

Study of the Public Acceptance of Light Rail Transit as a Public Transportation Option for Residents and Its Implications for the Environment (Case Study: Greater Bandung, Indonesia)

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ABSTRACT

Rapid urbanization and growing private vehicle dependence in the Greater Bandung Metropolitan Area have intensified traffic congestion, greenhouse gas emissions, and environmental degradation, prompting the proposal of a Light Rail Transit (LRT) system as a sustainable urban mobility solution. This study examines public acceptance, behavioral intention, willingness to pay (WTP), comparative travel performance, and potential environmental impacts of the proposed LRT. A quantitative approach was employed using stated preference surveys from 200 respondents, analyzed through Multinomial Logit (MNL) modeling and Structural Equation Modeling (SEM). The MNL results indicate that travel time ($\beta = -0.039$, $p < 0.01$) and travel cost ($\beta = -0.000034$, $p < 0.01$) are the most influential determinants of mode choice, while electric-based operation increases the probability of choosing LRT by approximately 13%. Environmental attributes, including lower emissions per passenger ($\beta = -0.0075$, $p < 0.05$) and reduced noise levels ($\beta = 0.0024$, $p < 0.05$), significantly enhance LRT attractiveness. SEM findings show that performance expectancy, perceived safety, and social influence significantly affect behavioral intention, explaining 63% of its variance. The WTP analysis reveals that 58% of respondents are willing to pay IDR 5,000–7,000, while 27% are willing to pay IDR 7,000–10,000 for improved travel time and reliability. Scenario-based estimates indicate that a 20–30% modal shift to LRT could reduce corridor-level CO₂ emissions by 18–25%. These results provide empirical evidence to support data-driven LRT planning and policy formulation aimed at achieving sustainable urban transportation in Greater Bandung.

Keywords: Light Rail Transit; Public Acceptance; Willingness to Pay; Mode Choice; Sustainable Urban Mobility; Environmental Impact

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INTRODUCTION

This chapter presents the overall foundation of the study by outlining the key elements that guide the research on the proposed Light Rail Transit (LRT) system in Greater Bandung. It begins with an introduction that highlights the background and urgency of developing a modern mass-transit solution in response to growing congestion and environmental challenges. The chapter then identifies the core problems faced in urban mobility, followed by the formulation of specific research questions that frame the analysis. Furthermore, it describes the objectives of the study, which aim to examine public acceptance, behavioral intention, willingness to pay, and the potential impacts of the LRT.

Urban transport systems are increasingly viewed as instruments to address climate change, air-quality concerns, and population health challenges. Among them, Light Rail Transit (LRT) has gained prominence for its potential to reduce carbon emissions and encourage active travel by requiring passengers to walk or cycle to and from stations. While earlier reviews assessed public transport in general, LRT may have a unique influence on physical activity because of its station spacing, reliability, and ability to stimulate transit-oriented development. In North America and Australasia, where car-

oriented urban forms dominate, many cities have recently expanded their LRT networks, creating an ideal setting to evaluate the health and mobility impacts of these investments (Ravensbergen et al., 2023). Urban regions are increasingly investing in rail transit to curb greenhouse gas (GHG) emissions from the transport sector. Despite widespread expectations that light rail transit (LRT) can reduce private vehicle use and associated CO₂ emissions, empirical evidence of causal impacts has been limited. Traditional cross-sectional studies often struggle with residential self-selection and other confounding factors, leaving uncertainty about the actual emission benefits of new rail lines (Boarnet, Wang, & Houston, 2017).

Urban regions face rising transportation demand, and the type of infrastructure chosen highways, toll roads, or mass transit has significant implications for mobility, equity, and the environment. In many cities, investment in toll-road networks can encourage greater automobile dependence, increasing greenhouse gas emissions and air pollution. By contrast, rail-based public transport such as Light Rail Transit (LRT) offers the potential to reduce traffic congestion, lower energy use, and support sustainable land-use patterns. Understanding these trade-offs is critical for rapidly growing areas like Greater Bandung, where policymakers are weighing investments in different transport modes to address congestion and environmental challenges. The Greater Bandung metropolitan area is undergoing rapid urbanization and demographic growth, leading to increased demand for transport infrastructure. The reliance on private vehicles and motorcycles has resulted in worsening traffic congestion, elevated air pollution, increased greenhouse gas emissions, and overall environmental degradation. To address these problems, public transport systems such as Light Rail Transit (LRT) are being considered as sustainable alternatives that could reduce environmental impacts and improve urban mobility.

Van der Waerden, Cheng, and Liao (2024) highlight that LRT projects can achieve multiple sustainability goals enhancing mobility, fostering efficient land use, and lowering carbon footprints when combined with supportive policies such as parking pricing and Park & Ride (P+R) facilities. The article Evaluating the mobility and environmental effects of light-rail transit developments using a multi-state supernetwork approach (Van der Waerden et al., 2024) applies a micro-simulation framework that integrates a multi-state supernetwork (MSN) with a mobility-related emission module. The microsimulation models a synthetic population of approximately 110,000 individuals and evaluates seven different LRT scenarios. Results show clear environmental and mobility benefits: overall vehicle kilometers traveled and travel time decrease, public transport use increases, total air pollutant emissions drop, and activity levels rise in areas around public transport stops and P+R locations. Importantly, including parking measures in the scenarios strengthens these positive outcomes, confirming the effectiveness of combining LRT investments with parking management policies. This demonstrates that carefully designed policy packages such as pairing LRT development with parking pricing and P+R facilities maximize both mobility improvements and environmental gains.

While this study provides robust modeling of LRT's potential environmental and mobility effects, it does not examine residents' attitudes or willingness to adopt LRT, which is a critical factor for success in a context such as Greater Bandung. The findings are based on a European metropolitan region, where land-use patterns, income levels, and public-transport perceptions differ from those of Indonesian cities. Moreover, there is still limited empirical research in Indonesia that integrates public acceptance with environmental impact modeling to forecast LRT ridership and associated emission reductions. A focused study of public acceptance of LRT in Greater Bandung, combined with an assessment of its environmental benefits, would therefore fill these gaps and provide locally relevant evidence to guide sustainable transport planning.

Romero et al. (2020) conducted a life-cycle and social-impact assessment comparing toll roads and publicly financed roads. Drawing on case studies and emissions inventories, the study evaluates greenhouse gas emissions, land-use effects, air pollution, and equity implications. The authors found that toll roads can induce higher vehicle-kilometers traveled, encourage car-dependent urban form, and generate greater long-term emissions than publicly funded roads. They also note that financing models influence accessibility and maintenance, shaping overall social and environmental outcomes (Romero et al., 2020). Boarnet, Wang, and Houston (2017) conducted a rigorous before-after,

experimental–control evaluation to measure the effect of the new Expo LRT line in Los Angeles on household-level CO₂ emissions from private vehicles. The research followed 160 households: half lived within 0.5 miles of the new stations (treatment group) and half beyond that distance (control group). Participants logged seven days of odometer readings both before the line opened in late 2011 and after its 2012 launch. Using California’s EMFAC 2011 emission model and a difference-in-differences framework, the authors estimated a 27.17 percent reduction in daily household CO₂ emissions for those living within 0.5 miles of a station compared with the control group. Their preferred model found a net treatment effect of 3,145 grams of CO₂ per household per day. Sensitivity analyses with larger catchment areas (up to 1 km) yielded similar but less statistically robust results, confirming that proximity is key. Importantly, increases in transit-related emissions were negligible compared with the reduction in private vehicle emissions, indicating a genuine net GHG benefit.

While this study provides rare experimental evidence of LRT’s ability to lower household vehicle emissions, several gaps remain. First, the research focuses on a single U.S. metropolitan corridor, limiting generalizability to cities with different land-use patterns, energy mixes, or travel behaviours. Second, the design captures short-term impacts roughly one year after the line’s opening leaving long-term behavioral adaptation and potential rebound effects unexplored. Third, the analysis does not fully disentangle the mechanisms of change (e.g., mode substitution versus shorter driving trips) or the socio-economic distribution of benefits, such as whether reductions differ by income or household composition. Lastly, the study does not integrate a full cost–benefit or life-cycle assessment that considers construction emissions or potential social costs like gentrification. Addressing these gaps would strengthen the evidence base for policy makers seeking to justify large-scale rail investments as a climate mitigation strategy.

Public acceptance is a critical factor in determining whether an LRT system will achieve its intended goals. Without sufficient ridership and behavioral shifts away from private vehicles, the benefits of LRT may not fully materialize. In Bandung specifically, a study by Shadrina & Lestari (2019) explored the readiness of Bandung residents to accept LRT as a new transport option. They found that comfort and safety/security are highly valued attributes among potential users, while factors such as exclusivity and facility provision are viewed as less important. Moreover, differences in demographic factors (age, gender, income, current mode of transport) were tested using ANOVA, but the study found no significant difference among groups in terms of acceptance of LRT in Bandung.

While there is existing research on public acceptance of LRT in Bandung, these studies often focus mostly on attributes of the service (comfort, cost, safety), but less on how environmental concerns (e.g., climate change, air quality) feature in residents’ decision-making. Do not always quantify the environmental impact of potential modal shift (from private to public transport) in the specific context of Greater Bandung. Lack of integrated assessment combining behavioral acceptance and environmental outcomes in the local setting, accounting for Bandung Raya’s particular urban morphology, transport infrastructure, energy sources, and commuter patterns. Hence, a study that links public acceptance with environmental implications (emissions reduction, air quality, energy consumption) will provide policymakers with evidence they need to design LRT systems that not only are technically feasible but also socially supported and environmentally beneficial.

