

Article

Parking Choice Behavior in Ecuadorian Cities: A National Stated Preference and Revealed Preference Analysis of Parking Demand, Technology Adoption, and Inter-City Heterogeneity

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Abstract

Parking management has become an increasingly important challenge in rapidly growing urban areas, yet evidence from intermediate Latin American cities remains scarce. This study analyzes parking choice behavior across Ecuadorian cities using a national stated preference (SP) experiment validated through revealed preference (RP) data and estimated via discrete choice models. Data were collected between 1 April and 3 May 2026 from 2150 active drivers across 12 cities spanning the Coast, Highlands, and Amazon regions. Multinomial Logit (MNL) and Mixed Logit (MIXL) models were estimated to evaluate the effects of parking cost, walking distance, search time, security, and surveillance on parking decisions. Results showed that all three cost-related attributes significantly reduced parking utility, while security improvements increased the probability of selecting formal parking alternatives. The MIXL model outperformed MNL specifications ($\Delta AIC = 211.84$), revealing significant unobserved heterogeneity in cost ($SD = 0.45$) and security preferences ($SD = 0.29$). Willingness-to-pay estimates reached USD 0.64 per 100 m reduction in walking distance and USD 0.69 per 10-min reduction in search time, with substantial inter-city variability. Despite low current adoption (18.4%), willingness to use digital reservation systems exceeded 75% across income groups. The findings underscore the need for locally calibrated, context-sensitive parking policies and support differentiated smart parking strategies in developing urban systems.

Keywords: discrete choice modeling; parking behavior; stated preference experiment; willingness-to-pay estimation; urban parking management



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1. Introduction

Urban motorization has intensified parking-related challenges in cities worldwide, particularly in contexts characterized by rapid urban growth, increasing private vehicle ownership, and limited street capacity. Parking scarcity contributes to traffic congestion, unnecessary vehicle circulation, fuel consumption, emissions, and reduced accessibility in central commercial districts and high-demand corridors [1,2]. Empirical evidence shows that drivers may spend considerable time searching for parking, and that cruising for parking can account for a substantial share of traffic in congested urban centers [3]. As a result, parking management has increasingly been recognized as an essential component of sustainable urban mobility and travel demand management strategies [4]. Understanding parking choice behavior is therefore necessary for designing effective pricing, enforcement, and demand-management policies [5].

The analysis of parking behavior has evolved through the application of random utility theory, stated preference experiments, and discrete choice modeling. Random utility models provide a theoretical framework for explaining how individuals choose among alternatives by trading off attributes such as cost, walking distance, search time, safety, availability, and enforcement risk [6,7]. Stated preference methods are particularly useful in parking research because they allow researchers to vary policy attributes that may be difficult to observe under real market conditions, including fine probability, parking availability, and surveillance level [8]. Previous studies in Europe have shown that parking cost, access distance, search time, and individual heterogeneity significantly influence parking decisions [4,9]. Similar evidence from Asian developing-city contexts indicates that parking fees, walking distance, queuing time, capacity, and information-related factors affect parking lot choice and support the use of mixed logit models to capture preference heterogeneity [10,11].

Parking management problems are especially relevant in intermediate and rapidly growing cities of developing countries, where urban expansion often exceeds institutional capacity for transport planning and enforcement. In Latin American cities, parking behavior is shaped not only by price and distance but also by weak regulation, informal parking practices, enforcement uncertainty, and limited off-street supply [12]. Ecuador constitutes a relevant case because its urban system includes large metropolitan areas as well as medium-sized and small cities with different mobility patterns, economic conditions, and institutional capacities. Evidence from Loja, Ecuador, shows that parking choices in an intermediate Andean city are influenced by parking cost, walking distance, enforcement sensitivity, security, and socioeconomic heterogeneity [13]. However, while this local evidence is valuable, nationally distributed and multicity behavioral evidence on parking choice in Ecuador remains limited.

Recent advances in parking research have emphasized the importance of incorporating behavioral heterogeneity, information availability, and technological adoption into parking demand analysis. Recent studies have shown that parking preferences vary substantially across individuals and urban contexts, particularly regarding sensitivity to parking fees, walking distance, and travel mode interactions, reinforcing the need for flexible modeling approaches capable of capturing heterogeneous behavioral responses [14]. Moreover, recent evidence suggests that individual preferences for parking attributes cannot be adequately represented through average population parameters, as willingness-to-pay estimates often differ significantly across socioeconomic groups and residential environments [15]. Emerging evidence also highlights the role of perceived risk and uncertainty in parking decisions, indicating that behavioral factors may be as influential as traditional cost and time variables in some urban contexts [16].

Mixed logit and related flexible discrete choice models allow researchers to account for systematic and random variation in preferences across individuals and urban contexts [4,6]. In addition, smart parking systems, mobile applications, digital payment technologies, and real-time information can modify search behavior and parking location choice, especially where formal parking supply is scarce or poorly coordinated [11,17]. Nevertheless, there is still limited evidence on how these factors interact in secondary Latin American cities, particularly in countries with marked regional and institutional heterogeneity. This limitation is relevant because parking policy transferability across cities may be constrained by differences in income distribution, urban morphology, enforcement capacity, and technological readiness.

Another important gap concerns the external validity and territorial representativeness of parking choice studies. Many stated preference parking experiments have been conducted in single cities or specific metropolitan areas, limiting the extent to which estimated behavioral parameters can be generalized across wider urban systems [9,18,19]. Although some recent studies have combined revealed and stated preference data to improve be-

havioral realism, multicity evidence remains comparatively scarce in developing-country contexts [8,11]. This gap restricts the ability of policymakers to design differentiated parking management strategies adapted to heterogeneous local conditions. Consequently, nationally distributed parking choice research is needed to jointly evaluate behavioral preferences [20], willingness to pay [21], technology adoption [22], and inter-city heterogeneity within a unified analytical framework. Recent research has further emphasized that behavioral parameters estimated in a single city may not necessarily be transferable to other urban environments due to differences in socioeconomic conditions, parking supply structures, and institutional contexts. Consequently, external validity and model transferability have become increasingly important concerns in parking choice research, particularly in developing-country settings where empirical evidence remains limited [23].

This study aims to analyze parking choice behavior in Ecuadorian cities using a national stated preference experiment combined with revealed preference validation and discrete choice modeling techniques. Specifically, the research evaluates the influence of parking cost, walking distance, search time, security, surveillance, availability, and enforcement-related variables on parking decisions among active drivers in Ecuador. Data were collected from drivers in multiple cities located across the Coast, Highlands, and Amazon regions of the country. The analytical framework includes multinomial logit and mixed logit models, willingness-to-pay estimations, stratified city-level analyses, and attitudinal indicators, following established approaches in stated choice and discrete choice modeling [6,8]. A revealed preference component and internal consistency procedures were also incorporated to improve data reliability and assess the consistency between hypothetical and reported parking behavior.

The study contributes to the parking and urban mobility literature in several ways. First, it provides nationally distributed evidence on parking choice behavior in Ecuador, extending previous local evidence from Loja to a broader set of heterogeneous urban contexts [13]. Second, it integrates stated and revealed preference components within a unified behavioral framework, allowing the assessment of convergent validity between hypothetical choices and reported parking behavior [8]. Third, it evaluates inter-city heterogeneity and technology adoption patterns associated with parking management, offering evidence relevant for differentiated and context-sensitive smart parking policies in developing urban systems. Finally, the analytical framework may support future comparative research and contribute to the design of parking policies for secondary cities in Latin America.

The remainder of this manuscript is organized as follows. Section 2 describes the study area and national context, the survey design and data collection instrument, sample eligibility criteria, data cleaning procedures, and the analytical framework including the discrete choice models and willingness-to-pay estimation methods. Section 3 presents the results, covering sample characteristics, stated and revealed preference parking choice distributions, national and city-level discrete choice model estimates, willingness-to-pay values, Mixed Logit findings, technology adoption patterns, and attitudinal indicators. Section 4 discusses the main findings in relation to the existing literature, addressing parking choice determinants, inter-city heterogeneity, equity implications, model performance, and study limitations. Section 5 summarizes the principal conclusions and their implications for parking policy and future research.

2. Materials and Methods

2.1. Study Area and National Context

This study was conducted in multiple Ecuadorian cities distributed across the country's three main continental geographic regions: the Coast, Highlands, and Amazon. The national scope of the survey was intended to capture heterogeneous parking behaviors

under different urban, socioeconomic, and territorial conditions, thereby improving the external validity and transferability of the estimated behavioral parameters.

Data collection was initially carried out in 27 cities through a decentralized fieldwork strategy involving undergraduate Civil Engineering students with a specialization in transportation infrastructure from Universidad Técnica Particular de Loja. Because these students originate from different regions of the country, they were instructed to collect data in one of the cities geographically closest to their place of residence, which facilitated broad territorial coverage and access to diverse urban contexts.

The final analytical sample included cities that reached a minimum threshold of 50 valid observations to ensure statistical robustness for the stratified analyses. Consequently, 12 cities were retained for the city-level modeling: Quito, Guayaquil, Cuenca, Loja, Latacunga, Tulcán, El Coca, Jipijapa, Macas, Gualaceo, Sucúa, and Gonzanamá.

The selected cities represent a wide range of Ecuadorian urban contexts, including large metropolitan areas, intermediate cities, and small urban centers. Population sizes [24] ranged from 2833 inhabitants in Gonzanamá to 2,665,392 inhabitants in Guayaquil, reflecting substantial variability in urban scale, motorization levels, parking supply constraints, urban density, and traffic enforcement conditions. This diversity allowed the study to capture heterogeneous parking management realities across the country, from highly congested metropolitan environments to smaller cities with emerging mobility challenges.

Figure 1 presents the spatial distribution of the 12 cities retained in the final analytical sample, together with their population sizes and regional classification. This figure supports the interpretation of the national scope of the study by showing that the selected cities cover Ecuador's Coast, Highlands, and Amazon regions and include large metropolitan areas, intermediate cities, and small urban centers.

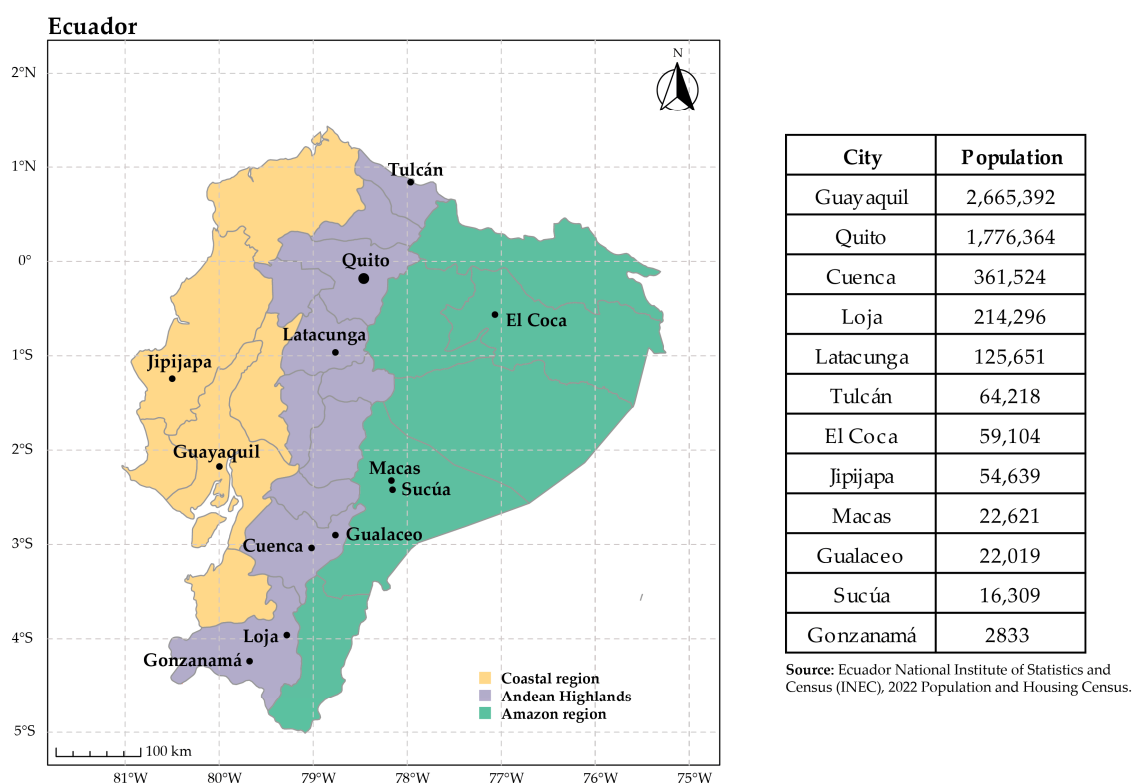


Figure 1. Geographic distribution of the 12 Ecuadorian cities included in the final analytical sample, classified by continental region and accompanied by city-level population values. The map illustrates the territorial coverage of the study across the Coast, Highlands, and Amazon regions. El Coca is the common name of the city officially named Puerto Francisco de Orellana.

