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Article

Mapping Route Overlaps and Untapped Demand: A Spatial Optimization Study of TransJakarta's Multimodal Network

Gema Krisni Indra Perdana[1*]

Corresponding author. *Email: krisni@jakarta.go.id

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Abstract

This study examines the spatial efficiency of TransJakarta's multimodal public transport network by analyzing route overlaps, passenger mobility patterns, and underserved high-density areas across Jakarta. Using a mixed-methods approach that combines passenger survey data, descriptive statistics, and GIS-based spatial modeling, the study evaluates 234 routes serving more than 96 million passengers between January and May 2023. Intersect geoprocessing reveals 34 overlapping routes, with three Mikrotrans services—JAK 120, Mikrotrans 13, and JAK 22—performing poorly despite running parallel to BRT and Non-BRT corridors with moderate to high ridership. These redundancies contribute to congestion, inefficient fleet utilization, and unnecessary subsidy expenditures. Desire line analysis further shows that commuter flows are highly concentrated in central Jakarta, yet several high-population kelurahan such as Tambora and Cipayung remain underserved by Non-BRT and Mikrotrans coverage. Findings highlight a significant mismatch between network supply and actual mobility needs, rooted in limited use of OD-based planning and fragmented coordination among service providers. The study underscores the need for data-driven route restructuring, the reduction of redundant services, and strategic expansion into high-demand areas to improve accessibility and support a more sustainable urban mobility system.

Keywords: Spatial Analysis; Route Optimization; TransJakarta; Public Transport Planning; Multimodal Network.

[1] Senior Urban Planner Specialist, Center for Research and Innovation – Regional Plan and Development Agency of Jakarta, Indonesia

I. Introduction

Jakarta is a city marked by high population density and complex urban mobility patterns. As its population continues to grow each year and density remains relatively uniform across sub-districts, residents are increasingly compelled to choose transportation modes that align with their daily activities. A wide range of urban functions such as employment, education, shopping, and recreation relies heavily on the efficiency and accessibility of transportation systems, with public transport playing a central role in facilitating this movement. As various studies highlight, transportation reflects the interaction between the supply and demand for services that enable the movement of people and goods across spatial boundaries.

However, the effectiveness of any transportation system is closely tied to the capacity of its supporting infrastructure. For example, data from statistik.jakarta.go.id shows that as of 2020, Jakarta had approximately 6,652 kilometers of road infrastructure only about 60% of what is required to effectively serve the city's peak-hour population of nearly 12 million, including daily commuters from the greater Bodetabek (Bogor, Depok, Tangerang, and Bekasi) region (Ministry of PUPR). While TransJakarta the city's Bus Rapid Transit (BRT) system has expanded to 234 routes with an annual growth of 10–20%, this expansion has often occurred without a comprehensive analysis of commuter origin–destination (OD) patterns, limiting its responsiveness to actual mobility needs.

A key strategic challenge facing Jakarta is the inefficiency of its public transportation system, particularly regarding overlapping bus routes and suboptimal subsidy allocations. These challenges are summarized in Table 1 using the Urgency, Seriousness, and Growth (USG) matrix.

Table 1. USG Matrix for Identification Main Problem

No	Problem	Urgency	Seriousness	Growth	Total Skor	Prioritas
1	Overlapping public transportation (bus) routes	5	5	5	15	Most Critical
2	Insufficient road infrastructure capacity	4	5	4	13	High
3	Increasing private vehicle ownership	4	4	5	13	High
4	Traffic congestion during peak hours	5	4	4	13	High
5	Low accessibility in underserved areas	3	4	4	11	Moderate to High

Among these, routes overlap within the public transportation network, especially in TransJakarta's BRT and its feeder services like Mikrotrans emerge as the most critical issue.

This problem stems from fragmented planning, limited integration of spatial and OD data, and a lack of coordination among transport operators. Consequently, multiple services often operate along the same corridors, resulting in inefficient fleet usage, increased congestion, longer travel times, and higher operational costs. This redundancy also leads to service imbalances, with some areas overserved while others remain inaccessible. Without strategic, data-driven optimization of the network, Jakarta's public transportation system risks becoming increasingly unsustainable and ill-equipped to meet the city's growing mobility demands.

1.1. Route Selection in Transportation Networks

An essential aspect of transportation planning is route selection, which represents the process by which individuals decide how to travel from one point to another. In public transport systems like TransJakarta, route choices are largely predetermined by the structure of fixed corridors. In contrast, private vehicle users must first choose a mode of transport before selecting an optimal route based on personal preferences or real-time traffic data. According to Tamin (2000), route choices in public transport are often driven by considerations such as distance, travel time, and cost efficiency.

Transportation modeling attempts to simulate these decision-making processes. Traffic flow on individual road segments is conceptualized as the result of route selection behavior, network characteristics, and assignment algorithms. This framework simulates how travelers perceive and select optimal routes between origin and destination zones, assigning these trips to corresponding segments in the network.

Tamin (2000) also stresses that travel time tends to outweigh travel distance as the dominant factor in determining route choice, particularly in dense urban settings. Additional influencing elements include travel costs (fuel or fares), congestion levels, the number of road maneuvers, segment types, signage, and perceived comfort and safety. While private routes are chosen by individuals, public transport operators typically set routes based on broader operational criteria such as service coverage, travel time, vehicle operating costs, and user convenience.

1.2. Overlapping Transportation Networks

A significant challenge in Jakarta's transit system is the phenomenon of overlapping transportation networks, where multiple transport modes or services operate along the same corridors or serve similar routes. Habibullah (2022) identifies such overlaps as operational inefficiencies, for example, when different BRT corridors intersect on a shared road segment. These overlaps, while designed to serve diverse areas, can unintentionally lead to congestion, redundancy, and increased operational costs.

Compounding the issue, urban bottlenecks emerge at key junctions where multiple services converge. As noted by Tamin (2000:45), route planning must account for road density, as congestion is more likely when traffic demand exceeds road capacity, a situation aggravated by inadequate road network expansion, rapid motorization, and aging infrastructure (Susantono, 2014; Adler, 1983). Urban expert Yayat Supriatna has pinpointed major congestion zones such as Cawang, Pancoran, Kuningan, Semanggi, Slipi, Tomang, and Grogol—locations where TransJakarta services (BRT, feeder, mikrotrans) frequently overlap, intensifying bottlenecks.

1.3. Geographic Information Systems (GIS)

To address complex urban transport issues, technological tools such as Geographic Information Systems (GIS) have become indispensable. GIS integrates systems, geography, and information to process and analyze spatial and non-spatial data. Supriadi (2007) defines GIS as a computer-based system designed to digitally represent and analyze Earth's surface features. These tools are vital for urban planning, transport modeling, disaster response, and infrastructure development.

GIS supports a complete data lifecycle, including data collection, management, transformation, analysis, and distribution (Santoso, 2021). One of its key strengths is the ability to integrate hardware and software systems that produce spatially referenced information for decision-making. Within GIS, the vector data model which includes points, lines, and polygons is commonly used to represent geographic elements. A basic variant, the spaghetti model, stores features individually without spatial relationships, whereas the more advanced topological model emphasizes spatial connectivity among features.

Additionally, GIS handles attribute data non spatial information about spatial features that categorized as nominal (labels), ordinal (ranks), and interval (quantitative). These classifications enable effective querying, visualization, and analysis. Another crucial element in spatial modeling is the Digital Elevation Model (DEM), which represents terrain elevation and is essential for tasks like watershed analysis, infrastructure design, and environmental modeling. DEMs can take the form of gridded mass points, contour lines, or raster-based grids derived from digital images.