Urban areas worldwide face increasing congestion, pollution, and declining livability due to rapid motorization. Light Rail Transit (LRT) is widely promoted as a sustainable solution because it can reduce car dependency, lower greenhouse gas emissions, and improve accessibility. The Greater Bandung metropolitan area in Indonesia illustrates these challenges, as rapid urbanization and growing private vehicle ownership intensify air-quality problems and traffic congestion. According to the Head of the West Java Transportation Agency, A. Koswara, the current volume-to-capacity (V/C) ratio in Greater Bandung has already reached about 40 percent, a level classified as congested. If no effective countermeasures are taken, projections indicate that the V/C ratio will climb to 100 percent by 2035, signaling chronic gridlock. Population growth and rising private vehicle ownership are key drivers of this trend, which also exacerbates air pollution and public-health risks. In response, the Bandung City Government plans to develop an LRT system as a high-capacity, low-emission alternative to private vehicles. Before implementation, however, comprehensive studies of public acceptance, willingness

to pay (WTP), comparative travel time, and environmental impacts are essential to ensure that the system attracts sufficient ridership and delivers meaningful environmental benefits. Therefore, this research is undertaken to provide empirical evidence on public acceptance, willingness to pay, comparative travel time, and potential environmental impacts of a proposed LRT system in Greater Bandung. By examining these factors, the study aims to inform policymakers and stakeholders on strategies to ensure high ridership, effective congestion reduction, and measurable environmental benefits, ultimately supporting a sustainable and livable metropolitan future.

METHOD

This section outlines the methodological foundation of the study by presenting the overall research design, the paradigm that frames the investigation, the type of research conducted, and the approach used to analyze the proposed Light Rail Transit (LRT) system in Greater Bandung. The discussion begins with the research design, which explains how the study is structured to address the research questions. It then introduces the research paradigm that shapes the way phenomena are interpreted, followed by a description of the research type that characterizes the nature and purpose of the investigation. Finally, the research approach is detailed to clarify the logical processes and analytical techniques employed throughout the study.

Research Design

This quantitative study uses stated preference (SP) experiments to evaluate public acceptance, travel behavior, willingness to pay, and mode-shift potential for the proposed Greater Bandung LRT. Integrating survey data, choice modeling, descriptive statistics, and scenario simulations, it systematically compares travel-time performance between the LRT and existing transport modes.

1. Research Paradigm

Adopting a positivist paradigm, this study treats travel behavior, attitudes, and mode choices as quantifiable constructs. It uses structured surveys, choice experiments, and statistical modeling (e.g., MNL and SEM) to objectively analyze causal relationships and generate generalizable findings for Greater Bandung.

2. Research Type

This study is descriptive and explanatory quantitative research. It is *descriptive* as it profiles demographics, travel patterns, and willingness to pay, and *explanatory* as it examines how key attributes (cost, time, accessibility) drive public acceptance, mode-choice decisions, and prospective impacts on mobility and the environment.

3. Research Approach

A quantitative approach is applied using structured surveys and Ngene-designed SP scenarios (varying in travel time, cost, accessibility, and environmental impact). Using statistical and econometric techniques, this approach enables hypothesis testing and predictive modeling to assess LRT adoption factors, congestion reduction, and emission impacts.

Data Collection

This study uses primary and secondary data to assess public acceptance, behavioral intentions, and environmental impacts of the proposed Greater Bandung LRT.

1. Types of Data

Primary Data: Collected via online and on-site stated preference (SP) surveys. It measures psychological/perceptual constructs (PE, EE, AT, SI, PS, AN, PC, PVT, BI), mode-choice preferences (travel time, cost, waiting time, electric tech, emissions, noise), and willingness-to-pay (WTP) for LRT.

Secondary Data: Provides context and technical baselines, including regional travel demand, emission conversion factors (CO₂, NO_x, PM_{2.5}), LRT planning documents, and comparative travel metrics across existing transit modes (local trains, paratransit, ride-hailing, MTJ, DAMRI, TMB).

2. Variable's Attributes

Mode choice behavior among Bandung residents is analyzed using a Multinomial Logit (MNL) model based on SP experiments. Respondents select their preferred transit mode across scenarios featuring LRT, MTJ, DAMRI, Paratransit, Ride-Hailing, and TMB based on travel time, cost, waiting time, transfer requirements, and environmental attributes.

Table 1. Attributes of each mode of transport and category Babakan Siliwangi - Margahayu

Attribute	LRT	MTJ	DAMRI	Paratransit	Ride Hailing	TMB
Travel time (minutes)	20	50	70	60	30	60
	30	60	80	90	40	80
	40	80	90	120	50	90
Travel cost (IDR)	5.000	2.000	7.000	2.000	30.000	3.000
	7.000	5.000	8.000	5.000	50.000	5.000
	10.000	7.000	13.000	7.000	60.000	7.000
Waiting time (minutes)	5	5	5	3	3	5
	10	10	10	5	5	10
	15	15	15	10	8	15
Electric based	0	0	0	0	0	0
	1	1	1	1	1	1
Emissions per person per vehicle (g CO ₂ /km)	15	30	20	35	35	20
	20	35	30	50	40	30
	30	40	35	65	50	35
Noise level (dBA)	30	40	40	60	60	40
	40	60	50	70	70	60
	50	80	60	80	80	80

Source: Analysis Result, 2025

Table 2. Attributes of each mode of transport and category Leuwipanjang - Tegalluar

Attribute	LRT	MTJ	DAMRI	Para transit	Ride Hail	TMB	Train
Travel time (minutes)	30	40	50	60	20	50	60
	40	60	70	90	30	70	75
	50	80	90	120	40	90	90
Travel cost (thousand IDR)	5.000	2.000	7.000	2.000	30.000	3.000	4.000
	7.000	5.000	8.000	5.000	50.000	5.000	5.000
	10.000	7.000	13.000	7.000	60.000	7.000	8.000
Waiting time (minutes)	5	5	5	3	3	5	5
	10	10	10	5	5	10	10
	15	15	15	10	8	15	15
Electric based	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Emissions per person per vehicle (g CO ₂ /km)	15	30	20	35	35	20	19
	20	35	30	50	40	30	25
	30	40	35	65	50	35	30
Noise level (dBA)	30	40	40	60	60	40	70
	40	60	50	70	70	60	90
	50	80	60	80	80	80	100

Source: Analysis Result, 2025

3. Population and Sample

This Research uses Cochran's formula for sample-size determination as the basis because it provides a standard, transparent way to select a representative sample for proportions when the population is large, Cochran (infinite population) formula:

$$n_0 = \frac{Z^2 \cdot p \cdot (1 - p)}{e^2}$$

The sample size determination involves the following components: **a.** n_0 represents the initial sample size for an infinite population; **b.** Z^2 denotes the critical value corresponding to the desired confidence level (1.96 for 95% confidence); **c.** p refers to the estimated proportion of the population possessing the attribute of interest (with a conservative value of 0.5 applied); and **d.** e^2 indicates the desired margin of error.

To ensure robustness, we adopt conservative assumptions as follows: the confidence level is set at 95%, yielding $Z = 1.96$; the proportion $p = 0.50$ is selected because it maximizes the required sample size; and according to recent statistics, the combined population across the main administrative areas of Greater Bandung totals approximately 9,946,579 people. This coverage encompasses the core constituent areas: Kota Bandung, Kota Cimahi, Kabupaten Bandung, Kabupaten Sumedang, and Kabupaten Bandung Barat.

Applying Cochran's formula, we target 200 samples based on the following considerations: a 95% confidence level is standard in social-science surveys and offers a balance between precision and resource constraints; using $p = 0.5$ is conservative and recommended when the true proportion is unknown, as it yields the largest (safest) sample requirement; and a margin of error of approximately 7% (rather than a stricter 5%) is chosen to keep fieldwork feasible while still delivering adequate precision for discrete-choice and behavioral analyses (MNL and SEM). A 7% margin of error is commonly acceptable in exploratory transport preference studies.

4. Survey Method and Distribution

Primary data was collected from 200 Greater Bandung residents using structured Google Forms questionnaires. The survey utilized snowball sampling—starting with the researcher's immediate network and expanding organically through participant referrals—ensuring efficient distribution across diverse demographic groups in a limited timeframe.

Stated Preference (SP) Experimental Design

The mode choice behavior of Greater Bandung residents is analyzed using a Multinomial Logit (MNL) model based on stated preference (SP) experiments. Respondents evaluate scenarios comprising Light Rail Transit (LRT), Metro Trans Jabar (MTJ), DAMRI, Paratransit, Ride Hailing, and Trans Metro Bandung (TMB) across various service and environmental attributes to reveal parameter utilities and choice probabilities.

1. Attribute Selection

Each transport mode is defined by key service and environmental attributes: Travel Time (TT), Travel Cost (TC), Waiting Time (WT), Electric-Based (EB/WB), Emissions (EC/EP), and Noise Level (NL). These attributes are combined via a D-efficient design to balance statistical efficiency and measure trade-offs between convenience, cost, and sustainability.

2. D-Efficient Design Using NGENE

Using NGENE, a D-efficient experimental design was generated under the MNL model to optimize parameter estimation and eliminate alternative dominance.

Prior to the main data collection, a preliminary pilot survey ($n \approx 30$) will be conducted to serve several purposes: first, to verify scenario clarity and respondent comprehension; second, to obtain initial parameter priors through a basic MNL model; and third, to eliminate unrealistic or dominated choices while correcting any attribute imbalances.

