roughly 35–45% increase in total trips from 2019 to 2031 aligns with expectations given a ~3% annual population growth, indicating the projections are plausible. It should be noted that these numbers assume current travel mode shares remain roughly constant. In reality, interventions (like improved public transport or new road infrastructure) could change the growth trajectory, which we discuss later.

c. Trip Distribution

After obtaining future trip generation and attraction totals for each zone, a trip distribution analysis was conducted to estimate how trips would be interchanged between zones. A simplified gravity model approach was conceptually applied: the interaction between any two zones is proportional to the product of trip origins in one zone and trip destinations in the other, and inversely proportional to some function of separation (often distance or travel time between zones) (Tamin, 2000). Given data limitations, we did not calibrate a full gravity model with friction factors, but we used qualitative reasoning and the structure of the network to infer likely trip distribution patterns. For example, Zone 2 (Samarinda Ulu–Tenggarong Seberang) contains part of Samarinda's urban core, so it likely attracts a large portion of trips from all other zones (as people travel to the city for work, school, etc.). Meanwhile, Zone 4 (Sambutan–Anggana), being more peri-urban and less densely developed, might generate many trips that head into the city rather than attract trips from elsewhere. We also considered the physical connectivity: major roads connect certain zones directly to the city (e.g., Zones 2, 3, and 5 each have a primary artery leading into Samarinda), which facilitates high interconnectivity, whereas Zone 1 and Zone 4 are somewhat more remote or have less direct links. The outcome of this step was a qualitative pattern: most zones show a strong trip interchange with Zone 2 (city area), indicating a radial pattern of travel towards Samarinda, as expected. Additionally, adjacent zones have some interaction (for instance, Zone 3 and Zone 5 both border Zone 2 and might exchange trips with it and with each other if there are circumferential movements). The trip distribution findings set the stage for understanding potential corridors that need transport service improvements, although for this paper we focus on the broad pattern rather than detailed OD matrices.

