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Discrete Choice Modeling Using Stated and Revealed Preference Analysis Prior to Implementation of Rail-Based Transportation MRT7 in Quezon City, Philippines

Eric John Laron[1,2*], Alexis M. Fillone[2], Maria Cecilia R. Paringit[1]

[1] Department of Civil Engineering, Gokongwei College of Engineering, De La Salle University, 1004 Manila, Philippines
[2] Department of Civil Engineering, College of Engineering, National University, 1004 Manila, Philippines

* Correspondence: Eric John Laron (eric_laron@dlsu.edu.ph)

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Abstract: This study investigates commuter mode choice behavior between Bulacan and Quezon City, in the context of the forthcoming Metro Rail Transit Line-7 (MRT7). In this study we examine current travel behavior and preferences using both revealed and stated preference (SP) data, while also describing the travel characteristics of private car users and the operational features of other public transportation services. We hypothesize that in-vehicle travel time and out-of-pocket travel cost are the most influential factors affecting the mode choice decisions. A total of 4600 survey responses were collected using orthogonally designed choice set and analyzed using Discrete Choice Modeling (DCM) through Multinomial Logit Framework (MNL) in LIMDEP NLOGIT and RStudio. Modal shift analysis shows in-vehicle travel time, cost relative-to-income, access-time, comfort and safety as the most influential factors shaping mode choice. More commuters choose rail-based transportation when in-vehicle travel time reaches 62.54 minutes. When it comes to out-of-pocket cost, a modal shift occurs around a cost-to-income ratio above 8% (equivalent to 120.87 pesos). The average access-time for road-based transportation is 22.9 minutes. Though less influential, a notable shift is observed at above 30 minutes access-time. Comfort shows a strong behavioral influence with rail commuters rising from 34.62% under poor comfort to 80.86% under high comfort. Similarly, safety perception affects choice: rail captures 77.57% when road modes are viewed as unsafe, but only 35.16% when they are seen as safe. Overall, in-vehicle travel time and fare affordability demonstrated the highest sensitivity in determining mode choice, indicating that commuters prioritize the efficiency of their travel time and their financial capacity to afford the fare.

Keywords: Access time; In-vehicle travel time; Mode choice; Stated preference survey; Revealed preference survey; Multinomial logit; Random utility theory

1 Introduction

Metro Manila, the Philippines' capital, faces exceptionally high travel demand driven by rapid population growth, urbanization, and economic activity [1]. Quezon city, a city within Metro Manila, alone accounts for 2.96 million or 22% or the region's population [2]. As the nation's hub for economic and social activity, the region suffers severe congestion. The Japan International Cooperation Agency (JICA) 2019 report estimates 3.5 billion pesos in daily losses, while the Asian Development Bank 2019 report notes northern corridor traffic exceeds 50% capacity, underscoring the urgent need for expanded mass transit [3, 4]. In alignment with these insights, the Philippine Development Plan (PDP) also highlighted the importance of promoting efficient, high quality public transportation systems to enhance the mobility of the people and goods, giving priority over private vehicle use [5].

Metro Manila is among the world's most congested cities, and heavy traffic dominates most major roads, business districts and government areas. Quezon City, Metro Manila's largest and most populous area, is a hub of government, commerce, and education. It attracts high commuter volumes from nearby provinces, intensifying congestion [6]. To address this, the government is promoting more sustainable transport through Metro Rail Transit Line-7 (MRT7),

bus routes, bike lanes and related programs which aim to reduce car dependency and improve accessibility.

This study examines the transport corridor linking San Jose Del Monte, Bulacan and Quezon City, Metro Manila currently served by Public Utility Buses (PUBs), Public Utility Jeepneys (PUJs), UV Express, and private vehicles. Despite high travel demand, these services face persistent challenges including limited accessibility, insufficient capacity, high costs, poor comfort, and safety concerns. While traffic demand in Metro Manila has been increasing, use of PUBs and PUJs has been steadily declining. From 2013 to 2023, PUJ use has declined by 50% and PUBs by 42%. Meanwhile, motorcycle usage rose 286% during this period. From 2017 to 2023, private vehicle use has increased by 47%, contributing to worsening congestion [7].

