

Evaluating Shuttle Feeder Service Preferences for MRT Lebak Bulus Station Using Scenario-Specific Binary Logit and Generalized Cost Analysis

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Keywords	Abstract
shuttle feeder; MRT Jakarta; stated preference; binary logit; generalized cost	First-mile access remains a critical challenge in connecting residential areas with urban rail stations. This study evaluates a proposed shuttle feeder service for MRT Lebak Bulus Station, Jakarta, using 249 valid stated-preference survey responses. Respondents evaluated Shuttle A (30 minutes, Rp10,000), Shuttle B (25 minutes, Rp15,000), Shuttle C (20 minutes, Rp20,000), and their existing access mode. The analysis integrated observed stated-preference choices, access-mode segmentation, data diagnostics, chi-square association tests, scenario-specific binary logit models, generalized cost sensitivity, willingness to pay, an affordability proxy based on existing access expenditure, and residential corridor synthesis. The findings show that 89.6% of respondents selected a shuttle alternative, with Shuttle B being the most preferred scenario (43.8%). Existing access mode was significantly associated with shuttle choice ($p = 0.034$), while data diagnostics indicated no serious multicollinearity between time and cost differences. Among the scenario-specific logit models, Shuttle C versus existing mode produced the strongest result (Omnibus $p = 0.010$; Nagelkerke $R^2 = 0.152$), with cost difference being statistically significant ($p = 0.007$). The significant Shuttle C model should be interpreted as evidence of a cost-sensitive segment rather than as the sole basis for selecting the initial service package. Nevertheless, Shuttle B remains the most realistic initial operational package because it combines the strongest stated preference, a middle fare, and consistency with dominant willingness-to-pay and affordability ranges. Cluster-based synthesis further indicates that the southwest corridor, particularly the Ciputat-Rempoa-Legoso cluster, should be prioritized for initial implementation.

INTRODUCTION

Urban rail systems are expected to improve mobility in metropolitan areas, but their performance depends strongly on the quality of first-mile and last-mile access. If the access trip to a station is costly, unreliable, or inconvenient, the attractiveness of the main rail service can decline even when the rail corridor itself is efficient (Birolini et al., 2019; Xu et al., 2023). First-mile feeder services therefore play an important role in supporting multimodal integration and reducing dependence on private vehicles for station access (Shah, 2025; Shen et al., 2018; Yadav et al., 2025).

MRT Lebak Bulus Station is a strategic terminal station on the Jakarta MRT network (PT MRT Jakarta, 2025). The surrounding residential areas are served by heterogeneous access modes, including motorcycles, private cars, ride-hailing, public transport, and non-motorized trips. This

diversity makes a uniform feeder strategy insufficient. A proposed shuttle feeder service must be evaluated not only by overall interest, but also by how its travel time and fare compare with the existing access modes used by different respondent groups (Amrapala, 2019; Baghestani et al., 2025; Chowdhury & Ceder, 2016; Saiyad et al., 2022).

Previous studies have discussed public transport access, service quality, willingness to pay, and first-mile/last-mile service design (Eboli and Mazzulla 2008; Alhassan et al. 2022; Sabinik Pecherski et al. 2025). However, there remains a need for local evidence that combines stated-preference choices, existing access-mode segmentation, time-cost-based scenario-specific binary choice model, WTP/affordability indicators, and residential corridor priorities in a single operational evaluation framework. This is particularly relevant for rail stations in large metropolitan contexts where users arrive from different residential corridors and access modes.

Conceptually, the analysis is grounded in transport choice and generalized cost frameworks that represent user choice as the outcome of trade-offs among time, cost, and service attributes (Ben-Akiva and Lerman 1985; Train 2009; Ortuzar and Willumsen 2011; Small and Verhoef 2007). The valuation of time and convenience in public transport is central to evaluating feeder services (Wardman 2004; International Transport Forum 2014; Litman 2023; Guo and Wilson 2011). Operational feeder services also require attention to route design, reliability, vehicle capacity, and demand-responsive public transport planning (Ceder 2007; Vansteenwegen et al. 2022).