1.4. Case Studies on Route Optimization and Public Transport Efficiency

Jakarta's overlapping public transport routes are a persistent cause of traffic congestion, especially at high density nodes. Various studies have sought solutions through route optimization. For instance, Devi et al. (2022) compared TransJakarta and TransJogja, concluding that system design and alignment with commuter needs were key performance differentiators. During the COVID-19 pandemic, Sari et al. (2023) applied Mixed Integer Linear Programming to Corridor 2 (Harmoni–Pulogadung), optimizing schedules for improved frequency and reliability.

Studies from Medan and Cirebon, Indonesia, provide localized comparisons highly relevant to Jakarta. A GIS-based study in Medan mapped the overlapping routes of paratransit services (angkot) and revealed a high degree of route redundancy. The researchers recommended redesigning the route network to align with trunk-feeder principles, where overlapping services could be reduced, and feeder lines reoriented to support main corridors. A similar study in Cirebon found that paratransit overlaps with formal bus routes significantly reduce operational efficiency. Other efforts, such as those by Putra et al. (2021), evaluated feeder route integration and found accessibility gains but persistent inefficiencies due to shared road conditions. Yusuf et al. (2016) employed clustering and ant colony algorithms to optimize bus stop locations in West Jakarta, reducing travel times and improving route efficiency.

Insights from other Indonesian cities further emphasize context-specific challenges. In Semarang, Andromeda et al. (2014) observed low corridor utilization and advocated for unified management. In Padang, Sari & Firdaus (2016) noted enhanced stop facilities post-BRT but also criticized weak pedestrian infrastructure. In Medan, Hutagalung & Nasution (2022) identified low public awareness and weak policy implementation as barriers.

Yogyakarta faced similar issues, with Wijayanti & Nurhadi (2016) underlining the need for public education to boost BRT adoption.

1.5. Global Perspectives on BRT Optimization

A relevant study conducted by Dixit, Cats, and Brands (2021) in Amsterdam explored how transit users perceive overlapping routes in multimodal urban transit systems. Using smart-card data and a path-size correction logit model (PSCL), the research examined different types of route overlap—including those occurring on shared links, legs, or transfer nodes. One of the key findings was that overlaps at transfer nodes tend to be perceived positively by users, while overlaps in travel segments (legs) may lead to inefficiencies or negative user experiences.

In a study focused on bus operational efficiency, researchers analyzed overlapping origin–destination (OD) pairs between bus stations using smart-card data to determine where service rationalization could improve performance. This research employed statistical methods to identify high-frequency OD pairs and map demand intensity, providing insights for network restructuring. A broader, international perspective is provided by a GIS-based accessibility study in Alexandria, Egypt (2024), which mapped formal and informal transport services to identify gaps in network coverage. Using walkability buffers and population density data, the research showed that many high-density neighborhoods lacked sufficient access to formal transport services. The study underscores the importance of spatial equity and supports your recommendation to prioritize underserved yet high-demand areas in future service expansions. European study on bus stop demand modeling used spatial statistics and Geographic Information Systems (GIS) to estimate passenger activity at the stop level. By integrating land use, demographic data, and bus network characteristics, the study identified key predictors of bus stop utilization.

Building on insights from prior studies on BRT route optimization, it becomes clear that Jakarta faces similar challenges in aligning service expansion with actual commuter needs. As of 2024, TransJakarta operates 234 routes, growing at a rate of 10–20% annually. However, this expansion has not been supported by comprehensive analysis of population mobility patterns, particularly regarding origin–destination (OD) flows that define daily commuting behavior. Without such data-driven planning, the risk of inefficiency increases, as new routes may fail to address the city's most critical travel demands.

In 2024, Trans Jakarta operates 234 routes, with an annual increase of 10-20%. However, the expansion of these routes has not been accompanied by an analysis of the population's needs and demands, particularly regarding the mobility patterns from origin to destination in their daily activities. Each public transportation service has a predefined route, and the optimal route for public transportation can be assessed in terms of either distance or travel time. Determining the optimal route based on travel time requires consideration of road density (Tamin, 2000, p. 45). Road density at specific times can influence the speed and duration of travel. When road density exceeds the capacity of a road segment, it results in transportation problems, particularly congestion. Congestion arises due to the continuous increase in the number of vehicles, while the expansion of the road network remains relatively fixed (Susantono, 2014: pp. 108-109). Several factors contribute to traffic congestion, including inadequate road infrastructure, such as narrow roads and substandard quality, as well as the rapid and unsustainable growth in the number of motorized vehicles, which is not matched by the available road capacity (Adler, 1983: p. 67).

One contributing factor to the urban transportation problems in Jakarta is the overlapping of Trans Jakarta routes, which adds to the number of traffic congestion points during peak hours. According to urban planning expert, Yayat Supriatna from Universitas Trisakti, there are seven critical traffic congestion points in Jakarta that need to be addressed. These points include the areas of Cawang, Pancoran, Kuningan, Semanggi, Slipi, Tomang, and Grogol, which are traversed by the Trans Jakarta Bus Rapid Transit (BRT), feeder buses (BRT, non-BRT, Rusun, tourist buses, Transjabodetabek, Trans Jakarta Cares), and Mikrotrans.

The negative impacts of traffic congestion on vehicle users are significant, including increased fuel consumption and longer travel times (Wardana, 2012: 2). An analysis utilizing Geographic Information Systems (GIS) can assist in addressing this issue through network analysis, which involves determining the shortest path or optimizing the best route based on travel distance.

These diverse national and international studies demonstrate that optimizing public transportation routes—whether through operational algorithms, infrastructure planning, integrated management, or GIS-based network analysis—is critical for enhancing optimization, minimizing redundancy, and addressing congestion. In the context of Jakarta, where Trans Jakarta routes frequently overlap and road density is a limiting factor, these approaches offer essential frameworks. Accordingly, this study is titled: **"Optimization Analysis of Trans Jakarta Multimodal Routes Based Spatial Analysis"** and aims to evaluate and optimize existing BRT and feeder routes to support a more efficient and sustainable public transportation system.

1.6. Research Gap

Despite a growing body of national and international literature on Bus Rapid Transit (BRT) optimization and multimodal integration, there remains a substantial gap in the spatially driven analysis of overlapping routes within Jakarta's TransJakarta system. Notably, the use of Geographic Information Systems (GIS) to align service routes with actual OD travel patterns has not been fully explored in the context of Jakarta. While the TransJakarta network has expanded significantly with over 234 active routes and annual growth rates between 10% to 20%, this expansion has not been systematically informed by commuter mobility data or OD-based planning. Existing studies predominantly focus on operational aspects such as scheduling efficiency and vehicle performance (e.g., Kusuma et al., 2020; Setiawan & Indrawati, 2021), while the spatial alignment of routes with passenger movement remains largely overlooked.

Furthermore, unlike international cities such as Bogotá and Guangzhou, where GIS-based tools have been effectively applied to restructure BRT networks and eliminate inefficiencies (Cervero, 2013; Deng & Nelson, 2012), Jakarta has yet to fully integrate GIS into its multimodal transport planning. As a result, overlapping services and underutilized routes persist, exacerbated by a lack of coordination among service providers. This fragmented approach to planning has led to congestion in overserved corridors and limited access in underserved areas. While Mikrotrans and feeder services are designed to complement the BRT backbone, research on the spatial interaction and integration between these modes remains scarce. Additionally, although global case studies offer valuable insights, they often fail to consider Jakarta's unique challenges, including its high urban density, mixed land use, and complex governance structure. Therefore, this study addresses these research gaps by applying GIS-based spatial analysis to evaluate the effectiveness of TransJakarta's multimodal network in relation to actual commuter mobility patterns, aiming to inform more integrated and data-driven transport planning for Jakarta.