2.2. Survey Design and Data Collection Instrument

The survey instrument employed in this study was based on the parking choice experiment previously developed and validated in the study published previously [13] parking choice study. The questionnaire structure, experimental design logic, and behavioral attributes were maintained to ensure methodological consistency and comparability with prior findings.

The instrument consisted of four main sections: (i) sociodemographic and mobility characteristics, (ii) revealed preference (RP) questions related to recent parking experiences, (iii) a stated preference (SP) discrete choice experiment, and (iv) attitudinal and technology adoption questions.

The SP experiment was designed following a random utility maximization framework. Participants were presented with six hypothetical parking choice scenarios, each containing four alternatives: regulated on-street parking, private parking, informal parking, and the option of avoiding vehicle use. Each alternative was characterized by several attributes, including parking cost, walking distance, parking search time, security level, surveillance level, probability of finding a space, and enforcement/fine risk.

Attribute levels were combined using a fractional factorial experimental design to reduce respondent burden while maintaining statistical efficiency. The resulting scenarios were randomized across respondents to minimize ordering effects and hypothetical bias. Attribute levels were defined based on observed parking conditions in Ecuadorian cities and prior evidence from the reference study [13]. Each attribute was assigned two to three levels, and a D-efficient fractional factorial design was generated, resulting in 24 choice scenarios blocked into four versions of six scenarios each. Each respondent was randomly assigned to one version, yielding six choice tasks per participant.

The questionnaire also included revealed preference questions aimed at validating the consistency between stated and actual parking behavior. Participants were asked about the last time they parked in a congested urban area, including the parking option selected, actual search time, parking expenditure, and contextual conditions.

Additional sections evaluated attitudes toward parking management policies, perceptions of parking scarcity, acceptance of parking regulation measures, and willingness to adopt smart parking technologies such as mobile applications and reservation systems.

To improve data quality, the survey incorporated an attention-control question intended to verify whether respondents were carefully reading the questionnaire. Responses failing this control criterion were excluded during data cleaning.

Data collection was conducted between 1 April and 3 May 2026 using face-to-face and digitally assisted survey administration procedures. Before field deployment, participating students received standardized training regarding participant recruitment, survey administration protocols, ethical considerations, and respondent eligibility criteria.

2.3. Sample Description and Eligibility Criteria

A total of 3114 questionnaires were initially collected nationwide. However, several exclusion criteria were applied to ensure consistency between the target population and the behavioral objectives of the study.

First, respondents younger than 18 years old were excluded because the study focused on adult drivers with autonomous parking decision-making capacity. Second, individuals who reported holding a valid driver's license but not currently driving were removed from the dataset, as were respondents who did not possess a valid driver's license. These exclusions were implemented to ensure that all participants represented active drivers exposed to real parking choice conditions.

Additional filtering criteria were applied to improve behavioral realism and internal consistency. Observations reporting parking search times below five minutes were excluded because previous evidence from the reference study identified five minutes as the lower realistic threshold for parking search time in congested urban environments in this particular survey [13]. Furthermore, all records failing the embedded attention-control question were removed.

After data cleaning and validation procedures, 2150 valid questionnaires were retained from the 3114 surveys initially collected, corresponding to a valid retention rate of 69.0%. Excluded observations were mainly associated with respondent ineligibility, inattentive responses, incomplete records, and inconsistent behavioral information.

The target sample size was determined based on the requirements of discrete choice model estimation. Following established guidelines for SP experiments [6], a minimum of 150–200 respondents per model is generally considered sufficient for stable parameter recovery in MNL specifications. The achieved national sample of 2150 respondents substantially exceeds this threshold and provides adequate statistical power for both pooled and stratified city-level estimations.

2.4. Data Cleaning and Preprocessing

Data preprocessing and quality control procedures were conducted prior to model estimation. The cleaning process aimed to eliminate incomplete, inconsistent, or behaviorally implausible responses that could compromise the reliability of discrete choice estimations.

The preprocessing pipeline included the following steps:

1. Removal of respondents younger than 18 years old.
2. Exclusion of non-active drivers and respondents without a valid driver's license.
3. Elimination of surveys failing the attention-control question.
4. Removal of observations with implausibly short parking search times (<5 min).
5. Verification of logical consistency among revealed preference and stated preference responses.
6. Standardization and recoding of categorical variables.
7. Transformation of the SP dataset into long format for discrete choice modeling.

Following cleaning procedures, the SP experimental database generated 51,600 observations in long format corresponding to repeated choice tasks across respondents.

Cities with fewer than 50 valid observations were excluded from city-level estimations in order to avoid unstable parameter estimates and inflated standard errors in stratified models. The threshold of 50 observations per city was established based on established guidelines for minimum cell sizes in stratified discrete choice model estimations. Following Train [6] and Louviere et al. [8], a minimum of approximately 150–200 respondents is generally recommended for stable MNL estimation at the pooled level. For city-level stratified models with a reduced attribute set and fewer alternatives, minimum samples of 50 valid respondents per city have been applied in comparable multi-city stated preference studies as a practical threshold for parameter recovery. This value ensures that each respondent contributes at least six choice observations (from the six SP tasks per respondent), yielding a minimum of 300 choice records per city-level model—a volume considered adequate for stable coefficient estimation under standard SP experimental designs [6,8].

2.5. Analytical Framework

The analytical framework of this study was grounded in Random Utility Theory (RUT), which assumes that individuals select the parking alternative that maximizes their perceived utility under a given choice set.

For respondent (n), the utility associated with parking alternative (i) was specified as:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (1)$$

where V_{in} represents the observable systematic utility component and ε_{in} denotes the unobserved random error term.

The systematic utility was specified as a linear-in-parameters function of the observed parking attributes:

$$V_{in} = \beta_0 + \beta_1 C_{in} + \beta_2 WD_{in} + \beta_3 ST_{in} + \beta_4 SEC_{in} + \beta_5 SURV_{in} \quad (2)$$

where C_{in} is parking cost, WD_{in} is walking distance to destination, ST_{in} is parking search time, SEC_{in} represents perceived security, and $SURV_{in}$ denotes surveillance or enforcement conditions. The parameters β_k capture the marginal utility associated with each attribute.

Initial model estimation was performed using the Multinomial Logit (MNL) formulation due to its interpretability and computational efficiency. Under the MNL framework, the probability that respondent n chooses alternative i from choice set J is given by:

$$P_{in} = \frac{\exp(V_{in})}{\sum_{j \in J} \exp(V_{jn})} \quad (3)$$

The MNL specification assumes that error terms are independently and identically distributed (IID) following a Gumbel distribution, which implies the Independence of Irrelevant Alternatives (IIA) property.

To account for unobserved taste heterogeneity across respondents, Mixed Logit (MIXL) models were subsequently estimated. In the MIXL formulation, selected parameters were treated as random variables:

$$\beta_n = \beta + \eta_n \quad (4)$$

where β is the population mean parameter vector and η_n captures individual-specific deviations following a predefined probability distribution. The resulting choice probability is expressed as:

$$P_{in} = \int \frac{\exp(V_{in}(\beta))}{\sum_{j \in J} \exp(V_{jn}(\beta))} f(\beta|\theta) d\beta \quad (5)$$

where $f(\beta|\theta)$ is the density function of the random parameters characterized by parameter vector θ . Because this integral has no closed-form solution, the model was estimated using simulated maximum likelihood with Halton draws. Simulated maximum likelihood estimation was performed using 500 Halton draws, which has been shown to provide stable and accurate approximations of the choice probability integral in parking and travel behavior contexts [6].

The log-likelihood function maximized during estimation was defined as:

$$LL(\beta) = \sum_{n=1}^N \sum_{i=1}^J y_{in} \ln(P_{in}) \quad (6)$$

where y_{in} equals 1 if respondent n selected alternative i , and 0 otherwise.

Willingness-to-pay (WTP) indicators were derived from estimated utility coefficients using marginal rate-of-substitution approaches. Specifically, the WTP associated with attribute (k) was calculated as:

$$WTP_k = -\frac{\beta_k}{\beta_c} \quad (7)$$

where β_k is the coefficient of the attribute of interest and β_c is the coefficient associated with parking cost. Confidence intervals for WTP estimates were obtained using the delta method.

Model goodness-of-fit was evaluated using McFadden's pseudo- (R^2) , computed as:

$$\rho^2 = 1 - \frac{LL(\beta)}{LL(0)} \quad (8)$$

where LL_β is the log-likelihood at convergence and LL_0 is the log-likelihood of the null model.

Additionally, stratified MNL models were estimated by city, income group, sex, and prior fine experience to evaluate behavioral heterogeneity across socioeconomic and territorial contexts.

Principal Component Analysis (PCA) was also applied to attitudinal variables in order to identify latent behavioral dimensions associated with parking preferences, enforcement perceptions, and mobility attitudes. The PCA transformation can be expressed as:

$$Z_k = a_{k1}X_1 + a_{k2}X_2 + \dots + a_{kp}X_p \quad (9)$$

where Z_k represents the k -th principal component, X_p are the standardized observed attitudinal variables, and a_{kp} are the component loadings. Components with eigenvalues greater than 1 were retained for interpretation.

2.6. Statistical Analysis and Software Environment

All statistical analyses were performed using R (version 4.3.1; R Foundation for Statistical Computing, Vienna, Austria) [25] within the RStudio (version 2023.09.1; Posit Software, PBC, Boston, MA, USA) [26]. Data processing, visualization, and model estimation were conducted using several specialized R packages.

Data manipulation and preprocessing were performed primarily with the tidyverse ecosystem (version 2.0.0), including dplyr (version 1.1.4), tidyr (version 1.3.1), readr (version 2.1.5), purrr (version 1.0.2), and ggplot2 (version 3.5.1).

Discrete choice models were estimated using the mlogit package (version 1.1-1) together with supporting dependencies including dfidx (version 0.1-2), maxLik (version 1.5-2.1), miscTools (version 0.6-28), and Formula (version 1.2-5). Mixed Logit estimations were conducted using simulated maximum likelihood with Halton sequences and BFGS optimization algorithms.

Additional analyses employed the psych package (version 2.4.6) for exploratory factor analysis and principal component analysis, the car package (version 3.1-2) for diagnostic procedures, and factoextra (version 1.0.7) for multivariate visualization.