This pairwise approach is more realistic for evaluating a new service against a status quo. Second, it combines this model with a deterministic generalized cost sensitivity analysis under multiple value-of-time assumptions, providing a robustness check that is rarely reported in stated-preference studies (Goldszmidt et al., 2020; Malisan & Tresnawati, 2019; Shams et al., 2017). Third, it translates statistical findings into a practical, cluster-based implementation roadmap that prioritizes specific residential corridors (e.g., Ciputat-Rempoa-Legoso) and target user segments (four-wheel private and ride-hailing users), which is a direct policy output that goes beyond academic modeling.

This article focuses on the operational feasibility of a shuttle feeder concept for MRT Lebak Bulus Station and emphasizes policy-relevant findings for service implementation. The objectives are to identify the preferred shuttle scenario, examine whether existing access mode is associated with shuttle choice, estimate scenario-specific binary logit models based on time and cost differences, evaluate shuttle competitiveness using generalized cost sensitivity, and translate the findings into cluster-based implementation recommendations.

METHOD

The study used a quantitative stated-preference survey with 249 valid respondents. The survey used purposive sampling and was distributed to MRT users and potential MRT users with relevance to MRT Lebak Bulus Station. Responses were considered valid when respondents completed the stated-preference section and provided usable information on existing access mode, travel time, and travel cost. Existing access time and cost were primarily obtained from

respondents' current access trips and were checked during data cleaning for consistency with the reported mode and residential corridor.

The survey presented three shuttle feeder scenarios. Shuttle A represents a lower-fare but longer-travel-time service, Shuttle B represents an intermediate alternative, and Shuttle C represents a higher-fare but shorter-travel-time service. Respondents could also remain with their existing access mode.

Table 1. Shuttle feeder scenarios used in the stated-preference survey

Scenario	Travel time	Fare
Shuttle A	30 minutes	Rp10,000
Shuttle B	25 minutes	Rp15,000
Shuttle C	20 minutes	Rp20,000

The original stated-preference choice variable recorded four alternatives: Shuttle A, Shuttle B, Shuttle C, and existing access mode. Three scenario-specific binary variables were then formed. Y_A_CURRENT was coded 1 for Shuttle A and 0 for the existing mode; Y_B_CURRENT was coded 1 for Shuttle B and 0 for the existing mode; and Y_C_CURRENT was coded 1 for Shuttle C and 0 for the existing mode. Respondents who selected other shuttle scenarios were treated as missing in each scenario-specific binary model.

The scenario-specific binary logit models should therefore be interpreted as pairwise stated-choice comparisons between each shuttle scenario and the existing access mode, rather than as a full multinomial choice model of all four alternatives.

Existing access modes were grouped into two levels. The detailed grouping included two-wheeled private vehicle, four-wheeled private vehicle, two-wheeled ride-hailing, four-wheeled ride-hailing, public transport, and non-motorized mode. For grouped-mode statistical tests, ride-hailing categories were combined, while the single non-motorized respondent was excluded from the grouped model analysis due to very small sample size.

The analysis was conducted in six stages. First, stated-preference choices and existing access modes were summarized descriptively. Second, data diagnostics were performed, including inspection of extreme values, correlation between time and cost differences, and multicollinearity checking using tolerance and variance inflation factor (VIF). Third, cross-tabulation and chi-square tests were used to examine the association between existing access mode and shuttle choice. Fourth, scenario-specific binary logit models were estimated for Shuttle A, Shuttle B, and Shuttle C against the existing access mode. Fifth, generalized cost was used as a deterministic sensitivity framework for time-cost competitiveness. Sixth, WTP, an affordability proxy, and residential corridor clusters were synthesized into implementation recommendations.

Scenario-Specific Binary Logit and Time-Cost Variables

For each shuttle scenario k , the model compared the selected shuttle scenario with the existing access mode. The time-cost variables were defined as the differences between the existing access mode and the corresponding shuttle scenario, as shown in Eq. (1) and Eq. (2).

$$\Delta T_k = T_{\text{existing}} - T_{\text{shuttle},k} \quad (1)$$

$$\Delta C_k = C_{\text{existing}} - C_{\text{shuttle},k} \quad (2)$$

Where ΔT_k is the travel-time difference and ΔC_k is the cost difference for shuttle scenario k . Cost difference was expressed in thousand rupiah to improve coefficient readability. A positive ΔT_k means that the existing access trip takes longer than the shuttle scenario, while a positive ΔC_k means that the existing access trip costs more than the shuttle scenario. The binary logit model was specified as Eq. (3).

$$\text{Logit}(P_k) = \beta_0 + \beta_T \Delta T_k + \beta_C \Delta C_k \quad (3)$$

Where P_k is the probability of choosing shuttle scenario k compared with the existing mode. The estimated coefficients were interpreted as scenario-specific logit functions based on time and cost differences for each scenario-specific choice comparison.