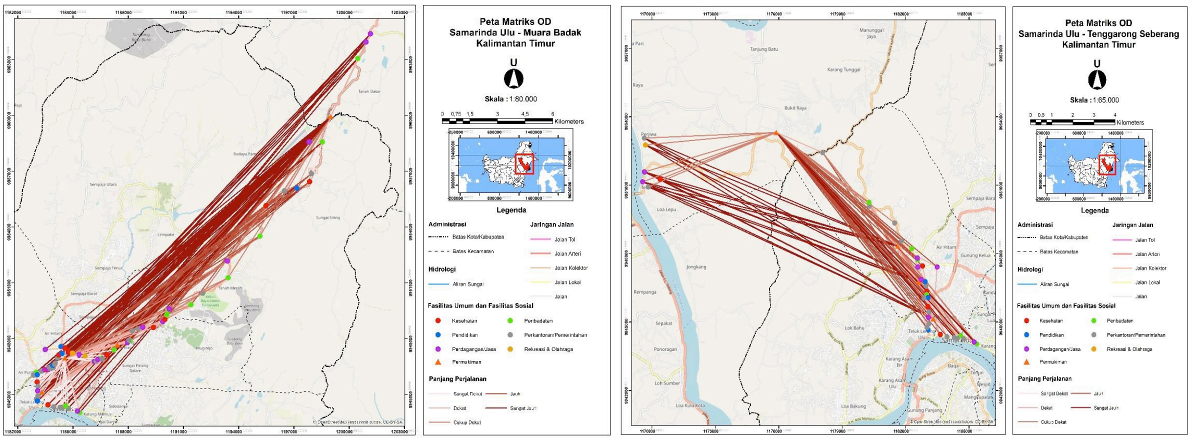

Figure 2. (Left) Trip Distribution Zone 1 and (Right) Trip Distribution Zone 2

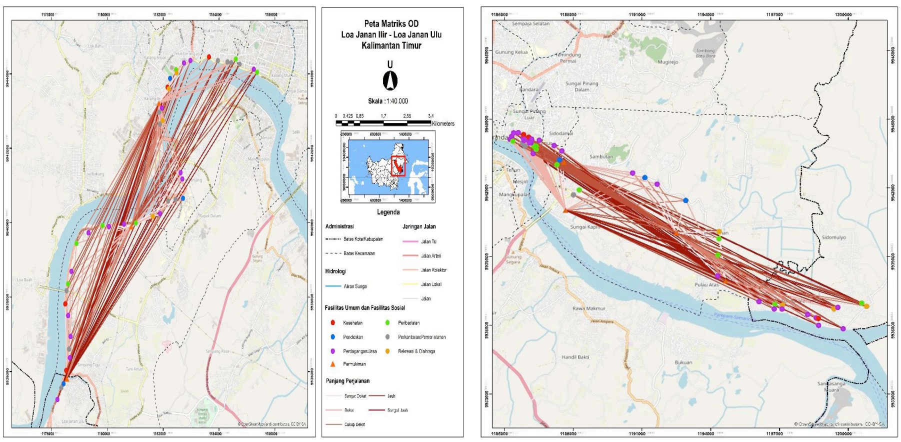

Figure 3. (Left) Trip Distribution Zone 3 and (Right) Trip Distribution Zone 4

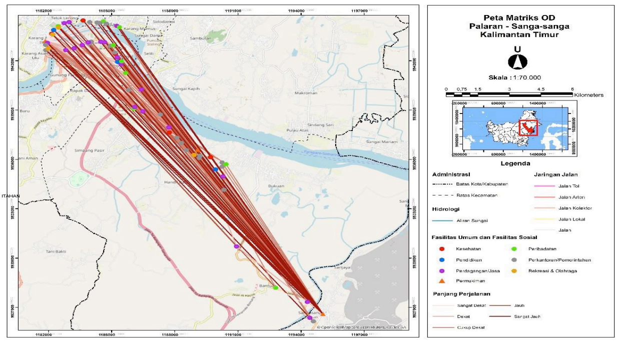

Figure 4. Trip Distribution Zone 5

The overall research methodology, from data collection through analysis, was designed to combine current empirical evidence (via surveys) with model-based forecasting. This approach ensures that recommendations are grounded in present realities while also forward-looking. The analytical framework is summarized conceptually in a research flowchart (not shown here due to format, but described): starting with defining the problem and study area, then data collection (primary & secondary), followed by parallel analyses of service performance and travel modeling, and finally synthesis of results for strategy formulation. This structured approach follows standard transport planning study procedures (Pamuji & Rustiadi, 2012; Tamin, 2000). In the next section, we present the results of the analysis, beginning with an evaluation of the current public transport service performance and then discussing the future demand projections.

3. Results

3.1. Current Public Transport Service Performance

The evaluation of the existing public transport services in the Samarinda–Kukar agglomeration reveals several performance shortcomings. User satisfaction levels are generally low, particularly in the dimensions of timeliness and comfort. Table 5 provides a summary of the average satisfaction scores (on a 1 to 5 scale) reported by surveyed users for key service attributes. These results are aggregated across all respondents (all zones combined), as the patterns were similar in each zone with minor variations.

Table 5. Public Transport Service Satisfaction Scores (Current Performance)

Service Aspect	Mean Satisfaction Score (1–5)	Interpretation
Travel Time Reliability (Punctuality)	2.5	Poor (often late/unreliable)
Service Frequency (Availability)	3.0	Fair (moderate waits)
Vehicle Capacity & Comfort	2.7	Poor (crowding, discomfort)
Accessibility (Coverage & Ease of Access)	3.2	Fair (adequate coverage)
Overall Service	**2.8**	**Poor to Fair**

From Table 5, punctuality has the lowest score (2.5), indicating that users frequently experience delays or inconsistent timing – vehicles do not adhere to schedules, causing uncertainty and longer wait or travel times. Comfort and capacity also score poorly (2.7); field observations corroborated this, noting that many vehicles are older minibuses without air conditioning, often overloaded during peak hours. Complaints from respondents included crowded conditions, lack of seating, and uncomfortable vehicle interiors. The relatively better scores are seen in frequency (3.0) and accessibility (3.2), but even these are just around the neutral midpoint. A score of 3.0 for frequency suggests that while some routes have acceptable headways (perhaps 10-15 minutes on main routes during peak times), others have much longer waits, and overall reliability day-to-day is inconsistent. Accessibility scoring 3.2 implies that, to an extent, people find the network coverage somewhat acceptable – primary neighborhoods are reached by routes – however, first/last

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mile issues remain (e.g., not all residential areas are near a public transport stop, and integration between city and regency routes is weak).