2.7. Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and the Ecuadorian Organic Law on Personal Data Protection, ensuring participant anonymity and the use of aggregated data only. Under the standardized procedures of the local Ethics Committee (CEISH-UTPL), ethical review and approval were waived for this study, as the research was classified as "Research Without Risk" due to its anonymous nature. The protocol identification code was 2026-04-INT-EO-SR-009. Consequently, informed consent was obtained from all participants prior to data collection, emphasizing the voluntary and confidential nature of their participation.

2.8. Use of Artificial Intelligence-Assisted Tools

During the preparation of this manuscript, Gemini (Google, version 1.5) and Claude (Anthropic, version 3.5) were used to review and identify potential corrections in portions of the R code. All outputs generated by these tools were carefully reviewed, verified, and

edited by the authors. The authors take full responsibility for the final content and accuracy of the manuscript.

3. Results

3.1. Sample Characteristics and Spatial Distribution

After the data cleaning and validation procedures, the final analytical sample consisted of 2150 valid respondents distributed across 12 Ecuadorian cities that met the minimum inclusion threshold of 50 observations per city. In total, the survey initially collected 3114 responses nationwide between 1 April and 3 May 2026. The final sample covered cities located in the Coast, Highlands, and Amazon regions, thereby capturing substantial territorial, socioeconomic, and urban heterogeneity within Ecuador. Quito ($n = 454$) and Loja ($n = 398$) represented the largest subsamples, while El Coca ($n = 51$) represented the minimum threshold retained for city-level analyses.

Figure 2 summarizes the number of valid responses obtained in each surveyed city after applying the data cleaning criteria. The figure also identifies the minimum threshold of 50 valid observations required for inclusion in city-level sub-analyses, distinguishing between cities retained for stratified modeling and those included only in the pooled national analysis.

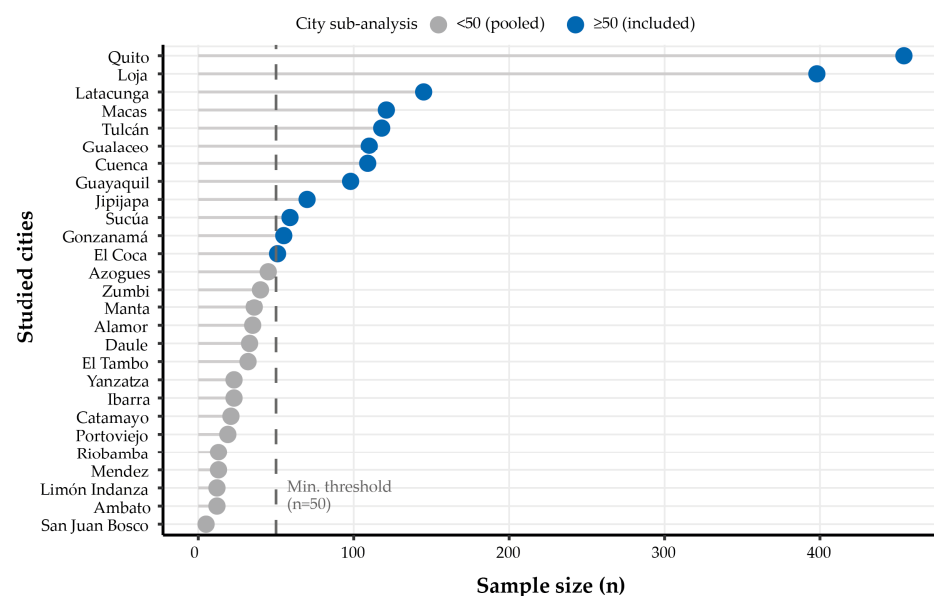


Figure 2. Distribution of valid survey responses by city after data cleaning and validation. The dashed vertical line indicates the minimum inclusion threshold of 50 valid observations required for city-level sub-analyses; cities meeting this criterion were retained for stratified model estimation.

The demographic composition of the sample showed a relatively balanced gender distribution and a predominance of economically active adults (see Table 1). Male respondents accounted for 53.5% of the sample ($n = 1151$), while female respondents represented 46.0% ($n = 989$). This distribution is reasonably consistent with national demographic statistics for Ecuador [24], where men represent 48.7% of the population and women 51.3%, suggesting an acceptable level of gender representativeness within the study sample. The largest age group corresponded to individuals aged 25–34 years (35.1%), followed by the 35–44 age group (30.2%).

Table 1. Sociodemographic, mobility, and technology-adoption characteristics of the final analytical sample.

Variable	Category	<i>n</i>	%
Gender	Male	1151	53.5
	Female	989	46.0
Age group	18–24	311	14.5
	25–34	754	35.1
	35–44	649	30.2
	45–54	292	13.6
	55–64	104	4.8
	65+	40	1.9
Income group	Low (<1500 USD)	1587	73.8
	Middle (1500–4000 USD)	461	21.4
	High (>4000 USD)	22	1.0
Previous parking fine	Yes	985	45.8
Parking app use	Yes	396	18.4
Willingness to use reservation system	Yes	1636	76.1

Note: Percentages are calculated using the final valid sample of 2150 respondents. Percentages may not sum to 100% in variables with missing or non-reported categories.

The predominance of respondents in the 25–44 age range (65.3% of the sample) reflects the age profile of the economically active urban driver population in Ecuador, but also represents a potential selection bias that should be acknowledged. Younger adults (18–24) and older drivers (55+) are underrepresented relative to their share of the national population and licensed driver pool. This age concentration may influence the estimated willingness-to-pay values, technology adoption rates, and sensitivity to parking attributes, as these dimensions are known to vary across age cohorts. In particular, older drivers may exhibit greater sensitivity to walking distance and lower willingness to adopt digital reservation systems, while younger drivers may show higher price sensitivity and stronger openness toward smart parking technologies. The implications of this age-related selection bias are discussed further in Section 4.6.

In terms of income, most participants belonged to the low-income category (<USD 1500/month), representing 73.8% of the sample. Approximately 45.8% of respondents reported having previously received a parking-related fine, 18.4% indicated using parking mobile applications, and 76.1% expressed willingness to use advance parking reservation systems.

The residential distribution of respondents revealed that consolidated residential areas represented the largest share of the sample (32.4%), followed by peripheral residential zones (25.0%). Regarding workplace or study locations, nearly half of respondents (45.4%) reported traveling regularly to city-center areas. This spatial diversity is relevant because parking behavior and willingness to pay may vary according to urban morphology, accessibility conditions, and land-use patterns.

3.2. Parking Choice Distribution and Revealed Preference Validation

The SP experiment generated a total of 12,900 valid parking choices. Each respondent evaluated six hypothetical parking choice scenarios with four alternatives per scenario, generating repeated observations suitable for discrete choice modeling. Private parking was the most selected alternative (44.7%), followed by regulated parking (38.7%) (see Figure 3). Irregular parking represented only 4.3% of responses, whereas 12.3% of respondents selected the alternative corresponding to abandoning car use for that trip. The RP component,

based on respondents' most recent parking experience, showed similar distributions, with regulated parking accounting for 42.1% and private parking for 45.4% of observed choices.

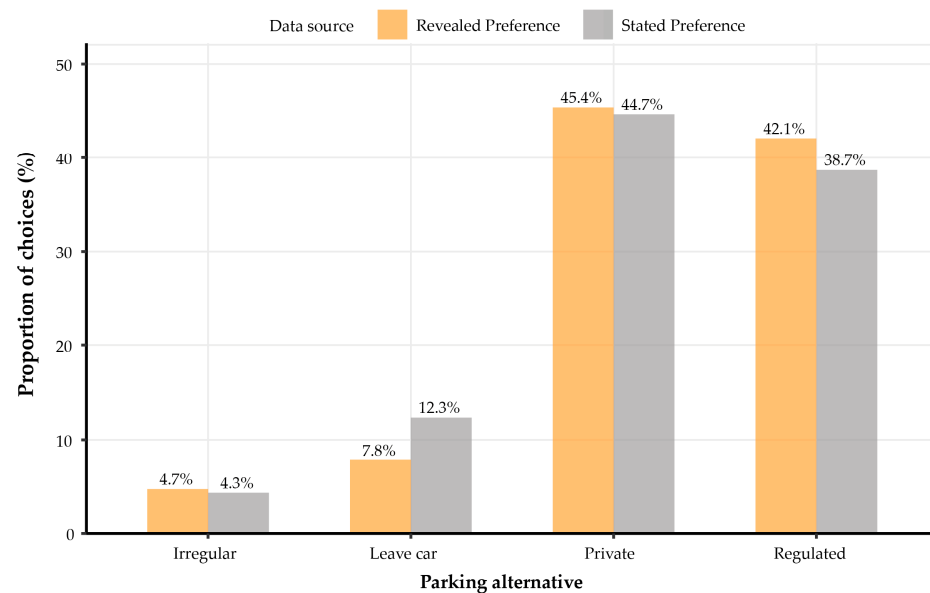


Figure 3. Comparison between revealed preference and stated preference parking choice distributions. Percentages represent the proportion of choices assigned to each parking alternative, allowing assessment of the consistency between reported recent parking behavior and hypothetical stated choice scenarios.

The relatively small differences between SP and RP distributions suggest behavioral consistency between hypothetical and observed choices. The largest discrepancy corresponded to the “leave the car” alternative, which appeared more frequently in the SP scenarios than in actual reported behavior. This finding is consistent with previous transportation SP studies in which respondents express greater willingness to adopt sustainable or restrictive travel options under hypothetical conditions.

The RP data further indicated that respondents paid an average parking cost of USD 0.97 per hour ($SD = 0.75$) and spent an average of 13.6 min searching for parking ($SD = 10.4$) (see Table 2). These descriptive indicators provide contextual evidence regarding parking scarcity and generalized parking costs in Ecuadorian urban environments.

Table 2. Revealed preference indicators for recent parking experiences.

Variable	Mean	SD
Parking cost (USD/h)	0.97	0.75
Parking search time (min)	13.6	10.4

Note: Values summarize reported parking cost and search time during respondents' most recent parking experience in a congested urban area.

3.3. National Multinomial Logit Model

The reduced Multinomial Logit (MNL) model was selected as the principal specification due to its parsimony and equivalent explanatory performance relative to the complete specification. The likelihood ratio test comparing the complete and reduced models was not statistically significant ($\chi^2 = 1.00$, $df = 2$, $p = 0.6065$), indicating that the excluded attributes did not significantly improve model fit. The final national model achieved a McFadden pseudo- R^2 of 0.009 and a hit rate of 47.4% (see Table 3).

Table 3. National reduced Multinomial Logit model estimates for parking choice.

Variable	β	SE	z-Value
ASC: Private parking	0.2050	0.0299	6.846
ASC: Irregular parking	−2.5934	0.0875	−29.625
ASC: Leave the car	−1.3983	0.0591	−23.669
Walking distance (m)	−0.0010	0.0001	−7.790
Parking cost (USD)	−0.1510	0.0261	−5.791
Search time (min)	−0.0104	0.0016	−6.418
Security score	0.1576	0.0382	4.123
Surveillance score	−0.0930	0.0374	−2.489

Note: β = estimated coefficient; SE = standard error. Negative coefficients indicate reduced parking utility, whereas positive coefficients indicate increased utility relative to the modeled attribute.

Although the McFadden pseudo- R^2 of 0.009 appears modest, this is consistent with large-scale disaggregate SP datasets where individual behavioral variation is high and unobserved factors account for a substantial share of choice variance [6,8]. The model's hit rate of 47.4% exceeds the random choice benchmark of 25% (given four alternatives), supporting its discriminative validity. Furthermore, a comparison of all discrete choice specifications estimated in this study (Table 4) confirms that while MNL models provide an interpretable baseline, the Mixed Logit specification achieves substantially better overall fit, motivating its estimation in Section 3.5.

Table 4. Comparative goodness-of-fit statistics for estimated discrete choice model specifications.

