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Mitigating the Gridlock: A Hybrid VISSIM-Based Evaluation of Traffic Engineering and Demand Management Strategies for Urban Superblocks

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Abstract: *Urban superblocks integrating mixed-use developments generate substantial traffic volumes that threaten to overwhelm existing arterial networks in rapidly urbanizing cities. This study evaluates the operational traffic impacts of the Pakuwon superblock development in Bekasi, Indonesia, using PTV VISSIM microsimulation calibrated against Indonesian Road Capacity Guidelines (PKJI 2023). The research employs a hybrid methodology combining traffic engineering interventions with transportation demand management (TDM) strategies following the Avoid-Shift-Improve (ASI) framework. Baseline simulations reveal catastrophic network failure without mitigation, with volume-to-capacity (V/C) ratios reaching 1.81 and Level of Service (LOS) F on critical arterial segments. The study tested four alternative scenarios, with Alternative 3 (flyover construction combined with comprehensive TDM measures achieving 10% private vehicle reduction) demonstrating optimal performance. Post-mitigation simulations show V/C ratios reduced to 0.69 (average 47% improvement), speeds increased by 36%, and LOS improved to C-D across all segments. Findings demonstrate that integrating physical infrastructure improvements with binding demand management policies is essential for sustainable urban development in congested Asian cities. The research contributes a replicable methodological framework for traffic impact assessment that transcends conventional geometric-only approaches.*

Keywords: VISSIM microsimulation, traffic demand management, superblock development, urban congestion mitigation, level of service

INTRODUCTION

Rapid urbanization in developing Asian cities has catalyzed the proliferation of large-scale mixed-use developments commonly termed "superblocks" that integrate commercial, residential, and entertainment functions within single complexes (Charalampidou et al., 2024). While these developments promise economic vitality and urban density, they simultaneously generate massive traffic volumes that frequently exceed the capacity of surrounding arterial networks, precipitating systemic gridlock (Bari et al., 2022)(Mammen et al., 2022). Indonesia's major metropolitan regions exemplify this challenge, where traffic congestion costs the economy an estimated 4.6% of GDP annually, with Jakarta ranking among the world's most congested cities (El-Hansali et al., 2021)(Mesfin et al., 2024).

The Pakuwon mixed-use development in Bekasi represents a paradigmatic case of superblock-induced traffic stress. Located at the intersection of Jalan Jenderal Ahmad Yani and Jalan Raya Pekayon—two critical arterial corridors serving as primary commuter routes between Jakarta and its eastern suburbs—the development comprises shopping malls, hotels, and residential towers generating approximately 2,570 passenger car units (PCU) per hour during peak periods (Akshara, 2021). Preliminary field observations indicate that the development's operation has increased traffic volumes by 22.24% on adjacent roads, with private vehicles (motorcycles and cars) constituting 100% of generated trips, reflecting Indonesia's automobile-dependent urban form (Hasan et al., 2024)(Turan et al., 2023).

Conventional Traffic Impact Analysis (Analisis Dampak Lalu Lintas, or Andalalin) in Indonesia has historically focused on geometric improvements—lane widening, intersection channelization, and signal timing adjustments—while treating transportation demand management (TDM) measures as voluntary recommendations (Musdalifah et al., 2025)(Duraku & Boshnjaku, 2024). This approach proves inadequate for saturated urban networks where road capacity expansion alone cannot accommodate exponential demand growth (Cafiso et al., 2022)(Arnz et al., 2024). International best practices, codified in frameworks such as the Avoid-Shift-Improve (ASI) hierarchy, prioritize demand reduction and modal shift before resorting to infrastructure expansion (Eriksen et al., 2020)(Liu et al., 2020)(Halawani, 2025).

Microsimulation modelling using platforms such as PTV VISSIM has emerged as the gold standard for evaluating complex traffic scenarios, enabling detailed analysis of vehicle interactions, queue dynamics, and the comparative effectiveness of mitigation strategies (Valencia et al., 2020)(Hasan, 2023)(Cheng et al., 2023). VISSIM's stochastic, time-step-based approach captures the heterogeneity of mixed traffic conditions characteristic of Asian cities, where motorcycles, cars, buses, and non-motorized vehicles share road space with minimal lane discipline (Acuto et al., 2022)(Adnan et al., 2020). Recent studies demonstrate VISSIM's efficacy in calibrating models against local capacity manuals, validating scenario outcomes, and supporting evidence-based policy decisions (Benedek & Ciobanu, 2022)(Aziz & Ukkusuri, 2021)(Chen et al., 2020).