One notable finding is that there are virtually no high scores (4 or 5) in these service aspects, highlighting that truly good or excellent service is absent from the current system in the eyes of users. In interviews, several respondents expressed that they only use public transport when they have no alternative; those who have motorcycles or can afford ridesourcing services (ojek or taxi) often prefer those due to the convenience and time savings. This sentiment reflects a broader trend in Indonesian secondary cities, where public transit has lost mode share to private vehicles over time (Hermansyah et al., 2024; Samsudin, 2017).

In terms of operational performance, the data from the local transport office indicate that the number of vehicles operating is insufficient. For instance, one major route from Samarinda to Tenggarong (traversing Zone 2) has about 25 angkot vehicles officially registered, but effective vehicles in service at any given time are fewer due to maintenance issues, etc. As a result, peak hour frequencies on this route average one vehicle every 15–20 minutes, which is not competitive with private transport. Other peripheral routes (e.g., into Zone 1 or Zone 4) have even fewer vehicles and can have wait times exceeding 30 minutes. Furthermore, there is a lack of through-service between Samarinda and points in Kukar: passengers often must transfer at the city boundary (or at the main terminal in Samarinda) to continue their journey into the regency, incurring extra time and cost. This gap is partly due to regulatory issues – different jurisdictions manage different parts of the route – but it severely affects user experience.

The mode share findings reinforce the implications of these service shortcomings. Based on the survey and supporting city data, it is estimated that only around 15% of daily commuters in the agglomeration currently use public transport, while roughly 85% rely on private vehicles (personal motorcycles being the dominant mode, followed by cars). This mode split is clearly unfavorable from a congestion and sustainability perspective. Public transport's low share can be attributed to its unreliability and discomfort – factors we have quantified in the satisfaction scores. For context, a study on urban transport in Palangkaraya (a city of comparable size) by Samsudin (2017) found that when public transport routes are limited or infrequent, modal share dips similarly low. In Samarinda's case, the widespread availability of affordable motorcycles has accelerated the shift away from public transit. The consequences are visible: during peak hours, major corridors such as Jl. Soekarno-Hatta (linking Samarinda with Tenggarong) experience significant congestion, with long queues of private vehicles and only sparse public transport vehicles in the mix.

Despite these issues, there are some positive aspects to note. The survey's accessibility score (3.2) suggests that people acknowledge the network does reach most main destinations. For example, key markets, schools, and government offices in Samarinda are on or near an angkot route, and the city has a central terminal (Terminal Sungai Kunjang) that serves as a hub. The challenge is more about service quality and inter-connectivity than complete absence of service. This means improvements can build on the existing framework rather than starting from zero. Additionally, the fact that frequency scored around 3.0 indicates that on some high-demand routes, operators have tried to dispatch vehicles at acceptable intervals, but consistency is lacking outside peak times.

In summary, the current performance analysis portrays a system in need of urgent improvement. The findings answer the first part of the research objective, highlighting that the current landscape of public transport in Samarinda–Kukar is underperforming, especially in timeliness and comfort, and that this leads to low utilization. The data-driven insight here is that boosting aspects like punctuality (through better scheduling and possibly dedicated lanes or traffic signal priority) and comfort (through fleet renewal and avoiding overloading) could significantly enhance user satisfaction. Past research (Pradana, 2017) in Tangerang indicated that increasing fleet size to reduce waiting times and replacing old vehicles improved passenger perceptions. Thus, similar interventions are likely necessary in Samarinda's case. These results set the stage for developing recommendations, but before that, we examine the second part of the objective: the future demand and what it implies for the transport system.

3.2. Travel Demand Forecasts and Future Needs

The transport modeling results provide a forward-looking view of travel demand in the Samarinda–Kukar agglomeration over the next decade. As detailed in Tables 2–4 earlier, the total daily trips in the study area are expected to grow substantially. To recap key figures: from a base of approximately 59,000 daily trips in 2019 (across the five zones combined), the demand is projected to reach about 65,000 by 2022, ~74,000 by 2026, and ~85,000 by 2031, assuming current trends continue. This growth is driven by

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population increases, ongoing urban expansion, and economic development in the region. It is also likely amplified by the influence of the new national capital (IKN) development attracting more movement into East Kalimantan, although our model did not explicitly incorporate IKN-related influx, which means these estimates could even be conservative.