Model	LogLik	AIC	McFadden R^2
Full MNL	−14,333.34	28,686.68	0.0090
Reduced MNL	−14,333.84	28,683.68	0.0090
Parsimonious MNL	−14,354.42	28,722.84	0.0075
Mixed Logit	−14,224.92	28,471.84	0.0165

Note: LogLik = log-likelihood at convergence; AIC = Akaike Information Criterion; McFadden R^2 = pseudo- R^2 . Lower AIC values indicate better relative model fit.

As shown in Table 3, the estimated coefficients exhibited signs consistent with random utility theory. Higher parking costs, longer walking distances, and greater parking search times significantly reduced the probability of selecting a parking alternative. Conversely, higher perceived security levels increased parking utility. The negative coefficient associated with surveillance suggests that respondents may perceive intensive surveillance measures as inconvenient or restrictive under certain parking contexts.

The alternative-specific constants (ASCs) also revealed systematic preference patterns (Table 3). Private parking exhibited a positive ASC, indicating a baseline preference for formal private facilities relative to the reference alternative. In contrast, irregular parking and abandoning car use displayed strongly negative ASCs, suggesting lower intrinsic utility among Ecuadorian drivers.

The comparative fit statistics in Table 4 confirm that the Reduced MNL specification achieves the best performance among MNL alternatives, while the Mixed Logit model substantially outperforms all MNL specifications by 211.84 AIC points. This systematic improvement justifies the estimation of a Mixed Logit model to account for preference heterogeneity, as detailed in Section 3.5.

3.4. Willingness-to-Pay Estimates

The willingness-to-pay (WTP) analysis derived from the reduced MNL model indicated that respondents were willing to pay approximately USD 0.64 to reduce walking distance by 100 m and USD 0.69 to reduce parking search time by 10 min (Table 5).

Table 5. National willingness-to-pay estimates derived from the reduced Multinomial Logit model.

Attribute	WTP (USD)	SE	95% CI
100 m less walking distance	−0.640	0.087	[−0.811, −0.469]
10 min less search time	−0.687	0.127	[−0.936, −0.439]
1-level security improvement	1.044	0.290	[0.475, 1.613]
1-level surveillance improvement	−0.616	0.241	[−1.088, −0.144]

Note: WTP values are expressed in USD and were calculated using marginal rate-of-substitution estimates. Confidence intervals were obtained using the delta method.

Security improvements generated positive WTP values exceeding USD 1.00 per security-level increase, whereas surveillance improvements exhibited a negative WTP value of −USD 0.616 per level of increased monitoring. This counterintuitive finding warrants deeper interpretation. Several complementary explanations may account for this result. First, in contexts with historically weak institutional trust and perceived over-enforcement, drivers may associate increased surveillance with higher probabilities of receiving fines or having their behavior scrutinized, generating disutility that outweighs the perceived safety benefit of greater oversight [27]. Second, the negative valuation may reflect a distinction between passive security (physical barriers, lighting, attendants)—which respondents valued positively—and active electronic monitoring, which may be perceived as intrusive or penalizing rather than protective. Third, a confusion between security and surveillance as constructs in the survey instrument cannot be fully ruled out, given that both concepts relate to parking environment safety but differ in their behavioral implications. These findings are consistent with evidence from other enforcement-sensitive transport contexts where increased visible policing or monitoring generates compliance at the cost of perceived freedom and comfort [5,27]. The negative coefficient for surveillance was statistically significant in both MNL and Mixed Logit specifications, suggesting this pattern is robust rather than incidental. Parking policy interventions aimed at improving safety should therefore carefully distinguish between security infrastructure investments, which generate positive user valuation, and punitive or surveillance-oriented measures, which may reduce parking utility and user acceptance.

Substantial heterogeneity emerged across cities regarding cost sensitivity and WTP estimates (Figures 4 and 5). Several intermediate cities exhibited stronger marginal sensitivities to walking distance and parking costs than larger metropolitan areas. However, confidence intervals overlapped considerably for some cities due to smaller local sample sizes. Figure 4 illustrates the variation in parking cost sensitivity coefficients across cities, while Figure 5 presents the corresponding WTP estimates for reductions in walking distance.

Although formal pairwise tests of coefficient equality were not conducted due to sample size constraints in smaller cities, the non-overlapping confidence intervals observed for Tulcán and El Coca relative to the national estimate suggest statistically meaningful behavioral differences in these urban contexts.

The stated maximum WTP for a two-hour parking session averaged USD 1.71, with notable variation across income groups (Table 6). High-income respondents reported the highest mean maximum WTP (USD 2.59), while low-income respondents reported a mean value of USD 1.58. These findings suggest the existence of income-related disparities in parking affordability and tolerance for parking costs.

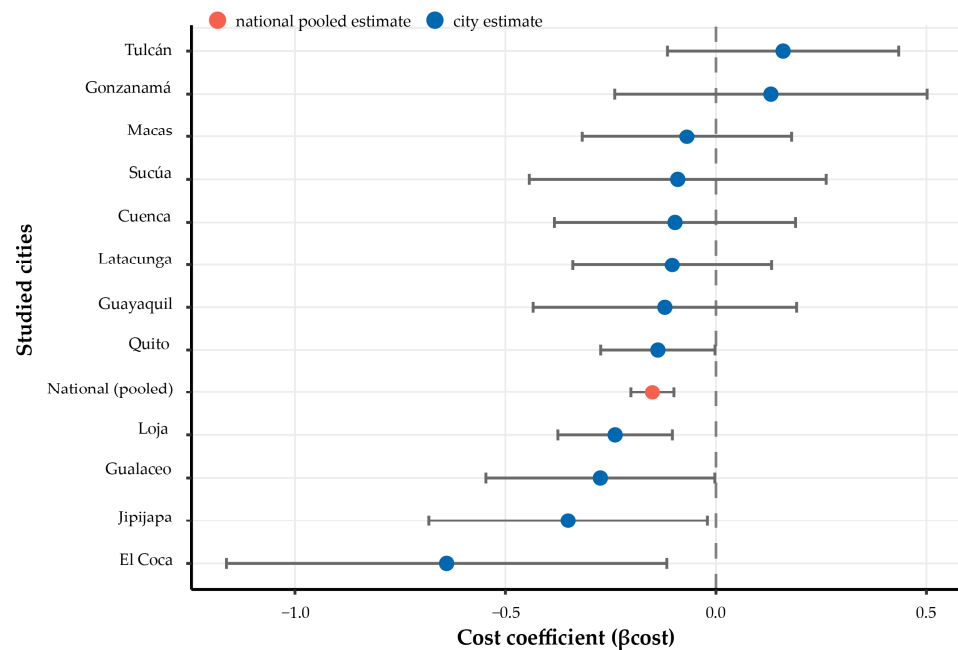


Figure 4. City-level parking cost sensitivity coefficients estimated from stratified Multinomial Logit models. Points represent estimated cost coefficients, horizontal bars indicate 95% confidence intervals, and the national pooled estimate is shown as a reference benchmark.

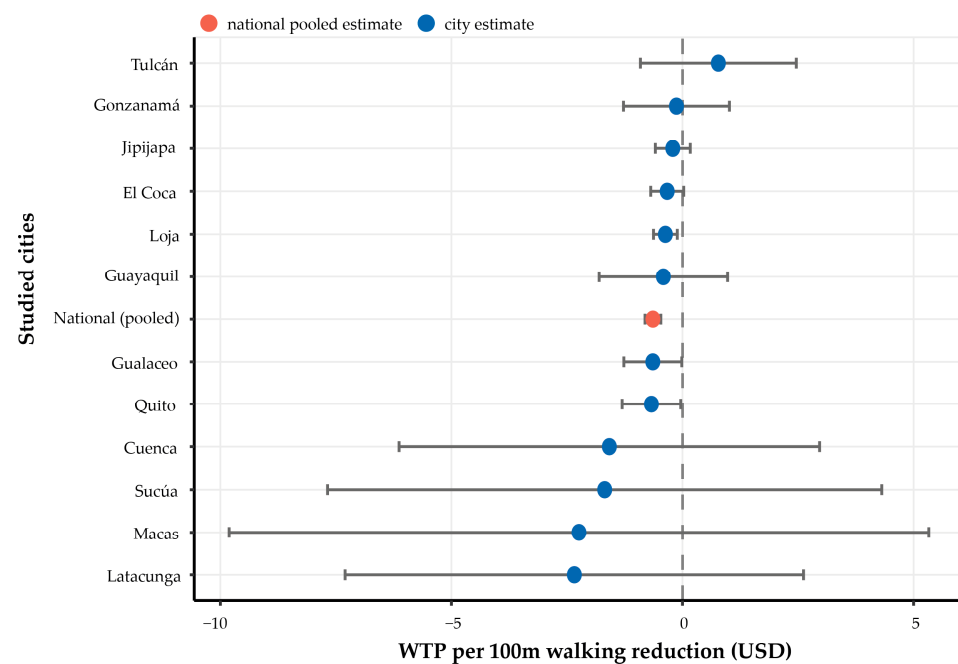


Figure 5. City-level willingness-to-pay estimates for a 100-m reduction in walking distance to the final destination. Points represent estimated WTP values derived from stratified Multinomial Logit models, horizontal bars show 95% confidence intervals, and the national pooled estimate is included for comparison.

The distribution of maximum stated WTP also varied substantially across cities, as illustrated in Figure 6. Some urban areas displayed more concentrated distributions around lower WTP values, whereas others exhibited broader distributions with higher upper tails, indicating greater heterogeneity in parking expenditure tolerance.

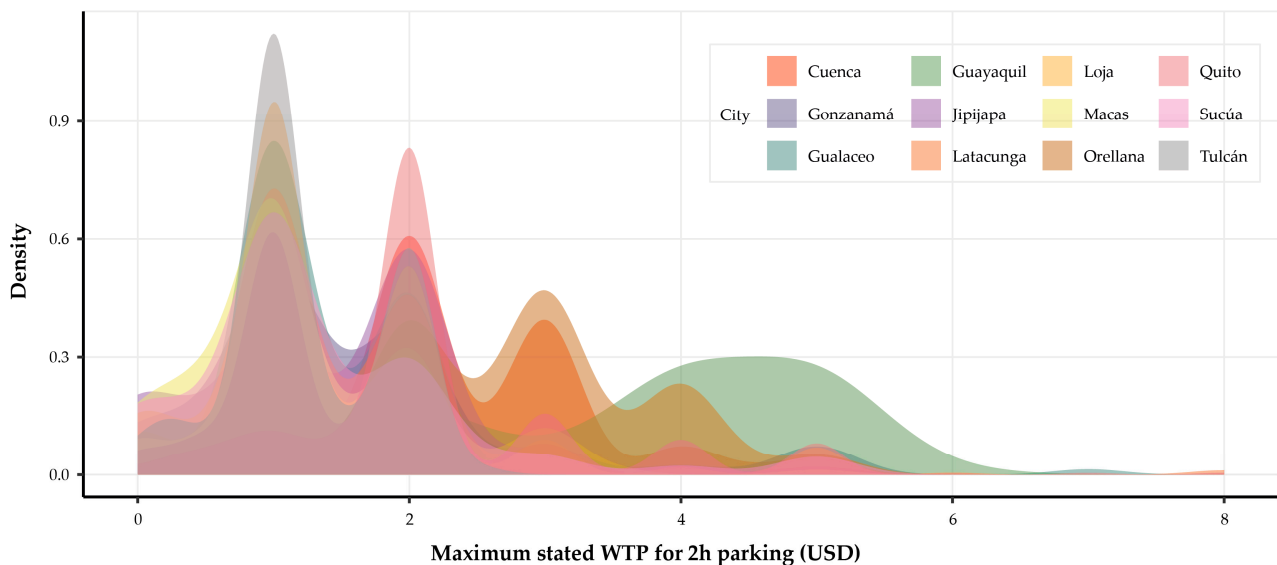


Figure 6. Kernel density distribution of maximum stated willingness to pay for a two-hour parking session by city. The figure illustrates differences in the distribution and dispersion of parking expenditure tolerance across urban contexts.