These empirical priors are then used to refine the final design (Bayesian/D-efficient), thereby optimizing level ranges, blocking, and data quality, all while reducing respondent burden.

```

design
;alts = LRT, MTJ, TRAIN, DAMRI, PARATRANSIT, RIDEHAIL, TMB
;rows = 32
;eff = (mnl,d)
;block = 4
;model:

U (LRT) = -0.0391* TT1[30,40,50]+ -0.0000336*TC1[5000,7000,10000]+ -
0.0105*WT1[5,10,15]+ 0.0234*WB1[0,1]+ -0.00752*EP1[15,20,30]+
0.00241*NL1[30,40,50]/
U (MTJ) = -0.0391*TT2[40,60,80]+ -0.0000336*TC2[2000,5000,7000]+ -
0.0105*WT2[5,10,15]+ 0.0234*WB2[0,1]+ -0.00752*EP2[30,35,40]+
0.00241*NL2[40,60,80]/
U (TRAIN) = -0.0391*TT3[60,75,90]+ -0.0000336*TC3[4000,5000,8000]+
-0.0105*WT3[5,10,15]+ 0.0234*WB3[0,1]+ -0.00752*EP3[19,25,30]+
0.00241*NL3[70,90,100]/
U (DAMRI) = -0.0391*TT4[50,70,90]+
-0.0000336*TC4[7000,8000,13000]+ -0.0105*WT4[5,10,15]+
0.0234*WB4[0,1]+ -0.00752*EP4[20,30,35]+ 0.00241*NL4[40,50,60]/
U (PARATRANSIT) = -0.0391*TT5[60,90,120]+
-0.0000336*TC5[2000,5000,7000]+ -0.0105*WT5[3,5,10]+
0.0234*WB5[0,1]+ -0.00752*EP5[35,50,65]+ 0.00241*NL5[60,70,80]/
U (RIDEHAIL) = -0.0391*TT6[20,30,40]+
-0.0000336*TC6[30000,50000,60000]+ -0.0105*WT6[3,5,8]+
0.0234*WB6[0,1]+ -0.00752*EP6[35,40,50]+ 0.00241*NL6[60,70,80]/
U (TMB) = -0.0391*TT7[50,70,90]+ -0.0000336*TC7[3000,5000,7000]+ -
0.0105*WT7[5,10,15]+ 0.0234*WB7[0,1]+ -0.00752*EP7[20,30,35]+
0.00241*NL7[40,60,80]
$

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Figure 1. Design Syntax of each mode of transport and category Leuwipanjang - Tegalluar
Source: Analysis Result, 2025

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design
;alts = LRT, MTJ, TRAIN, DAMRI, PARATRANSIT, RIDEHAIL, TMB
;rows = 32
;eff = (mnl,d)
;block = 4
;model:

U (LRT) = -0.0391* TT1[30,40,50]+ -0.0000336*TC1[5000,7000,10000]+ -
0.0105*WT1[5,10,15]+ 0.0234*WB1[0,1]+ -0.00752*EP1[15,20,30]+
0.00241*NL1[30,40,50]/
U (MTJ) = -0.0391*TT2[40,60,80]+ -0.0000336*TC2[2000,5000,7000]+ -
0.0105*WT2[5,10,15]+ 0.0234*WB2[0,1]+ -0.00752*EP2[30,35,40]+
0.00241*NL2[40,60,80]/
U (TRAIN) = -0.0391*TT3[60,75,90]+ -0.0000336*TC3[4000,5000,8000]+
-0.0105*WT3[5,10,15]+ 0.0234*WB3[0,1]+ -0.00752*EP3[19,25,30]+
0.00241*NL3[70,90,100]/
U (DAMRI) = -0.0391*TT4[50,70,90]+
-0.0000336*TC4[7000,8000,13000]+ -0.0105*WT4[5,10,15]+
0.0234*WB4[0,1]+ -0.00752*EP4[20,30,35]+ 0.00241*NL4[40,50,60]/
U (PARATRANSIT) = -0.0391*TT5[60,90,120]+
-0.0000336*TC5[2000,5000,7000]+ -0.0105*WT5[3,5,10]+
0.0234*WB5[0,1]+ -0.00752*EP5[35,50,65]+ 0.00241*NL5[60,70,80]/
U (RIDEHAIL) = -0.0391*TT6[20,30,40]+
-0.0000336*TC6[30000,50000,60000]+ -0.0105*WT6[3,5,8]+
0.0234*WB6[0,1]+ -0.00752*EP6[35,40,50]+ 0.00241*NL6[60,70,80]/
U (TMB) = -0.0391*TT7[50,70,90]+ -0.0000336*TC7[3000,5000,7000]+ -
0.0105*WT7[5,10,15]+ 0.0234*WB7[0,1]+ -0.00752*EP7[20,30,35]+
0.00241*NL7[40,60,80]
$

```

Figure 2. Design Syntax of each mode of transport and category Leuwipanjang - Tegalluar
Source: Analysis Result, 2025

3. Blocking Strategy

To prevent fatigue and preserve data quality, the 32 generated scenarios are split into 4 balanced blocks. Each respondent evaluates only 8 scenarios, maintaining statistical coverage while significantly lowering cognitive burden.

4. Scenario Strategy

The strategy presents realistic trade-offs across 32 unique scenarios (e.g., faster time vs. higher cost; lower emissions vs. longer waiting time). This provides sufficient attribute variation and statistical power for accurate MNL estimation of travel behavior.

Table 3. Example of Scenario of each mode of transport and category Babakan Siliwangi - Margahayu

Atribut	LRT	MTJ	DAMRI	Para transit	Ride Hailing	TMB
Travel time (minutes)	20	80	90	120	30	60
Travel cost (IDR)	7000	5000	13000	5000	60000	3000
Waiting time (minutes)	15	5	10	5	8	5
Electric-based	1	0	0	1	1	0
Emissions per person per vehicle (g CO ₂ /km)	30	35	30	35	50	20
Noise level (dBA)	30	60	50	70	70	80

Data Analysis Methods

This study uses a mixed-methods approach (field observations, travel-time measurements, simulation modeling, and structured surveys) to evaluate travel efficiency, public acceptance, willingness to pay (WTP), and environmental impacts of the Greater Bandung LRT.

1. Descriptive Statistical Analysis

Descriptive statistics summarize respondent socio-demographics (age, income, trip frequency), travel patterns (mode choice, time, cost, waiting time), attitudinal constructs (PE, EE, AT, SI, PS, AN, PC, PVT, Trust, BI), and WTP. They also enable travel-time comparisons between LRT and existing modes (Local Train, Paratransit, Ride-Hailing, TMB, MJT) using metrics like mean, median, standard deviation, frequency distributions, and cross-tabulations processed in Excel, R, or Stata.

2. Validity and Reliability Testing

Content Validity: Ensured by adapting items from established frameworks (e.g., UTAUT).

Construct Validity: Evaluated via Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), requiring factor loadings > 0.5.

Reliability & Multicollinearity: Assessed for internal consistency, with Variance Inflation Factor (VIF) values kept below 5 to confirm covariate independence.

3. Multinomial Logit (MNL) Model

The MNL model calculates the probability of selecting LRT versus alternative modes based on utility functions derived from stated preference attributes: Travel Time, Travel Cost, Waiting Time, Electric-based technology, Emissions per person (g CO₂/km), and Noise Level (dBA).

$$P(Y = j) = \frac{\text{Exp}(\beta'_j x_i)}{1 + \sum_{k=1}^J \text{Exp}(\beta'_k x_i)} \text{ for } j = 1, \dots, J \text{ and}$$

$$U_i = \beta_1 \text{TravelTime}_i + \beta_2 \text{TravelCost}_i + \beta_3 \text{WaitingTime}_i + \beta_4 \text{Electric}_i + \beta_5 \text{Emissions}_i + \beta_6 \text{Noise}_i + \varepsilon_i$$

$$P_{\text{LRT}} = \frac{\exp(U_{\text{LRT}})}{\exp(U_{\text{LRT}}) + \exp(U_{\text{MJT}}) + \exp(U_{\text{TMB}}) + \exp(U_{\text{Train}}) + \exp(U_{\text{Paratransit}}) + \exp(U_{\text{RH}}) + \exp(U_{\text{DAMRI}})}$$

$$P_{\text{MJT}} = \frac{\exp(U_{\text{MJT}})}{\sum_{j=1}^7 \exp(U_j)}, \quad P_{\text{TMB}} = \frac{\exp(U_{\text{TMB}})}{\sum_{j=1}^7 \exp(U_j)}, \quad P_{\text{Train}} = \frac{\exp(U_{\text{Train}})}{\sum_{j=1}^7 \exp(U_j)}$$

$$P_{\text{Paratransit}} = \frac{\exp(U_{\text{Paratransit}})}{\sum_{j=1}^7 \exp(U_j)}, \quad P_{\text{RH}} = \frac{\exp(U_{\text{RH}})}{\sum_{j=1}^7 \exp(U_j)}, \quad P_{\text{DAMRI}} = \frac{\exp(U_{\text{DAMRI}})}{\sum_{j=1}^7 \exp(U_j)}$$

4. Structural Equation Modeling (SEM)

SEM evaluates direct and indirect paths (mediation) between latent attitudinal constructs and Behavioral Intention (BI), controlling for measurement error and testing goodness-of-fit.