Generalized Cost Sensitivity

In addition to the estimated binary logit models, a deterministic generalized cost analysis was used to compare shuttle scenarios under different value-of-time assumptions. The generalized cost of each access alternative was calculated using Eq. (4).

$$GC = C + \lambda T \quad (4)$$

$$\Delta GC_k = GC_{\text{existing}} - GC_{\text{shuttle},k} \quad (5)$$

A positive ΔGC_k indicates that shuttle scenario k has a lower generalized cost than the existing access mode and is therefore more competitive.

Where GC is generalized cost, C is travel cost or fare, T is travel time, and λ is the assumed value of time. Values of Rp500, Rp1,000, and Rp1,500 per minute were selected to represent low, moderate, and high time valuation assumptions for access trips in the Jakarta urban context. This analysis was used as sensitivity evidence and was not treated as a direct estimation of respondents' value of time.

RESULTS AND DISCUSSION

Observed Stated-Preference Choice and Existing-Mode Segmentation

Table 2 shows the distribution of respondents selected stated-preference alternatives. A total of 223 respondents (89.6%) selected a shuttle alternative, while 26 respondents (10.4%) selected the existing access mode. Shuttle B was the most preferred alternative, selected by 109 respondents (43.8%).

Table 2. Distribution of observed stated-preference choices

Alternative	Frequency	Valid percent
Shuttle A	60	24.1%
Shuttle B	109	43.8%
Shuttle C	54	21.7%
Existing access mode	26	10.4%
Total	249	100.0%

The distribution suggests that the proposed shuttle service received strong stated acceptance. However, the dominance of Shuttle B indicates that respondents did not simply

prefer the cheapest or fastest option. Instead, they tended to select the intermediate service package that balances travel time and fare.

Table 3. Existing access-mode distribution

Existing access mode group	Frequency	Valid percent
Two-wheeled private vehicle	97	39.0%
Four-wheeled private vehicle	56	22.5%
Two-wheeled ride-hailing	69	27.7%
Four-wheeled ride-hailing	14	5.6%
Public transport	12	4.8%
Non-motorized	1	0.4%
Total	249	100.0%

Existing access-mode segmentation is important because different user groups face different access costs, travel times, and levels of flexibility. Two-wheeled private vehicle users formed the largest group, followed by two-wheeled ride-hailing and four-wheeled private vehicle users.

Data Diagnostics and Association between Existing Mode and Shuttle Choice

Before estimating the scenario-specific logit models, the data were examined to ensure that the main time and cost variables were suitable for model testing. The 249 valid observations had an average existing access time of 13.51 minutes and an average existing access cost of Rp10,415.56. After the single non-motorized observation was excluded from grouped-mode modelling, 248 observations remained for the grouped access-mode analysis. The correlation between time difference and cost difference for the Shuttle B comparison was 0.265, indicating a low-to-moderate relationship. The VIF value was 1.075, indicating no serious multicollinearity between the time and cost difference variables. Similar diagnostic checks were conducted for the Shuttle A and Shuttle C comparisons, and no serious multicollinearity was detected.