Figure 5. Projected growth of total daily trips in the Samarinda–Kutai Kartanegara agglomeration (2019–2031). The trend line illustrates a steady increase in travel demand over time, corresponding to an average annual growth rate of roughly 3–4%. Daily trip estimates (on the vertical axis) rise from about 60 thousand in 2019 to over 85 thousand by 2031. This significant growth underscores the increasing strain that will be placed on the transportation system if current modal distributions and service levels persist. Ensuring that public transport capacity keeps up with this rising demand is critical to prevent exacerbation of congestion and mobility issues.

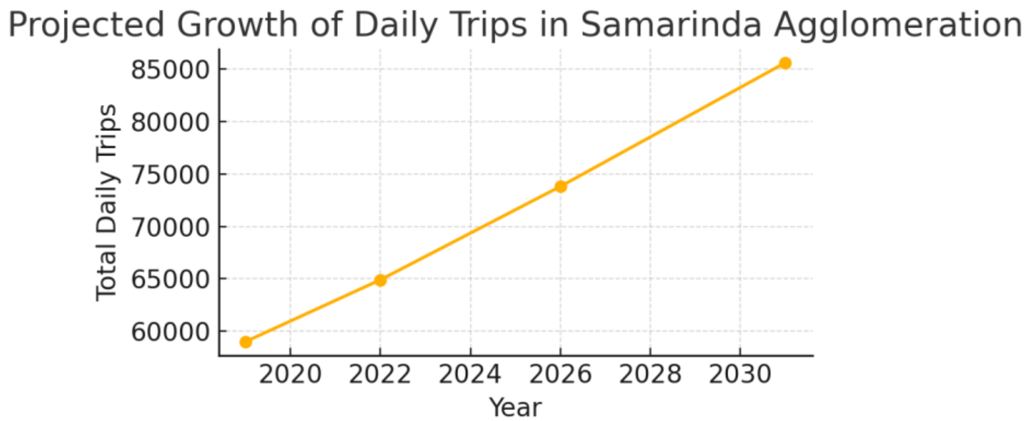

Figure 5. Trip Distribution Zone 5 Projected growth of total daily trips in the Samarinda–Kutai Kartanegara agglomeration (2019–2031)

The distribution of this future growth across the zones is uneven. Zone 2 (Samarinda Ulu–Tenggarong Seberang) consistently shows the highest trip generation and attraction values in all future scenarios. By 2031, Zone 2 is expected to generate around 26,100 trips daily and attract over 30,000 trips (see Table 4). This makes sense as Zone 2 includes part of Samarinda's urban core as well as the outskirts of Tenggarong, meaning it encompasses both a major origin area (residential neighborhoods in Samarinda) and a destination area (city center jobs and services, plus some in Tenggarong). Essentially, Zone 2 is a critical hub in the agglomeration's travel network. Zones 1 and 5 (northern and southern edges, respectively) have more moderate trip volumes; they are projected to each generate on the order of 10,000–16,000 trips by 2031. These zones are less populated than the city core, but still significant sources of trips, likely mostly traveling into Samarinda. Zone 3 (southwest) also shows high generation (20,300 by 2031) indicating that the suburban areas in Loa Janan Ilir and adjacent Kukar are growing residentially, yet its attraction is lower (17,100), suggesting many of those trips leave the zone for elsewhere (e.g., into Zone 2 or central Samarinda). Zone 4 (east) remains the smallest contributor, with about 10,200 generated and 12,800 attracted in 2031, reflecting its relatively lower population and perhaps some inflow to its industrial or resource areas (Anggana has oil/gas operations that might draw commuting from the city). Importantly, we maintained a balanced growth assumption (total generation equals total attraction across zones), so every trip generated is destined for a zone within the region. In reality, some trips do leave the agglomeration (for instance, intercity travel to Balikpapan or elsewhere), but those were beyond our scope as we focused on internal urban travel.

The trip distribution qualitative analysis indicates that a large portion of the trips generated in the outer zones (1, 3, 4, 5) will be destined to Zone 2 (the city). This radial movement pattern means that the transport corridors connecting each outer zone to the city center will bear heavy loads. For example, the road from Zone 3 (Loa Janan) to Samarinda city center, and the road from Zone 5 (Palaran) to the city (which includes a major bridge over the Mahakam River), are expected to see much higher traffic volumes. If public transport services are not improved, most of this increased travel demand could manifest as additional private car and motorcycle traffic on these corridors, worsening congestion to new levels. The Mahakam River bridges

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(connecting north-south within Samarinda and towards Palaran) are already bottlenecks; a projected growth of even 20-30% more traffic could gridlock these critical links in coming years.

