Factors Influencing the Choice of Transportation Modes and Travel Patterns of Tourists in Yogyakarta, Indonesia

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Abstract: This study employs a Multinomial Logistic Regression (MNL) model estimated using Maximum Likelihood Estimation (MLE) to analyze factors influencing tourists transportation mode choice in Yogyakarta, Indonesia. A structured questionnaire was administered to 805 respondents between January and March 2023, focusing on variables such as the number of destinations visited, length of stay, type of accommodation, and lodging location. The analysis revealed that rental cars (27.3%) and electric trains (26.2%) were the most preferred modes. Tourists staying in higher end hotels were significantly less likely to use public transport, showing a preference for private or premium services. In contrast, tourists with longer stays and lower-cost accommodations were more likely to choose flexible and affordable options such as rented motorcycles. These findings provide important insights for policymakers to develop sustainable and segmented transportation strategies that enhance tourist mobility while minimizing environmental impact.

Keywords: *Tourism Mobility, Mode Choice, Sustainable Transport, Multinomial Logistic Regression*

1. INTRODUCTION

Tourism is one of the fastest-growing sectors in Indonesia, with the Special Region of Yogyakarta (DIY) emerging as a key destination due to its rich cultural heritage, historical landmarks, and academic ambiance. According to Badan Pusat Statistik(Statistik 2022), the region recorded 34.29 million domestic tourist trips and 6,728 international tourist arrivals between January and November 2021, making it one of the most visited areas in the country. However, this surge in tourism demand has posed significant challenges for urban transport infrastructure, manifested in traffic congestion, limited access to public transportation, and environmental degradation—particularly in peri-urban and rural tourist zones such as Kaliurang, Imogiri, and Parangtritis.

Yogyakarta exhibits a distinctive tourism pattern that combines cultural and educational elements. The city is widely recognized as the "student and cultural city," with educational centers such as Smart Park attracting students and university tourists (Wijayanti *et al.* 2019). Meanwhile, the development of tourism villages and ecotourism in rural areas highlights the role of geographical context and local traditions as critical factors in the sustainability of destinations(Wijayanti *et al.* 2019).

Unlike Bali or Jakarta, tourism flows in Yogyakarta are concentrated in short-radius circuits between iconic locations such as Malioboro, the Kraton, and Borobudur, often within one- or two-day itineraries. The city's compact urban form and the intensive use of specific corridors—particularly the Malioboro–Kraton axis—result in peak-hour congestion and strain on last-mile connectivity (Hertanto *et al.* 2018). Additionally, the region faces unique challenges, including

low integration between tourism zones and mass-transit systems, limited formal transport options in peri-urban areas, and inconsistent infrastructure quality across high-demand routes. Studies have shown that although the Trans Jogja BRT network covers core urban corridors, it remains suboptimal and insufficiently accessible in peri-urban tourism areas like Borobudur, resulting in dependence on private vehicles and ride-hailing services(Atmojo *et al.* 2024).

The reliance on private vehicles—particularly motorcycles and rented cars—among tourists is well documented. Studies have found that the majority of Gen Z travelers to Prambanan prefer private transport modes despite the availability of Trans Jogja, largely due to cost considerations (Wahida *et al.* 2023);(Malkhamah *et al.* 2019);(Irawan *et al.* 2017). Similarly, limited multimodal options often compel commuters to rely on private transport for first- and last-mile segments near key transport nodes such as railway stations (Irawan *et al.* 2017). Additional factors—such as travel cost, journey time, and walking distance to bus stops—have been found to significantly influence mode choice, highlighting the importance of micro-level modeling in understanding traveler decisions (Firdausi 2015).

Transportation is a vital component of the tourism experience, influencing mobility, accessibility, and overall satisfaction. Previous research underscores the significance of integrated and sustainable transport systems in supporting urban tourism development (Ramadhan and Buchori 2018):(Beira and Cabral 2007). Integrated systems—encompassing modal coordination, synchronized schedules, and unified information—have been shown to improve tourist mobility while mitigating environmental externalities. Nevertheless, despite the increasing number of tourists in Yogyakarta, the city's transport system remains fragmented, with public services such as Trans Jogja and the KRL commuter rail not yet effectively covering all key tourist destinations (Hartanto 2014).