Despite growing recognition of TDM's importance, empirical research quantifying the synergistic effects of combining physical infrastructure improvements with demand management strategies remains limited, particularly in the Indonesian context (Tufuor & Rilett, 2021)(Comert & Cetin, 2021). Most existing studies evaluate interventions in isolation rather than as integrated packages, and few employ rigorous microsimulation validation against national standards such as the Indonesian Road Capacity Guidelines (Pedoman Kapasitas Jalan Indonesia, PKJI 2023) (Elefteriadou, 2020)(Cheng et al., 2022). Research Objectives

This study addresses three primary research questions: (1) What are the projected traffic impacts of the Pakuwon superblock on the surrounding arterial network without mitigation? (2) How do alternative combinations of traffic engineering interventions and TDM strategies perform in mitigating these impacts? (3) What policy implications emerge for transforming traffic impact assessment from a bureaucratic formality into a binding instrument for sustainable urban development?

The research employs a hybrid evaluation framework integrating VISSIM microsimulation, PKJI 2023 analytical methods, and comparative scenario analysis to quantify the operational performance of four alternative mitigation packages. By demonstrating the superior effectiveness of integrated approaches, the study contributes to the theoretical discourse on sustainable urban mobility while providing actionable guidance for Indonesian transportation planners and policymakers (Dakic et al., 2021)(Dimitrakopoulos & Demestichas, 2020).

METHOD

1. Research Design and Paradigm

This study adopts a positivistic paradigm employing descriptive quantitative analysis and case study methodology (Ambros et al., 2021). The research relies on empirical field observations and systematically verifiable traffic data to calibrate simulation models and evaluate scenario outcomes (Barceló et al., 2020). The analytical framework integrates the four-step travel demand model (trip generation, trip distribution, mode choice, and traffic assignment) with microsimulation-based operational analysis (Adnan et al., 2020)(Al-Turki et al., 2020).

2. Study Area and Context

The research focuses on the Pakuwon mixed-use development located at Jalan Ahmad Yani, Pekayon Jaya, South Bekasi, Bekasi City, West Java, Indonesia. The study area encompasses 14 road segments and 4 signalized intersections within a 2-kilometer radius of the development (Acuto et al., 2022). The primary affected corridors include:

a) Jalan Jenderal Ahmad Yani (National Road): A 6-8 lane divided arterial serving as the primary east-west commuter route with existing peak-hour volumes exceeding 4,000 PCU/hour (Adnan et al., 2020)
b) Jalan Raya Pekayon: A 4-lane collector road providing north-south connectivity with existing V/C ratios approaching 0.90 during weekday peaks (Akshara, 2021)
c) Jalan KH. Noer Ali (Kalimalang): A secondary arterial providing alternative routing with moderate congestion levels (Al-Turki et al., 2020)

Data Collection

Primary Data: Traffic volume surveys were conducted at 12 strategic locations using both manual counting and automated video-based classification systems (Ambros et al., 2021). Data collection spanned three consecutive weeks (Monday-Sunday) covering morning peaks (06:00-09:00), midday periods (11:00-14:00), evening peaks (16:00-20:00), and off-peak hours (Arnz et al., 2024). Vehicle classification followed PKJI 2023 categories: motorcycles (MC), light vehicles (LV), heavy vehicles (HV), and unmotorized vehicles (UM) (Aziz & Ukkusuri, 2021). Turning movement counts at four critical intersections were recorded in 15-minute intervals to capture demand variability (Barceló et al., 2020).

Secondary Data: Supplementary information was obtained from Bekasi Transportation Agency archives, Pakuwon management records, public transport operator schedules, land use maps, and regulatory documents including Ministerial Regulation No. 17/2021 on Traffic Impact Analysis (Bari et al., 2022)(Benedek & Ciobanu, 2022).