Another noteworthy projection is the growth in inter-zonal travel beyond just city-centric trips. As the metropolitan region matures, there could be more zone-to-zone trips that do not go all the way to the city center. For instance, some residents of Zone 1 (north) might commute to industrial sites in Zone 4 (east) or vice versa, if economic opportunities diversify. While our simplified model primarily emphasizes city-bound travel (since that's currently dominant), it is plausible that new sub-centers (like a developing town in Muara Badak or a port in Palaran) could generate their own attraction, leading to non-central flows. Such potential developments mean that the public transport network in the future may need to accommodate not only radial routes to the city, but also tangential or cross-border routes directly linking the suburban zones.

In summary, the future demand analysis highlights the following key points :

1. Significant increase in travel demand: The agglomeration will witness tens of thousands more daily trips in the next decade. If left unmanaged, this will translate to more vehicles on the road and heightened congestion/pollution.
2. Critical role of the city core (Zone 2): As the major trip attractor, the capacity of transport infrastructure and services in and around Samarinda's core needs expansion. Public transport must be scaled up substantially here to handle influx from all sides.
3. Strain on key corridors: Each zone's connection to the city (north, south, east, west, southwest corridors) is a candidate for targeted improvement, possibly high-capacity transit or at least high-frequency bus lines, to carry the growing commuter volume.
4. Opportunity to shape mode share: These projections assume current mode split, but they also represent an opportunity – if a greater share of these future trips can be shifted to public transport, the negative impacts of growth can be mitigated. Conversely, if public transport remains as is, the mode share could further tip toward private vehicles, compounding problems. This aspect is explored in the discussion on policy implications.

To visualize the urgency of improving public transit from a mode share perspective, consider the scenario where public transport's share could be increased from the current ~15% to, say, 30% by 2030 through interventions. That would mean a much larger absolute number of people using transit given the growth in trips – which implies needing more vehicles, more routes, and better service. Conversely, if its share declines or stays the same, nearly all of the additional 26,000 daily trips from 2019 to 2031 could be on private vehicles, an unsustainable outcome for the road network.

Overall, the results from the modeling reinforce the necessity for forward-thinking transport planning. The future directions clearly point to: (a) scaling up capacity, (b) integrating services across the agglomeration, and (c) encouraging modal shift to public transport. These will be discussed along with recommended strategies in the next section, considering broader literature and policy contexts.

4. Discussion

The combination of current service performance evaluation and future demand forecasting provides a comprehensive picture of challenges and opportunities for public transport in the Samarinda–Kutai Kartanegara agglomeration. In this discussion, we interpret these findings in the context of broader urban transport planning principles and similar experiences in other regions. We also propose strategic recommendations, linking them to both the study's data and relevant policies or literature.

4.1. Integration and Network Planning

A clear insight from this study is the critical need for better integration of the public transport network across the agglomeration. Presently, the disjointed nature of city and regency services (with transfers at city borders and no unified routing) greatly diminishes the attractiveness of public transport. Integrated network planning would involve coordinating routes so that a passenger can travel from any zone to another (especially to the city center) seamlessly. This could be achieved by extending certain Samarinda city transport routes further into the regency or creating jointly managed routes that serve both jurisdictions. Examples from elsewhere in Indonesia show the benefits of integration: for instance, Yogyakarta and its surrounding regency have a unified Trans Jogja bus system that crosses administrative boundaries; Bali's Ubud tourist area has integrated shuttle systems (Tama, 2021). For Samarinda–Kukar, a similar integration might involve establishing a Metropolitan Transport Authority that can plan and regulate services region-wide, as suggested by principles of metropolitan governance (Tamin, 2000). Such an authority would overcome the institutional fragmentation noted in the results by aligning the goals of city and regency transport management.

The zoning approach from our study can inform this integration. Knowing that Zone 2 is a major hub, planners can prioritize high-capacity connections between Zone 2 and all other zones. One idea is to introduce a Bus Rapid Transit (BRT) or limited-stop bus lines radiating from central Samarinda to the outskirts (perhaps to points in each zone where passenger demand concentrates). This would dramatically cut travel times and improve reliability, addressing the top user concern of punctuality. Moreover, network integration should incorporate feeder services: smaller vehicles or shuttle vans operating within each zone to bring people from neighborhood areas to the main trunk route stops. By improving first-mile/last-mile connectivity, overall accessibility improves (Andriani & Yuliastuti, 2013 emphasize that a green/sustainable transport system must provide door-to-door convenience to compete with private vehicles).