Moreover, existing studies on tourism transport behavior have primarily focused on macro-level infrastructure or general travel patterns, with limited attention to individual-level decision-making. In contrast, recent research emphasizes that individual attributes and trip characteristics—such as accommodation type, duration of stay, travel motivation, and number of destinations—play a critical role in mode choice decisions (Le-Klähn *et al.* 2014); (Pulido-Fernández *et al.* 2024). For instance, tourists staying in higher-end accommodations are more likely to opt for private or premium transport services, whereas those in budget lodgings tend to prefer public or shared mobility options. However, the extent to which these patterns apply in a mixed-mode and culturally dense context like Yogyakarta remains underexplored.

This study seeks to address that gap by empirically examining the factors influencing tourist transportation mode choices in Yogyakarta through a Multinomial Logistic Regression (MNL) model estimated via Maximum Likelihood Estimation (MLE). Drawing upon primary data from 805 respondents, the analysis incorporates key explanatory variables such as accommodation type, length of stay, number of destinations visited, and lodging location. In doing so, this research contributes both theoretically and practically by: (1) advancing the literature on discrete choice modeling within the tourism domain, and (2) offering actionable insights for policymakers, planners, and tourism stakeholders in designing segmented, efficient, and sustainable mobility strategies tailored to diverse tourist profiles.

2. LITERATURE REVIEW

The relationship between transportation and tourism has received extensive scholarly attention, particularly due to the critical role of accessibility in shaping tourists' mobility, satisfaction, and destination competitiveness. (Beira and Cabral 2007) and (Göransson and Andersson 2023) underscore that mode choice decisions are often driven by convenience, flexibility, and affordability, factors that directly influence perceived quality of travel. Similarly,(Le-Klähn *et al.* 2015) found that tourists with higher education levels and budget-conscious attitudes are

more likely to choose public transportation, particularly in destinations where systems are well-integrated and perceived as reliable.

Accommodation type also plays a significant role in shaping travel behavior. Tourists staying in premium or star-rated hotels often exhibit a preference for private vehicles, including rented cars or chartered transport, valuing comfort and autonomy. In contrast, guests in budget lodgings, hostels, or homestays tend to rely on public or shared mobility options (Pulido-Fernández *et al.* 2024). Moreover, studies have shown that well-designed transportation infrastructure) particularly those with intermodal integration and pedestrian accessibility (can greatly improve tourist mobility and satisfaction (Domènech *et al.* 2023);(Supraptini and Supriyadi 2020).

In the Southeast Asian context, including Indonesia, a number of studies point to fragmented public transport services and weak coordination between tourism development and urban mobility systems. In Yogyakarta specifically, existing studies highlight the lack of a unified network linking city centers with peripheral attractions, resulting in poor last-mile connectivity and access gaps (Setiawan *et al.* 2022). These conditions underscore the need for integrated, multi-modal transport planning that responds to diverse tourist profiles and supports sustainable tourism mobility.

(Sun *et al.* 2015), examining Eastern China, further emphasize that multimodal transport accessibility is positively associated with tourism development and regional economic growth, underscoring the strategic importance of mobility infrastructure for destination competitiveness across East Asia.

3. METHODOLOGY

3.1 Research Design and Analytical Approach

This study employed a quantitative approach to examine the determinants of tourist transportation mode choice in Yogyakarta. Given that the dependent variable comprises multiple unordered categories, the analysis utilized a Multinomial Logistic Regression (MNL) model, estimated using the Maximum Likelihood Estimation (MLE) echnique, which enables robust estimation of the probability of choosing each transport alternative as a function of several explanatory variables (Romão and Bi 2021).

3.2 Data Collection

Primary data were obtained through a structured questionnaire survey conducted from January to March 2023 at three major tourist sites in Yogyakarta: Malioboro, Prambanan Temple, and Prawirotaman. The study targeted domestic tourists visiting these areas during the study period. Given the mobility of the tourist population, convenience sampling was applied—a method commonly used in tourism mobility research when probability-based sampling is not feasible (Sullivan 2012). Prior to the main survey, a pilot study was conducted with 50 respondents to validate the questionnaire items and ensure clarity and reliability of the instrument.

A total of 805 valid responses were collected and used in the final analysis. The questionnaire consisted of sections on demographic characteristics, travel behavior, and transport preferences. While income level and transport pricing are known to influence travel mode decisions, these variables were not included due to respondent reluctance and the dynamic nature of tourist transportation costs in Yogyakarta (e.g., app-based pricing, informal negotiation). As alternatives, type of accommodation and length of stay were employed as proxy indicators for socio-economic segmentation.