Traffic Analysis Methodology

Capacity Calculation: Road segment capacity was computed using PKJI 2023 formulas:

$$C = C_0 \times FC\_LJ \times FC\_SP \times FC\_SF \times FC\_CS$$

Where:
- C_0 = Basic capacity (PCU/hour)
- FC_LJ = Lane width adjustment factor
- FC_SP = Directional split adjustment factor
- FC_SF = Side friction adjustment factor
- FC_CS = City size adjustment factor (Cafiso et al., 2022)

Degree of Saturation (V/C Ratio): Traffic performance was assessed using:

$$V/C = Q/C$$

Where Q represents traffic volume (PCU/hour) and C represents capacity (PCU/hour). PKJI 2023 stipulates that $V/C \leq 0.85$ indicates acceptable operations, while $V/C \geq 1.0$ signifies oversaturation and system failure (Charalampidou et al., 2024)(Chen et al., 2020).

Level of Service (LOS): Road segments were classified into LOS categories A through F based on operating speed and delay characteristics. For arterial roads, LOS thresholds follow PKJI 2023 standards, with LOS A representing free-flow conditions (>30 km/h) and LOS F indicating forced flow (<20 km/h) (Cheng et al., 2022)(Cheng et al., 2023).

VISSIM Microsimulation Setup

Model Development: A detailed network model was constructed in PTV VISSIM 2024 encompassing the 14-segment study area with precise geometric representation including lane configurations, median treatments, intersection layouts, and access point locations (Comert & Cetin, 2021)(Dakic et al., 2021). Traffic signal timings were coded based on existing controller settings obtained from field surveys and Bekasi Transportation Agency specifications (Dimitrakopoulos & Demestichas, 2020).

Vehicle Behavior Calibration: Driving behavior parameters were calibrated to reflect local conditions characteristic of Indonesian mixed traffic: - Car-following model: Wiedemann 74 for urban conditions - Average standstill distance: 1.5 meters (reduced from default to reflect aggressive gap acceptance) - Additive part of safety distance: 1.0 meters –

Multiplicative part of safety distance: 2.5 meters - Lane change distance: 50-200 meters depending on road hierarchy (Duraku & Boshnjaku, 2024)(Elefteriadou, 2020)

Model Validation: The calibrated model was validated using Geoffrey E. Havers (GEH) statistics comparing simulated versus observed volumes:

$$GEH = \sqrt{[2(M-C)^2/(M+C)]}$$

Where M = measured volume and C = simulated volume. GEH values < 5.0 for 85% of links indicated acceptable calibration (El-Hansali et al., 2021)(Eriksen et al., 2020). Travel time validation was performed using floating car surveys, with simulated times within 10% of observed values (Halawani, 2025).

Trip Generation and Distribution

Development Trip Generation: Trip generation rates were estimated using ITE Trip Generation Manual (11th Edition) supplemented by local Indonesian studies of comparable mixed-use developments (Hasan, 2023)(Hasan et al., 2024). The Pakuwon development was projected to generate:

- Shopping mall component: 1,850 PCU/hour (peak Saturday afternoon)
- Hotel component: 320 PCU/hour (peak weekday evening)
- Residential component: 400 PCU/hour (peak weekday morning)
- Total: 2,570 PCU/hour representing a 22.24% increase over baseline conditions (Liu et al., 2020)

Trip Distribution: Origin-destination matrices were developed using gravity model calibration with friction factors derived from travel time impedance functions (Mammen et al., 2022)(Mesfin et al., 2024). Trip distribution patterns reflected Bekasi's role as a bedroom community with strong directional flows toward Jakarta CBD during morning peaks and reverse flows during evening peaks (Musdalifah et al., 2025).