Table 6. Maximum stated willingness to pay for a two-hour parking session by income group.

Income Group	<i>n</i>	Mean (USD)	Median	SD
High income	22	2.59	2.00	1.01
Middle income	461	2.14	2.00	1.32
Low income	1587	1.58	1.00	1.07

Note: WTP values are expressed in USD for a two-hour parking session. Income categories are based on monthly household income.

3.5. Mixed Logit Model and Preference Heterogeneity

The Mixed Logit model substantially improved model performance relative to all MNL specifications, as previously indicated in Table 4. The model achieved a log-likelihood of $-14,224.92$ and an AIC of $28,471.84$, outperforming the reduced MNL model by 211.84 AIC points. The McFadden pseudo- R^2 of 0.0165 represents a near doubling of explanatory performance relative to the MNL baseline (Table 7).

Table 7. Mixed Logit model estimates and random-parameter standard deviations.

Variable	β	SE	<i>p</i> -Value
Walking distance	−0.0011	0.0001	<0.001
Parking cost	−0.1662	0.0288	<0.001
Search time	−0.0101	0.0017	<0.001
Security score	0.1421	0.0400	<0.001
Surveillance score	−0.1073	0.0381	0.005
SD cost	0.4533	0.0280	<0.001
SD search time	0.0001	0.0034	0.968
SD security	0.2922	0.0534	<0.001

Note: SD parameters indicate estimated standard deviations of random coefficients. Statistically significant SD estimates indicate unobserved heterogeneity in preferences across respondents.

As shown in Table 7, the estimated coefficients maintained signs consistent with the MNL specifications and random utility theory expectations. Higher parking costs, longer walking distances, and increased search times significantly reduced the probability of se-

lecting a parking alternative, while higher perceived security increased utility. Surveillance conditions continued to exhibit a negative effect on parking utility.

Significant standard deviations for parking cost and security parameters confirmed the existence of unobserved heterogeneity among respondents (Table 7). In contrast, the standard deviation associated with search time was not statistically significant, suggesting more homogeneous preferences regarding parking search duration. The relatively large standard deviation estimated for parking cost ($SD = 0.4533$) indicates substantial variation in price sensitivity across individuals, whereas the heterogeneity observed for security perceptions ($SD = 0.2922$) suggests that users value safety conditions differently depending on their personal or contextual characteristics.

The Hausman-McFadden test further indicated violation of the Independence of Irrelevant Alternatives (IIA) assumption ($\chi^2 = 67.368$, $p < 0.001$), providing additional statistical justification for the Mixed Logit specification over the standard MNL model.

3.6. Technology Adoption and Spatial Moderation

Technology adoption remained relatively limited across the sample. Only 18.4% of respondents reported current use of parking mobile applications, although willingness to adopt advance reservation systems exceeded 75% across most income groups and cities (Table 8 and Figure 7). App adoption rates were highest in Guayaquil (33.7%) and Gualaceo (27.3%), whereas Gonzanamá and Tulcán exhibited the lowest adoption levels.

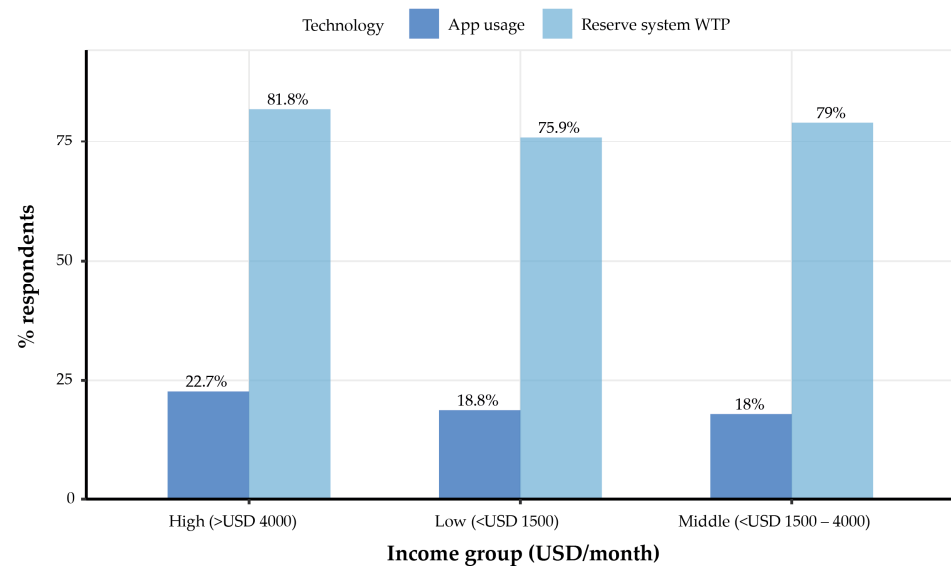


Figure 7. Parking mobile application use and willingness to use an advance reservation system by household income group. Percentages indicate the share of respondents in each income category reporting current app use or willingness to adopt reservation-based parking services.

Table 8. Parking technology adoption indicators by household income group.

Income Group	Parking App Use (%)	Reservation Willingness (%)
High income	22.7	81.8
Middle income	18.0	79.0
Low income	18.8	75.9

Note: Values represent the percentage of respondents in each income group reporting current mobile parking application use and willingness to use an advance parking reservation system.

Spatial analyses further demonstrated that parking choices varied according to residential and workplace contexts (Table 9 and Figure 8). Respondents residing in suburban

and peripheral residential areas showed higher probabilities of selecting regulated parking alternatives, whereas respondents living in consolidated urban zones exhibited greater use of private parking facilities. In contrast, irregular parking and the decision to leave the car were comparatively more frequent among respondents living in suburban areas, suggesting that parking availability, urban density, and accessibility conditions may influence parking-related decision-making.

Table 9. Stated parking choice distribution by residential zone typology.

Residential Zone	Regulated	Private	Irregular	Leave Car
Historic/commercial center	35.1	49.0	3.7	12.3
Consolidated residential	33.1	51.2	4.2	11.5
Peripheral residential	42.6	42.6	3.4	11.4
Suburban	44.2	34.2	7.0	14.6
Rural near city	42.6	39.5	4.0	13.9

Note: Values are percentages within each residential zone. Parking alternatives correspond to the options presented in the stated preference experiment.

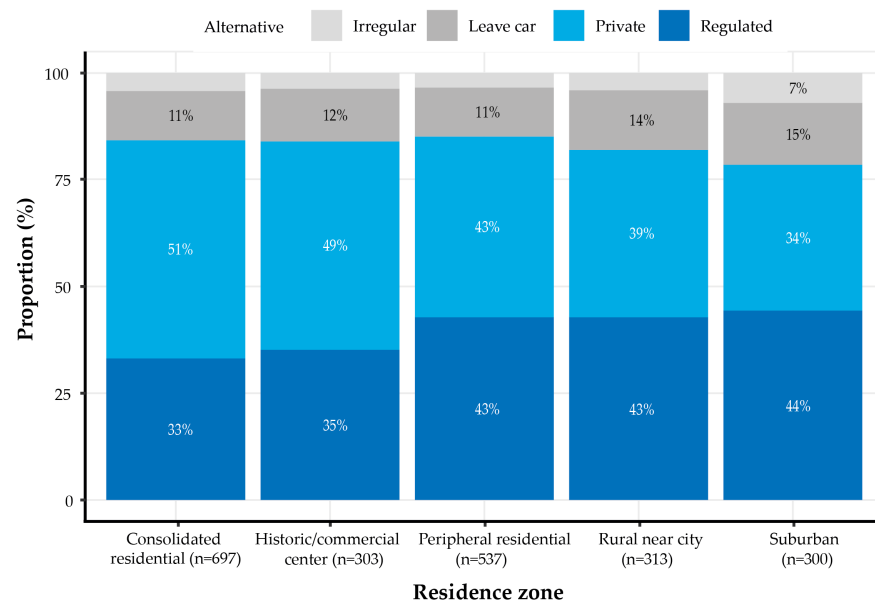


Figure 8. Distribution of stated parking choices by residential zone typology. Stacked bars show the proportion of respondents selecting regulated parking, private parking, irregular parking, or leaving the car for each residential context.

3.7. Attitudinal Structure and Behavioral Perceptions

Attitudinal indicators revealed moderate agreement regarding the necessity of parking regulation and the perceived insufficiency of urban parking infrastructure (Table 10). Respondents generally agreed that they would be willing to pay more for parking if the facility were located closer to their destination and expressed a preference for private parking facilities despite their higher associated costs. Likewise, respondents reported moderate agreement with the statement that they would reduce private vehicle use if public transportation services improved, suggesting potential openness toward more sustainable mobility alternatives.

Factor analyses further suggested the existence of latent attitudinal dimensions associated with payment willingness, infrastructure concern, and skepticism toward enforcement policies. The extracted factors indicated that parking-related decisions were influenced not only by observable parking attributes, but also by underlying perceptions regarding convenience, fairness, and urban mobility conditions. These attitudinal structures ex-

hibited substantial variation across cities, reflecting differences in local parking systems, enforcement intensity, and urban development patterns (Figure 9).

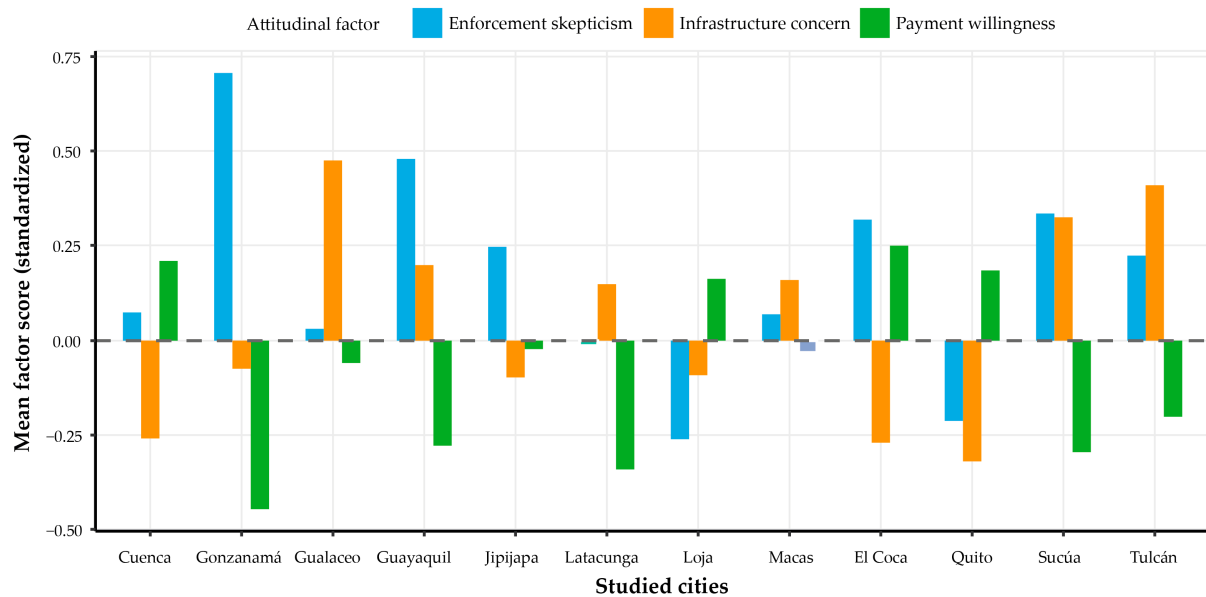


Figure 9. Mean standardized attitudinal factor scores by city. The factors summarize latent dimensions related to payment willingness, infrastructure concern, and enforcement skepticism, derived from the principal component analysis of attitudinal indicators.