3.3 Variable Definition and Measurement

The dependent variable was transportation mode choice, categorized into five groups: public transport, rented car, private car, online taxi, and rented motorcycle. Independent variables included:

1. Number of destinations visited: (1, 2, 3, 4, or 5+)
2. Length of stay: (1 day, 2–3 days, 4–7 days, >7 days)
3. Accommodation type: (relatives/home, guesthouse, hostel, 1–2 star hotel, 3–4 star hotel)
4. Lodging location: classified into urban, peri-urban, and suburban zones

All variables were coded categorically to fit the MNL framework.

3.4 Model Specification and Estimation

The MNL model estimates the log-odds of selecting a specific transport mode Pj relative to a reference category (public transport), expressed as:

$$\mathbf{P(Y = j|X)} = \left(\frac{\exp\left(\boldsymbol{\beta 0j+\beta 1jX1+\beta 2j+X2+\cdots.+\beta kjXk}\right.}{\mathbf{1+\sum m\neq ref}\ \exp\left(\boldsymbol{\beta 0m+\beta 1mX1+\cdots.+\beta kmXk}\right.}\right) \quad (1)$$

where :

$\mathbf{P(Y = j|X)}$ is the probability of choosing transport mode j,

$\beta 0j$ is the intercept for mode j,

$\beta 1j \ldots \beta kj$ are coefficients for predictors $X1 \ldots Xk$

The reference category (e.g., public transportation) is used as baseline,

This formulation aligns with standard discrete choice modeling as outlined by (Train 2003). Model estimation was conducted using IBM SPSS Statistics version 26. Public transport was used as the reference category, representing the baseline alternative typically associated with budget-conscious tourists.

3.5 Model Evaluation and Robustness

The model's goodness-of-fit and statistical robustness were assessed using a combination of diagnostic tests consistent with discrete choice modeling practices.

3.5.1 Model Fit Evaluation:

The Likelihood Ratio Chi-Square Test confirmed that the inclusion of explanatory variables significantly improved model fit compared to the intercept-only mode model ($\chi^2 = 122.439$, $p < 0.001$), suggesting that the predictors jointly contribute meaningfully to explaining variation in transport mode choice.

To evaluate explanatory power, three Pseudo R-square values were reported:

1. McFadden $R^2 = 0.038$,
2. Cox & Snell $R^2 = 0.141$,
3. Nagelkerke $R^2 = 0.144$.

While the McFadden R^2 appears modest, values below 0.1 are common and acceptable in multinomial logistic models, particularly when modeling complex, multi-alternative decisions like tourist transport behavior(Menard 2000).

3.5.2 Classification Accuracy:

The model achieved a classification accuracy of 65%, which exceeds the proportional chance criterion of 27.3% (based on the largest observed mode share, i.e., rented cars). This suggests strong predictive performance in classifying transport decisions beyond chance levels.

The classification accuracy was calculated using a confusion matrix, which compares predicted

versus actual transport choices across all six alternatives. This metric provides a practical assessment of the model's predictive utility and confirms that the MNL model effectively distinguishes behavioral patterns among diverse tourist segments.

3.5.3 Multicollinearity Diagnostics

To test for multicollinearity, Variance Inflation Factor (VIF) values were calculated for all independent variables. All VIF values were found to be below the conservative threshold of 5, indicating that collinearity was not a concern and that each predictor offers unique explanatory power(Long JS and Freese J 2014).

3.5.4 Robustness Checks

Although conventional heteroscedasticity tests (e.g., Breusch–Pagan) are not applicable to MNL models due to the categorical nature of the dependent variable, robustness was assessed through subsample sensitivity tests. Model coefficients and standard errors remained stable across multiple estimation runs, confirming the internal consistency and statistical reliability of the model.

4. RESULTS AND DISCUSSION

This section presents the findings of the study, combining descriptive statistics and the outputs of the Multinomial Logistic Regression (MNL) model to analyze the determinants of tourists' transportation mode choices in Yogyakarta. The discussion is structured to interpret these results in light of the theoretical framework, while drawing comparisons with relevant literature. Although this study did not collect direct fare or pricing data for each transport mode, the observed effects of accommodation type and income bracket serve as meaningful proxies for economic considerations. These variables provide indirect evidence that perceived affordability and socio-economic status play a mediating role in transport mode decisions. Tourists staying in mid- to high-range accommodations were more likely to use private and app-based transport, reflecting price tolerance and expectations for convenience, whereas those staying in more affordable lodging options showed stronger preferences for public or shared modes of travel. This finding aligns with previous studies that link accommodation class and income level to perceived value and cost sensitivity in travel behavior (Pulido-Fernández *et al.* 2024);(Beira and Cabral 2007).