Table 4. Data diagnostics and existing-mode association results

Diagnostic item	Result	Interpretation	Use in analysis
Valid stated-preference cases	249	Main cleaned sample	Descriptive and stated-preference analysis
Grouped-mode cases	248	One non-motorized respondent excluded	Grouped access-mode analysis
Mean existing access time	13.51 minutes	Access trip time varies across modes	Cost-function variable
Mean existing access cost	Rp10,415.56	Access expenditure varies across modes	Cost-function variable
Correlation: Δ Time_B and Δ Cost_B	$r = 0.265$	No strong correlation	Supports joint model entry
Multicollinearity diagnostic	Tolerance = 0.930; VIF = 1.075	No serious multicollinearity	Supports binary logit testing
Chi-square: Mode group \times Y_SHUTTLE	$p = 0.034$; Cramer's V = 0.187	Significant weak association	Supports access-mode segmentation

The chi-square result indicates that shuttle acceptance varies by existing access mode. The grouped crosstab showed that 87.6% of two-wheeled private vehicle users, 92.9% of four-wheeled private vehicle users, 92.8% of ride-hailing users, and 66.7% of public transport users selected a shuttle alternative. Therefore, existing access mode remains substantively important even when it is not included directly in the final logit model.

Scenario-Specific Binary Logit Results

Three binary logit models were estimated by comparing each shuttle scenario with the existing access mode. This specification follows the binary mode-choice logic in which each respondent's existing mode is compared with a candidate shuttle alternative using time and cost differences. Table 5 summarizes the model results.

Table 5. Scenario-specific binary logit results

Model	Valid N	Omnibus p	Nagelkerke R ²	Hosmer-Lemeshow p	Significant variable	Interpretation
Shuttle A vs existing mode	86	0.145	0.062	0.906	None	Model not significant at 5%
Shuttle B vs existing mode	135	0.255	0.032	0.220	None; $\Delta\text{Time_B}$ approaches 10% (p = 0.099)	Model not significant at 5%
Shuttle C vs existing mode	80	0.010	0.152	0.362	$\Delta\text{Cost_C}$ (p = 0.007; $\text{Exp(B)} = 1.095$)	Best-performing model
Shuttle C + access-mode group	80	0.075	0.164	0.551	None	Diagnostic check; weaker due small subgroup size

The scenario-specific results show that Shuttle C versus existing mode produced the strongest statistical model. The model was significant at the 5% level, with Omnibus p = 0.010 and Nagelkerke R² = 0.152. The cost-difference variable for Shuttle C was statistically significant, with B = 0.091, p = 0.007, and Exp(B) = 1.095. This means that each additional Rp1,000 in the cost difference between the existing access mode and Shuttle C increased the odds of selecting Shuttle C by approximately 9.5%, holding the time difference constant. In practical terms, Shuttle C becomes more attractive for respondents whose existing access trips are relatively expensive. Therefore, the Shuttle C model is best interpreted as identifying a cost-sensitive potential segment, while the choice of the initial service package still requires synthesis with stated preference, WTP, affordability, and corridor priority.

The time-difference variable in the Shuttle C model was not statistically significant (p = 0.206). Therefore, the statistically supported driver in the Shuttle C comparison is cost difference rather than time difference. The models for Shuttle A and Shuttle B did not reach statistical significance at the 5% level. This does not mean that Shuttle A and Shuttle B are irrelevant; instead,

it indicates that their selection is not sufficiently explained by time and cost differences alone in the available stated-preference data.

A supplementary model added the grouped existing access mode variable to the Shuttle C model. The model approached but did not reach the 5% significance threshold ($p = 0.075$), and the access-mode categories were not significant. Because the Y_C_CURRENT model contains only 80 valid cases, adding multiple access-mode categories increases estimation instability. Therefore, existing access mode is interpreted through crosstabulation and chi-square analysis, while the simpler Shuttle C model is retained as the most reliable scenario-specific logit result.

Table 6. Estimated scenario-specific logit functions

Model	Estimated logit function	Main interpretation
Shuttle A	$\text{Logit}(P_A) = 0.127 - 0.046\Delta T_A + 0.044\Delta C_A$	Not statistically significant as a full model
Shuttle B	$\text{Logit}(P_B) = 1.125 - 0.047\Delta T_B + 0.031\Delta C_B$	Most preferred stated-preference scenario, but not statistically significant as a logit model
Shuttle C	$\text{Logit}(P_C) = 1.334 - 0.038\Delta T_C + 0.091\Delta C_C$	Best-performing model; ΔCost_C is significant

The estimated scenario-specific logit functions show that the scenario with the strongest statistical support is Shuttle C. However, the stated-preference distribution shows that Shuttle B remains the dominant chosen alternative. This distinction is important: the logit model identifies where cost differences statistically explain choice, while the stated-preference distribution identifies which service package is most acceptable to respondents overall.