4.2. Service Quality Improvements

Addressing the service quality deficits (punctuality and comfort) is paramount. The study's findings on these fronts align with common issues identified in urban transport systems in Indonesia. For instance, in Tangerang's case, Pradana (2017) found that increasing the number of vehicles on a route was necessary to reduce waiting times and avoid overloading, which parallels our suggestion that fleet expansion is needed in Samarinda. The local government could consider incentive schemes or subsidies for operators to add newer vehicles and operate at higher frequencies, especially during peak hours. Another approach is to introduce scheduled services – currently angkot typically run on a load-based dispatch (they wait to fill up before departing), which hurts punctuality. By enforcing a schedule (even if at longer headways at first), passengers can count on departure times. This might require some form of contract or transformation of the system (e.g., shifting from individual owner-operators to a cooperatively or centrally managed service).

Comfort can be improved by fleet modernization. Many angkot are old and not built for comfort; replacing them with modern minibuses (with adequate seating, ventilation/air-conditioning) would raise the comfort level. Additionally, preventing overcrowding (perhaps by setting a maximum passenger limit and ensuring enough vehicles to carry the demand) is important. These improvements can significantly elevate the image of public transport. Cities like Surakarta have trialed modern buses for certain routes in pursuit of "green transportation" goals (Andriani & Yuliastuti, 2013), with positive public response.

One cannot ignore the potential of technology in improving service quality. Implementing a real-time tracking and passenger information system (through a smartphone app or displays at stops) can tackle the perceived unreliability. If users know exactly when the next vehicle will arrive and can plan accordingly, their tolerance for waiting increases. Such systems are increasingly feasible even in developing cities given the ubiquity of mobile phones. Technology can also help in operations: GPS tracking of vehicles could help a control center maintain schedule adherence.

4.3. Modal Shift and Environmental Benefits

Increasing the mode share of public transport (from 15% to higher levels) is both a challenge and a necessity. The congestion and growth data clearly indicate that without mode shift, the road network will be overwhelmed. Encouraging people to switch to public transport requires it to be a competitive alternative to private modes in terms of travel time, cost, and convenience. Our recommendations above (BRT lines, higher frequency, integrated routes, better comfort) all aim to make public transport more attractive. In addition, park-and-ride facilities at the city periphery could entice those coming from outer zones to leave their motorcycles or cars and take a bus for the remainder of the trip, reducing inner-city congestion.

A successful modal shift will yield significant environmental benefits by cutting vehicle emissions. Currently, the heavy use of private motorcycles and cars contributes to urban air pollution and carbon output. If the city can double or triple public transport ridership, it aligns with Indonesia's broader sustainable transport and emissions reduction targets (Andriani & Yuliastuti, 2013 discuss moving towards greener transport systems). It will also support the vision of the new capital region to be modern and environmentally friendly, since Samarinda and Kukar's transport ecosystem will interact with that of IKN.

Policy measures might be required to push modal shift alongside improving transit. These could include demand management strategies such as parking controls or congestion charges in busy areas to dissuade car use, as well as motorcyclist safety regulations (since in many cities, improving public transit alone isn't enough to get motorcyclists to switch, unless driving conditions become less convenient or more regulated).

However, any restrictive measures should be carefully timed after transit improvements so as not to unfairly burden commuters without giving them a viable alternative.