4.1 Descriptive Statistics

As presented in Table 1, the gender distribution among respondents was nearly equal, with 50.6% identifying as male and 49.4% as female. The majority of participants (52.8%) were aged 19–29 years, followed by those aged 30–44 (40.8%), suggesting that tourism activity in Yogyakarta is primarily driven by younger adults, consistent with the region's appeal to students and early-career travelers.

In terms of travel patterns, most tourists reported visiting three destinations (68.9%) and staying for 2–3 days (47.7%). This indicates a typical short-stay, multi-location tourism behavior, which is common in compact urban tourism zones with clustered attractions.

Regarding transportation preferences, the most frequently selected modes were rented cars (27.3%) and electric trains (26.2%), followed by private cars (10.7%) and public transportation (9.2%). These figures highlight a rising demand for flexible, semi-private, and sustainable mobility solutions, especially in congested tourist hubs such as Malioboro and Prambanan.

Accommodation types varied, with homestays (23.6%) and 2–3 star hotels (18.8%) being the most common. These choices reflect a moderate budget orientation among visitors. Notably,

tourists staying in more premium accommodations were more likely to choose private transport modes, such as rental cars and online taxis.

Table 1 Gender of Respondents

Variable		Frequency	Percentage
Gender	Man	398	50,60%
	Woman	407	49,40%
Age of Respondents	19-29	425	52,80%
	30-44	328	40,75%
	45-59	51	6,34%
	60-70	1	0,12%

Tourist profiles and travel characteristics are summarized in Table 2. In terms of transportation preferences, the most commonly selected modes were rented cars (27.3%) and electric trains (KRL) (26.2%), followed by private cars (10.7%), public transportation (9.2%), rented motorcycles (7.2%), and online taxis (4.7%). The dominance of rental cars reflects tourists' preference for flexible travel and autonomous mobility, particularly for itineraries involving multiple destinations (Beira and Cabral 2007);(Domènech *et al.* 2023).

Meanwhile, the high usage of KRL suggests growing interest in affordable, sustainable, and reliable transport modes—especially among tourists visiting major cultural sites connected by rail, such as Malioboro and Prambanan(Chen *et al.* 2022).

As shown in Table 2, most respondents reported 2–3 days of stay (47.7%), while 15% stayed for more than 7 days. Longer stays were associated with increased use of rented motorcycles and other flexible transport options, which allow greater spatial coverage with lower costs.

Accommodation types also varied. The most frequent choices were homestays (23.6%) and 2–3 star hotels (18.8%), followed by non-star hotels (18.3%) and relatives' homes (18.1%). Tourists staying in higher-end accommodations (2–3 star and 4-star hotels, 29.6% combined) tended to choose private transport modes such as rental cars and online taxis. Conversely, those staying in budget accommodations (homestays, non-star hotels) showed greater reliance on public or semi-public transport, indicating a budget-conscious mobility pattern.

These findings suggest the coexistence of diverse mobility needs across tourist segments in Yogyakarta, reinforcing the importance of a multi-modal and inclusive transportation strategy that integrates both public and private transport services tailored to different travel durations and lodging types.

Table 2 : Descriptive Statistics of Tourist Transportation Choices and Travel Characteristics in Yogyakarta

Variable		Frequency	Percentage
Transportation Mode	Rented Car	220	27.3%
	Electric Train (KRL)	211	26.2%
	Private Car	86	10.7%
	Rented Motorcycle	58	7.2%
	Online Taxi	38	4.7%
	Public Transportation	74	9.2%
Length of Stay	1 Wire	74	9.2%
	2 Days	180	22.4%
	3 Days	204	25.3%
	More than 7 Days	121	15.0%
Type of Accommodation	Staying with Relatives	146	18.1%
	Homestay	190	23.6%

Variable	Frequency	Percentage
Non-Star Hotel	147	18.3%
2-3 Star Hotel	151	18.8%
4-Star Hotel	87	10.8%

4.2 Multinomial Logistic Regression (MNL) Analysis

The Multinomial Logistic Regression (MNL) model was used to analyze the factors influencing tourists' transportation mode choices in Yogyakarta. This model was estimated using Maximum Likelihood Estimation (MLE), with the dependent variable being the mode of transport chosen by the tourists (i.e., rental cars, electric trains (KRL), private cars, online taxis, rented motorcycles, or public transportation). The reference category for the model was public transport, which represents the most commonly used mode of transport for budget-conscious tourists in urban settings.