Generalized Cost Sensitivity and Mode-Specific Competitiveness

The deterministic generalized cost sensitivity analysis was retained as a complementary framework to compare the three fixed shuttle scenarios under alternative value-of-time assumptions. Table 7 presents the generalized cost of the shuttle alternatives under three assumed values of time.

Table 7. Generalized cost of shuttle scenarios under value-of-time sensitivity

Value of time	GC Shuttle A	GC Shuttle B	GC Shuttle C	Most competitive shuttle scenario
Rp500/minute	Rp25,000	Rp27,500	Rp30,000	Shuttle A
Rp1,000/minute	Rp40,000	Rp40,000	Rp40,000	A/B/C equal
Rp1,500/minute	Rp55,000	Rp52,500	Rp50,000	Shuttle C

The sensitivity results show that the preferred shuttle scenario changes according to the assumed value of time. Shuttle A is more competitive when time is valued relatively low, all scenarios are equal at Rp1,000/minute, and Shuttle C becomes more competitive when time is valued higher. This result supports the interpretation that Shuttle C is more attractive for users with higher cost or time burdens, while Shuttle B remains the most acceptable compromise in stated-preference terms.

Table 8. Percentage of respondents for whom each shuttle scenario is more competitive than the existing mode under $\lambda = \text{Rp}500/\text{minute}$

Existing access mode group	Shuttle A	Shuttle B	Shuttle C
Two-wheeled private vehicle	0.0%	0.0%	0.0%
Four-wheeled private vehicle	44.6%	25.0%	5.4%
Two-wheeled ride-hailing	23.2%	15.9%	10.1%
Four-wheeled ride-hailing	42.9%	21.4%	14.3%
Public transport	58.3%	50.0%	41.7%
Non-motorized	0.0%	0.0%	0.0%
Total	21.7%	13.7%	6.8%

The mode-specific comparison indicates that two-wheeled private vehicle users are the most difficult segment to shift based on time and cost alone. Their existing access trips are relatively cheap and fast, making all shuttle scenarios less competitive. In contrast, four-wheeled private vehicle users and ride-hailing users are more promising target groups because their existing access costs are closer to or higher than the shuttle fare. Public transport users appear competitive in generalized cost terms, but their observed stated-preference acceptance was lower than that of private vehicle and ride-hailing users, suggesting a gap between cost-based competitiveness and perceived service attractiveness.

WTP, Affordability Proxy, and Residential Cluster Synthesis

Willingness to pay was interpreted as respondents' maximum acceptable shuttle fare, while ability to pay was treated as an affordability proxy based on existing access expenditure. Therefore, ATP in this study should not be interpreted as household income-based ability to pay, but as an affordability indication derived from current access expenditure. The dominant WTP range was Rp10,000-Rp15,000, followed by Rp15,000-Rp20,000. The dominant existing travel expenditure range was also in the middle-cost range, especially Rp10,001-Rp15,000 and Rp15,001-Rp20,000. This supports the feasibility of a Rp15,000 service, especially if it provides reliable travel time and accessible pickup locations.

Table 9. Cluster-based synthesis for implementation recommendation

Cluster/corridor	Main characteristics	Preference/WTP pattern	Recommendation
Cluster 1: South corridor (Cirendeuh-Cinere)	Medium access burden, medium-to-upper existing cost	Shuttle B; WTP Rp10,000-Rp15,000	Medium priority; emphasize reliability and time efficiency
Cluster 2: Southwest corridor (Ciputat-Rempoa-Legoso)	Strong commuter profile, frequent MRT use, highest interest	Shuttle B; WTP Rp10,000-Rp15,000	Primary implementation corridor
Cluster 3: North and east corridor (Pondok Indah-Cilandak-Fatmawati)	Work and education trips, moderate cost	Shuttle B; WTP Rp10,000-Rp15,000	Secondary implementation corridor
Cluster 4: Northwest corridor (Karang Tengah-Pangkalan Jati)	Heavier access conditions, smaller sample, higher fare tolerance	Shuttle B; WTP Rp15,000-Rp20,000	Selective or pilot implementation

The southwest corridor, represented by Cluster 2 (Ciputat-Rempoa-Legoso), is the most suitable initial implementation area because it combines strong commuter characteristics, high stated interest, and a WTP range consistent with the Shuttle B fare. Other corridors can be developed gradually based on demand potential, access burden, and operational readiness.