II. Method

The research was conducted in Jakarta, which covers an area of 662.33 km² (based on Governor Decree No. 171 of 2007). Geographically, Jakarta is located between 6°12' South Latitude and 106°48' East Longitude. The map of the study area is shown in Figure 1 below.

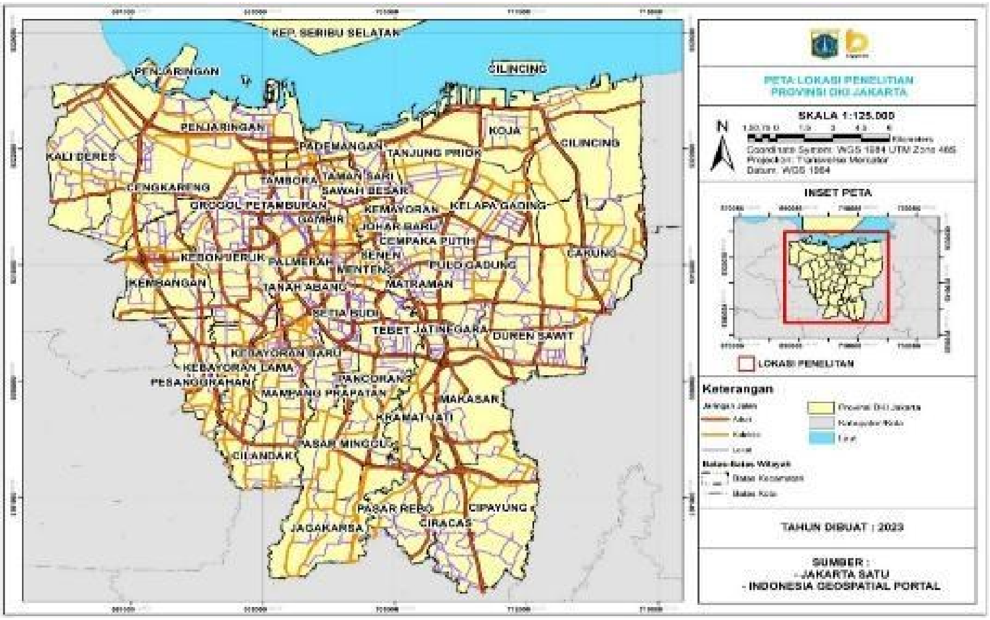

Figure 1. Map of the Research Location – DKI Jakarta Province, Source: *Jakarta Satu*, Indonesia Geospatial Portal

2.1. Research Objective

This study aims to identify the available routes and overlaps within the current Trans Jakarta services by examining the routing patterns of all Trans Jakarta service modes, passenger mobility across these modes, and the population density within the 267 urban villages (kelurahan) of Jakarta. Formulating policy recommendations related to the subsidy efficiency by assessing the optimization of intermodal Trans Jakarta routes.

2.2. Method of Collecting Data

This study adopts quantitative and qualitative research method, utilizing a sample of Trans Jakarta users as primary data, specifically passenger data collected from January to May 2023. This is complemented by secondary data, including the area size of each urban village, population per urban village, road networks, land use classifications, and the existing Trans Jakarta routes.

2.3. Data Analysis

The research involves two populations: (1) all Trans Jakarta corridors (corridors 1-13) and TransJakarta service modes (BRT, non-BRT, city tour buses, Rusun services, TransJabodetabek, Trans Jakarta Cares), Mikrotrans (2) the human population, referring to the total number of passengers across all Trans Jakarta service modes. The sampling of passengers was conducted using Slovin's formula. In 2022, the total number of Trans Jakarta passengers reached 191,419,447. Using Slovin's formula with a 5% margin of error, a sample size of 400 respondents was determined. To ensure adequate representation, stratified sampling was applied first, by corridor, dividing the sample between Corridors 1 to 13 and Mikrotrans, with a minimum of 30 respondents per corridor. Additionally, another layer of categorization was conducted based on service mode, grouping the sample into Trans Jakarta services (BRT, non-BRT, TransJabodetabek, Rusun, and Royaltrans) and Mikrotrans, with a minimum sample size of 400 respondents allocated for this classification.

This study employs a mixed-method approach as shown in figure 2 below, combining both quantitative and qualitative analysis. The quantitative analysis involves descriptive analysis of the primary data including the categorization of passenger volumes and analysis of respondents' OD data TransJakarta user survey. The qualitative analysis includes spatial analysis by GIS, focusing on overlapping Trans Jakarta routes by overlay SHP data and do Intersect Geoprocessing Analysis Between Trans Jakarta Modes, color symbology based on passenger volume categories, desire line analysis based on primary OD survey data, and population density by urban village (kelurahan).

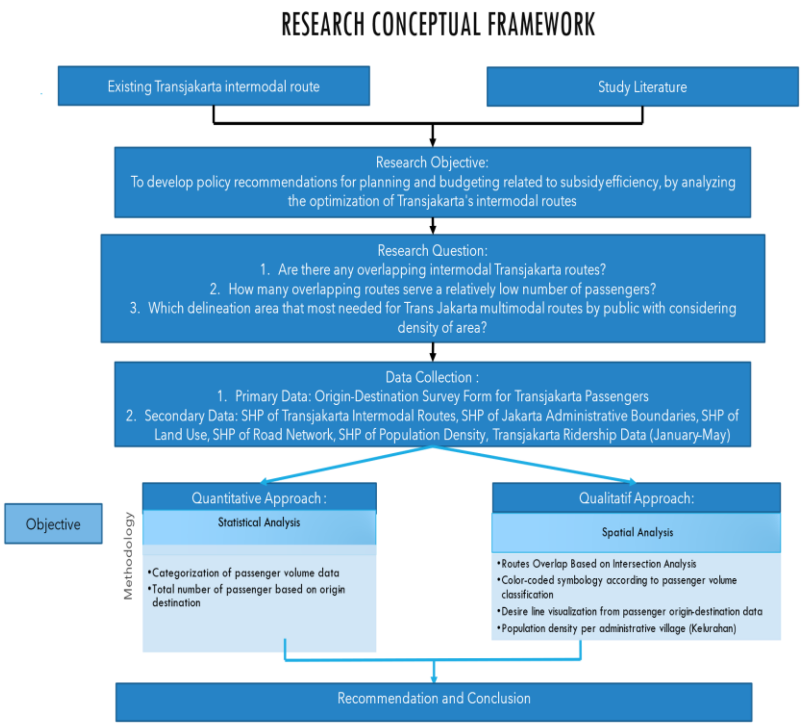

Figure 2. Conceptual Framework, Source: Author's compilation

Based on passenger data for all Trans Jakarta service modes from January to May 2023, a total of 234 intermodal routes were identified, serving 96,160,968 passengers. Statistical analysis using SPSS produced for the descriptive analysis for the mean, median, and standard deviation values, as presented in Table 1 below.