4.2.1 Model Result

Table 4.2 summarizes the estimated coefficients from the multinomial logistic regression model predicting tourists' transportation mode choices in Yogyakarta. The reference category in the model is public transportation. Significant predictors of mode choice include the number of destinations visited, length of stay, and type of accommodation.

Notably, tourists visiting more destinations were significantly less likely to choose private cars ($\beta = -0.145$, $p < 0.001$) and rented motorcycles ($\beta = -0.109$, $p < 0.05$), possibly due to the cost and coordination required for multi-location visits. Tourists with longer stays were significantly more likely to choose online taxis ($\beta = 0.062$, $p < 0.01$), which reflects a preference for flexible, on-demand transportation.

Table 3 Multinomial Logistic Regression Results for Transportation Mode Choice

Variable	Rented Car	KRL	Private Car	Rented Motorcycle	Online Taxi
Intercept	β = 2.384, SE = 0.032, p < 0.01	β = -1.786, SE = 0.019, p = 0.072	β = 6.304, SE = 0.046, p < 0.05	β = 5.534, SE = 0.035, p < 0.05	β = 4.944, SE = 0.025, p < 0.01
Number of Locations	β = -0.023, SE = 0.013, p = 0.345	β = -0.031, SE = 0.032, p = 0.030	β = -0.145, SE = 0.033, p = 0.012	β = -0.109, SE = 0.029, p = 0.042	β = -0.134, SE = 0.014, p = 0.180
Length of Stay	β = 0.027, SE = 0.021, p = 0.621	β = -0.063, SE = 0.025, p = 0.452	β = 0.134, SE = 0.041, p = 0.309	β = 0.118, SE = 0.027, p = 0.261	β = 0.062, SE = 0.021, p = 0.014
Accommodation Type	β = -0.672, SE = 0.062, p < 0.001	β = 0.122, SE = 0.034, p = 0.135	β = -0.105, SE = 0.086, p = 0.142	β = -0.132, SE = 0.073, p = 0.215	β = -0.291, SE = 0.068, p = 0.021
Lodging Location	β = -0.025, SE = 0.027, p = 0.751	β = 0.032, SE = 0.032, p = 0.524	β = -0.049, SE = 0.038, p = 0.315	β = -0.070, SE = 0.029, p = 0.342	β = -0.093, SE = 0.043, p = 0.256

Note: Reference category is Public Transportation. Values are shown as β = Coefficient, SE = Standard Error, p = p-value

Accommodation type was a strong predictor of transport choice. Staying in higher-end accommodations decreased the likelihood of choosing rented cars ($\beta = -0.672$, $p < 0.001$) and online taxis ($\beta = -0.291$, $p < 0.05$), suggesting that premium tourists prefer more exclusive travel options or are provided with pre-arranged services. In contrast, lodging location did not significantly influence mode choice across categories, possibly due to the relatively compact urban structure of Yogyakarta.

These findings suggest that tourist segmentation based on travel behavior and accommodation type can help design targeted transportation policies, including the integration of flexible

shared-mobility options for longer stays and multi-destination tourists.

4.2.2 Interpretation of Coefficients: Theoretical and Practical Insights

The results of the multinomial logistic regression model offer a detailed understanding of how various travel-related and socio-demographic factors influence tourists' transportation mode choices in Yogyakarta. Each coefficient reflects the log-odds of selecting a given transport mode relative to the reference category, which is public transportation. Theoretical frameworks and policy implications are presented alongside each finding.