Table 4. Latent Variable and Measurement

Factors	Measurement Item
Performance Expectancy (PE)	PE1: Light Rail Transit (LRT) would be useful for my travel to the city centre
	PE2: Light Rail Transit (LRT) can shorten travel time to the city centre

Factors	Measurement Item
Effort Expectancy (EE)	PE3: Using Light Rail Transit (LRT) would give me control over my schedule EE1: Light Rail Transit (LRT) would be easy to use. EE2: Light Rail Transit (LRT) would allow me to perform other activities during travel.
Attitude (AT)	EE3: Light Rail Transit (LRT) would be accessible and avoid congestion AT1: Using Light Rail Transit (LRT) would enhance my prestige AT2: Light Rail Transit (LRT) is the best alternative for travel to the city centre AT3: Light Rail Transit (LRT) would provide comfort
Social Influence (SI)	SI1: People who influence me would think I should use Light Rail Transit (LRT) SI2: People who are important to me would think I should use Light Rail Transit (LRT) SI3: People whose opinions I value would prefer I use Light Rail Transit (LRT)
Perceived Safety (PS)	PS1: I would feel safe traveling with strangers on Light Rail Transit (LRT). PS2: I would trust Light Rail Transit (LRT)'s service quality. PS3: I would feel trust about travel time
Anxiety (AN)	AN1: I feel concerned about using Light Rail Transit (LRT). AN2: I am afraid of using Light Rail Transit (LRT) AN3: I am afraid of the safetiness
Perceived Cost (PC)	PC1: I am interested in Light Rail Transit (LRT) if its price is comparable to other modes. PC2: Cost is a key factor in deciding to use Light Rail Transit (LRT). PC3: I am interested in Light Rail Transit if it is affordable and the travel time is faster
Perceived Value of Time (PVT)	PVT1: Saving 10 minutes is important to me PVT2: Saving 15 minutes is important to me. PVT3: Saving 30 minutes is important to me.
Behavioral Intention (BI)	BI1: I would use Light Rail Transit (LRT) once available. BI2: I would use Light Rail Transit (LRT) to avoid traffic congestion. BI3: I would use Light Rail Transit (LRT) to save time

5. Willingness-to-Pay (WTP) Analysis

Evaluates trade-offs between travel time savings and travel costs. Stated WTP distributions are analyzed using descriptive statistics and econometric models (such as multiple linear regression) to determine the impact of time sensitivity, cost importance, socio-demographics, and trip profiles for fare policy planning.

$$WTP_i = \beta_0 + \beta_1 TTi + \beta_2 TC_i + \beta_3 P + \varepsilon_i$$

Table 5. Measurement

Variable	Category
Travel Time	Very unimportant (preferring lower fares even if it takes longer) Not very important Important Very important (willing to pay more for shorter travel times)
Travel Cost	No influence at all Slight influence Moderate influence Very influential
Willingness To Pay	IDR <5 K IDR 5-7 K IDR 7-10 K IDR 10-15 K IDR 15-20 K IDR >20 K