Table 10. Descriptive statistics for the main attitudinal indicators related to parking management.

Statement	Mean	SD
Parking fines are fair and necessary	3.60	1.06
Willing to pay more if parking is closer	3.73	0.98
Prefer private parking despite higher cost	3.77	1.00
Parking infrastructure is insufficient	3.66	0.96
Would leave the car if public transport improved	3.74	1.02

Note: Attitudinal responses were measured using a Likert-type scale, with higher values indicating stronger agreement with each statement.

4. Discussion

4.1. Parking Choice Determinants and Behavioral Interpretation

The findings of this study confirm that parking choice behavior in Ecuadorian cities is primarily influenced by generalized parking costs, including monetary cost, walking distance, and parking search time. The negative and statistically significant coefficients associated with these attributes are consistent with Random Utility Theory [7] and align with previous parking choice studies conducted in Europe, North America, and Asia, where users systematically prefer parking alternatives that minimize access impedance and uncertainty [4,9,10]. The estimated sensitivity to parking costs also corroborates findings reported in Latin American urban contexts, where parking pricing remains a critical determinant of modal and destination decisions due to lower household purchasing power and high transport expenditure burdens [12].

Walking distance emerged as one of the most stable predictors across both national and city-level models, suggesting that pedestrian accessibility remains a fundamental component of parking utility regardless of city size or geographic region. This finding is coherent with studies indicating that drivers often perceive walking time as more burdensome than in-vehicle travel time, particularly in environments with inadequate pedestrian infrastructure or perceived safety concerns [4,5]. In the Ecuadorian context, this sensitivity

may be amplified by fragmented urban development patterns, limited sidewalk quality, and climatic conditions that discourage longer walking distances between parking locations and final destinations [13].

Parking search time also exerted a negative effect on parking utility, although the magnitude of the coefficient was lower than that of direct monetary costs. This result supports previous evidence showing that uncertainty and cruising behavior generate both psychological and operational disutility for drivers [2,3]. The average reported search time exceeded 13 min, suggesting relatively inefficient parking allocation conditions in several Ecuadorian cities. From a transportation policy perspective, these findings reinforce the importance of demand management strategies and real-time parking information systems capable of reducing cruising time and improving network efficiency [28,29].

The positive valuation of security conditions indicates that users are willing to pay for safer parking environments, particularly in contexts where vehicle theft or vandalism risk is perceived as relevant [13]. Interestingly, surveillance-related variables exhibited negative utility effects in the national models. One possible explanation is that intensive surveillance measures may be associated with stricter enforcement, greater perceived restrictions, or reduced flexibility in parking behavior. Similar paradoxical findings have been reported in studies where enforcement visibility increases perceived inconvenience despite improving formal compliance [5,27].

4.2. Inter-City Heterogeneity and Transferability of Parking Preferences

One of the principal contributions of this study lies in the identification of substantial inter-city heterogeneity in parking preferences across Ecuadorian urban contexts. Although the national pooled model revealed consistent directional effects for the principal parking attributes, city-specific models demonstrated considerable variation in coefficient magnitude, statistical significance, and willingness-to-pay estimates. These findings suggest that parking behavior cannot be assumed to be fully transferable between Ecuadorian cities, even within the same national context [18,30]. Similar findings have been reported in recent studies conducted in Asia and South Asia, where substantial variations in parking preferences and willingness-to-pay values were observed across cities with different demographic, economic, and land-use characteristics. These results suggest that locally calibrated parking policies are generally more effective than adopting uniform parking management strategies across diverse urban contexts [14,15].

Intermediate and smaller cities such as Gualaceo, El Coca, and Jipijapa exhibited stronger sensitivity to parking costs than some larger metropolitan areas. This pattern may reflect differences in household income levels, parking supply conditions, urban density, or cultural attitudes toward parking regulation. In contrast, larger cities such as Guayaquil displayed lower statistical sensitivity to certain parking attributes, potentially due to greater adaptation to congestion, parking scarcity, and diversified parking supply structures. These results are particularly relevant because much of the existing parking choice literature has focused predominantly on large metropolitan environments, while intermediate cities in developing countries remain underrepresented [11].

The heterogeneity observed across cities also has important methodological implications. The confidence intervals associated with several city-level willingness-to-pay estimates revealed limited parameter stability in smaller samples, suggesting that local calibration remains essential when designing parking pricing policies or simulation models [6]. Consequently, transferring parking demand parameters between cities without contextual adjustment may generate biased forecasts and inefficient policy recommendations. This issue is especially relevant in Latin American countries characterized by high territorial diversity and uneven urban development trajectories [31].

4.3. Willingness-to-Pay and Equity Implications

The willingness-to-pay estimates indicate that Ecuadorian drivers attribute positive economic value to reductions in walking distance and parking search time, as well as to improvements in parking security conditions. The observed WTP values are generally lower than those reported in high-income countries [4], which is expected given Ecuador's lower average income levels and different urban mobility structures. The strong sensitivity observed for parking search time is consistent with recent evidence demonstrating that parking search behavior constitutes a significant component of perceived travel burden and plays a central role in parking location decisions within congested urban environments [32]. Nevertheless, the relative importance assigned to accessibility and security attributes demonstrates that users are not exclusively price-oriented and may support quality improvements under appropriate pricing conditions [17].

The income-segmented analyses revealed important distributive implications for parking policy. Lower-income respondents exhibited stronger sensitivity to parking prices than middle-income groups, indicating that uniform tariff increases may disproportionately affect economically vulnerable users. This finding is consistent with broader transportation equity literature showing that pricing-based demand management strategies can produce regressive impacts if socioeconomic heterogeneity is ignored [27,28,33]. Therefore, parking policies based exclusively on generalized pricing mechanisms may generate unintended accessibility inequalities, particularly in cities with limited public transport alternatives. Recent evidence indicates that willingness-to-pay for parking improvements is strongly associated with income level, travel purpose, and user perceptions of convenience and security, raising important equity considerations for the design of parking pricing policies and parking management interventions [34].

At the same time, the relatively high willingness to adopt reservation systems and digital parking technologies suggests that smart parking strategies could improve efficiency without relying solely on tariff escalation [11]. However, the current adoption rate of parking applications remains relatively low, indicating that technological diffusion in Ecuadorian cities is still incipient. This gap between willingness and actual adoption may be explained by limited digital integration of parking systems, low interoperability between municipalities and private operators, or insufficient trust in digital payment platforms [13].

The empirical results of this study suggest several targeted strategies to bridge the gap between stated willingness and actual adoption. First, the high WTP for reductions in parking search time (USD 0.69 per 10 min) indicates that real-time parking availability information—delivered through mobile applications or variable message signs—would address a primary behavioral pain point and may translate stated willingness into actual digital adoption. In European contexts, values range from EUR 1.20 to EUR 3.50 per 100 m reduction in walking distance [4,5]. Providing tangible, immediate utility through information accessibility represents a low-barrier entry point for technology uptake. Second, the income-stratified analyses show that low-income users exhibit strong willingness to adopt reservation systems (75.9%) despite limited current use, suggesting that adoption barriers are structural rather than attitudinal. Reducing or eliminating data costs, offering simplified interfaces, and ensuring compatibility with low-cost smartphones could substantially lower technological access barriers in this segment. Third, the spatial analyses indicate that respondents from peripheral and suburban zones show distinct parking preferences; geographically differentiated technology deployment strategies—prioritizing areas of highest parking scarcity and demand uncertainty—could maximize adoption efficiency. Finally, the positive WTP for security improvements suggests that integrating safety-related features (e.g., lighting status, occupancy verification, user ratings) into digital parking platforms

could enhance perceived value and accelerate adoption beyond the purely transactional functions currently available in most parking applications.

4.4. Mixed Logit Performance and Preference Heterogeneity

The Mixed Logit specification substantially improved model performance relative to the traditional Multinomial Logit models, confirming the existence of unobserved preference heterogeneity among respondents. The significant standard deviations associated with parking cost and security parameters indicate that individuals do not value parking attributes uniformly [35,36]. Such heterogeneity is theoretically consistent with the diversity of socioeconomic conditions, travel purposes, and urban environments represented in the national sample [4,18].

The violation of the Independence of Irrelevant Alternatives (IIA) assumption further supports the superiority of the Mixed Logit approach for modeling parking choice behavior in complex urban systems. The MNL framework assumes proportional substitution patterns between alternatives, an assumption that is often unrealistic in transportation behavior contexts where parking alternatives may share correlated unobserved characteristics [6,7]. By relaxing this assumption, the Mixed Logit model captured a broader range of behavioral variability and produced better overall fit indicators [5,9].

Despite the improved performance of the Mixed Logit model, the pseudo- R^2 values remained relatively modest. This outcome is common in disaggregate choice models involving heterogeneous behavioral processes and large-scale SP datasets [8]. Parking decisions are influenced not only by observable attributes but also by latent psychological factors, habitual behavior, contextual trip constraints, and real-time environmental conditions that are difficult to capture in cross-sectional survey instruments. Consequently, relatively low pseudo- R^2 values should not necessarily be interpreted as evidence of poor explanatory validity [6].

4.5. Technology Adoption and Spatial Context

The technology adoption results reveal that Ecuadorian cities may be approaching a transitional stage toward digital parking management systems. Although current parking application usage remains limited, the strong willingness to adopt reservation systems suggests latent acceptance of smart parking technologies among urban drivers [11]. This finding is particularly relevant for medium-sized cities, where digital parking management remains largely underdeveloped compared to major metropolitan areas [28]. This discrepancy between current adoption levels and future willingness to use smart parking technologies has also been identified in recent research. Concerns regarding platform reliability, information accuracy, reservation certainty, and trust in digital systems often slow adoption despite generally positive attitudes toward smart parking services [37]. Furthermore, behaviorally informed parking reservation systems have been shown to improve parking allocation efficiency while supporting dynamic pricing mechanisms that reduce search time and improve parking utilization rates in dense urban environments [16].

The spatial analyses also demonstrated that parking choices vary according to residential and workplace urban typologies. Respondents residing in peripheral and suburban areas exhibited different parking preferences than those living in consolidated urban centers. These differences likely reflect variations in public transport accessibility, land-use density, vehicle dependence, and parking supply availability. Similar spatial moderation effects have been identified in urban form literature, where built environment characteristics systematically influence travel behavior and parking demand patterns [38].

The observed relationship between urban structure and parking behavior reinforces the importance of context-sensitive parking policies. Uniform parking management strate-

gies may be ineffective when applied across heterogeneous urban zones with distinct mobility patterns and accessibility conditions [27,39,40]. Therefore, differentiated pricing structures, localized parking regulations, and geographically adaptive digital systems may be more appropriate for Ecuadorian urban environments.

Recent developments in smart parking systems increasingly combine reservation platforms, mobile applications, real-time occupancy detection, and predictive analytics to improve parking allocation and user experience. These technologies have demonstrated considerable potential for reducing cruising traffic and enhancing parking efficiency when integrated within broader urban mobility strategies [41].

4.6. Study Limitations and Future Research

Several limitations should be acknowledged when interpreting the results of this study. First, the research relied on cross-sectional survey data collected during a specific time period, which limits the ability to evaluate temporal changes in parking behavior or causal dynamics. Longitudinal analyses would be necessary to examine how parking preferences evolve in response to policy interventions, economic fluctuations, or technological adoption.

Second, although the stated preference experiment incorporated revealed preference validation, SP methods remain susceptible to hypothetical bias [8]. Respondents may express preferences under hypothetical conditions that differ from their actual behavior in real-world settings. Nevertheless, the relatively consistent distributions between SP and RP choices suggest acceptable convergent validity within the present study [11].