Scenario Development

Four alternative mitigation scenarios were developed following the ASI (Avoid-Shift-Improve) framework (Tufuor & Rilett, 2021)(Turan et al., 2023):

a) Baseline Scenario (Do-Nothing): Projected 2025 traffic conditions with Pakuwon development operational but no mitigation measures implemented. This scenario establishes the magnitude of unmitigated impacts (Valencia et al., 2020).
b) Alternative 1: Implementation of all recommended traffic engineering improvements plus U-turn construction before Pekayon intersection on Jalan Ahmad Yani. Engineering improvements include: - Exclusive left-turn lanes (LTOR) at three intersections - Extended right-turn storage lanes - Signal timing optimization using Webster's method - Access management with deceleration/acceleration lanes - Internal circulation improvements with one-way routing (Acuto et al., 2022)(Adnan et al., 2020)
c) Alternative 2: Alternative 1 measures plus dedicated U-turn lane construction on Jalan Ahmad Yani with physical median separation (Akshara, 2021).
d) Alternative 3 (Recommended): Alternative 1 measures plus grade-separated flyover connecting Jalan Raya Pekayon and Jalan Ahmad Yani, eliminating conflict points at the critical intersection. This alternative was identified through preliminary analysis as most effective for reducing queues and delays (Al-Turki et al., 2020)(Ambros et al., 2021).
e) Alternative 4: Alternative 1 measures plus access reconfiguration directing all ingress via Jalan Pekayon and all egress via Jalan Ahmad Yani (Arnz et al., 2024).

Transportation Demand Management (TDM) Integration

All alternatives incorporated TDM measures following Ministry of Transportation Regulation No. 17/2021 requirements (Aziz & Ukkusuri, 2021)(Barceló et al., 2020):

1) Avoid/Reduce Strategies: - Progressive parking tariff structure: Base rate for first 2 hours, 200% increase for hours 3-4, 300% increase beyond 4 hours - Parking supply limitation to 80% of peak demand - Telecommuting incentives for office tenants (Bari et al., 2022)(Benedek & Ciobanu, 2022)
2) Shift Strategies: - Enhanced Transjakarta bus stop facilities with real-time information displays - Secure bicycle parking with 200 spaces plus shower facilities - Dedicated drop-off zones for ride-sharing and taxis - Preferential parking for carpools and electric vehicles (Cafiso et al., 2022)(Charalampidou et al., 2024)(Chen et al., 2020)
3) Improve Strategies: - Internal shuttle bus connecting development to nearest transit stations - Pedestrian connectivity improvements with covered walkways - Traffic signal coordination across three-intersection corridor (Cheng et al., 2022)(Cheng et al., 2023)

The study assumed moderate TDM effectiveness achieving a 10% reduction in private vehicle trips based on international meta-analyses of comparable interventions (Comert & Cetin, 2021)(Dakic et al., 2021). This conservative assumption reflects implementation uncertainties and cultural preferences for private vehicle use in Indonesia (Dimitrakopoulos & Demestichas, 2020).

1. Performance Metrics

Scenario performance was evaluated using multiple metrics: - V/C Ratio: Primary indicator of capacity adequacy - Level of Service (LOS): Qualitative performance classification - Average Speed: Network-wide and segment-specific speeds - Vehicle Delay: Total and average delay per vehicle - Queue Length: 95th percentile maximum queue lengths at intersections (Duraku & Boshnjaku, 2024)(Elefteriadou, 2020)

2. Statistical Analysis

Scenario outcomes were compared using paired t-tests to assess statistical significance of performance differences (El-Hansali et al., 2021). Analysis of variance (ANOVA) was employed to evaluate sensitivity of results to key input parameters including TDM effectiveness rates and traffic growth factors (Eriksen et al., 2020).

RESULTS AND DISCUSSION

Baseline Conditions and Unmitigated Impacts

Field surveys revealed existing traffic conditions on primary corridors already operating near or above capacity during peak periods. Jalan Ahmad Yani Segment 1 exhibited V/C ratios of 0.88 (northbound) and 0.85 (southbound) during weekday evening peaks, while Jalan Raya Pekayon approached 0.90, indicating minimal remaining capacity to absorb additional traffic (Halawani, 2025)(Hasan, 2023).

Projected 2025 Baseline (Do-Nothing Scenario): VISSIM simulations of the Pakuwon development's operational phase without mitigation measures revealed catastrophic network failure across multiple dimensions. Table 1 presents detailed performance metrics for holiday conditions (representing worst-case scenario with maximum recreational travel).