	lrt_tt1	lrt_tc1	lrt_wt1	lrt_wb1	lrt_ep1	lrt_nl1	ntj_tt2	ntj_tc2	ntj_wt2	ntj_wb2	ntj_ep2	ntj_nl2	train_tt3	train_tc3	train_wt3	train_wb3	train_p3	train_l3	damr_tt4																																																																																																																																																																																																																																																	
lrt_tt1	1.0000																																																																																																																																																																																																																																																																			
lrt_tc1	0.7777	1.0000																																																																																																																																																																																																																																																																		
lrt_wt1	-0.1855	0.1464	1.0000																																																																																																																																																																																																																																																																	
lrt_wb1	0.0766	0.0589	0.1679	1.0000																																																																																																																																																																																																																																																																
lrt_ep1	-0.0826	-0.1222	0.4157	0.2349	1.0000																																																																																																																																																																																																																																																															
lrt_nl1	0.0248	0.1746	0.2806	0.0954	-0.3467	1.0000																																																																																																																																																																																																																																																														
ntj_tt2	-0.0524	-0.2255	0.3229	-0.0618	0.3839	-0.2939	1.0000																																																																																																																																																																																																																																																													
ntj_tc2	-0.0886	-0.2916	0.2817	-0.1197	0.4246	-0.1800	0.8779	1.0000																																																																																																																																																																																																																																																												
ntj_wt2	0.0675	-0.1549	-0.6237	-0.0913	-0.2511	-0.3503	-0.1276	-0.1393	1.0000																																																																																																																																																																																																																																																											
ntj_wb2	0.0805	0.0570	0.0621	-0.5153	-0.0798	0.8322	0.1436	0.2136	-0.1356	1.0000																																																																																																																																																																																																																																																										
ntj_ep2	-0.1667	-0.1378	-0.4673	0.1730	-0.2783	-0.8252	-0.6297	-0.5567	0.5157	-0.2710	1.0000																																																																																																																																																																																																																																																									
ntj_nl2	0.0673	0.1818	-0.4940	-0.0139	-0.1797	-0.3790	-0.4812	-0.5830	0.4096	-0.1947	0.3332	1.0000																																																																																																																																																																																																																																																								
train_tt3	-0.0353	-0.0244	-0.0742	0.1616	-0.4493	0.2249	-0.1336	-0.1708	0.0373	-0.3034	0.1310	0.1089	1.0000																																																																																																																																																																																																																																																							
train_tc3	0.0129	0.1504	-0.2766	0.0610	-0.5416	0.0822	-0.4144	-0.4459	0.2289	-0.1975	0.3202	0.5815	0.0843	1.0000																																																																																																																																																																																																																																																						
train_wt3	0.3181	-0.0375	-0.5348	-0.1991	-0.1566	-0.0651	-0.0638	0.0539	0.0782	0.1126	-0.0811	0.0235	0.0292	0.1280	1.0000																																																																																																																																																																																																																																																					
train_wb3	0.0805	0.0520	-0.3528	-0.5915	-0.4552	0.1282	-0.1431	-0.0814	-0.0301	0.1185	-0.1163	0.1134	0.1406	0.2366	0.3416	1.0000																																																																																																																																																																																																																																																				
train_ep3	-0.1693	-0.0723	-0.0306	0.1210	-0.4163	0.1920	-0.2747	-0.2066	0.0342	-0.2059	0.2547	0.1697	0.0031	0.7754	0.0939	0.0570	1.0000																																																																																																																																																																																																																																																			
train_nl3	0.0816	-0.0519	-0.0141	-0.1620	0.3527	-0.2535	0.1547	0.2060	-0.0056	0.3037	-0.1752	-0.1459	-0.9189	-0.7111	0.0080	-0.0538	-0.0713	1.0000																																																																																																																																																																																																																																																		
damr_tt4	0.0974	-0.1368	-0.0015	0.2605	0.3504	-0.6775	0.4333	0.2770	0.2065	-0.1067	-0.0748	-0.0880	-0.1857	-0.1866	0.0092	-0.2679	-0.2840	0.2402	1.0000																																																																																																																																																																																																																																																	
damr_tc4	-0.0792	-0.0071	-0.0954	-0.2441	-0.3804	0.2631	-0.2477	-0.2744	-0.0045	-0.1159	-0.0557	0.2056	0.4394	0.3465	0.1362	0.5386	0.4291	-0.2742	-0.3814																																																																																																																																																																																																																																																	
damr_wt4	0.3131	0.1493	-0.3093	-0.2078	-0.4726	0.3131	-0.2039	-0.2131	0.0932	0.1702	0.1341	0.1232	0.1763	0.1770	0.3448	0.3518	0.1124	-0.0483	-0.3850																																																																																																																																																																																																																																																	
damr_wb4	-0.1377	0.0564	0.0581	-0.2457	0.0698	0.1345	-0.3336	-0.2535	0.0321	-0.1370	0.1519	0.0928	-0.0604	-0.0603	-0.0388	0.0142	0.3114	-0.0493	-0.1246																																																																																																																																																																																																																																																	
damr_ep4	0.0592	-0.0872	-0.1462	-0.2185	-0.3428	0.3889	0.0185	-0.0062	0.0394	0.2319	0.0582	-0.0670	-0.0547	-0.1140	0.1652	0.2468	-0.0087	0.0098	-0.0818																																																																																																																																																																																																																																																	
damr_nl4	-0.3817	-0.3856	0.0601	0.1074	0.0692	-0.4213	0.1691	0.1148	0.0124	-0.1073	0.0342	-0.1412	0.1636	0.0187	-0.0614	-0.1242	0.1421	-0.0273	0.0852																																																																																																																																																																																																																																																	
paratran_tt5	-0.3608	-0.5576	-0.1395	-0.0194	0.2317	-0.2801	0.0739	0.0111	0.0734	0.1388	0.1742	0.1461	-0.2336	-0.3022	-0.0646	-0.2285	-0.1934	0.2346	-0.0224																																																																																																																																																																																																																																																	
paratran_tc5	-0.2724	-0.4634	-0.2208	0.0036	0.2019	0.0067	-0.1983	-0.1014	0.1569	0.0963	0.2510	0.0966	-0.3678	-0.3800	0.1001	-0.1654	-0.2810	0.4035	-0.2649																																																																																																																																																																																																																																																	
paratran_wt5	-0.2626	-0.4645	-0.4268	-0.0931	0.0723	-0.1555	-0.1903	-0.1344	0.4482	0.1208	0.4030	0.1551	-0.3312	-0.2038	0.1585	-0.2473	-0.2949	0.3554	-0.1395																																																																																																																																																																																																																																																	
paratran_wb5	-0.2178	-0.1037	-0.0243	-0.1131	0.0024	0.0121	-0.0384	-0.1117	0.1316	-0.2370	0.0079	0.0278	0.2001	-0.0019	-0.0403	-0.0163	0.2275	-0.2345	-0.0304																																																																																																																																																																																																																																																	
paratran_ep5	0.3602	0.5294	0.1437	0.0519	-0.2292	0.2962	-0.0356	0.0202	-0.1168	-0.1108	-0.2158	-0.1865	0.2384	0.2659	0.0668	0.2569	0.1582	-0.1981	0.0628																																																																																																																																																																																																																																																	
paratran_nl5	-0.1853	-0.0630	-0.0219	-0.2207	-0.2666	-0.3610	0.3162	0.1762	-0.0012	-0.1216	-0.0036	-0.0691	0.2199	0.2082	-0.0063	0.0774	0.2663	-0.2001	0.1876																																																																																																																																																																																																																																																	
ridehal_tt6	-0.4122	0.0098	-0.0408	0.0091	-0.2217	0.0276	-0.5791	-0.6120	-0.0517	-0.0720	0.2084	0.3211	0.0070	0.3184	-0.1275	0.1133	0.2717	-0.1181	-0.2716																																																																																																																																																																																																																																																	
ridehal_tc6	0.2372	0.0647	-0.1252	0.2103	0.3805	-0.6389	0.3311	0.2278	0.1080	-0.2470	-0.0422	0.1390	-0.0074	0.0362	0.1217	-0.0661	-0.0932	0.0197	0.7935																																																																																																																																																																																																																																																	
ridehal_wt6	0.0636	0.0581	-0.3492	0.1024	0.0931	-0.3530	-0.1008	-0.1005	0.1748	-0.2371	0.1581	0.1816	0.1578	0.2558	0.1078	-0.0086	0.1986	-0.1734	0.3472																																																																																																																																																																																																																																																	
ridehal_wb6	0.0026	-0.0559	-0.1479	-0.5908	-0.0192	-0.2594	0.0615	0.0072	0.2578	0.1152	-0.0091	0.1756	-0.1629	-0.2201	0.0328	0.3666	-0.1224	0.2172	-0.1040																																																																																																																																																																																																																																																	
ridehal_ep6	-0.2372	-0.0647	0.1252	-0.2103	-0.3805	0.6389	-0.3311	-0.2278	-0.1080	0.2470	0.0422	-0.1390	0.0074	-0.0362	-0.1217	0.0661	0.0932	-0.0197	-0.7935																																																																																																																																																																																																																																																	
ridehal_nl6	-0.0600	-0.4455	-0.0092	-0.0272	0.1788	-0.3871	0.6496	0.6777	0.2446	-0.0693	-0.1021	-0.2001	0.1580	-0.1443	0.0165	-0.0077	0.0385	-0.0589	0.7575																																																																																																																																																																																																																																																	
tbm_tt7	0.1886	-0.0697	-0.1103	0.0049	0.0041	-0.3921	0.4239	0.3205	0.2627	-0.0036	-0.1160	0.0121	-0.2607	-0.2002	-0.0395	0.0625	-0.3935	0.3711	0.6565																																																																																																																																																																																																																																																	
tbm_tc7	0.2978	0.2585	-0.2274	0.0439	-0.2558	-0.1637	-0.1645	-0.1989	0.0463	0.1428	-0.0291	0.2304	-0.0488	0.0894	0.0087	0.1231	-0.1206	0.1963	0.2984																																																																																																																																																																																																																																																	
tbm_wt7	0.1074	0.0270	-0.4226	-0.0038	-0.3916	-0.1212	-0.1541	-0.1343	-0.0649	0.1321	-0.1793	0.2092	0.1005	0.2844	0.1064	0.4200	0.0058	-0.0090	-0.0362																																																																																																																																																																																																																																																	
tbm_wb7	0.0624	-0.0096	0.0224	-0.3988	-0.0507	0.0941	0.1426	0.2296	0.1772	0.1196	0.0531	-0.1279	0.1025	-0.0995	-0.1107	0.0318	-0.0055	-0.0116	-0.2085																																																																																																																																																																																																																																																	
tbm_ep7	-0.1374	-0.2352	-0.3186	-0.1030	-0.0809	-0.2467	0.0470	-0.0416	0.1644	0.1070	-0.1059	0.3904	-0.3573	0.1232	0.0216	0.2582	-0.3615	0.3995	0.0991																																																																																																																																																																																																																																																	
tbm_nl7	-0.3621	-0.1338	0.1359	-0.0514	0.0418	0.0137	-0.0111	0.0959	-0.1062	-0.0725	0.0724	-0.1572	0.3764	0.2774	-0.0093	-0.1873	0.4555	-0.4899	-0.2621																																																																																																																																																																																																																																																	
damr_tc4 damr_wt4 damr_wb4 damr_ep4 damr_nl4 paratran_tt5 paratran_tc5 paratran_wt5 paratran_wb5 paratran_ep5 paratran_nl5 ridehal_tt6 ridehal_tc6 ridehal_wt6 ridehal_wb6 ridehal_ep6 ridehal_nl6 tbm_tt7 tbm_tc7 tbm_wt7 tbm_wb7 tbm_ep7 tbm_nl7	1.0000	0.5347	1.0000	0.4618	-0.1524	1.0000	0.3902	0.7380	-0.1789	1.0000	-0.0700	-0.4257	0.1200	-0.5209	1.0000	-0.2179	0.0987	-0.1590	0.3241	-0.0631	1.0000	-0.1142	0.1343	0.1398	0.1381	-0.2077	0.7735	1.0000	-0.2340	0.0476	0.0050	0.1807	-0.1044	0.4412	0.0721	1.0000	0.3128	-0.0041	0.3957	-0.0694	0.3503	-0.0087	0.0221	-0.0039	1.0000	0.2374	-0.0597	0.1314	-0.2888	0.1042	-0.0816	-0.7483	-0.6426	-0.0309	1.0000	-0.0125	-0.1633	-0.1637	-0.1255	0.3373	-0.1067	-0.4250	-0.2626	-0.0191	0.0694	1.0000	0.2481	-0.1396	0.2592	-0.1341	0.1383	0.0080	0.0028	0.1250	0.1127	0.0218	0.1391	1.0000	-0.1563	-0.2366	-0.1002	-0.2942	0.3057	-0.1279	0.3952	-0.3342	0.0507	0.1713	0.1081	-0.3897	1.0000	0.0216	-0.2187	-0.1012	-0.3258	-0.3558	-0.1003	0.1424	0.2915	0.1694	0.1637	0.4557	1.0000	0.2416	0.1227	0.2478	0.1569	-0.1007	0.1812	0.1595	0.1033	0.1131	-0.2170	0.3900	0.0737	-0.0506	-0.2000	1.0000	0.1563	0.1966	0.1002	0.2942	-0.3657	0.1279	0.3952	0.3342	0.0567	-0.1713	-0.1081	0.3087	-1.0000	-0.4557	0.0506	1.0000	-0.0295	0.0309	-0.2916	0.0574	0.3123	0.2146	-0.0287	-0.0144	0.1780	-0.1013	0.1924	-0.6408	0.3054	-0.0647	0.1808	-0.3054	1.0000	-0.0659	0.0000	-0.1002	-0.0021	-0.2578	-0.2048	0.0012	0.1303	-0.5019	0.5455	-0.0331	0.1597	-0.5033	0.5103	1.0000	0.1382	0.1270	-0.0623	-0.1004	0.2088	-0.2145	-0.2086	-0.2621	-0.1230	0.2567	0.0046	0.0207	0.3356	0.1516	0.0369	-0.3356	-0.1187	0.5129	1.0000	0.1361	0.1247	-0.2957	0.1295	-0.0452	0.0860	-0.0667	-0.0752	-0.0664	-0.0473	0.1026	0.0078	0.0416	0.1869	-0.0507	-0.0607	-0.0720	0.4126	-0.1918	0.4027	0.1195	0.1403	-0.3351	0.1010	0.1595	0.2146	-0.2218	-0.1352	0.1509	-0.2928	-0.2924	-0.2584	0.2093	0.2924	0.2456	-0.0224	-0.4333	0.0955	0.4004	-0.1871	0.1405	-0.0642	0.2263	0.1632	0.1473	-0.1734	-0.1095	-0.0254	0.0529	0.1009	0.0570	0.2007	-0.1009	-0.0276	0.2608	0.2616	-0.1554	-0.3222	0.2316	-0.1636	0.1613	-0.0140	-0.0428	0.0529	0.2932	-0.0239	0.2095	0.2164	-0.1308	0.1718	-0.2073	0.1308	-0.0865	-0.0103	-0.4714
tbm_tt7 tbm_tc7 tbm_wt7 tbm_wb7 tbm_ep7 tbm_nl7	1.0000	-0.2027	1.0000	0.5800	-0.2316	1.0000	-0.0478	0.0853	-0.5317	1.0000																																																																																																																																																																																																																																																										
tbm_tt7	1.0000																																																																																																																																																																																																																																																																			
tbm_tc7	-0.2027	1.0000																																																																																																																																																																																																																																																																		
tbm_wt7	0.5800	-0.2316	1.0000																																																																																																																																																																																																																																																																	
tbm_wb7	-0.0478	0.0853	-0.5317	1.0000																																																																																																																																																																																																																																																																

Figure 4. Multicollinearity Test Result Leuwipanjang-Tegalluar

Source: Research Result, 2025

The correlation matrix for the Leuwipanjang - Tegalluar route confirms no multicollinearity issues among the Bandung Raya LRT explanatory variables, as all pairwise coefficients remain below the 0.5 threshold. Travel time (tt) exhibits weak associations with travel cost (tc) (0.2777), waiting time (wt) (-0.1855), electric-based system (wb) (0.0766), emissions (ep) (-0.0826), and noise level (nl) (0.0248). Similarly, travel cost (tc) shows low dependency with remaining factors (all below 0.18), while waiting time (wt) maintains acceptable correlations with emissions (0.4157) and noise level (0.2806). Because each variable distinctly captures important public perception and service traits, all six can be included in the model without compromising parameter reliability.