Table 2. Descriptive Statistics of Intermodal Trans Jakarta Passenger Volumes (January–May 2023)

N	Valid	83
	Missing	0
Mean (M)		413.417,61
Median (MD)		422.808,00
Standard Deviation (SD)		187.315,58
	25	280.131,00
	50	422.808,00
Percentiles	75	530.223,00

Source: Trans Jakarta

The passenger volume data needs to be categorized based on the guidelines provided by Azwar (2012), as follows:

Table 3. Value Categorization, Source: Azwar (2012)

Low	$X < M - 1SD$
Average	$M - 1SD \leq X < M + 1SD$
High	$M + 1SD \leq X$

Calculation of Category Thresholds:

- **Lower bound of Medium**:

$M - 1SD = 413{,}417.61 - 187{,}315.58 = 226.102{,}03$

- **Upper bound of Medium**:

$M + 1SD = 413{,}417.61 + 187{,}315.58 = 600.733{,}19$

Table 4. Sample volume by categorization, source: Author's analysis

Category	Passenger Range
Low	< 226.102,03
Medium	226,102.03 – 600,733.19
High	≥ 600,733.19

The categorized passenger data presented in the table above will be incorporated as supplementary information in the spatial analysis by GIS to be conducted in the subsequent phase.

Based on OD data of Trans Jakarta users obtained from the mobility behavior survey conducted by the Regional Research and Innovation Center of the Developing and Planning Agency in collaboration with the Statistics Division of the Department of Communication, Information, and Statistics, it was found that the data needs to be refined due to many respondents having identical origin and destination points. The origin and destination data refer to the sub-districts (kelurahan) within the Greater Jakarta area (Jabodetabek), which can be georeferenced to determine travel distances for each respondent and be utilized in spatial analysis by GIS.

III. Results and Discussions

3.1 Spatial Analysis

3.1.1. Intersect Geoprocessing Analysis Between Trans Jakarta Modes (BRT, Non-BRT, and Mikrotrans)

TransJakarta operates several service modes, including Bus Rapid Transit (BRT), Integrated Public Transport (Non-BRT), and Mikrotrans. As of the July 2023 update, the total number of transportation routes in DKI Jakarta is 235.

In this GIS analysis, several maps sourced from *Jakarta Satu* were utilized, including shapefiles (shp) of administrative boundaries at the kelurahan level in DKI Jakarta, land use, road networks, processed population density per kelurahan, and Trans Jakarta multimodal routes comprising BRT, non-BRT, and Mikrotrans services.

These available map layers were sequentially imported and overlaid. Subsequently, passenger volume data for each route, along with the previously analysed passenger categorization by SPSS, were added to the route layer. Each passenger volume category was visualized using colour coding: green for low, yellow for medium, and red for high passenger volume. This visualization enables identification of overlapping Trans Jakarta services, as illustrated in figure 3 below.

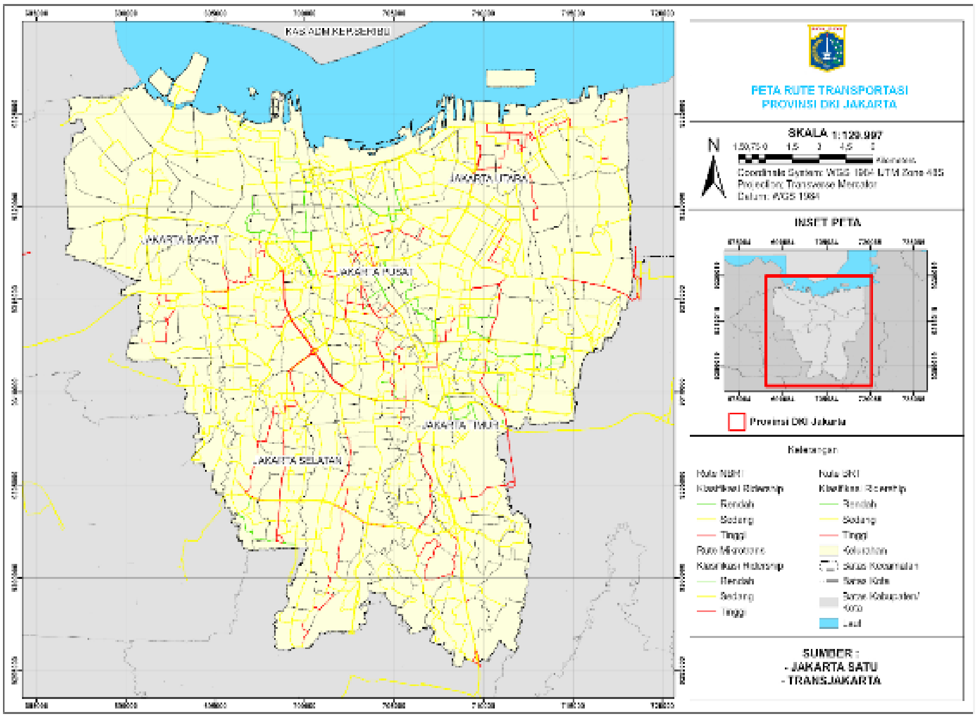

Figure 3. An overlay map displaying the intersection of existing Trans Jakarta routes, the road network, and passenger volume data, *Data source: Jakarta Satu and the Indonesia Geospatial Portal*

Overlapping occurs when two or more types of transportation modes serve the same route or journey. This results in inefficiencies in time and additional costs for service providers, as well as traffic congestion on the road sections. To address the issue of overlapping, recommendations can be made to avoid routes that already have an established transportation service, enabling more efficient travel times with the help of GIS applications, specifically network analysis.

In this research study, the author will focus on identifying non-productive routes due to excessive overlapping using intersect geoprocessing analysis.

The results of the map overlay will be followed by an intersect geoprocessing analysis, with the objective of identifying routes that intersect and overlap between different Trans Jakarta modes. Intersect is a spatial analysis tool related to overlay, which combines intersecting features, such as lines or polygons. Only features that overlap is combined and recorded in the output. The results of the intersect analysis are shown in Figure 4 below.

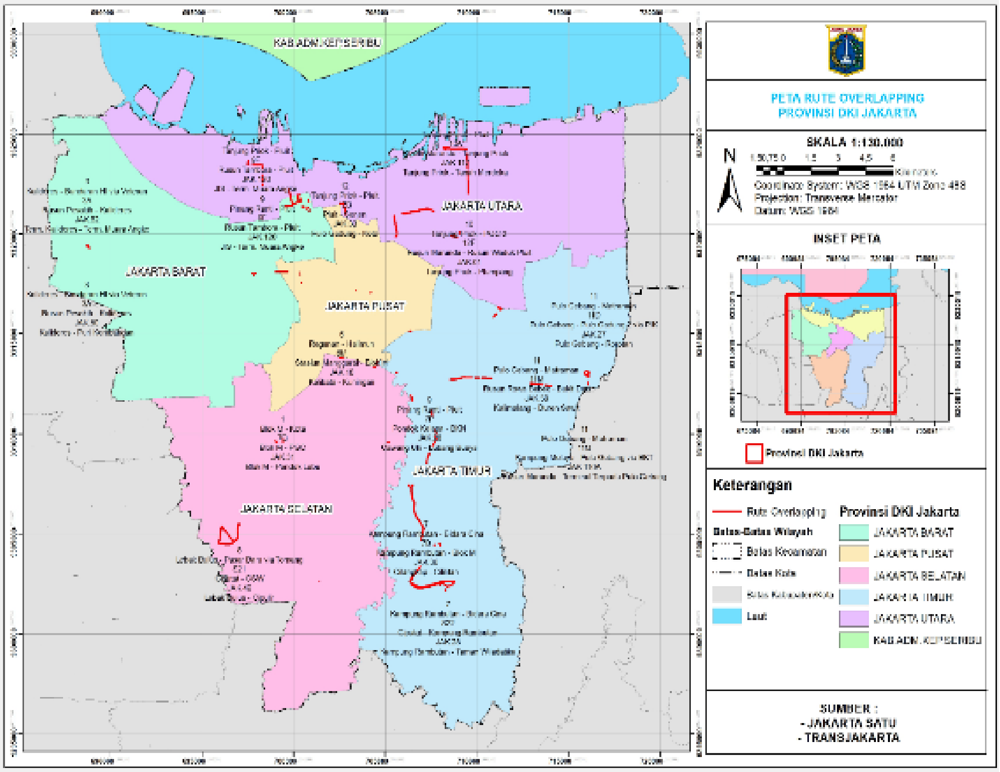

Figure 4. Map of Intersect Analysis Results from Overlaying Existing Trans Jakarta Routes, Road Network, and Passenger Volume.