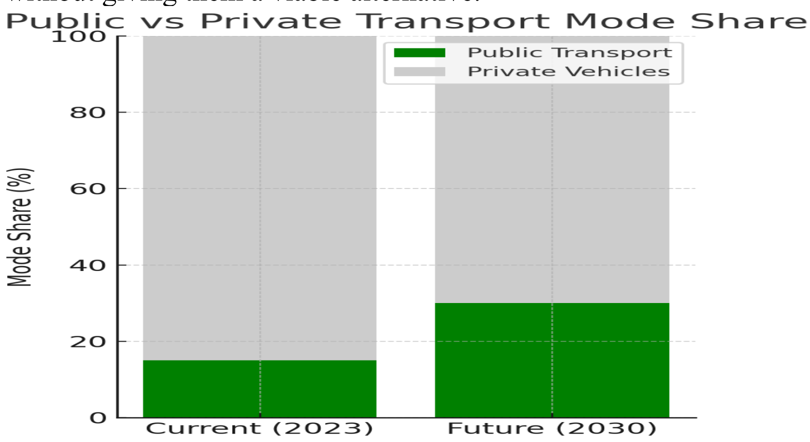

Figure 6. Current vs. Future Mode Share of Public vs Private Transport

The left bar shows the estimated current situation (2023) where only ~15% of trips are via public transport (green segment) and ~85% by private vehicles (grey segment). The right bar illustrates a potential future scenario (2030) if strategic improvements are implemented: public transport's share could increase to ~30%, with private modes at 70%. This shift would mean thousands of daily trips moving from private cars/motorbikes to buses or other transit, alleviating road congestion and reducing emissions. Achieving such a shift requires significant enhancements in public transport service quality and capacity, as discussed in this study.

Figure 6 above conceptually demonstrates the mode share challenge and goal. The future target of 30% public transport mode share is ambitious but not unrealistic if one considers that some Indonesian cities with BRT systems (like Jakarta with TransJakarta, or even smaller cities like Pekanbaru with Trans Metro) have seen improved ridership when good service is offered. Moreover, the presence of a young demographic in Samarinda (many students) is an opportunity – if public transport is made affordable or even subsidized for students, it can build a culture of transit use early on, as suggested by a spatial travel model study of students in Makassar (Tahir, 2017).

4.4. Institutional and Financial Considerations

The findings and recommendations inevitably face institutional and financial hurdles. The conclusion of our analysis (reflected in the original Indonesian text) pointed out that creating an integrated transport service is "not easy" due largely to institutional fragmentation and funding issues. The city and regency have their own transportation departments; aligning their policies and budgets will require political will and possibly higher-level intervention (e.g., provincial government facilitation). One way forward is to formalize collaboration through a memorandum of understanding or a metropolitan transport forum that regularly convenes stakeholders from both administrations. Given that the national government is very invested in the success of IKN and its surrounding region, there may be national funding or programs available to support integrated transport in Samarinda–Kukar as a neighboring metropolis. This could come through grants or loans for infrastructure like bus lanes, new terminals, or funding for new vehicles.

Non-conventional financing schemes could be explored, as the Indonesian text mentioned. Public-private partnerships (PPP) might attract investment into the public transport system – for example, a private company could be given a concession to operate a BRT line or a fleet of buses under certain agreements, reducing the financial burden on local governments. Land value capture is another concept: improving public transport often increases land values around transit corridors, so capturing some of that gain (through taxes or development fees) can fund the transport investment. While sophisticated, such mechanisms are increasingly considered in urban projects.

Finally, any improvement plan should be accompanied by public awareness and stakeholder engagement. The community needs to be informed about the benefits of a robust public transport system – not just in abstract terms, but how it can save them time and money and improve livability. If public perception shifts positively, it creates a virtuous cycle where more people ride, the service gets fare revenue and justification for expansion, and so on. Conversely, there may be resistance from current angkot operators or drivers to changes like new regulated systems or competition from larger buses. Thus, change management is essential: including existing operators in the new system (for instance, retraining angkot drivers to operate new buses, or forming cooperatives that become contractors for the metropolitan service) can help mitigate resistance. Such inclusive approaches have been used in Jakarta's integration of its paratransit into the TransJakarta feeder system.

4.5. Land Use and Transport Synergy

An important point often discussed in literature (Tamin, 2000) and reflected in our findings is the synergy between land use planning and transport provision. The Samarinda–Kukar region's transport issues partly stem from how the urban sprawl has occurred. To ensure transport supports the region's development, future land use planning (like the spatial plan RTRW of Kutai Kartanegara, etc.) should designate transit-oriented development areas, protect corridors for future transit lines, and avoid uncontrolled expansion where providing transit would be difficult. Our conclusion highlighted that road network plans must align with planned land use. We reinforce that: if new housing areas are being opened in, say, Zone 1 or Zone 4, there should simultaneously be a plan for extending public transport services there. Otherwise, car-dependent communities will form, locking in future traffic problems. Integrated planning can lead to a more polycentric urban form, where not all trips funnel into one center (Samarinda), but smaller sub-centers in the agglomeration have their own local public transport circulators and attract nearby residents for daily needs, reducing pressure on inter-zone travel.