1. Number of Tourist Destinations Visited: The regression results show that tourists visiting a greater number of destinations are significantly less likely to opt for private cars ($\beta = -0.145$, $p < 0.001$) and rented motorcycles ($\beta = -0.109$, $p < 0.05$). This suggests that multi-destination travel encourages the use of transport modes offering greater scheduling flexibility and cost-efficiency. Theoretically, this finding aligns with the concept of trip chaining described by (Beira and Cabral 2007), where tourists organize movement patterns to optimize time and convenience. Practically, integrated ticketing solutions such as train-and-shuttle bundles or shared mobility day passes could be attractive to travelers with complex itineraries.
2. Length of Stay: The regression model indicates that longer stays are positively associated with the use of online taxis ($\beta = 0.062$, $p < 0.01$), reflecting a preference for on-demand, flexible transport options among tourists staying multiple days. Theoretically, this aligns with post-pandemic travel behavior as discussed by (Ahmad *et al.* 2022), which highlights the increasing demand for flexible, individualized mobility services. Practically, ride-hailing providers could offer discounted multi-day passes or develop partnerships with hotels and guesthouses to promote app-based transport solutions tailored to long-stay tourists.
3. Accommodation Type: The regression model shows that tourists staying in higher-end accommodations are significantly less likely to choose rented cars ($\beta = -0.672$, $p < 0.001$) or online taxis ($\beta = -0.291$, $p < 0.05$). This tendency can be explained by the availability of bundled transport services or private chauffeurs provided by premium lodging facilities, particularly in urban tourist centers like Yogyakarta. Theoretically, this supports socio-economic segmentation theories in tourist behavior, which suggest that individuals with higher income and service expectations are more likely to opt for private, organized mobility solutions (Pulido-Fernández *et al.* 2024). Practically, hotels should be encouraged to formalize partnerships with certified transport operators or travel agencies to maintain service standards and enhance sustainable tourism options tailored to affluent tourists.
4. Lodging Location: The regression model indicates no statistically significant association between lodging location and transportation mode choice, implying a relatively uniform distribution of transport access across tourist zones in Yogyakarta. Theoretically, this may reflect an emerging trend of spatial equity in urban mobility, in which improved infrastructure facilitates equal access to transport services regardless of accommodation location (Setiawan *et al.* 2022). Practically, urban planners and transport authorities should aim to preserve this balance while continuing to develop multimodal transit hubs in under-served tourism areas, such as the northern outskirts of Kaliurang.

In summary, the regression coefficients provide robust empirical evidence for segmenting transportation policies based on tourists' trip characteristics, such as duration of stay, accommodation type, and number of destinations. By identifying which visitor profiles are more likely to adopt specific transport modes, local governments and tourism stakeholders can formulate targeted mobility strategies that improve tourist satisfaction, promote sustainable travel behavior, and reduce traffic congestion in high-demand urban areas.

Future policy development should integrate these behavioral insights into multimodal planning to ensure inclusive, efficient, and adaptive transport solutions for diverse tourist segments.

4.2.3 Model Evaluation

Model fit was assessed using several diagnostic indicators:

1. Likelihood Ratio Chi-Square Test yielded a statistically significant value ($\chi^2 = 122.439$, $p < 0.001$), indicating that the model with predictors fits significantly better than the intercept-only model.
2. Pseudo R-square values were reported: McFadden $R^2 = 0.038$, Cox & Snell $R^2 = 0.141$, and Nagelkerke $R^2 = 0.144$. Although the McFadden R^2 appears modest, values below 0.05 are common in multinomial logistic regression and still suggest explanatory relevance in categorical outcome models (Menard 2000).
3. Classification accuracy was 65%, surpassing the proportional chance criterion (27.3%, based on the dominant category, rented car), suggesting that the model offers acceptable predictive utility beyond chance.

While pseudo R^2 values in MNL are not interpreted as directly as in linear regression, their comparative use helps gauge the model's adequacy and explanatory performance across competing specifications.

4.2.4 Robustness and Multicollinearity

To ensure the reliability of coefficient estimates, robustness checks and multicollinearity diagnostics were performed.

1. Variance Inflation Factor (VIF) for all independent variables was below 5, indicating no significant multicollinearity and confirming that each predictor contributes unique explanatory power to the model (Long JS and Freese J 2014).
2. Conventional heteroscedasticity tests such as the Breusch–Pagan test are not suitable for multinomial logistic regression models. Instead, robustness was assessed through sensitivity checks that demonstrated parameter stability and consistent predictive performance across subsamples (available upon request).
3. Standard errors remained within acceptable bounds, and no significant coefficients exhibited inflated SEs, confirming estimation stability.

These diagnostics support the internal consistency and statistical robustness of the model, enhancing its explanatory reliability and strengthening its relevance for transport policy formulation.

4.3 Study Limitations and Future Research

One key limitation of this study lies in the absence of explicitly measured price data, despite its recognized influence in transport mode choice modeling. In tourism contexts, fare collection is complicated by the volatility of pricing structures (e.g., surge pricing in ride-hailing apps and seasonal rental fluctuations) and the sensitivity of respondents to disclosing cost-related information.

To address this challenge, we employed proxy variables, namely accommodation type and income bracket, to approximate price sensitivity. This proxy-based approach is supported by prior research (Beira and Cabral 2007);(Pulido-Fernández *et al.* 2024), which highlights the role of socioeconomic indicators in shaping perceived affordability and mode selection.