In response, the government implemented both short-term traffic management measures and long-term investments, including Bus Rapid Transit (BRT) and Mass Rapid Transit (MRT) systems. In 2016, 1 trillion pesos was allocated for 14 railway projects nationwide [8]. Globally, MRT systems are recognized as transformative solutions to urban mobility [9, 10]. MRT7, a 20.1-kilometer line with 14 stations (see Figure 1), was prioritized in the JICA (2014) transport roadmap and is expected to significantly reshape commuting patterns in Quezon City [11, 12]. However, its success depends on attracting users away from private vehicles and road-based modes.

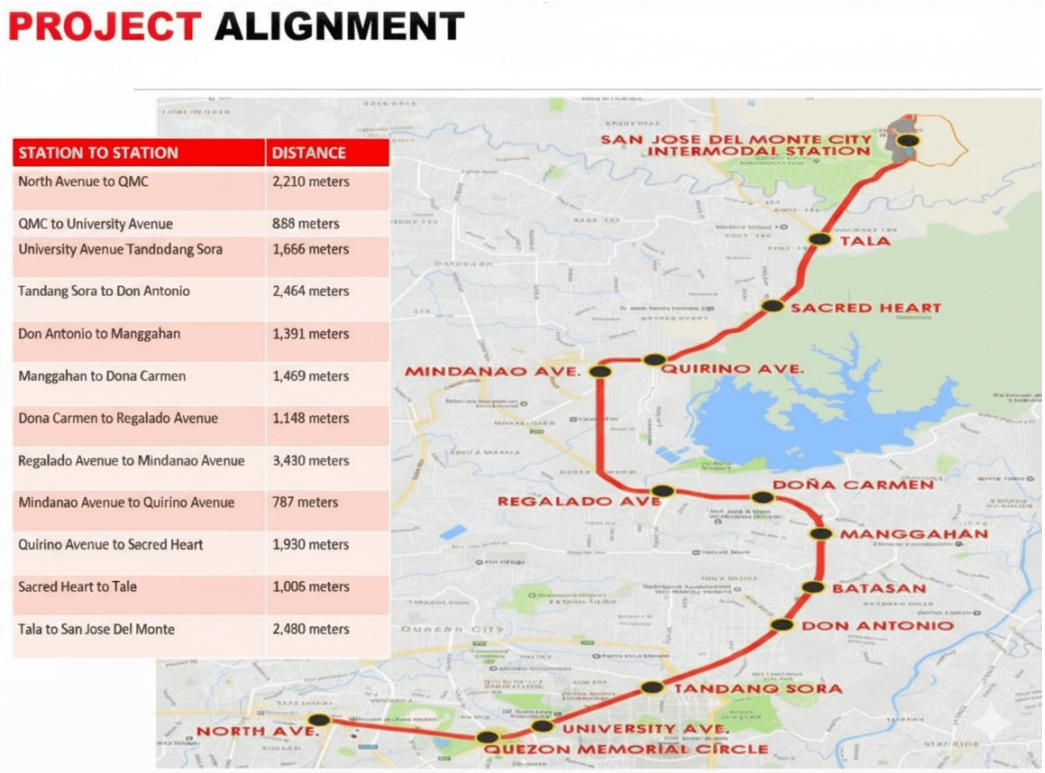

Figure 1. MRT7 stations

While previous studies highlight entrenched car dependence and limited willingness to shift modes, even with cost reductions [13–16], many overlook broader determinants such as accessibility, affordability, socioeconomic characteristics, and trip attributes and how these influence users' preferences and attitudes toward MRT systems [17]. This lack of context-specific insights hinders the ability of decision-makers to develop effective strategies for optimizing MRT adoption. This study addresses these gaps by developing a utility-based mode choice model that integrates transport attributes with socio-demographic variables to estimate elasticities, threshold values, and relocation impacts. The analysis provides insights into the potential for modal shift toward MRT7.