4.6. Comparison with Other Regions and Broader Implications

The scenario in Samarinda–Kukar, while having local specifics, echoes transport challenges in many emerging metropolitan areas in Indonesia and other developing countries. Rapid urbanization without matching public transport development leads to the issues we observed: declining transit usage, congestion, and inequity in mobility. Studies and cases from other cities provide lessons. For example, Aksa (2014) studied a much more remote region (Mappi in Papua) and found that transport network performance was very poor due to limited infrastructure; the lesson there is that even in a developing metropolis like Samarinda, if infrastructure and services are lacking, the outcomes can approach "poor" levels of performance category, undermining growth. On the other hand, the presence of basic infrastructure in Samarinda (roads, some transit routes) means improvements can have an outsized positive impact if implemented well.

Another relevant example: The city of Palangkaraya explored different types of services (fixed routes vs flexible routes) to improve coverage (Samsudin, 2017). For Samarinda–Kukar, one could consider whether a mix of services might work: perhaps main corridors served by fixed-route large buses, and low-density areas by demand-responsive or flexible services (e.g., app-based minibuses). The discussion of fixed vs flexible route is particularly pertinent for Zones like 4 or 1 which have more dispersed settlements.

In essence, the broader implication is that policy integration is key transport policy cannot be siloed. It must integrate with environmental policy (to address pollution), with economic policy (to ensure connectivity supports commerce), and with social policy (to guarantee all socio-economic groups have access). The recommendations here contribute to those integrative goals: a good public transport system reduces emissions (environmental), boosts productivity by reducing travel time (economic), and provides mobility for non-drivers (social equity).

5. Conclusions

This research examined the state of urban public transportation in the Samarinda–Kutai Kartanegara agglomeration and outlined the pathway toward a better future transport system. Several conclusions can be drawn :

1. Current Performance is Suboptimal: The public transport services as they stand are falling short of user needs. Satisfaction levels are low, particularly for punctuality and comfort, leading to a marginal share of trips by public transport. The system's shortcomings – inconsistent service, insufficient coverage integration, and aging fleet – contribute to a cycle of declining ridership and increasing reliance on private vehicles.

2. Future Demand Will Escalate: Travel demand in this region is on a steep rise and will continue to grow with urban expansion and economic development (and likely even more with the nearby new capital). By around 2030, daily trip volumes are projected to be roughly 1.4 times the current levels. If the modal split remains unchanged, this could translate into thousands of additional cars and motorcycles on the road, exacerbating congestion and environmental problems. However, this also means there is a significant opportunity to shift a substantial volume of new trips to public transport – if the system is improved proactively.
3. Strategic Improvements Can Yield Major Benefits: Enhancing public transport service quality and capacity can address current issues and make the system more attractive for the projected future demand. Key strategies include :
   a. Increasing frequency and reliability (through fleet expansion, better schedules, possibly dedicated lanes for buses).
   b. Improving comfort and safety (new vehicles, enforcing reasonable passenger loads, vehicle maintenance, and amenities like A/C).
   c. Expanding and integrating route networks (linking the zones without requiring transfers, creating feeder services, and ensuring all major residential and commercial areas are connected).
   d. Embracing technology for operations and user information (GPS-based tracking, mobile ticketing, etc.).
   e. Aligning land use planning with transit provision (promoting transit-oriented development and preventing sprawl beyond the reach of transit).
4. Policy Support and Implementation: The findings underscore that these improvements require not just technical fixes but also supportive policies. National and local policies should encourage public transport use (e.g., subsidies, priority measures like bus lanes, and restrictions on private vehicle use in congested areas at peak times). The Regulation of Minister of Transportation No. 15/2009 provides a framework obligating regions to ensure public transport services; implementing its spirit here might involve formalizing a single network across Samarinda and Kukar. Financial investment is needed, but innovative funding (PPP, cross-subsidies from more profitable routes to cover social service routes, etc.) can be part of the solution.

In closing, the Samarinda–Kukar agglomeration stands at a crossroads in its urban transport trajectory. The current landscape has significant challenges, but the research presented in this paper offers a detailed diagnosis and a hopeful direction forward. The future vision is of a well-connected metropolitan area where residents can rely on efficient public transit to move between home, work, and other activities, reducing the burdens that uncontrolled urban traffic would otherwise impose. Achieving this vision will require diligent effort from planners, government officials, and community stakeholders – but it is a necessary journey toward sustainable and inclusive urban mobility. The lessons from this study are applicable not only to this region but to many fast-growing cities in Indonesia and beyond: invest in public transport now, guided by data and best practices, to unlock a better urban future.

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