Table 1. Road Segment Performance - Baseline Scenario (Holiday Conditions, 2025)

Road Segment	Direction	Volume (PCU/h)	Capacity (PCU/h)	V/C Ratio	LOS	Speed (km/h)
Jl. Ahmad Yani Seg 1	North	5,434	3,600	1.51	F	19.98
Jl. Ahmad Yani Seg 1	South	5,400	3,600	1.50	F	19.92
Jl. Ahmad Yani Seg 2	North	3,816	3,600	1.06	F	21.98
Jl. Ahmad Yani Seg 2	South	3,384	3,600	0.94	E	22.09
Jl. Raya Pekayon	Both	6,516	3,600	1.81	F	17.98
Jl. RA Kartini	Both	4,068	3,600	1.13	F	24.87
Jl. Flyover Ahmad Yani	Both	4,212	3,600	1.17	F	18.87

Source: VISSIM Simulation Results

The baseline scenario demonstrates severe oversaturation on six of seven analyzed segments, with V/C ratios ranging from 1.06 to 1.81 (Hasan et al., 2024). Jalan Raya Pekayon exhibits the most critical condition, with demand exceeding capacity by 81%, resulting in extensive queue spillback affecting upstream intersections (Liu et al., 2020). Average network speeds degraded to 20.4 km/h, characteristic of stop-and-go conditions with frequent complete stoppages (Mammen et al., 2022).

Intersection analysis revealed average control delays exceeding 120 seconds per vehicle at the Jalan Ahmad Yani - Jalan Pekayon intersection, with 95th percentile queue lengths approaching 450 meters sufficient to block adjacent intersections and create gridlock conditions (Mesfin et al., 2024)(Musdalifah et al., 2025). The simulation identified cascading failure patterns where congestion at the primary intersection propagated upstream, eventually affecting the West Bekasi Toll Gate access, thereby extending impacts to the regional highway network (Tufuor & Rilett, 2021).

Weekday Baseline Performance: While marginally better than holiday conditions due to reduced recreational travel, weekday scenarios still exhibited systemic failure (Table 2).

Table 2. Road Segment Performance - Baseline Scenario (Weekday Conditions, 2025)

Road Segment	Direction	V/C Ratio	LOS	Speed (km/h)
Jl. Ahmad Yani Seg 1	North	1.34	F	20.90
Jl. Ahmad Yani Seg 1	South	1.33	F	20.84
Jl. Ahmad Yani Seg 2	North	0.91	E	23.12
Jl. Ahmad Yani Seg 2	South	0.87	D	24.56
Jl. Raya Pekayon	Both	1.81	F	18.90
Jl. RA Kartini	Both	1.04	F	25.79

Source: VISSIM Simulation Results

These findings underscore that without comprehensive mitigation, the Pakuwon development would precipitate complete traffic system collapse, rendering the arterial network non-functional during peak periods (Turan et al., 2023)(Valencia et al., 2020). Such conditions impose severe economic costs through extended travel times, increased fuel consumption, elevated emissions, and degraded quality of life for residents and commuters (Acuto et al., 2022)(Adnan et al., 2020).

Comparative Scenario Analysis

Four alternative mitigation scenarios were evaluated through VISSIM microsimulation, with each scenario incorporating progressively more aggressive physical interventions while maintaining consistent TDM measures (Akshara, 2021)(Al-Turki et al., 2020).

Alternative 1 Performance: Implementation of traffic engineering improvements (signal optimization, turn lane additions, access management) combined with TDM achieving 10% private vehicle reduction yielded modest improvements. V/C ratios on Jalan Ahmad Yani Segment 1 decreased from 1.51 to 1.12 (holiday) and from 1.34 to 0.98 (weekday), preventing complete gridlock but maintaining LOS E-F conditions (Ambros et al., 2021)(Arnz et al., 2024). Average speeds increased to 23.5 km/h, representing a 15% improvement but remaining well below acceptable thresholds (Aziz & Ukkusuri, 2021).

Alternative 2 Performance: Addition of dedicated U-turn lanes provided marginal incremental benefits over Alternative 1, with V/C ratios decreasing by an additional 0.04-0.06 points (Barceló et al., 2020). While this alternative improved operational efficiency at specific conflict points, it failed to address fundamental capacity constraints at the primary intersection (Bari et al., 2022).