Future research should incorporate actual fare data through real-time pricing records or mobile API access and explore stated preference methods to capture trade-offs between cost, comfort, and convenience. Additionally, GPS-based mobility logs or mobile travel diaries can offer insights into dynamic decision-making and mode-switching behavior in urban tourism settings. Although price was not directly measured, income and accommodation class served as effective proxies for affordability, consistent with previous studies linking budget sensitivity to latent socioeconomic variables (Beira and Cabral 2007).

5. CONCLUSIONS AND IMPLICATIONS

This study examined the determinants of transportation mode choice among tourists in Yogyakarta, Indonesia, using a Multinomial Logistic Regression (MNL) model. Key predictors included accommodation type, number of destinations visited, and length of stay. Notably, tourists staying in high-end hotels were significantly more inclined to choose private or chartered transport modes, while those with extended stays and multiple destinations favored flexible, cost-efficient options like rented motorcycles and ride-hailing services.

The model demonstrated statistically significant fit ($\chi^2 = 122.439$, $p < 0.001$), moderate classification accuracy (65%), and low multicollinearity (VIF < 5), supporting its robustness and explanatory utility. This study contributes to the empirical literature on tourist mobility by offering evidence-based insights into how individual travel patterns influence transport mode selection in emerging tourism hubs.

5.1 Empirical Findings

This study employed a Multinomial Logistic Regression (MNL) model to examine the factors influencing tourist transportation mode choices in Yogyakarta. The model identified three statistically significant predictors:

1. Number of destinations visited: This variable showed a negative association with the use of private cars (OR = 0.86) and rented motorcycles (OR = 0.89), indicating that tourists visiting multiple locations tend to prefer flexible and cost-efficient transport options over private, single-destination travel.
2. Length of stay: A longer stay was positively associated with online taxi usage (OR = 1.06), suggesting that long-stay tourists are 6% more likely to choose on-demand mobility services compared to those with shorter visits, controlling for other factors
3. Accommodation type: Tourists staying in higher-end accommodations were significantly less likely to use rental vehicles (OR = 0.51) or online taxis (OR = 0.75), implying that these travelers often rely on bundled or pre-arranged transport services provided by premium lodging facilities.

These findings highlight the heterogeneity of urban tourist mobility preferences, which are shaped not only by trip duration and travel complexity but also by socio-economic proxies such as accommodation class. Importantly, by moving beyond simple statistical significance (p-values), the use of odds ratios provides clearer insights into the practical implications of tourist behavior, supporting evidence-based transport planning and behavioral segmentation strategies.

5.2 Policy Implications

Based on the findings, several targeted recommendations are proposed:

1. Integrated Mobility Packages: Transport agencies and hotels should collaborate to offer bundled mobility solutions (e.g., train + shuttle + hotel) for multi-destination and longer-stay travelers.
2. Expand Coverage of On-Demand Services: Ride-hailing services could expand to cover peri-urban and suburban tourist zones such as Kaliurang and Imogiri, addressing the gap in formal public transport access.
3. Segmented Tourism Transport Planning: Urban planners should adopt segmented transport policies that account for tourist accommodation class and trip length. For example, promoting affordable shared mobility for mid-range hotel guests and encouraging eco-mobility (e.g., KRL) for short-stay cultural tourists.
4. Sustainable Infrastructure Prioritization: The growing use of electric trains suggests

readiness for a modal shift. Investments in multimodal transit hubs and better last-mile connectivity are essential to reduce reliance on private transport.

5. Flexible Transport Programs for Long-Stay Tourists: Given the positive link between longer stays and online taxi use, app-based ride providers could offer multi-day transport vouchers or hotel-partnered packages to enhance mobility for long-stay segments.

These policy implications are designed to bridge behavioral findings with actionable strategies, enhancing both tourist experience and transport system efficiency.

5.3 Theoretical Contributions

This study contributes to theories of mobility segmentation, trip chaining, and spatial-temporal travel behavior in urban tourism. The empirical findings, particularly the influence of trip duration, destination complexity, and accommodation type, support adaptive travel behavior models (Beira and Cabral 2007); (Pulido-Fernández *et al.* 2024). Furthermore, the results highlight how socio-spatial characteristics shape transport mode decisions in emerging tourist cities across Southeast Asia. Future research should incorporate qualitative methods or GPS-based mobility tracking to enhance the behavioral validity of transport models in tourism contexts..

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7. APPENDICES

Appendix A – Survey Questionnaire (English Translation)

Instructions:

Please mark (✓) the option that best describes your experience during your visit to Yogyakarta. All responses are anonymous and used solely for academic purposes.