Policy Implications

First, a Shuttle B-like service is the most realistic initial scenario because it aligns with the strongest stated preference and dominant WTP/affordability ranges. A fare around Rp15,000 and a target travel time around 25 minutes should therefore be used as the baseline operational package.

Second, the significant Shuttle C model indicates that cost difference becomes important for respondents with higher existing access costs. Therefore, a faster shuttle variant similar to Shuttle C may be relevant for selected user segments, especially those currently using costly access modes.

Third, implementation should prioritize the southwest residential corridor around Ciputat-Rempoa-Legoso. This corridor has the strongest demand indicators and is likely to provide a more reliable early ridership base.

Fourth, marketing and service design should initially target four-wheeled private vehicle and ride-hailing users, whose existing access costs are more comparable to shuttle fares. Two-wheeled private vehicle users may require additional incentives such as promotional fares, parking-related benefits, integrated ticketing, or comfort and safety improvements.

Fifth, service planning should not rely on fare alone. Schedule certainty, pickup-point accessibility, reliability, and integration with MRT departure times are likely to influence acceptance and should be considered in future operational design.

Limitations

This study has several limitations. First, the analysis is based on stated-preference responses and is therefore subject to hypothetical bias. Second, the shuttle scenarios contain only three fixed time-fare combinations, limiting the variation available for estimating stronger behavioral models. Third, the access-mode categories become small when the sample is divided into scenario-specific binary comparisons; therefore, access mode is interpreted primarily through crosstabulation and chi-square analysis rather than as a full categorical predictor in the final logit model. Fourth, generalized cost analysis uses value-of-time assumptions rather than a value of time estimated directly from richer choice data. Fifth, ATP is approximated using existing access expenditure, not household income. Sixth, the scenario-specific binary models exclude respondents who selected other shuttle scenarios in each pairwise comparison; therefore, the results should not be interpreted as full market-share estimates across all alternatives. Finally, this article does not simulate fleet size, headway, route design, vehicle capacity, or detailed pickup-point locations.

CONCLUSION

This study evaluates a proposed shuttle feeder service for MRT Lebak Bulus Station by integrating stated-preference choices, existing access-mode segmentation, data diagnostics, scenario-specific binary logit models, generalized cost sensitivity, WTP, an affordability proxy, and residential corridor analysis. The results show that shuttle acceptance is high, with 89.6% of respondents selecting a shuttle alternative. Shuttle B is the most preferred alternative, selected by

43.8% of respondents, indicating that the intermediate package of 25 minutes and Rp15,000 is the most acceptable stated-preference scenario. Existing access mode is significantly associated with shuttle choice, and diagnostic checks showed no serious multicollinearity between time and cost differences. Among the scenario-specific logit models, Shuttle C versus existing mode produced the strongest result, with Omnibus $p = 0.010$ and Nagelkerke $R^2 = 0.152$. The cost-difference variable was statistically significant, indicating that respondents with higher existing access costs are more likely to choose Shuttle C. In contrast, the Shuttle A and Shuttle B logit models did not reach statistical significance at the 5% level. Despite the stronger statistical result for Shuttle C, the observed stated-preference result supports Shuttle B as the most realistic initial service package. Shuttle B should be interpreted as a compromise between affordability and travel-time improvement, rather than as the scenario with the strongest estimated time-cost response effect. The recommended implementation strategy is to develop a Shuttle B-like service, prioritize the southwest residential corridor, and focus early targeting on users whose existing access costs are relatively high, especially four-wheeled private vehicle and ride-hailing users. Overall, the findings suggest that an initial Shuttle B-like service can serve as the operational baseline, while Shuttle C-like improvements may be considered for higher-cost access segments after demand is validated. Future research should refine the stated-preference design by introducing more varied combinations of fare, travel time, headway, pickup location, and reliability. Further work should also estimate value of time directly from richer choice data and integrate operational simulations for fleet size, headway, and route design.

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