A further limitation concerns the potential influence of sample composition on the WTP estimates. The sample is concentrated among respondents aged 25–44 (65.3%) and low-income earners (73.8%), which may systematically affect the direction and magnitude of willingness-to-pay values. Younger, economically active individuals typically exhibit higher time sensitivity and stronger preferences for digital parking solutions, which could lead to an overestimation of WTP for search time reductions relative to broader driver populations. Conversely, the predominance of low-income respondents may suppress WTP estimates for monetary cost attributes, producing values that underestimate the average WTP among higher-income segments of the driver population. Future research incorporating quota-based sampling by age and income group would allow more precise calibration of WTP heterogeneity and improve the generalizability of the estimated parameters.

Third, despite the national scope of the dataset, some cities retained relatively modest sample sizes after the cleaning procedures, which may have affected parameter stability in stratified estimations [6]. It is important to clarify, however, that the students involved in data collection served exclusively as field enumerators—they recruited participants and administered the survey—and did not themselves constitute the respondent population. The study targeted active drivers encountered in public urban spaces across each city. Nevertheless, the use of student enumerators may have introduced proximity bias if recruiters preferentially approached individuals within familiar social or demographic circles. To mitigate this risk, participating students received standardized training on random participant recruitment protocols, including explicit instructions to approach individuals across different age groups, genders, and apparent socioeconomic profiles. Future studies should consider complementing this approach with quota-based sampling or stratified random sampling frameworks to ensure more systematic representativeness of the driver population across age, income, and vehicle ownership dimensions.

Finally, the latent class models could not be successfully estimated due to specification constraints related to class probability variables. Consequently, the study could not fully explore latent behavioral segmentation structures beyond the Mixed Logit framework.

Future research should expand the analytical framework developed in this study through longitudinal and panel-data approaches capable of capturing temporal dynamics in parking behavior. Repeated observations over time would allow researchers to evaluate behavioral adaptation following parking pricing reforms, technological implementation, or broader mobility policy changes. Additional research is also needed to examine the interaction between parking behavior and emerging mobility systems, including shared mobility services, electric vehicle infrastructure, and integrated smart-city platforms. In particular, future studies could investigate whether digital parking management systems effectively reduce cruising behavior and congestion in intermediate Latin American cities.

Further methodological developments may include hybrid choice models integrating latent attitudinal variables, as well as advanced latent class specifications capable of identifying distinct behavioral segments within heterogeneous urban populations. Such approaches could improve explanatory performance and provide more nuanced insights into parking demand structures. Finally, comparative studies across Latin American countries would contribute to evaluating the transferability of parking demand parameters and identifying regional similarities and differences in parking behavior. Given the scarcity of large-scale parking choice studies in developing-country intermediate cities, the framework applied in this research may serve as a methodological basis for future multicity analyses throughout the region.

5. Differentiated Parking Policy Proposals for Ecuadorian Cities

The empirical findings of this study—including city-level cost sensitivity coefficients, willingness-to-pay (WTP) estimates, income distributions, technology adoption rates, and attitudinal indicators—provide a sufficient behavioral basis to formulate differentiated, evidence-based parking policy recommendations for Ecuadorian cities. Rather than proposing uniform national tariff structures, this section presents city-group-specific proposals that reflect the heterogeneous parking conditions, user profiles, and institutional capacities identified across the 12 cities analyzed. The cities are organized into three policy tiers based on population size, urban density, observed cost sensitivity, and WTP levels: (i) large metropolitan cities, (ii) intermediate cities, and (iii) small and Amazonian cities.

5.1. Large Metropolitan Cities: Quito and Guayaquil

Quito and Guayaquil represent Ecuador's two largest urban centers, with populations of approximately 1.8 million and 2.7 million inhabitants, respectively. These cities are characterized by higher levels of motorization, greater parking scarcity in central commercial districts, more diversified formal parking supply, and relatively higher household income levels compared to the national average. The city-level models revealed lower marginal cost sensitivity in these metropolitan contexts, consistent with greater adaptation to parking expenditure and a more heterogeneous supply structure.

For these cities, the following parking tariff and policy framework is proposed:

On-street regulated parking in high-demand central zones should be priced at USD 0.75–1.00 per hour, reflecting current market rates and the lower price elasticity observed in metropolitan respondents. This range exceeds the national average stated WTP for short-duration parking sessions and is consistent with the higher maximum WTP reported by middle- and high-income respondents in these cities (mean maximum WTP for a two-hour session: approximately USD 2.00–2.60). A progressive tariff structure—with lower rates for the first 30 min and increasing rates for sessions exceeding 90 min—would incentivize turnover in high-demand zones without disproportionately penalizing short-stay users.

Private off-street parking facilities should be encouraged to maintain market-competitive rates of USD 0.80–1.20 per hour, supported by municipal zoning policies

that prevent below-cost informal alternatives from undercutting formal supply. Given the high willingness to adopt digital reservation systems in both cities (Guayaquil exhibited the highest parking application usage at 33.7%), integration of real-time occupancy data and mobile pre-booking platforms should be prioritized as near-term infrastructure investments. A parking guidance information system (PGIS) connected to variable message signs on primary access corridors would directly address the high search times reported in these cities and generate efficiency gains consistent with the WTP for search time reductions (USD 0.69 per 10 min nationally).

Enforcement should be strengthened through automated license plate recognition systems, given the attitudinal evidence showing moderate enforcement sensitivity and the negative relationship between perceived surveillance and utility. Enforcement mechanisms should be framed as facilitators of availability rather than punitive tools, to minimize user resistance while improving formal parking compliance.

5.2. Intermediate Cities: Cuenca, Loja, Latacunga, and Tulcán

Cuenca, Loja, Latacunga, and Tulcán represent Ecuador's principal intermediate cities, with populations ranging from approximately 50,000 to 400,000 inhabitants. These cities exhibit active commercial cores, growing motorization rates, and emerging parking scarcity in central zones, but operate under more limited institutional capacity for enforcement and technology deployment than the major metropolitan areas. City-level models revealed moderate-to-high cost sensitivity in these contexts, with Tulcán in particular exhibiting among the strongest price sensitivity coefficients in the national sample.

For intermediate cities, the following framework is proposed:

On-street regulated parking in central commercial zones should be priced at USD 0.40–0.60 per hour, calibrated to the lower average WTP and higher cost sensitivity observed in these urban contexts. In Loja and Cuenca—cities with established parking regulation systems—existing tariff structures can be incrementally adjusted toward the upper end of this range, contingent on measurable improvements in parking availability and enforcement consistency. In Tulcán, given the particularly high cost sensitivity documented in the city-level model, tariff increases should be introduced gradually and accompanied by compensatory measures such as extended free parking grace periods (15–20 min) or subsidized rates for low-income resident permit holders.

Time-limited parking zones (maximum 60–90 min) should be established in the immediate vicinity of commercial and administrative centers to improve turnover without relying exclusively on price signals. Parking supply audits are recommended for Loja, Latacunga, and Tulcán to establish accurate baselines for on-street supply, informal occupation rates, and average search times—data necessary for calibrating local demand management interventions.

Technology adoption strategies in intermediate cities should prioritize low-cost, low-barrier digital solutions: QR-code-based payment systems, SMS confirmation of parking duration, and integration with existing municipal mobile applications are preferred over high-investment smart sensor infrastructure in the near term. The relatively high stated willingness to adopt reservation systems in these cities (above 70% across income groups) suggests favorable conditions for incremental digital transition.

5.3. Small and Amazonian Cities: El Coca, Jipijapa, Macas, Gualaceo, Sucúa, and Gonzanamá

The smaller cities in the analytical sample—including Amazonian cities such as El Coca, Macas, and Sucúa, as well as smaller highland and coastal centers such as Jipijapa, Gualaceo, and Gonzanamá—present distinct parking management realities. These cities have lower urban densities, smaller commercial cores, limited formal off-street parking sup-

ply, and predominantly low-income populations. Population sizes range from fewer than 3000 inhabitants in Gonzanamá to approximately 50,000 in El Coca, reflecting substantial variability even within this group.

For these cities, the following framework is recommended:

Formal on-street parking regulation, where currently absent, should be introduced at USD 0.25–0.40 per hour in the immediate commercial core—a range consistent with the lower WTP values observed in smaller urban centers and the higher income vulnerability of the local population. In Gonzanamá and Sucúa, where parking scarcity remains emergent rather than critical, the immediate priority should be the demarcation of regulated parking zones and the establishment of clear signage and time limits, rather than tariff implementation. A phased approach—beginning with physical organization and time restriction before introducing pricing—is more appropriate given the low institutional enforcement capacity and limited formal parking culture in these contexts.

In Amazonian cities such as El Coca and Macas, specific attention should be given to the intersection of parking demand with freight and commercial vehicle activity, which generates distinct parking pressure patterns that differ from those of highland intermediate cities. Mixed-use loading and short-stay zones adjacent to commercial areas may be more effective than pure passenger parking regulation in these contexts.

Digital parking technology deployment in small and Amazonian cities should be deferred until baseline regulatory frameworks are consolidated and urban mobility data infrastructure is minimally established. The low observed parking application usage in Gonzanamá and Tulcán suggests that premature technology mandates would face adoption barriers that cannot be resolved through information campaigns alone. Investment in basic parking data collection—occupancy counts, search time monitoring, and informal parking mapping—constitutes the appropriate immediate step to build the evidence base for future policy decisions.

5.4. Cross-Cutting Policy Recommendations

Beyond the city-group-specific proposals, several cross-cutting recommendations apply to the national parking policy framework in Ecuador:

Revenue allocation for parking reinvestment. Parking tariff revenues in all city tiers should be earmarked, at least partially, for pedestrian infrastructure improvements, parking supply expansion in underserved zones, and public transport integration measures. This revenue-recycling principle increases political acceptability of pricing reforms and directly addresses the WTP for walking distance reductions documented across the national sample.

Income-differentiated permit systems. Given the strong income stratification in WTP values—with low-income respondents reporting a mean maximum WTP of USD 1.58 for a two-hour session compared to USD 2.59 for high-income users—resident parking permit systems with income-tiered pricing are recommended in all cities where residential on-street parking pressure is significant. This mechanism preserves mobility access for economically vulnerable populations while generating revenue from higher-income users with greater payment capacity.

Security as a value driver. The positive WTP for security improvements (USD 1.04 per security-level increase nationally) indicates that investment in lighting, physical barriers, attendant presence, and parking facility certification programs can function as demand management tools, shifting users from informal to formal parking alternatives without requiring tariff increases. This strategy is particularly relevant in intermediate and smaller cities where enforcement capacity is limited but security perceptions significantly influence parking choice.

National parking data observatory. The inter-city heterogeneity identified in this study underscores the importance of establishing a national parking monitoring system capable of tracking occupancy rates, tariff levels, enforcement intensity, and technology adoption across Ecuadorian cities over time. Such an observatory would provide the longitudinal data necessary to evaluate the effectiveness of differentiated policies and recalibrate local demand models as urban conditions evolve.

Nevertheless, successful implementation of smart parking initiatives requires more than technological deployment alone. Institutional coordination, data governance, long-term maintenance capacity, and organizational readiness remain critical determinants of implementation success, particularly in resource-constrained urban environments [42].