Source: Jakarta Satu, Indonesia Geospatial Portal

The results of the intersect analysis shown in the image above reveal the occurrence of route overlap, where 34 (thirty-four) Trans Jakarta multimodal routes intersect and overlap, as presented in Table 3 below. Three (3) routes with low passenger volume data, as well as overlaps between BRT, Non-BRT, and Mikrotrans routes, are highlighted with red lines in the image above and are presented in the following table 4.

Table 4 above highlights that there are 34 transportation routes in Jakarta—served by BRT, Non-BRT, and Mikrotrans—that experience route overlaps. It also shows that three TransJakarta routes overlap with one another, where Mikrotrans services tend to have low passenger volumes, while BRT and Integrated Public Transport services show moderate usage. These overlaps also span relatively long distances. The three Mikrotrans routes with low ridership that overlap with other TransJakarta modes are:

1. Mikrotrans JAK 120 (JIS – Muara Angke Terminal),
2. Mikrotrans 13 (Tanah Abang – Kota Intan via Jembatan Lima), and
3. Mikrotrans JAK 22 (Dwikora – Penas Kalimalang).

The author will provide a more detailed explanation of the overlapping route involving Mikrotrans JAK 120 (JIS – Muara Angke Terminal) with spatial analysis, which is illustrated in Figure 5 below.

Table 4. Data on Overlap Between Trans Jakarta Modes with Passenger Classification Types, *Source: GIS Analysis, Author*

No	Kode Rute	Rute/Trayek	Tipe Rute	Ridership	Klasifikasi Ridership	Kode Rute	Rute/Trayek	Tipe Rute	Ridership	Klasifikasi Ridership	Kode Rute	Rute/Trayek	Tipe Rute	Ridership	Klasifikasi Ridership
1	10	Tanjung Priok - PGC 2	BRT	3081877	Sedang	12F	Rusun Marunda - Rusun Waduk Pluit	Rusun	18859	Sedang	JAK.01	Tanjung Priok - Plumpang	Mikrotrans	374034	Sedang
2	10	Tanjung Priok - PGC 2	BRT	3081877	Sedang	10B	Rusun Cipinang Besar Selatan - Penas Kalimalang	Rusun	15576	Sedang	JAK.02	Kampung Melayu - Duren Sawit	Mikrotrans	273106	Sedang
3	8	Lebak Bulus - Pasar Baru via Tomang	BRT	3918942	Sedang	7A	Kampung Rambutan - Lebak Bulus	Angkutan Umum Integrasi	535360	Tinggi	JAK.03	Lebak Bulus - Andara	Mikrotrans	219251	Rendah
4	3	Kalideres - Bundaran HI via Veteran	BRT	3662638	Sedang	9E	Kebayoran Lama - Jelambar	Angkutan Umum Integrasi	153945	Sedang	JAK.04	Grogol - Tubagus Angke	Mikrotrans	146972	Rendah
5	12	Tanjung Priok - Pluit	BRT	1279542	Rendah	12A	Kaliadem - Kota	Angkutan Umum Integrasi	5937	Sedang	JAK.10	Tanah Abang - Kota	Mikrotrans	465461	Sedang
6	11	Pulo Gebang - Matraman	BRT	1231563	Rendah	11M	Rusun Rawa Bebek - Bukit Duri	Rusun	25590	Sedang	JAK.106	Terminal Klender - Terminal Kampung Melayu	Mikrotrans	146997	Rendah
7	11	Pulo Gebang - Matraman	BRT	1231563	Rendah	11D	Pulo Gebang - Pulo Gadung 2 via PIK	Angkutan Umum Integrasi	266700	Sedang	JAK.110A	Rusun Marunda - Terminal Terpadu Pulo Gebang	Mikrotrans	332294	Sedang
8	2	Pulo Gadung 1 - Monas	BRT	3180171	Sedang	2F	Rusun Cakung Barat - Pulo Gadung	Rusun	29733	Sedang	JAK.112	Terminal Tanah Merah - Pulo Gadung	Mikrotrans	362161	Sedang
9	4	Pulo Gadung 2 - Dukuh Atas 2	BRT	2226088	Sedang	4E	Rusun Jatinegara Kaum - Pulo Gadung	Rusun	918	Rendah	JAK.112	Terminal Tanah Merah - Pulo Gadung	Mikrotrans	362161	Sedang
10	12	Tanjung Priok - Pluit	BRT	1279542	Rendah	12B	Pluit - Senen	Angkutan Umum Integrasi	172682	Sedang	JAK.118	Taman Waduk Papanggo - Kota Tua	Mikrotrans	394233	Sedang
11	1	Blok M - Kota	BRT	7550622	Tinggi	1A	Pantai Maju - Balai Kota	Angkutan Umum Integrasi	672462	Tinggi	JAK.118	Taman Waduk Papanggo - Kota Tua	Mikrotrans	394233	Sedang
12	12	Tanjung Priok - Pluit	BRT	1279542	Rendah	12P	St. LRT Pegangsaan Dua - JIS	Angkutan Umum Integrasi	60261	Sedang	JAK.120	JIS - Term. Muara Angke	Mikrotrans	159817	Rendah
13	9	Pinang Ranti - Pluit	BRT	6057903	Tinggi	9F	Rusun Tambora - Pluit	Rusun	3090	Sedang	JAK.120	JIS - Term. Muara Angke	Mikrotrans	159817	Rendah
14	3	Kalideres - Bundaran HI via Veteran	BRT	3662638	Sedang	8M	S. Parman - Tanah Abang	Angkutan Umum Integrasi	49523	Sedang	JAK.13	Tanah Abang - Kota Intan via Jembatan Lima	Mikrotrans	186871	Rendah
15	10	Tanjung Priok - PGC 2	BRT	3081877	Sedang	10A	Rusun Marunda - Tanjung Priok	Rusun	9578	Sedang	JAK.15	Terminal Tanjung Priok - Rusun Marunda	Mikrotrans	764708	Tinggi
16	7	Kampung Rambutan - Bidara Cina	BRT	2808961	Sedang	7B	Kampung Rambutan - Blok M	Angkutan Umum Integrasi	599749	Tinggi	JAK.16	Cililitan - Condet	Mikrotrans	543576	Sedang
17	6	Ragunan - Halimun	BRT	3401821	Sedang	6M	Stasiun Manggarai - Blok M	Angkutan Umum Integrasi	115270	Sedang	JAK.18	Kalibata - Kuningan	Mikrotrans	307699	Sedang
18	9	Pinang Ranti - Pluit	BRT	6057903	Tinggi	7C	Cibubur - BKN	Angkutan Umum Integrasi	514022	Tinggi	JAK.20	Cawang Uki - Lubang Buaya	Mikrotrans	431652	Sedang
19	7	Kampung Rambutan - Bidara Cina	BRT	2808961	Sedang	7Q	Blok M - PGC	Angkutan Umum Integrasi	62086	Sedang	JAK.21	Cililitan - Dwikora	Mikrotrans	460119	Sedang
20	10	Tanjung Priok - PGC 2	BRT	3081877	Sedang	7P	Pondok Kelapa - BKN	Angkutan Umum Integrasi	173479	Sedang	JAK.22	Dwikora - Penas Kalimalang	Mikrotrans	92926	Rendah
21	4	Pulo Gadung 2 - Dukuh Atas 2	BRT	2226088	Sedang	4C	TU Gas - Bundaran Senayan	Angkutan Umum Integrasi	118273	Sedang	JAK.23	Senen - Pisangan Baru	Mikrotrans	176982	Rendah
22	2	Pulo Gadung 1 - Monas	BRT	3180171	Sedang	2H	Rusun Jati Rawasari - Senen	Rusun	10643	Sedang	JAK.23	Senen - Pisangan Baru	Mikrotrans	176982	Rendah
23	2	Pulo Gadung 1 - Monas	BRT	3180171	Sedang	2E	Rusun Rawa Bebek - Pakin	Rusun	21115	Sedang	JAK.24	Senen - Pulo Gadung via Kelapa Gading	Mikrotrans	730478	Tinggi
24	1	Blok M - Kota	BRT	7550622	Tinggi	1C	Pesanggrahan - Blok M	Angkutan Umum Integrasi	106452	Sedang	JAK.31	Blok M - Pondok Labu	Mikrotrans	424220	Sedang
25	8	Lebak Bulus - Pasar Baru via Tomang	BRT	3918942	Sedang	6H	Senen - Lebak Bulus	Angkutan Umum Integrasi	424248	Tinggi	JAK.32	Lebak Bulus - Petukangan	Mikrotrans	595142	Sedang
26	4	Pulo Gadung 2 - Dukuh Atas 2	BRT	2226088	Sedang	4F	Pinang Ranti - Pulo Gadung	Angkutan Umum Integrasi	420408	Tinggi	JAK.33	Pulo Gadung - Kota	Mikrotrans	437539	Sedang
27	9	Pinang Ranti - Pluit	BRT	6057903	Tinggi	7D	Kampung Rambutan - Tegal Parang	Angkutan Umum Integrasi	369402	Sedang	JAK.36	Cilangkap - Cililitan	Mikrotrans	510979	Sedang
28	5	Kampung Melayu - Ancol	BRT	2458406	Sedang	7ST	Kampung Melayu - Matraman 1 - Kampung Melayu	Angkutan Umum Integrasi	102760	Sedang	JAK.41	Kampung Melayu - Pulo Gadung	Mikrotrans	659806	Tinggi
29	11	Pulo Gebang - Matraman	BRT	1231563	Rendah	5B	Stasiun Tebet - Bidara Cina	Angkutan Umum Integrasi	92842	Sedang	JAK.41	Kampung Melayu - Pulo Gadung	Mikrotrans	659806	Tinggi
30	6	Ragunan - Halimun	BRT	3401821	Sedang	6N	Ragunan - Blok M via Kemang	Angkutan Umum Integrasi	230812	Sedang	JAK.45	Lebak Bulus - Ragunan	Mikrotrans	365142	Sedang
31	8	Lebak Bulus - Pasar Baru via Tomang	BRT	3918942	Sedang	S21	Ciputat - CSW	Transjabodetabek	504017	Tinggi	JAK.49	Lebak Bulus - Cipulir	Mikrotrans	366395	Sedang
32	3	Kalideres - Bundaran HI via Veteran	BRT	3662638	Sedang	3A	Rusun Pesakih - Kalideres	Rusun	36890	Sedang	JAK.50	Kalideres - Puri Kembangan	Mikrotrans	422808	Sedang
33	11	Pulo Gebang - Matraman	BRT	1231563	Rendah	11Q	Kampung Melayu - Pulo Gebang via BKT	Angkutan Umum Integrasi	79131	Sedang	JAK.86	Term. Rawamangun - Term. Manggarai	Mikrotrans	255364	Sedang
34	4	Pulo Gadung 2 - Dukuh Atas 2	BRT	2226088	Sedang	4B	Stasiun Manggarai - UI	Angkutan Umum Integrasi	476681	Tinggi	JAK.86	Term. Rawamangun - Term. Manggarai	Mikrotrans	255364	Sedang