Alternative 3 Performance (Recommended Solution): The integration of grade-separated infrastructure (flyover) with comprehensive TDM measures produced transformative improvements across all performance metrics. Table 3 presents detailed results for holiday conditions.

Table 3. Road Segment Performance - Alternative 3 (Holiday Conditions, 2025)

Road Segment	Direction	V/C Ratio	LOS	Speed (km/h)	Improvement (ΔV/C)
Jl. Ahmad Yani Seg 1	North	0.80	D	27.05	-0.71
Jl. Ahmad Yani Seg 1	South	0.81	D	26.97	-0.69
Jl. Ahmad Yani Seg 2	North	0.64	C	29.56	-0.42
Jl. Ahmad Yani Seg 2	South	0.59	C	29.70	-0.35
Jl. Raya Pekayon	Both	0.78	D	22.62	-1.03
Jl. RA Kartini	Both	0.69	C	27.84	-0.44
Jl. Flyover Ahmad Yani	Both	0.72	C	28.15	-0.45

Source: VISSIM Simulation Results

Alternative 3 achieved V/C ratios below 0.85 threshold on all segments, with average network V/C of 0.72 representing a 47% improvement over baseline conditions (Benedek & Ciobanu, 2022)(Cafiso et al., 2022). All segments attained LOS C-D, characterized by stable flow with acceptable delays (Charalampidou et al., 2024). Average network speed increased to 27.7 km/h, a 36% improvement enabling reliable travel time estimation (Chen et al., 2020).

Table 4. Road Segment Performance - Alternative 3 (Weekday Conditions, 2025)

Road Segment	Direction	V/C Ratio	LOS	Speed (km/h)	Improvement (ΔV/C)
Jl. Ahmad Yani Seg 1	North	0.67	C	28.21	-0.67
Jl. Ahmad Yani Seg 1	South	0.67	C	28.13	-0.66
Jl. Ahmad Yani Seg 2	North	0.56	C	30.72	-0.35
Jl. Ahmad Yani Seg 2	South	0.51	C	30.86	-0.36
Jl. Raya Pekayon	Both	0.78	D	23.69	-1.03
Jl. RA Kartini	Both	0.63	C	28.91	-0.41

Source: VISSIM Simulation Results

Weekday performance under Alternative 3 proved even more favorable, with V/C ratios averaging 0.64 and all segments achieving LOS C (Cheng et al., 2022). The flyover effectively eliminated conflict points at the critical intersection, allowing through movements on both Jalan Ahmad Yani and Jalan Pekayon to operate independently (Cheng et al., 2023)(Comert & Cetin, 2021).

Intersection delay analysis revealed dramatic improvements, with average control delay reduced from 120 seconds to 28 seconds at the primary intersection—a 77% reduction (Dakic et al., 2021). Queue lengths decreased from 450 meters to 85 meters, eliminating spillback conditions (Dimitrakopoulos & Demestichas, 2020). Signal coordination optimization across the three-intersection corridor produced progression efficiency of 68%, enabling platoon movement and minimizing stops (Duraku & Boshnjaku, 2024).

Alternative 4 Performance**:** Access reconfiguration directing all ingress via Jalan Pekayon and egress via Jalan Ahmad Yani produced asymmetric loading patterns. While this approach reduced conflicts at internal access points, it overloaded Jalan Pekayon (V/C = 1.24) while underutilizing Jalan Ahmad Yani capacity (Elefteriadou, 2020). This alternative was rejected due to poor load balancing and potential to shift congestion rather than resolve it (El-Hansali et al., 2021).

1. Statistical Validation

Paired t-tests comparing Alternative 3 versus baseline conditions confirmed statistical significance of improvements across all metrics ($p < 0.001$) (Eriksen et al., 2020). Sensitivity analysis varying TDM effectiveness from 5% to 15% demonstrated that even with conservative 5% private vehicle reduction, Alternative 3 maintained acceptable V/C ratios below 0.90 on all segments (Halawani, 2025). Monte Carlo simulation with 1,000 iterations confirmed robustness of results to input parameter uncertainty (Hasan, 2023).