We seek to examine current travel behavior and preferences using both revealed and stated preference (SP) data, while also describing the travel characteristics of private car users and the operational features of PUB, PUJ, and UV Express services along the corridor. Further we evaluate the relative importance of transport attributes and explore the interaction effects between in-vehicle travel time and access-time. We hypothesize that in-vehicle travel time and out-of-pocket travel cost are the most influential factors affecting the mode choice decisions of commuters and private car users and that the probability of shifting to MRT7 varies across different user groups, with private car users exhibiting lower modal shift probabilities compared to current public transport users. We also hypothesize that there exists a statistically significant interaction effect between access time and in-vehicle travel time on mode choice behavior.

Finally, the research also investigates the long-term impacts of relocation on travel behavior, identifies potential relocation drivers linked to transport system improvements, and conducts sensitivity analysis to test the reliability of the model.

2 Literature Review

A wide range of studies have explored modal shift behavior, particularly in the context of introducing new mass transit systems like Metro Rail Transit (MRT). Transportation demand is considered derived, as people travel primarily to access activities such as work, shopping, education, and social interaction, rather than for the act of travel itself [18]. Transportation is vital for mobility since human activities are spatially dispersed. Despite time, cost, and resource demands, travel remains essential to meet trip purposes across distant locations [19].

2.1 Effects of Travel Behavior to Travel Demand

Understanding factors that influence travel demand such as individual preferences, choices, and their determinants is essential for shaping safe and sustainable transport policies [20]. Travel demand modeling typically addresses four core questions: how many trips will be made, to which destinations, by which modes, and along which routes [21]. These patterns define transport demand and underscore the importance of mode choice as a central focus in transport planning [22]. Mode choice models aim to realistically simulate travel behavior, supporting planning and decision-making [23, 24]. However, in many developing cities, their integration into planning remains limited [25]. With major investments in BRT, rail, and other systems, choice modeling is critical to predict adoption and guide infrastructure development.

2.2 Factors Influencing Transport Mode Choice

Studies emphasize multiple determinants of modal shift in developing cities. In Dhaka, 75% of commuters expressed willingness to adopt an MRT system, contingent on comfort, affordability, reduced travel time, and accessibility [26]. Classic frameworks classify mode choice factors into categories of hard (time, cost, reliability), soft (comfort, safety, convenience), and complementary (social influences, weather, health) [27]. Empirical work highlights socioeconomic and demographic influences such as age, gender, income, household size, and car ownership [28–30]. Land use patterns also matter, as compact or dense, mixed-use developments reduce vehicle miles traveled and support sustainable mobility [31–33]. Additionally, service quality and user satisfaction linked to frequency, reliability, cleanliness, and information are vital in shaping ridership [34–36]. Collectively, these studies underscore that mode choice reflects intertwined practical, experiential, and contextual factors.

Mode choice is shaped by multiple interrelated factors rather than a single determinant. Demographic variables such as age, gender, household size, income, and trip purpose strongly influence behavior [37–40]. Travel cost, time, and comfort are widely recognized as key predictors [27], with bus usage particularly sensitive to travel time [41]. Access time also affects choice, as shorter access combined with longer overall trips increases switching likelihood. This is not only seen in case study of Salaya in Thailand [9], but also in the Case of Oxfordshire in the UK and Hamburg in Germany [42]. Al-Salih and Esztergár-Kiss [43] ranked factors including trip distance, purpose, travel time, income, cost, vehicle ownership, transfers, family size, age, gender, employment, and education. They found that trip distance was the most significant factor, followed by travel time and purpose. Yet, İmre and Çelebi [44] emphasizes that comfort, measured by seating, noise, air quality, and temperature, is crucial yet often overlooked. Sohoni et al. [45] also stresses comfort being a significant factor.