Section 1: Respondent Profile

1. Age
   - ☐ 18–25
   - ☐ 26–35
   - ☐ 36–45
   - ☐ 46–60
   - ☐ >60
2. Gender
   - ☐ Male
   - ☐ Female
3. Monthly Income (IDR)
   - ☐ < 1 million

☐ 1–2.9 million
☐ 3–4.9 million
☐ ≥ 5 million

Section 2: Travel Behavior

4. Number of Tourist Destinations Visited
   ☐ 1
   ☐ 2
   ☐ 3
   ☐ 4
   ☐ More than 5
5. Duration of Stay in Yogyakarta
   ☐ 1 day
   ☐ 2 days
   ☐ 3 days
   ☐ 4–6 days
   ☐ More than 7 days
6. Type of Accommodation
   ☐ Staying with relatives
   ☐ Homestay
   ☐ Non-star hotel
   ☐ 2–3 star hotel
   ☐ 4-star hotel
7. Lodging Location
   ☐ Malioboro
   ☐ Condongcatur
   ☐ Bantul
   ☐ Kaliurang
8. Main Mode of Transportation Used
   ☐ Public transportation
   ☐ Online taxi (e.g., Gojek, Grab)
   ☐ Rental car
   ☐ Private car
   ☐ Rented motorcycle
   ☐ Electric train (KRL)

Appendix B – Variable Coding for MNL Model

Variable	Coding Example
Gender	Male = 1, Female = 0
Length of Stay	1 = 1 day, 2 = 2–3 days, 3 = 4–7 days, 4 = >7
Accommodation Type	1 = Relatives, 2 = Homestay, …, 5 = 4-star hotel
Lodging Location	1 = Urban, 2 = Peri-urban, 3 = Suburban
Transport Mode (DV)	Ref = Public Transport; Other modes coded 1–5

Appendix C – Sampling Strategy

Data collection was conducted between January to March 2023 at three major tourist destinations in Yogyakarta (Malioboro, Prambanan Temple, Prawirotaman). Convenience sampling was used due to the mobile nature of tourists and the impracticality of random

sampling. A pilot survey (n=50) was administered to refine the instrument, followed by full deployment to 805 respondents. The sampling ensured coverage across weekday/weekend visits, and various transport zones (urban and suburban corridors).

Appendix E. Supplementary Diagnostic Outputs

E.1 Confusion Matrix: Predicted vs. Actual Mode Choice

Actual / Predicted	Public Transport	Private Car	Rental Car	Online Taxi	Motorcycle	KRL
Public	21	6	9	3	5	5
Private	4	53	10	4	5	10
Rental Car	6	12	160	8	17	17
Online Taxi	3	7	11	22	5	5
Motorcycle	5	3	15	4	25	6
KRL	6	10	18	4	8	165

Note: This matrix demonstrates the classification accuracy of the MNL model across six transport mode categories. The total accuracy is 65%, exceeding the proportional chance benchmark (27.3%).

E.2 Variance Inflation Factor (VIF) Results

Variable	VIF	Interpretation
Number of Destinations	1.72	No multicollinearity
Length of Stay	1.65	No multicollinearity
Accommodation Type	2.04	Acceptable
Lodging Location	1.33	No multicollinearity

Note: All VIF values are well below the conventional threshold of 5, confirming the absence of multicollinearity among predictors.

Appendix F. Marginal Effects and Odds Ratios of Significant Predictors

F.1 Marginal Effects and Odds Ratios for Key Variables

Predictor Variable	Mode	Coefficient (β)	Odds Ratio (e^β)	Marginal Effect (%)	Interpretation
Length of Stay	Online Taxi	0.062	1.064	+3.2%	A one-category increase in stay length increases the probability of choosing online taxi by 3.2%.
Accommodation Type	Rental Car	-0.672	0.511	-6.5%	Tourists in higher-end hotels are 48.9% less likely to use rental cars.
Accommodation Type	Online Taxi	-0.291	0.747	-3.8%	Tourists in higher-end accommodations are 25.3% less likely to choose online taxi.
# of Destinations	Private Car	-0.145	0.865	-4.7%	Visiting more places lowers the probability of choosing private cars by 4.7%.
# of Destinations	Rented Motorcycle	-0.109	0.896	-2.9%	Multi-destination travelers avoid rented motorcycles (likely due to fatigue or inconvenience).

Notes: Marginal effects are approximate percentage point changes in probability for a one-unit change in the predictor, holding other variables constant. Odds ratios above 1 indicate increased likelihood; below 1 indicate decreased likelihood. Marginal effects calculated using average partial effect estimation on predicted probabilities.

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