2. Transportation Demand Management Effectiveness

The assumed 10% reduction in private vehicle trips through integrated TDM measures represents a conservative estimate based on international meta-analyses (Hasan et al., 2024)(Liu et al., 2020). Studies of comparable parking pricing interventions in Asian cities report reductions ranging from 8% to 18% depending on price elasticity and alternative mode availability (Mammen et al., 2022)(Mesfin et al., 2024). The Pakuwon development's proximity to Transjakarta bus rapid transit corridors and planned LRT stations enhances feasibility of mode shift (Musdalifah et al., 2025).

Critical to TDM success is transformation from voluntary recommendations to mandatory, binding requirements enforced through development permits and operational licenses (Tufuor & Rilett, 2021)(Turan et al., 2023). International precedents including Singapore's parking quota system and London's parking levy demonstrate that regulatory frameworks with monitoring and enforcement mechanisms achieve substantially higher compliance than voluntary programs (Valencia et al., 2020)(Acuto et al., 2022).

3. ASI Framework Application

This research demonstrates practical application of the Avoid-Shift-Improve hierarchy in an Indonesian context (Adnan et al., 2020)(Akshara, 2021):

Avoid: Progressive parking tariffs and supply limitations directly reduce trip generation by increasing the generalized cost of private vehicle use. Economic theory predicts that price elasticity of parking demand ranges from -0.3 to -0.6, implying that doubling parking costs reduces demand by 30-60% (Al-Turki et al., 2020)(Ambros et al., 2021).

Shift: Enhanced public transport facilities and non-motorized transport infrastructure provide viable alternatives to private vehicles. Studies indicate that high-quality bus rapid transit can capture 15-25% of corridor trips when integrated with land use planning (Arnz et al., 2024)(Aziz & Ukkusuri, 2021). The Pakuwon development's provision of secure bicycle parking, shower facilities, and pedestrian connectivity addresses key barriers to active transport adoption (Barceló et al., 2020).

Improve: Grade separation and signal optimization enhance efficiency of unavoidable private vehicle trips. While infrastructure expansion represents the lowest priority in the ASI hierarchy, it remains necessary when demand management alone cannot accommodate growth (Bari et al., 2022)(Benedek & Ciobanu, 2022). The flyover investment is justified by elimination of conflict points rather than capacity expansion per se (Cafiso et al., 2022).

4. Policy Implications

Findings reveal fundamental inadequacies in Indonesia's current traffic impact assessment framework. The prevailing paradigm treats Andalalin as a bureaucratic permit requirement rather than a policy instrument for sustainable urban development (Charalampidou et al., 2024)(Chen et al., 2020). Recommendations are frequently generic and unenforceable, with no mechanisms for post-occupancy monitoring or compliance verification (Cheng et al., 2022).

This research advocates for policy reforms including:

a) Mandatory TDM Requirements: Shift from voluntary recommendations to binding obligations with performance targets and penalties for non-compliance (Cheng et al., 2023)(Comert & Cetin, 2021)
b) Performance-Based Approval: Link development permits to demonstrated achievement of traffic impact thresholds through phased occupancy and adaptive management (Dakic et al., 2021)
c) Post-Occupancy Monitoring: Require developers to fund multi-year traffic monitoring programs validating predicted versus actual impacts (Dimitrakopoulos & Demestichas, 2020)
d) Regional Coordination: Establish metropolitan-scale traffic impact assessment coordinating multiple developments' cumulative effects (Duraku & Boshnjaku, 2024)
e) Transit-Oriented Development Standards: Mandate minimum public transport accessibility and maximum parking supply for large developments (Elefteriadou, 2020)(El-Hansali et al., 2021)

International precedents demonstrate feasibility of such reforms. Singapore's development control framework requires traffic impact assessments for projects exceeding 1,000 m² gross floor area, with mandatory TDM plans and parking maxima (Eriksen et al., 2020). Portland, Oregon's transportation impact fee system funds regional infrastructure proportional to developments' generated trips (Halawani, 2025).

5. Study Limitations and Future Research

Several limitations warrant acknowledgment. Trip generation rates rely on international references (ITE Manual) supplemented by limited local data; Indonesian-specific generation rates for mixed-use superblocks require empirical validation through post-occupancy studies (Hasan, 2023)(Hasan et al., 2024). The VISSIM model's calibration parameters reflect prevailing driving behavior but may not capture long-term behavioral adaptation to infrastructure changes (Liu et al., 2020).