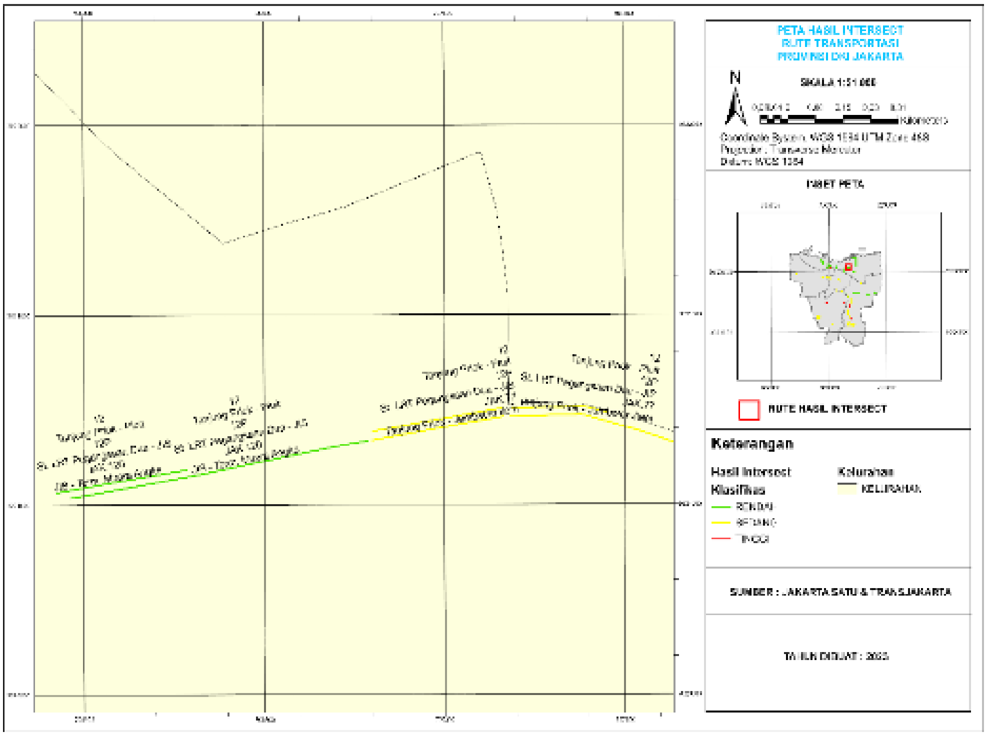

Figure 5. Map of Intersect Analysis Results Highlighting Routes with Low Passenger Volume, *Source: Jakarta Satu, Indonesia Geospatial Portal*

The figure 5 above highlights that based on spatial analysis using geometry calculations, one of the longest overlapping routes is Mikrotrans JAK 120. It overlaps with the Bus Rapid Transit (BRT) Corridor 12, which runs from Tanjung Priok to Pluit, and the Non-BRT Corridor 12P, which operates from Pegangsaan Dua LRT Station to JIS. The total length of this overlapping segment is 5.43 kilometers.

3.1.2. Desire Line Analysis Based on Primary OD Survey Data

This analysis, known as a desire line analysis, aims to represent straight lines that connect origin and destination points within a movement pattern. The flow of movement illustrated in this analysis has both direction and volume, representing the number of passengers or the amount of goods being transported. These flows move from origin zones to destination zones within a defined area and over a specific time (Tamin, 1997:130). From the resulting travel patterns, it is possible to identify areas with high, medium, or low movement intensity. However, one limitation of this method is that it does not clearly present exact numerical values of movement.