6. Conclusions

This study analyzed parking choice behavior across 12 Ecuadorian cities using a nationally distributed SP experiment combined with RP validation and discrete choice modeling. The results confirmed that parking cost, walking distance, and search time consistently reduce parking utility across urban contexts, while security improvements increase the probability of selecting formal parking alternatives. The Mixed Logit specification outperformed MNL models by 211.84 AIC points, revealing significant preference heterogeneity in cost and security valuations that cannot be captured by standard logit approaches. The inter-city analyses demonstrated that parking preferences are not fully transferable across Ecuadorian urban environments, with intermediate cities such as Tulcán and Gualaceo exhibiting stronger cost sensitivity than larger metropolitan areas. These findings have direct implications for parking pricing policy: uniform national tariff structures may be inadequate, and locally calibrated demand models are necessary for efficient and equitable parking management. The income-segmented WTP estimates further indicate that price-based parking management strategies carry equity risks if applied without socioeconomic differentiation. At the same time, the high willingness to adopt digital reservation systems (>75%) suggests that smart parking technologies represent a viable demand management complement in cities where tariff increases may generate regressive distributional effects. Taken together, these findings lead directly to a set of practical recommendations that are grounded in the behavioral evidence generated by this study. The demonstrated sensitivity to parking costs and search times supports the implementation of demand-responsive pricing mechanisms and real-time parking information systems as primary policy instruments. The documented income heterogeneity in WTP calls for differentiated tariff structures—with reduced rates or protected access options for low-income drivers—to prevent parking pricing reforms from generating regressive distributional effects. The strong latent demand for smart parking technologies, combined with the low current adoption rate, points to the need for institutional investment in interoperable digital infrastructure, simplified mobile interfaces, and spatially targeted deployment strategies rather than uniform technology rollouts. Finally, the inter-city variability in behavioral parameters reinforces the importance of locally calibrated demand models over generic national standards: what constitutes an effective parking policy in Guayaquil may be poorly suited to an intermediate city such as Tulcán or Gonzanamá. This research provides a scalable analytical framework for evidence-based parking demand assessment in intermediate Latin American cities, contributing empirical results from an underrepresented regional context. Future work should incorporate longitudinal panel data, latent class specifications, and cross-country comparisons to further evaluate the behavioral dynamics and policy transferability of parking demand across the region.

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References

1. Shoup, D.C. *The High Cost of Free Parking*; Routledge: London, UK, 2011.
2. Hampshire, R.C.; Shoup, D. What Share of Traffic Is Cruising for Parking? *J. Transp. Econ. Policy* **2018**, *52*, 184–201. [\[CrossRef\]](#)
3. Shoup, D.C. Cruising for Parking. *Transp. Policy* **2006**, *13*, 479–486. [\[CrossRef\]](#)
4. Ibeas, A.; Dell’Olio, L.; Bordagaray, M.; Ortúzar, J.d.D. Modelling Parking Choices Considering User Heterogeneity. *Transp. Res. Part A Policy Pract.* **2014**, *70*, 41–49. [\[CrossRef\]](#)
5. Antolín, G.; Ibeas, Á.; Alonso, B.; dell’Olio, L. Modelling Parking Behaviour Considering Users Heterogeneities. *Transp. Policy* **2018**, *67*, 23–30. [\[CrossRef\]](#)
6. Train, K.E. *Discrete Choice Methods with Simulation*, 2nd ed.; Cambridge University Press: Cambridge, UK, 2009.
7. McFadden, D. Conditional Logit Analysis of Qualitative Choice Behavior. In *Frontiers in Econometrics*; Zarembka, P., Ed.; Academic Press: Cambridge, MA, USA, 1974; pp. 105–142.
8. Louviere, J.J.; Hensher, D.A.; Swait, J.D.; Adamowicz, W. *Stated Choice Methods: Analysis and Applications*; Cambridge University Press: Cambridge, UK, 2000.
9. Hess, S.; Polak, J.W. An Analysis of Parking Behaviour Using Discrete Choice Models Calibrated on SP Datasets. In *Proceedings of the ERSA Conference Papers*; European Regional Science Association: Milan, Italy, 2004.
10. Hoang, P.H.; Zhao, S.; Houn, S.E. Motorcycle Drivers’ Parking Lot Choice Behaviors in Developing Countries: Analysis to Identify Influence Factors. *Sustainability* **2019**, *11*, 2463. [\[CrossRef\]](#)
11. Long, N.V.; Linh, H.T.; Tuan, V.A. Towards Smart Parking Management: Econometric Analysis and Modeling of Public-Parking-Choice Behavior in Three Cities of Binh Duong, Vietnam. *Sustainability* **2023**, *15*, 16936. [\[CrossRef\]](#)
12. Soto Martínez, J.J.; Márquez Díaz, L.G.; Macea Mercado, L.F. Preferencias Sobre Alternativas de Estacionamiento En Cartagena: ¿Cuánto Están Dispuestos a Pagar Los Conductores? *Econ. Región* **2018**, *12*, 163–180.
13. García-Ramírez, Y.; Díaz-Muñoz, F.; Merino-Vivanco, X. Sustainable Parking Choice Behavior in an Intermediate Andean City: A Stated Preference Analysis of Willingness to Pay, Enforcement Sensitivity, and Policy Implications in Loja, Ecuador. *Sustainability* **2026**, *18*, 3304. [\[CrossRef\]](#)
14. Parmar, J.; Saiyed, G.; Dave, S. Analysis of Taste Heterogeneity in Commuters’ Travel Decisions Using Joint Parking– and Mode–Choice Model: A Case from Urban India. *Transp. Res. Part A Policy Pract.* **2023**, *170*, 103610. [\[CrossRef\]](#)
15. Zhang, D.; Zhang, K.; Tian, Y. Beyond One-Size-Fits-All: Heterogeneous Preferences and Attribute-Based Pricing for Residential Parking in Urban China. *Res. Transp. Bus. Manag.* **2026**, *68*, 101742. [\[CrossRef\]](#)
16. Li, X.; Xie, B.; Wang, X.; Li, G.; Yao, Z. Parking Choice Behavior of Urban Village Residents Considering Parking Risk: An Integrated Modeling Approach. *Case Stud. Transp. Policy* **2024**, *15*, 101145. [\[CrossRef\]](#)
17. Rodríguez, A.; dell’Olio, L.; Moura, J.L.; Alonso, B.; Cordera, R. Modelling Parking Choice Behaviour Considering Alternative Availability and Systematic and Random Variations in User Tastes. *Sustainability* **2023**, *15*, 8618. [\[CrossRef\]](#)
18. Hess, S. Mixed Logit Modelling of Parking Type Choice Behaviour. In *Proceedings of the Engineering, Economics, Environmental Science*, Washington, DC, USA, 18–21 October 2009.
19. Rodríguez, A.; Alonso, B.; Moura, J.L.; dell’Olio, L. Analysis of User Behavior in Urban Parking under Different Level of Information Scenarios Provided by Smart Devices or Connected Cars. *Travel Behav. Soc.* **2024**, *37*, 100847. [\[CrossRef\]](#)

20. Morfoulaki, M.; Kotoula, K.M.; Myrovali, G.; Ayfantopoulou, G. Calculating the Impacts of Alternative Parking Pricing and Enforcement Policies in Urban Areas with Traffic Problems. *Period. Polytech. Transp. Eng.* **2017**, *45*, 35–41. [CrossRef]
21. Trichês Lucchesi, S.; Larrañaga, A.M.; Cybis, H.B.; Arellana, J.A. Are People Willing to Pay More to Live in a Walking Environment? A Multigroup Analysis of the Impact of Walkability on Real Estate Values and Their Moderation Effects in Two Global South Cities. *Res. Transp. Econ.* **2021**, *86*, 100976. [CrossRef]
22. Ornelas, D.A.; Nourinejad, M.; Park, P.Y.; Roorda, M.J. Managing Parking with Progressive Pricing. *Transp. Res. Part C Emerg. Technol.* **2023**, *152*, 104040. [CrossRef]
23. Namakula, H.; Bukenya, I.; Tusubira, J.; Bwambale, A.; Legese, A.T.; Bagampadde, U. Complementarity between Stated and Revealed Preferences in Pedestrian Route Choice: Evidence from a University Campus Living Lab in Kampala. *Sci. Afr.* **2026**, *33*, e03434. [CrossRef]
24. INEC Censo Ecuador. Available online: <https://cubos.inec.gob.ec/AppCensoEcuador/> (accessed on 17 May 2026).
25. R Core Team. *A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2026.
26. RStudio: Integrated Development Environment for R, Posit Software; PBC: Boston, MA, USA, 2023. Available online: <https://posit.co/download/rstudio-desktop/> (accessed on 18 May 2026).
27. Marsden, G. The Evidence Base for Parking Policies—A Review. *Transp. Policy* **2006**, *13*, 447–457. [CrossRef]
28. Litman, T. Parking Management—Strategies, Evaluation and Planning. Available online: https://www.vtpi.org/park_man.pdf (accessed on 18 May 2026).
29. Axhausen, K.W.; Polak, J.W. Choice of Parking: Stated Preference Approach. *Transportation* **1991**, *18*, 59–81. [CrossRef]
30. Ben Hassine, S.; Mraïhi, R.; Lachiheb, A.; Kooli, E. Modelling Parking Type Choice Behavior. *Int. J. Transp. Sci. Technol.* **2022**, *11*, 653–664. [CrossRef]
31. Ríos Flores, R.A.; Vicentini, V.L.; Acevedo-Daunas, R.M. *Practical Guidebook: Parking and Travel Demand Management Policies in Latin America*; Inter-American Development Bank: Washington, DC, USA, 2013.
32. Vakrinou, K.; Mantouka, E.G.; Kanatas, M.; Vlahogianni, E.I. Understanding Searching for Parking Behavior in Urban Road Networks. *Case Stud. Transp. Policy* **2026**, *23*, 101739. [CrossRef]
33. Arnott, R.; Inci, E. Microsimulation Parking Choice and Search Model to Assess Dynamic Pricing Scenarios. *Transp. Res. Part A Policy Pract.* **2022**, *156*, 253–269. [CrossRef]
34. Hong, D.; Jang, S. Bridging the Behavioral Valuation Gap: A Prosumer Perspective on Discrepancies between Willingness to Accept and Willingness to Pay in Shared Parking. *Transp. Res. Part A Policy Pract.* **2026**, *208*, 104988. [CrossRef]
35. Bagloee, S.A.; Ceder, A.; Bozic, C. Effectiveness of En Route Traffic Information in Developing Countries Using Conventional Discrete Choice and Neural-Network Models. *J. Adv. Transp.* **2014**, *48*, 486–506. [CrossRef]
36. Hoyos, D.; Mariel, P.; Hess, S. Incorporating Environmental Attitudes in Discrete Choice Models: An Exploration of the Utility of the Awareness of Consequences Scale. *Sci. Total Environ.* **2015**, *505*, 1100–1111. [CrossRef] [PubMed]
37. Macea, L.F.; Serrano, I.; Carcache-Guas, C. A Reservation-Based Parking Behavioral Model for Parking Demand Management in Urban Areas. *Socioecon. Plan. Sci.* **2023**, *86*, 101477. [CrossRef]
38. Ewing, R.; Cervero, R. Travel and the Built Environment. *J. Am. Plan. Assoc.* **2010**, *76*, 265–294. [CrossRef]
39. van der Waerden, P.; van der Waerden, J. Social Influences in the Context of Parking: An Exploratory Study Using a Stated Choice Approach. *Travel Behav. Soc.* **2026**, *42*, 101109. [CrossRef]
40. Simićević, J.; Vukanović, S.; Milosavljević, N. The Effect of Parking Charges and Time Limit to Car Usage and Parking Behaviour. *Transp. Policy* **2013**, *30*, 125–131. [CrossRef]
41. Gong, S.; Qin, J.; Xu, H.; Cao, R.; Liu, Y.; Jing, C.; Hao, Y.; Yang, Y. Spatio-Temporal Parking Occupancy Forecasting Integrating Parking Sensing Records and Street-Level Images. *Int. J. Appl. Earth Obs. Geoinf.* **2023**, *118*, 103290. [CrossRef]
42. Ahmadian, M.M.; Baker, D.; Paz, A. Leveraging Business Intelligence Solutions for Urban Parking Management. *City Cult. Soc.* **2024**, *37*, 100579. [CrossRef]

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