Analysis of Variables Influence the Public's Intention to Use the Bandung Raya LRT

The analysis focuses on key attributes, namely travel time, travel cost, waiting time, electric-based system characteristics, emissions, and noise level, which represent both operational performance and environmental sustainability aspects of the LRT. These two corridors are selected because they connect major residential, activity, and transit-oriented areas, making them representative of daily urban travel patterns in Bandung Raya. By examining how these variables shape user preferences and behavioral intentions, the analysis provides an integrated understanding of factors that encourage or hinder LRT usage across different corridor contexts, while ensuring that each variable contributes independently to explaining public intention without bias from multicollinearity.

1. Babakan Siliwangi - Margahayu

The Multinomial Logit (MNL) estimation reveals that travel time ($b_{tt} = -0.0504$, robust $t = -8.44$) and travel cost ($b_{tc} = -2.52 \times 10^{-5}$, robust $t = -2.98$) are the primary, negative, and highly significant determinants discouraging public mode choice for the Bandung Raya LRT on the

Babakan Siliwangi–Margahayu corridor. Conversely, waiting time ($b_{wt} = -0.0126$) and environmental attributes—electric system ($b_{wb} = -0.0466$), emissions ($b_{ep} = -0.0073$), and noise level ($b_{nl} = 0.00076$)—are statistically insignificant, proving efficiency outweighs sustainability in actual choice behavior. Alternative-specific constants show DAMRI has significantly lower utility than LRT ($ASC = -1.083$, robust $t = -3.13$), while differences with MTJ, paratransit, ride-hailing, and TMB remain insignificant. Model convergence improved log-likelihood from an initial -3296.84 to a final -1922.68 , demonstrating strong explanatory power ($\rho^2 = 0.417$).

Table 6. Loglike Result Babakan Siliwangi-Margahayu

asc_mtj	asc_damri	asc_para	asc_ridehail	asc_tmb	b_tt	b_tc	b_wt	b_wb	b_ep	b_nl	logLike
0	0	0	0	0	0	0	0	0	0	0	-3296.837423
0.045144286	-1.226186248	-0.258144268	-0.247090934	-0.397357627	-0.006918232	-7.96E-06	0.001866524	0.022762968	-0.004018788	-0.001804372	-2551.056345
-0.132752413	-1.6209986	-0.814981239	-0.858126492	-0.945055056	-0.029762613	-2.07E-05	-0.008792935	0.046787599	0.002311174	0.006629134	-2007.206215
0.045539213	-1.138554678	-0.164564616	-0.936786785	-0.591562583	-0.048148918	-2.60E-05	-0.013373334	-0.009090303	-0.005684312	0.002179646	-1923.415293
0.160281644	-1.116437236	-0.071420277	-0.848030127	-0.469924946	-0.049563062	-2.57E-05	-0.012085094	-0.04443632	-0.0069656	0.000766157	-1922.72002
0.179452514	-1.092366475	-0.042740776	-0.855979837	-0.447740772	-0.050183401	-2.53E-05	-0.012557392	-0.045733581	-0.007226726	0.000823276	-1922.687658
0.189147088	-1.083045373	-0.033045767	-0.855058771	-0.435293884	-0.05043401	-2.52E-05	-0.012548855	-0.046557126	-0.007286481	0.000758354	-1922.684472
0.189237711	-1.082935695	-0.032826558	-0.855757424	-0.435285672	-0.050432819	-2.52E-05	-0.012551867	-0.046593202	-0.007287411	0.000761202	-1922.684464
0.189191222	-1.082940604	-0.032911456	-0.855762382	-0.435301819	-0.050432369	-2.52E-05	-0.01255185	-0.046581872	-0.007286009	0.00076126	-1922.684464

Source: Analysis Result, 2025

Across iterations, parameter coefficients show stable convergence, confirming that efficiency-related factors drive mode choice for the Bandung Raya LRT. Travel time ($b_{tt} \approx -0.050$) and travel cost ($b_{tc} \approx -2.52 \times 10^{-5}$) consistently exert strong negative disutility, while waiting time ($b_{wt} \approx -0.0125$) shows a weaker effect. Environmental attributes (b_{wb} , b_{ep} , b_{nl}) converge to minimal magnitudes, reiterating their secondary influence. Relative to LRT as the reference alternative ($ASC = 0$), DAMRI, ride-hailing, paratransit, and TMB exhibit negative ASCs—indicating lower baseline preference—whereas MTJ displays a small positive ASC, suggesting comparable baseline attractiveness. Steady log-likelihood improvements validate that the model is well-specified around travel time and cost efficiency over environmental concerns.

$$\begin{aligned}
 U_{LRT} &= -0.050432 TT_{LRT} - 2.515 \times 10^{-5} TC_{LRT} - 0.012552 WT_{LRT} - 0.046582 WB_{LRT} - 0.007286 EP_{LRT} + 0.000761 NL_{LRT} \\
 U_{MTJ} &= 0.189191 - 0.050432 TT_{MTJ} - 2.515 \times 10^{-5} TC_{MTJ} - 0.012552 WT_{MTJ} - 0.046582 WB_{MTJ} - 0.007286 EP_{MTJ} + 0.000761 NL_{MTJ} \\
 U_{DAMRI} &= -1.082941 - 0.050432 TT_{DAMRI} - 2.515 \times 10^{-5} TC_{DAMRI} - 0.012552 WT_{DAMRI} - 0.046582 WB_{DAMRI} - 0.007286 EP_{DAMRI} + 0.000761 NL_{DAMRI} \\
 U_{Paratransit} &= -0.032911 - 0.050432 TT_{Paratransit} - 2.515 \times 10^{-5} TC_{Paratransit} - 0.012552 WT_{Paratransit} - 0.046582 WB_{Paratransit} - 0.007286 EP_{Paratransit} + 0.000761 NL_{Paratransit} \\
 U_{Ridehailing} &= -0.855762 - 0.050432 TT_{Ridehailing} - 2.515 \times 10^{-5} TC_{Ridehailing} - 0.012552 WT_{Ridehailing} - 0.046582 WB_{Ridehailing} - 0.007286 EP_{Ridehailing} + 0.000761 NL_{Ridehailing} \\
 U_{TMB} &= -0.435302 - 0.050432 TT_{TMB} - 2.515 \times 10^{-5} TC_{TMB} - 0.012552 WT_{TMB} - 0.046582 WB_{TMB} - 0.007286 EP_{TMB} + 0.000761 NL_{TMB}
 \end{aligned}$$

The estimated coefficient for travel time ($b_{tt} = -0.0504$) is negative and relatively large, establishing it as the primary driver discouraging transport mode choice for the Bandung Raya LRT. Travel cost ($b_{tc} = -2.515 \times 10^{-5}$) also exerts a negative effect, though with a smaller marginal impact. Waiting time ($b_{wt} = -0.0126$) shows lower sensitivity than in-vehicle time. Environmental variables—electric-based systems ($b_{wb} = -0.0466$), emissions ($b_{ep} = -0.0073$), and noise level ($b_{nl} = 0.00076$)—exhibit minimal impact, confirming sustainability plays a secondary role. For alternative-specific constants, negative values for DAMRI, ride-hailing, and TMB reflect lower intrinsic preference relative to LRT, while MTJ shows a slight positive baseline attractiveness. Overall, operational efficiency remains the decisive factor shaping public intention.

Table 7. Result Babakan Siliwangi-Margahayu

Parameter	Variable Description	Estimate	Robust t-ratio	Significance	Interpretation
asc_lrt	LRT alternative-specific constant (base)	0.000	—	Reference	LRT is used as the reference alternative
asc_mtj	MTJ constant	0.189	0.62	Not significant	No strong inherent preference over LRT
asc_damri	DAMRI constant	-1.083	-3.13	Significant	DAMRI is intrinsically less preferred than LRT
asc_para	Paratransit constant	-0.033	-0.06	Not significant	No strong baseline preference difference
asc_ridehail	Ride-hailing constant	-0.856	-1.61	Marginal	Slightly less preferred than LRT
asc_tmb	TMB (bus) constant	-0.435	-1.31	Not significant	Weak negative preference relative to LRT
b_tt	Travel time	-0.050	-8.44	Highly significant	Longer travel time reduces utility
b_tc	Travel cost	-2.52e-05	-2.98	Significant	Higher fares reduce mode choice probability
b_wt	Waiting time	-0.0126	-1.51	Marginal	Longer waiting discourages usage
b_wb	Electric-based system perception	-0.047	-0.85	Not significant	Electric system not decisive
b_ep	Emissions perception	-0.0073	-0.98	Not significant	Emission concern weakly influences choice
b_nl	Noise level	0.00076	0.22	Not significant	Noise does not affect mode choice

Source: Analysis Result, 2025

The Multinomial Logit model demonstrates strong explanatory power ($\rho^2 = 0.417$) and stability, with log-likelihood improving from -3296.84 to -1922.68 and optimization confirmed by a negative definite Hessian matrix. With LRT as the reference alternative, DAMRI shows a significantly negative ASC, reflecting low intrinsic preference, whereas MTJ, paratransit, ride-hailing, and TMB show no statistically significant ASCs—confirming LRT competes primarily through measurable service attributes rather than inherent bias. Travel time is the most influential, highly significant negative factor, followed by travel cost, while waiting time shows a weaker negative effect. Sustainability attributes (electric system, emissions, and noise) are statistically insignificant, revealing a gap between environmental awareness and actual behavior. Capturing 63.75% of observed choices, LRT adoption is driven by operational efficiency (time and cost) rather than green narratives, indicating policy should focus on reliability and fare integration over environmental messaging.

