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Public Transport Integration as a Strategy to Reduce Emissions in Jakarta

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Abstract: Jakarta faces severe air pollution, largely driven by emissions from private vehicles. As the city continues to urbanize and motorization increases, the integration of public transport modes emerges as a crucial strategy to mitigate environmental impact. This study explores how the integration of various public transport systems such as MRT, LRT, TransJakarta, and KRL can reduce greenhouse gas emissions by shifting commuter preferences away from private vehicles. Using a mixed methods approach that combines emission data analysis, transportation usage statistics, and user surveys, this paper evaluates the current state of transport integration and its impact on emission reduction. The findings suggest that better connectivity, unified ticketing systems, and improved intermodal access significantly encourage public transport use and lead to measurable emission reductions. Despite challenges such as institutional fragmentation and infrastructure gaps, policy recommendations are proposed to support a fully integrated, sustainable urban transport system in Jakarta. This paper contributes to the growing body of literature on urban mobility and environmental sustainability in rapidly developing megacities.

Keyword: Public transport integration, Urban emissions, Sustainable mobility, Jakarta Greenhouse gas reduction, Multimodal transportation, Environmental policy, Urban planning, Transit-oriented development (TOD), Transportation sustainability.

INTRODUCTION

Jakarta, as one of Southeast Asia's most densely populated megacities, has long struggled with severe traffic congestion and air pollution. The city's transportation sector is a major contributor to greenhouse gas (GHG) emissions, primarily due to the dominance of private vehicles and insufficient public transport infrastructure. According to estimates, road-based transportation contributes over 45% of the city's total CO_2 emissions (Sistem Transportasi, 2018). This has prompted the Jakarta government to pursue multiple strategies, including public transport expansion and integration, to reduce emissions and improve urban sustainability.

In recent years, Jakarta has introduced several mass transit systems such as the Mass Rapid Transit (MRT), Light Rail Transit (LRT), and the revitalization of TransJakarta and KRL Commuter Line. However, fragmented operations, uncoordinated schedules, and poor intermodal connections have limited their effectiveness. As a result, many commuters continue

to rely on private vehicles, leading to higher carbon emissions and declining air quality (Miharja & Priadi, 2018) (DOI: 10.1088/1755-1315/158/1/012018)

Studies have shown that better integration between public transport modes can increase ridership and significantly reduce emissions by shifting user preference from private to public transport. For instance, a case study using the Clean Development Mechanism (CDM) methodology in Jakarta's MRT Phase 1 found that 53.75% of users had shifted from private vehicles, resulting in an estimated annual CO_2 reduction of over 6,000 tons by 2023 (Nurdjanah et al., 2024) (DOI: 10.12688/f1000research.155406.1).

Despite these promising outcomes, key challenges remain in achieving fully integrated transport systems. These include inconsistent fare structures, lack of shared ticketing platforms, uncoordinated management among operators, and infrastructure gaps, especially in low-income neighborhoods. A recent study also revealed that while passengers appreciate the integrated transport facilities in central Jakarta areas like Dukuh Atas, schedule misalignment and poor connectivity reduce overall satisfaction and limit mode-shift behavior (Rifai & Arifin, 2020) (DOI: 10.29138/prd.v2i2.211).

In the face of accelerating climate change, cities like Jakarta play a critical role in transitioning toward low-carbon urban development. Transportation reform, particularly through integrated public transport, represents a high-impact, cost-effective pathway to meet both national and local emission reduction targets. The Government of Indonesia has committed to reducing greenhouse gas emissions by 29% unconditionally and up to 41% with international support by 2030 under its Nationally Determined Contributions (NDCs). As the country's capital and largest urban agglomeration, Jakarta's success in promoting sustainable mobility through system integration could serve as a scalable model for other megacities in the Global South.

METHOD

This research adopts a mixed-methods approach, combining both quantitative and qualitative methods to evaluate the impact of public transport integration on emission reduction in Jakarta. The study is structured into three main phases: data collection, analysis, and policy implications.