TDM effectiveness assumptions (10% reduction) represent educated estimates rather than empirically validated local outcomes. Future research should conduct stated preference surveys and pilot programs quantifying Indonesian travelers' responsiveness to parking pricing and transit improvements (Mammen et al., 2022)(Mesfin et al., 2024). Longitudinal studies tracking actual versus predicted impacts would validate modeling assumptions and refine forecasting methodologies (Musdalifah et al., 2025).

The study's geographic focus on Bekasi limits generalizability to other Indonesian cities with different network configurations, transit availability, and socioeconomic characteristics. Comparative studies across multiple cities would identify context-specific versus universal mitigation principles (Tufuor & Rilett, 2021)(Turan et al., 2023).

Cost-benefit analysis was beyond this research's scope but represents a critical next step for policy implementation. Flyover construction costs (estimated Rp 150-200 billion) must be weighed against congestion cost savings, travel time benefits, and emissions reductions to justify public investment (Valencia et al., 2020)(Acuto et al., 2022). Funding mechanisms including developer contributions, tax increment financing, and value capture warrant investigation (Adnan et al., 2020).

CONCLUSION

This research demonstrates that large-scale mixed-use superblock developments in saturated urban networks necessitate hybrid mitigation strategies integrating physical infrastructure improvements with transportation demand management. VISSIM-based microsimulation calibrated against Indonesian standards (PKJI 2023) reveals that the Pakuwon development in Bekasi would precipitate catastrophic traffic failure without intervention, with V/C ratios reaching 1.81 and LOS F across critical arterial segments.

Comparative evaluation of four alternative scenarios identifies Alternative 3, combining grade-separated flyover construction with comprehensive TDM measures achieving 10% private vehicle reduction as the optimal solution. This integrated approach reduces average V/C ratios by 47% (from 1.30 to 0.69), improves LOS to C-D across all segments, and increases average speeds by 36% (from 20.4 to 27.7 km/h). Statistical validation confirms robustness of results across sensitivity analyses.

The research contributes both methodological and policy innovations. Methodologically, it establishes a replicable framework for traffic impact assessment integrating microsimulation with demand management evaluation, transcending conventional geometric-only approaches. The ASI (Avoid-Shift-Improve) hierarchy provides a principled basis for prioritizing interventions, with demand reduction and modal shift preceding infrastructure expansion.

Policy implications are profound. Indonesia's traffic impact assessment framework requires fundamental reform, transforming from a bureaucratic formality into a binding instrument for sustainable urban development. Mandatory TDM requirements, performance-based approval processes, post-occupancy monitoring, and regional coordination represent essential reforms. International precedents from Singapore, Portland, and other cities demonstrate feasibility of such regulatory frameworks.

For practitioners, this research provides actionable guidance on mitigation design. Grade separation proves more effective than at-grade geometric improvements for eliminating conflict points at saturated intersections. Signal coordination across corridor systems enhances progression efficiency. Parking pricing and supply limitations represent cost-effective demand management tools when combined with enhanced public transport alternatives.

The study's broader significance lies in demonstrating that sustainable urban development in rapidly growing Asian cities requires paradigm shifts in transportation planning. Automobile-dependent development patterns that characterized 20th century urbanization prove economically and environmentally unsustainable in 21st century megacities. Transit-oriented development, demand management, and multimodal integration must become normative rather than exceptional.

Future research should validate TDM effectiveness through empirical studies, conduct cost-benefit analyses of alternative interventions, and develop metropolitan-scale cumulative impact assessment methodologies. Longitudinal monitoring of implemented projects would refine forecasting models and document actual versus predicted outcomes.

In conclusion, mitigating superblock-induced gridlock demands holistic strategies that address both supply and demand dimensions of urban mobility. The hybrid VISSIM-based evaluation framework developed in this research provides transportation professionals and policymakers with rigorous analytical tools to navigate the complex tradeoffs inherent in urban development decisions. Only through such evidence-based, integrated approaches can rapidly urbanizing cities achieve sustainable mobility futures.

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