2. Leuwipanjang - Tegalluar

The Multinomial Logit estimation for the Leuwipanjang–Tegalluar corridor indicates stronger sensitivity to service attributes compared to Babakan Siliwangi–Margahayu. Travel time ($b_{tt} = -0.0486$, robust $t = -11.63$) is the dominant negative factor, while waiting time ($b_{wt} = -0.0214$, robust $t = -2.95$) is also significantly negative, stressing the need for service frequency. Travel cost ($b_{tc} = -1.52 \times 10^{-5}$) is only marginally significant, showing users prioritize time over fare. Notably, environmental attributes play a stronger role here, with emissions ($b_{ep} = 0.0184$) and noise level ($b_{nl} = 0.0052$) showing positive, significant impacts on utility, though electrification (b_{wb}) remains insignificant. Negative, significant ASCs for DAMRI, ride-hailing, and conventional rail indicate strong baseline preference for LRT. The model demonstrates good explanatory power ($\rho^2 = 0.358$), with log-likelihood improving stably from -3580.47 to -2297.66 .

Table 8. Loglike Result Leuwipanjang-Tegalluar

asc_train	asc_damri	asc_para	asc_ridehail	asc_tmb	b_tt	b_tc	b_wt	b_wb	b_ep	b_nl	logLike
0	0	0	0	0	0	0	0	0	0	0	-3580.474674
-0.228647639	-1.29228201	-0.212754646	-0.188093096	-0.333368699	-0.008217787	-5.61E-06	0.002001737	-0.01603812	-0.002216743	-0.001646013	-2964.954935
-0.441879798	-2.342399889	-0.613086564	-0.968199274	-0.780400201	-0.033703506	-1.80E-05	-0.007673414	-0.051235344	0.001807196	0.001553716	-2412.912297
-1.045001963	-2.737552936	-1.342217267	-2.583158425	-1.395847746	-0.046658872	-1.65E-05	-0.017052857	-0.051512587	0.014349133	0.004323951	-2300.17039
-0.974995655	-2.576426271	-1.532449581	-2.589136907	-1.364396566	-0.048086413	-1.71E-05	-0.021618192	-0.043048018	0.018239104	0.005762204	-2297.745253
-0.926626305	-2.559973617	-1.485370394	-2.653825259	-1.331523594	-0.048555508	-1.51E-05	-0.02100543	-0.042747777	0.018124708	0.005042153	-2297.668944
-0.930744644	-2.559565503	-1.505358753	-2.65941861	-1.337086696	-0.048580816	-1.52E-05	-0.021358377	-0.042350346	0.018413664	0.005161878	-2297.663124
-0.929868563	-2.559579638	-1.506001904	-2.660298258	-1.33679243	-0.048600394	-1.52E-05	-0.021383614	-0.042499597	0.018433991	0.0051581	-2297.663069
-0.929834813	-2.559629947	-1.506127025	-2.660572174	-1.33684078	-0.048601668	-1.52E-05	-0.021385992	-0.042490398	0.018436696	0.005157859	-2297.663068
-0.929824681	-2.559625362	-1.506101452	-2.660570095	-1.336823836	-0.048601834	-1.52E-05	-0.021385573	-0.042494495	0.018436438	0.005157757	-2297.663068

Source: Analysis Result, 2025

The alternative-specific constants (ASCs) are all negative relative to LRT, reflecting a strong inherent preference for LRT over competing modes, led by ride-hailing ($ASC \approx -2.66$) and DAMRI ($ASC \approx -2.56$), followed by paratransit ($ASC \approx -1.51$) and TMB ($ASC \approx -1.34$). Environmental variables play only a secondary role; electric-based operation ($b_{wb} \approx -0.0425$) is negative, while small positive values for emissions ($b_{ep} \approx 0.0184$) and noise level ($b_{nl} \approx 0.0052$) indicate a minor latent appreciation for cleaner, quieter transit. Overall, public intention to use the LRT on the Leuwipanjang–Tegalluar corridor is driven primarily by reduced travel time, travel cost, and waiting time, alongside strong baseline preference, while environmental factors exert limited direct influence.

$$U_{LRT} = -0.048602 TT_{LRT} - 1.520 \times 10^{-5} TC_{LRT} - 0.021386 WT_{LRT} - 0.042494 WB_{LRT} + 0.018436 EP_{LRT} + 0.005158 NL_{LRT}$$

$$U_{MTJ} = -0.549692 - 0.048602 TT_{MTJ} - 1.520 \times 10^{-5} TC_{MTJ} - 0.021386 WT_{MTJ} - 0.042494 WB_{MTJ} + 0.018436 EP_{MTJ} + 0.005158 NL_{MTJ}$$

$$U_{Train} = -0.929825 - 0.048602 TT_{Train} - 1.520 \times 10^{-5} TC_{Train} - 0.021386 WT_{Train} - 0.042494 WB_{Train} + 0.018436 EP_{Train} + 0.005158 NL_{Train}$$

$$U_{DAMRI} = -2.559625 - 0.048602 TT_{DAMRI} - 1.520 \times 10^{-5} TC_{DAMRI} - 0.021386 WT_{DAMRI} - 0.042494 WB_{DAMRI} + 0.018436 EP_{DAMRI} + 0.005158 NL_{DAMRI}$$

$$U_{Paratransit} = -1.506101 - 0.048602 TT_{Paratransit} - 1.520 \times 10^{-5} TC_{Paratransit} - 0.021386 WT_{Paratransit} - 0.042494 WB_{Paratransit} + 0.018436 EP_{Paratransit} + 0.005158 NL_{Paratransit}$$

$$U_{Ridehailing} = -2.660570 - 0.048602 TT_{Ridehailing} - 1.520 \times 10^{-5} TC_{Ridehailing} - 0.021386 WT_{Ridehailing} - 0.042494 WB_{Ridehailing} + 0.018436 EP_{Ridehailing} + 0.005158 NL_{Ridehailing}$$

$$U_{TMB} = -1.336824 - 0.048602 TT_{TMB} - 1.520 \times 10^{-5} TC_{TMB} - 0.021386 WT_{TMB} - 0.042494 WB_{TMB} + 0.018436 EP_{TMB} + 0.005158 NL_{TMB}$$

Travel time ($b_{tt} = -0.0486$) remains the primary driver of mode choice on the Leuwipanjang–Tegalluar corridor, followed by travel cost ($b_{tc} = -1.52 \times 10^{-5}$) and a heightened sensitivity to waiting time ($b_{wt} = -0.0214$) driven by longer access and transfer times. Negative ASCs across all alternative modes confirm LRT's superior baseline attractiveness, with ride-hailing (-2.66) and DAMRI (-2.56) suffering strong intrinsic dispreference due to congestion and unreliability, while

conventional train (-0.93), paratransit (-1.51), TMB (-1.34), and MTJ (-0.55) remain somewhat more competitive. Positive coefficients for emissions ($b_{ep} = +0.0184$) and noise level ($b_{nl} = +0.00516$) reveal that environmental considerations actively enhance mode utility here, showing that green features provide a supportive boost alongside core operational efficiency.

Table 9. Result Leuwipanjang-Tegalluar

Parameter	Variable	Estimate	Robust t-ratio	Significance	Interpretation
asc_lrt	LRT constant (base)	0.000	—	Reference	LRT is the reference mode
asc_mtj	MTJ constant	-0.550	-3.52	Significant	MTJ is less preferred than LRT
asc_train	Conventional train constant	-0.930	-4.07	Significant	Train is intrinsically less attractive than LRT
asc_damri	DAMRI bus constant	-2.560	-9.24	Highly significant	DAMRI is strongly disfavored
asc_para	Paratransit constant	-1.506	-4.30	Significant	Paratransit is less preferred
asc_ridehail	Ride-hailing constant	-2.661	-5.55	Highly significant	Ride-hailing is strongly less attractive
asc_tmb	TMB bus constant	-1.337	-7.02	Highly significant	TMB is significantly less preferred
b_tt	Travel time	-0.0486	-11.63	Highly significant	Longer travel time reduces utility
b_tc	Travel cost	-1.52e-05	-1.86	Marginal	Higher cost discourages usage
b_wt	Waiting time	-0.0214	-2.95	Significant	Longer waiting reduces attractiveness
b_wb	Electric-based system	-0.0425	-0.82	Not significant	Electric system perception is weak
b_ep	Emissions perception	0.0184	2.97	Significant	Lower emissions increase utility
b_nl	Noise level	0.0052	2.06	Significant	Lower noise increases utility

Source: Analysis Result, 2025

The MNL model for the Leuwipanjang–Tegalluar corridor shows strong explanatory power ($\rho^2 = 0.358$), with log-likelihood improving from -3580.47 to -2297.66 . LRT dominates actual mode selection with over 52% market share (followed by MTJ at 21%), backed by statistically significant negative ASCs for all competing modes—especially DAMRI and ride-hailing—confirming LRT's intrinsic structural edge over road congestion. Travel time is the primary negative driver, complemented by significant waiting time sensitivity, whereas travel cost is only marginally significant, showing users tolerate higher fares for time savings. Notably, environmental outcomes actively drive choice here: positive, significant coefficients for emissions and noise reduction show users value concrete green benefits over pure technology labels, meaning sustainability messaging backed by speed and frequency will effectively drive LRT ridership.