The creation of desire lines requires geographic coordinates for both origin and destination points, which can be obtained from Trans Jakarta user mobility survey data. This data is categorized based on kelurahan (urban village-level administrative units) and processed using Geographic Information System (GIS) analysis.

The results of this analysis display the travel patterns of survey respondents from their points of departure to their destinations. The OD flows are categorized into those occurring within Jakarta and those spanning across the Greater Jakarta (Jabodetabek) area, as illustrated in the following figure 6.

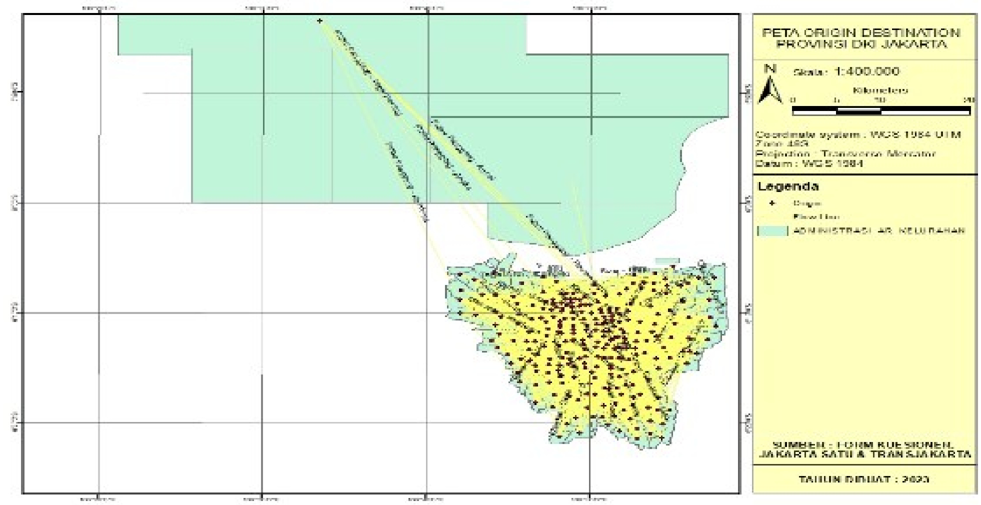

Figure 6. Map of Desire Line Analysis Results for OD Patterns within DKI Jakarta Province, *Source: Jakarta Satu, Indonesia Geospatial Portal*

The figure 6 above illustrates the public transportation needs of Jakarta residents, clearly showing a high concentration of Trans Jakarta user trips within the Jakarta area. Meanwhile, the figure 7 below highlights public transportation needs for residents of the Greater Jakarta region (Jabodetabek), also known as the Jakarta Metropolitan Area.

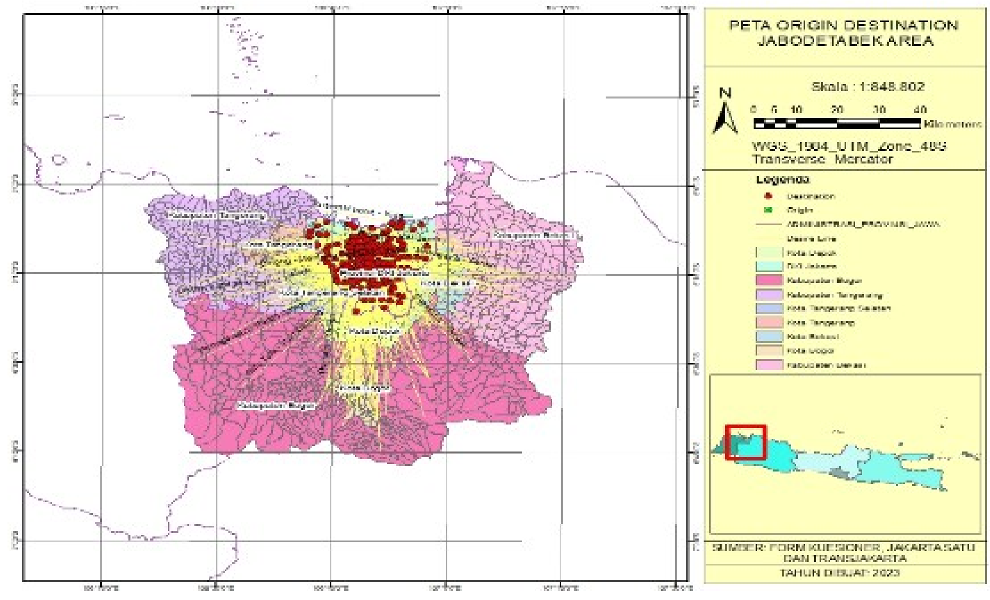

Figure 7. Map of Desire Line Analysis Results for OD Patterns in the Greater Jakarta Area (Jabodetabek),

Source: Jakarta Satu, Indonesia Geospatial Portal

Based on the results of the desire line analysis, it was found that certain high-population-density kelurahan (urban villages) lack Non-BRT and Mikrotrans routes. Additionally, overlapping of Trans Jakarta service modes and OD data from the Trans Jakarta user mobility survey were observed. The analysis focused on three sample delineation areas:

- Kelurahan Tambora: Jembatan Besi, Krendang, Kali Anyar, and Tanah Sereal
- Kecamatan Cipayung: including the kelurahan of Cipayung, Cilangkap, Pondok Ranggon, and Munjul

The following figure 8 and 9 below illustrates the lack of Trans Jakarta multimodal coverage in these areas:

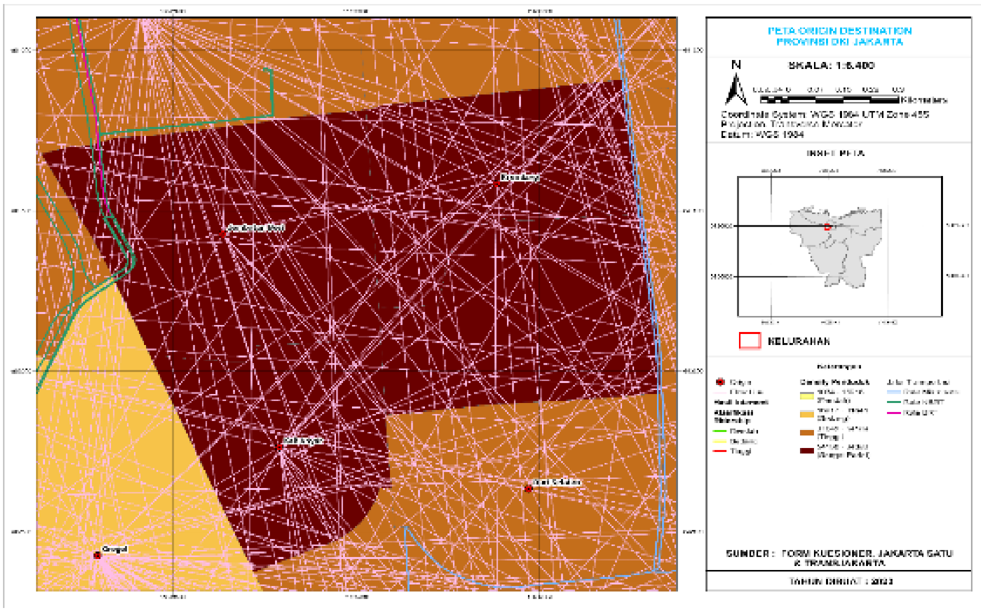

Figure 8. Map of Desire Line Analysis Results for OD Patterns in West Jakarta, Kelurahan Tambora