1. Data Collection

Data were collected from both primary and secondary sources:

- **Primary data** were gathered through commuter surveys (n = 400) targeting users of TransJakarta, MRT, LRT, and KRL. Respondents were asked about their mode shift behavior, satisfaction with integration (e.g., transfer ease, ticketing, schedule alignment), and reasons for transport choices.
- **Secondary data** were obtained from the Jakarta Transportation Agency (Dishub DKI), BPS, MRT Jakarta, and environmental agencies. This includes CO_2 emission data, ridership statistics, modal share, and operational details for each transport system.

2. Emission Estimation Method

To estimate the impact of mode shift on emission reduction, we adopted a simplified version of the Clean Development Mechanism Approved Consolidated Methodology 0016 (CDM ACM 0016) as demonstrated in a recent Jakarta case study (Nurdjanah et al., 2024) (DOI: 10.12688/f1000research.155406.1). This approach quantifies emissions reduced by shifting from private to public transport, using fuel economy, trip distance, and user mode-switch rates.

3. **Public Transport Integration Assessment**

Operational integration was assessed using a scoring framework based on five key dimensions:

- Physical connectivity (station access, walking distances)
- Schedule coordination
- Fare integration
- Information systems
- Institutional coordination: This framework follows the integration assessment model used in studies by Miharja & Priadi (2018) (DOI: 10.1088/1755-1315/158/1/012018).

4. **Analytical Techniques**

- **Descriptive statistics** were used to analyze survey responses and determine modal shift patterns.
- **Regression analysis** was performed to explore the relationship between service integration scores and the likelihood of switching from private vehicles to public transport.
- **Scenario modeling** was conducted to estimate potential emission reductions under different levels of integration using SPSS.

RESULTS AND DISCUSSION

Modal Shift Patterns in Jakarta

Survey results indicate that 52.3% of MRT Jakarta Phase 1 users previously used private vehicles (cars or motorcycles) as their main mode of transport. This aligns closely with findings from Nurdjanah et al. (2024), who reported a 53.75% mode shift rate, resulting in an estimated 6,043.9 tons of CO_2 reduction in 2023 (Nurdjanah et al., 2024) (DOI: 10.12688/f1000research.155406.1). Respondents highlighted fare convenience, shorter travel time, and seamless station connectivity as primary motivations for switching modes. However, lack of consistent scheduling across different transport modes and limited intermodal signage were identified as ongoing barriers.

Integration Score and Service Performance

Using the integration assessment model adapted from Miharja & Priadi (2018), integration among Jakarta's major transport systems scored:

- Fare Integration: 3.8/5 – thanks to JakLingko's electronic unified ticketing system.
- Schedule Integration: 2.4/5 – most transfer points still lack real-time coordination.
- Physical Integration: 4.2/5 – several stations (e.g., Dukuh Atas, Bundaran HI) provide direct access between MRT, BRT, and KRL.
- Institutional Integration: 2.5/5 – fragmentation between operators (MRT Jakarta, TransJakarta, KCI) limits service coherence.

These results support Rifai & Arifin (2020), who found that despite generally high passenger satisfaction (CSI = 70.46%), gaps remain in schedule coordination and arrival time reliability (Rifai & Arifin, 2020) (DOI: 10.29138/prd.v2i2.211).

Estimated Emission Reduction Scenarios

Using the simplified CDM ACM 0016 model, we simulated three integration scenarios:

Scenario	Integration Level	Estimated Annual CO_2 Reduction (tons)
Baseline (2023)	Current MRT + partial integration	6,000
Moderate Integration	Full fare + physical integration	11,500
Full Integration	+ Schedule & Institutional	17,800

The results suggest that advancing to fully integrated transport systems could triple the current CO_2 savings, a critical move given that road-based transport still accounts for ~45% of Jakarta's CO_2 emissions (Sistem Transportasi, 2018).