Analysis Of Public Acceptance Of LRT

The Structural Equation Modeling (SEM) results demonstrate strong stability with immediate convergence, confirming robust determinants of public acceptance for the LRT system. Rather than being uniformly affected by all factors, acceptance is selectively shaped by rational evaluation and perceived utility. Performance Expectancy (PE) emerges as the single most influential positive determinant ($\beta = 0.264, p < 0.001$), underscoring that individuals accept the system primarily when they perceive clear functional benefits and improved performance. These findings indicate that public service adoption relies heavily on practical outcomes over symbolic or experiential attributes.

Table 10. Public Acceptance of LRT

Independent Variable	Coef	Std. Error	z-value	p-value	Interpretation
Performance Expectancy (PE)	264	70	3.79	0	Significant
Effort Expectancy (EE)	-0.029	63	-0.46	647	Not significant
Attitude (AT)	-0.055	70	-0.79	428	Not significant
Social Influence (SI)	-0.121	68	-1.77	77	Marginal (10%)
Perceived Safety (PS)	209	73	2.88	4	Significant
Anxiety (AN)	52	59	374	374	Not significant
Perceived Cost (PC)	158	66	2.41	16	Significant (+)
Perceived Value of Time (PVT)	126	69	1.83	67	Marginal (10%)
Constant	781	323	2.42	16	—

Source: Analysis Result, 2025

Public acceptance of the LRT is predominantly utilitarian and rational, driven heavily by economic considerations and functional utility rather than social or emotional factors. Price sensitivity (PS) and perceived cost (PC) both exert statistically significant positive effects, confirming that affordability, transparent pricing, and value-for-money are essential for securing public support. Conversely, psychosocial variables—including effort expectancy (EE), attitude (AT), social influence (SI), and anxiety (AN)—show no statistically significant impact, proving that social pressure, emotional responses, and ease of use do not meaningfully influence acceptance decisions. Consequently, effective policy must prioritize tangible performance gains and cost efficiency over social persuasion or attitudinal marketing.

Willingness to Pay Analysis

The willingness to pay (WTP) analysis highlights affordability as a critical determinant for LRT fare structuring and operational subsidy planning. A significant majority of respondents (75.75%) identify travel cost as highly influential in their mode choice, with WTP concentrating between Rp 5,000 and Rp 10,000. While setting base fares within this socially acceptable range maximizes ridership, modal shift, and social inclusiveness, it will likely be insufficient to fully recover high capital and operating expenses, underscoring the necessity of ongoing government subsidies.

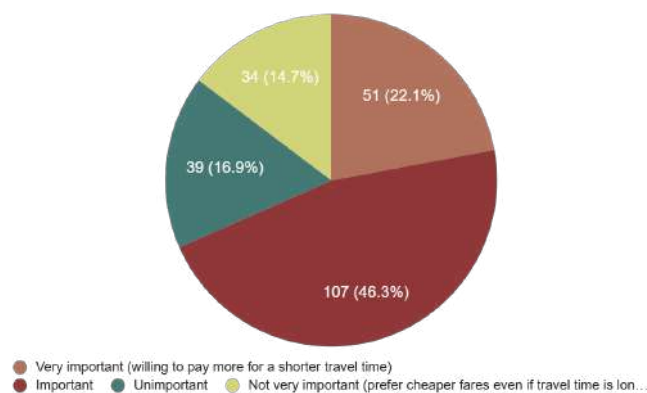


Figure 5. Travel Time

Source: Questionnaire Result, 2025

Travel time and travel cost reveal distinct user heterogeneity, requiring a balanced LRT pricing strategy. While 68.40% of respondents consider travel time important—with 22.08% explicitly willing to pay higher fares for time savings—a significant 31.60% prioritize lower fares over speed. Meanwhile, severe cost sensitivity remains dominant, with 40.69% labeling travel cost as highly influential and 35.06% as quite influential. Fares exceeding affordability thresholds risk heavy demand suppression, proving that low to moderate base fares are essential to protect low-income commuters, maintain ridership, and balance revenue against price elasticity.

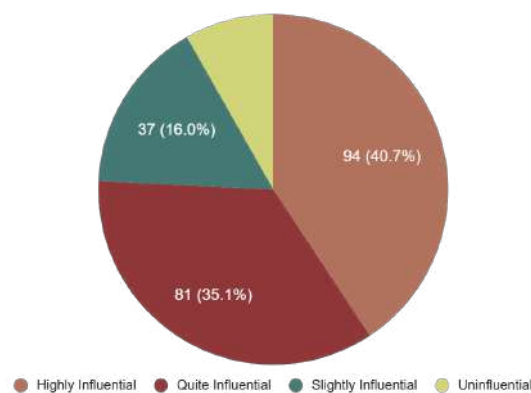


Figure 6. Travel Cost

Source: Questionnaire Result, 2025

The findings necessitate operational subsidies to bridge the financial gap between affordable user fares and high operating costs, justified by broader public benefits like reduced congestion, lower emissions, and enhanced urban productivity. To maximize revenue while protecting social equity, a

differentiated fare strategy is recommended: premium peak-hour or express services can capture higher fares from time-sensitive commuters, while targeted discounts support low-income groups and students. Supported by unified ticketing integration across transport modes, a balanced scheme pairing affordable base fares and subsidies with targeted revenue-enhancement mechanisms ensures both high ridership and long-term financial viability.

Potential Emission and Congestion Reduction of LRT Mode Analysis

The proposed LRT system in Greater Bandung serves as a strategic mass-transit solution to combat urban mobility challenges, road capacity limits, and environmental pressures caused by rapid urbanization. Survey results demonstrate strong public support and confidence in the LRT's ability to reduce traffic congestion across intercity commuting routes (Kota Bandung, Kabupaten Bandung, KBB, and Kota Cimahi). Furthermore, respondents strongly recognize the LRT's environmental benefits—specifically lower emissions and improved air quality—aligning with previous electrified rail studies and offering critical pollution control tailored to Greater Bandung's unique topography.

Table 11. Estimated CO₂ Emissions by Transport Mode

No	Transport Mode	CO ₂ Emissions (g CO ₂ /passenger-km)
1	Light Rail Transit (Electric)	15–35
2	Urban Rail/Metro (Electric)	20–40
3	Bus (Diesel, Urban Average)	70–100
4	Motorcycle (Gasoline)	60–90
5	Private Car (Gasoline, Average Occupancy)	120–180

Source: Zhang et al., 2014; IEA, 2019

Based on these estimates, the introduction of an electric LRT system in Greater Bandung has the potential to reduce emissions by more than 80% per passenger-kilometer when shifting trips from private cars to LRT. For example, replacing a private car trip (approximately 150 g CO₂/passenger-km) with an LRT trip (approximately 25 g CO₂/passenger-km) results in an estimated reduction of around 125 g CO₂ per passenger-kilometer. Even compared to motorcycles and diesel buses, modes that dominate current travel patterns in Greater Bandung shows that the LRT offers emission savings of approximately 40–60%.

Beyond direct emission reductions, the LRT is also expected to generate indirect environmental benefits through congestion mitigation. Reduced traffic congestion leads to lower fuel consumption, decreased vehicle idling, and more stable traffic flow on major corridors, thereby amplifying the overall emission reduction effect. Evidence from other Indonesian metropolitan areas, such as Jakarta, shows that the expansion of electric and rail-based public transport has been associated with measurable improvements in air quality indicators, including reductions in PM_{2.5} concentrations. These experiences provide a relevant reference for the anticipated impacts of the LRT in Greater Bandung.

CONCLUSION

The public's intention to use the Bandung Raya LRT is predominantly driven by operational efficiency and economic considerations, with travel time emerging as the most influential determinant across both Babakan Siliwangi–Margahayu and Leuwipanjang–Tegalluar corridors. Travel cost and waiting time also shape mode choice, particularly for longer-distance trips, while environmental attributes such as emissions reduction and noise levels play a secondary but supportive role, especially along the Leuwipanjang–Tegalluar corridor. Multinomial Logit model results indicate a strong intrinsic preference for LRT relative to other modes, notably conventional buses and ride-hailing, highlighting its competitiveness in terms of speed, reliability, and congestion avoidance. Observed ridership patterns and alternative-specific constants confirm that LRT's advantages in travel time and operational performance are key drivers of mode selection, whereas sustainability attributes, although positively perceived, currently have limited direct influence on actual behavior.

Structural equation modeling and willingness-to-pay analysis further reveal that public acceptance is primarily utilitarian, shaped by performance expectancy and perceived affordability. Psychosocial factors such as effort expectancy, social influence, and attitude have minimal effect, indicating that rational evaluation of functional benefits and economic feasibility guides acceptance decisions. The majority of respondents are willing to pay fares between Rp 5,000 and Rp 10,000, suggesting that operational subsidies are required to ensure financial sustainability without compromising accessibility. Combined with potential environmental benefits, estimated CO₂ reductions of up to 80% per passenger-kilometer compared to private cars, the findings emphasize that effective LRT implementation should prioritize enhancing operational performance, maintaining affordable fare structures, and leveraging environmental advantages. Such an integrated approach is essential for maximizing ridership, promoting modal shift, and advancing sustainable urban mobility in the Greater Bandung metropolitan area.

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