Source: Jakarta Satu, Indonesia Geospatial Portal

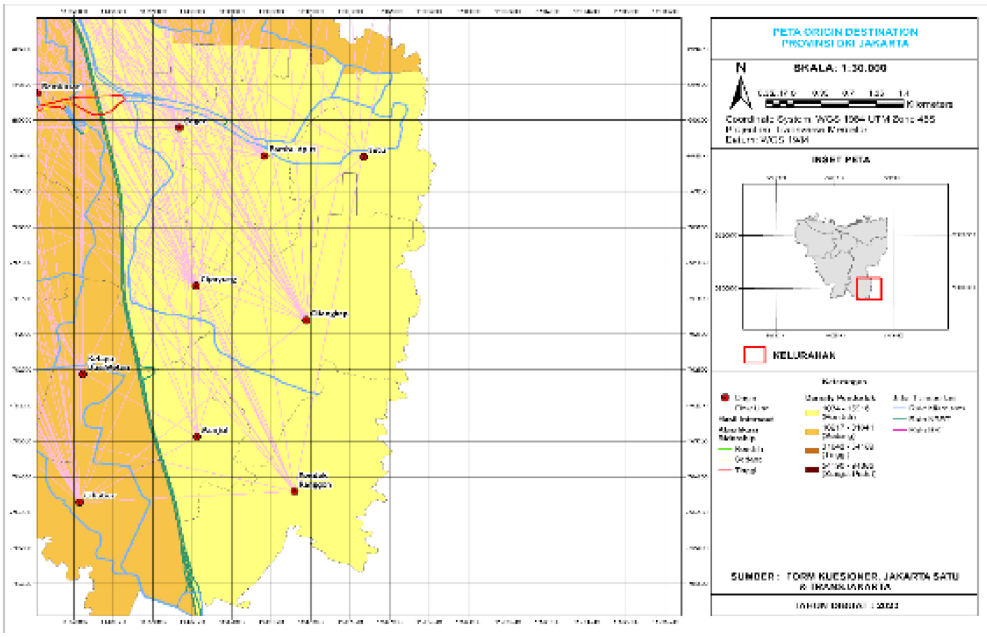

Figure 9. Map of Desire Line Analysis Results for OD Patterns in East Jakarta, Kecamatan Cipayung

Source: Jakarta Satu, Indonesia Geospatial Portal

Considering that the three sample delineation areas above have both high and low population densities, a significant number of Trans Jakarta user OD pairs, and are situated within the boundaries of **Kecamatan** and **Kelurahan**, as well as falling within the local and collector road network, there is a need for Trans Jakarta multimodal routes to pass through these areas.

IV. Conclusions and Recommendation

4.1. Conclusion

This study aimed to optimize the multimodal routes of TransJakarta services comprising BRT, Non-BRT, and Mikrotrans by identifying spatial inefficiencies, particularly overlapping routes and underserved areas, through GIS-based spatial and network analyses. Drawing on both primary and secondary data, including OD survey responses and population density by *kelurahan*, the research revealed critical insights into Jakarta's urban transport dynamics.

The Intersect Geoprocessing Analysis identified 34 overlapping routes, with three Mikrotrans routes JAK 120, 13, and JAK 22 exhibiting low passenger volumes despite running parallel to BRT and Non-BRT corridors with moderate to high ridership. These overlaps highlight inefficiencies in route planning, resulting in redundant services, increased operational costs, and contributing to traffic congestion, particularly during peak hours. The Desire Line Analysis further illustrated that high-demand origin–destination flows are concentrated within central Jakarta, yet several high-population-density areas remain underserved by existing Non-BRT and Mikrotrans routes. Case studies in Tambora, Cipayung, and other suburban neighborhoods revealed a clear mismatch between commuter needs and current route alignments.

These findings demonstrate that Jakarta's public transportation network lacks a data driven spatial approach in route planning one that effectively integrates passenger mobility patterns, population density, and GIS-based modeling. The absence of OD based planning and fragmented coordination among service providers has led to both overserved corridors and accessibility gaps, undermining system efficiency and public service equity. Ultimately, optimizing TransJakarta's route network through spatial analysis not only enhances service effectiveness and reduces operational costs but also supports more equitable access to public transportation, contributing to Jakarta's broader goals of sustainable urban mobility.

Nevertheless, several limitations of this study must be acknowledged. The OD data were aggregated at the *kelurahan* level, restricting the analysis of finer-scale mobility patterns and potentially overlooking intra *kelurahan* travel behavior. Moreover, the survey data required refinement due to identical or incomplete responses, which may have introduced simplifications. Temporally, the study was constrained to data from January to May 2023, limiting its ability to capture seasonal, weekly, or peak-hour variations. The lack of real time operational data, such as GPS tracking or smart card usage, also limited the modeling of service reliability. Furthermore, the study focused exclusively on land-based public transport modes managed by TransJakarta, excluding commuter rail (KRL), MRT, LRT, and informal modes like *ojek* and ride-hailing services. While some regional travel patterns from Bodetabek were considered, the analysis was primarily confined to DKI Jakarta, reducing its applicability to the wider metropolitan scale. Finally, although the research highlights the need for improved institutional coordination, it does not examine the political or regulatory barriers that may impact the implementation of spatial optimization strategies. Addressing these limitations in future studies will be essential for advancing a more integrated, real-time, and metropolitan-wide approach to public transport planning in Jakarta and similar urban environments.

4.2. Recommendation

Based on the findings, this study recommends that TransJakarta adopt a more data driven and spatially informed approach to route planning. The integration of Geographic Information Systems (GIS) should be institutionalized as a core analytical tool to identify overlapping routes, underserved areas, and inefficiencies within the multimodal network. Redundant services, particularly low ridership Mikrotrans routes that overlap with existing BRT and Non-BRT lines should be critically evaluated for potential consolidation, rerouting, or termination to enhance operational efficiency and reduce urban congestion. Simultaneously, future service expansion should prioritize high demand yet underserved areas, such as parts of Tambora and Cipayung, to promote more equitable access to public transport.

Strengthening multimodal integration among BRT, Non-BRT, and Mikrotrans services is also essential to ensure these modes function as complementary components of a unified network, rather than as fragmented or competing services. To support this, regular OD surveys, passenger mobility behavior studies, and demand forecasting must be conducted and incorporated into TransJakarta's annual planning cycles. Improved coordination among planning agencies, transport operators, and policy stakeholders is also critical to address the institutional fragmentation that currently limits Jakarta's public transport optimization. This policy recommendation will be outlined in a Governor's Decree, which will regulate the standards for determining TransJakarta route requirements and the minimum service standards for integrated multimodal TransJakarta transportation services.

For future research, further studies should incorporate temporal and real-time data such as peak hour congestion levels, service frequency, and travel time variability to more accurately model urban mobility patterns and system performance. The use of mobile phone data, GPS tracking, and smart card transaction records could significantly enrich OD analysis and reveal more dynamic insights into passenger flow and system demand. Additionally, transport modeling tools should be used to simulate and evaluate the impact of proposed route restructuring on ridership, efficiency, and environmental outcomes. Expanding the spatial scope of future studies to include the broader Jabodetabek region will also be important for developing an integrated metropolitan transport strategy that addresses both intra city and intercity commuting needs.

By combining these practical measures with deeper academic inquiry, Jakarta can advance toward a more efficient, equitable, and sustainable public transportation system that better serves its growing urban population.

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