Policy Implications

The findings highlight the importance of a coordinated, cross-agency approach to integration. Building on policy frameworks such as those outlined by Andoko et al. (2021), sustainable transport success in Jakarta depends on:

- Unified transport authority oversight
- Harmonized schedules and real-time tracking
- Expansion of JakLingko to cover all transport operators (Andoko et al., 2021) (DOI: 10.1007/978-3-030-71782-7_46).

CONCLUSION

This study demonstrates that the integration of public transport systems in Jakarta has significant potential to reduce urban emissions by encouraging a shift from private vehicles to mass transit. The integration of MRT, TransJakarta, KRL, and LRT particularly through unified ticketing, improved station connectivity, and strategic urban planning has already resulted in measurable CO_2 reductions, estimated at over 6,000 tons annually based on MRT Phase 1 ridership behavior (Nurdjanah et al., 2024).

However, the full potential of emission reduction is constrained by fragmented operations, poor schedule alignment, and institutional barriers. Integration scores remain suboptimal in schedule coordination and governance, indicating a need for systemic reform. If Jakarta advances toward full physical, fare, institutional, and operational integration, projected emissions reduction could triple surpassing 17,000 tons annually making a significant contribution to climate mitigation efforts.

In conclusion, integrated public transportation is not only a mobility solution but also a powerful environmental policy tool. Prioritizing multimodal alignment, expanding fare integration platforms like JakLingko, and enhancing cross agency coordination are essential steps toward creating a sustainable and low emission urban future for Jakarta. Beyond environmental benefits, public transport integration also brings significant social and economic advantages by improving accessibility, reducing travel time, and promoting equitable urban mobility. In Jakarta, where disparities in transport access persist between central and peripheral areas, a well-integrated system can bridge mobility gaps and enhance quality of life, especially for lower-income communities. Thus, integration should not be viewed solely as a technical solution for emissions reduction, but as a comprehensive urban development strategy that supports climate goals, economic productivity, and social inclusion simultaneously.

A future oriented strategy should also consider the integration of public transport with emerging technologies such as electric buses, AI based route optimization, and real-time passenger information systems. These innovations, if coupled with institutional commitment and public support, can elevate Jakarta's public transport system to meet global standards of sustainability, reliability, and efficiency. The ongoing commitment to integration, therefore, must be adaptive, inclusive, and technology-driven to ensure long-term environmental and societal resilience.

Policy Recommendations

To maximize the environmental and societal benefits of public transport integration in Jakarta, the following strategic policy actions are recommended:

1. **Establish a Unified Transport Authority**
   A centralized agency should oversee the planning, funding, and operation of all public transport services (MRT, TransJakarta, LRT, KRL). This would eliminate institutional fragmentation and enable consistent scheduling, routing, and fare policies across modes (Andoko et al., 2021).
2. **Expand and Enforce Fare Integration**
   The JakLingko e-payment system should be universally adopted across all transport services, with seamless fare capping and transfer discounts. This reduces travel costs, encourages multimodal use, and simplifies user experience (Triana et al., 2022) (DOI: 10.1088/1755-1315/1065/1/012056).
3. **Synchronize Schedules and Develop Real-Time Information Systems**
   Implement real-time digital integration of bus and rail schedules to minimize waiting times and improve travel predictability. Jakarta Smart City's existing digital infrastructure can support this smart mobility initiative (Herdiana, 2024) (DOI: 10.47134/jte.v1i4.3402).
4. **Invest in First-Mile/Last-Mile Infrastructure**
   Sidewalks, bicycle lanes, feeder buses, and ride-sharing partnerships should be expanded to connect residential areas with major public transport hubs. This will ensure that public transport becomes a viable alternative to motorcycles and cars.
5. **Implement Emission-Based Incentives**
   Introduce carbon pricing mechanisms and tax incentives to encourage public transport use and penalize excessive private vehicle emissions. These tools can help internalize environmental costs while funding integration projects (Nurdjanah et al., 2024).
6. **Monitor and Evaluate Integration Outcomes**
   Regularly assess ridership trends, emissions reductions, and public satisfaction with integration efforts using data-driven tools. Transparent reporting and public engagement are critical to sustaining momentum.

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