2.3 Modal Shift Analysis

A wide range of studies have explored modal shift behavior, particularly in the context of introducing new mass transit system like Metro Rail Transit. In Mumbai, Sohoni et al. [45] found waiting time, travel time, cost, and discomfort to have negative utilities, with discomfort most influential. Dilay et al. [46] in the Philippines highlighted cost-to-income ratio as the strongest disutility, while Estrella et al. [47] in Baguio identified cost-time ratio and comfort as key factors for Aerial Ropeway Transit adoption. Youssef et al. [48] in Riyadh showed fare, in-vehicle time, and walking time as critical, with fare most decisive. Febriani et al. [49] in Jakarta emphasized affordability, accessibility, and acceptability, while Shakya and Bajracharya [50] in Kathmandu found 66% willingness to shift to MRT.

Conversely, resistance was observed in Hanoi [10] and Europe [51, 52], where awareness did not match willingness. Accessibility is a recurring determinant: Calvo et al. [53] in Madrid linked metro use to spatial accessibility, while Aktar et al. [26] in Jakarta and Hamidun et al. [54] in Malaysia confirmed convenience, cost, and time savings as drivers of MRT adoption. Other various studies highlighted travel time, cost, income, car ownership, and feeder modes as critical [55–58].

Overall, the current literature underscores that MRT adoption depends on aligning infrastructure with socioeconomic, behavioral, and spatial factors to ensure successful modal shift.

2.4 Revealed Preference and Stated Preference Survey

In transportation research, traveler preferences are commonly analyzed using Revealed Preference (RP) and SP methods: e.g., Table 1. RP captures actual choices made under existing conditions, reflecting current behavior and market equilibrium [59]. However, its scope is limited as it only considers available alternatives, restricting insights into future scenarios [60]. Conversely, SP allows respondents to evaluate hypothetical options, enabling the analysis of new transport modes and attributes through controlled experimental designs [24, 59]. While SP provides valuable foresight, its reliability depends on how realistically respondents perceive the scenarios [61]. To address these limitations, scholars recommend combining RP and SP data to enhance the quality of their research, especially when modeling demand for non-existent modes [62]. SP surveys are particularly advantageous as they present alternatives composed of multiple attributes such as cost, travel time, and comfort using experimental designs to ensure statistical validity [63].

Table 1. Similar studies using revealed preference and stated preference methods

Author	Survey Type	Model
Dilay and Fillone [46]	SP	Discrete Choice Model
Dissanayake and Morikawa [62]	RP	Nested Logit Model
Estrella et al. [47]	RP+SP	Discrete Choice Model
Sohoni et al. [45]	RP+SP	Discrete Choice Model

3 Methodology

This study develops a transport mode choice model for the San Jose del Monte-Quezon City corridor, where commuters evaluate available alternatives based on mode-specific attributes (in-vehicle travel time, cost, comfort, and safety), route-related factors (access time, transfers, walking distance, and trip length), and socio-demographic variables (age, household size, income, civil status, and work conditions). Current options include private cars, PUBs, jeepneys (PUJ), and UV Express, with the latter three serving as the most accessible and affordable public modes, making them direct competitors of the forthcoming MRT7. While private car users typically exhibit strong habit persistence and lower willingness to shift, their inclusion remains critical, as car-oriented corridors such as Commonwealth, Regalado, Quirino, and Mindanao avenues sustain high volumes of traffic. Accounting for both public and private users provide a comprehensive framework for analyzing modal shift potential, particularly under conditions where MRT7 offers improvements in efficiency, affordability, and accessibility.

3.1 Theoretical Framework and Modeling Specification

This study employs Random Utility Theory (RUT) as the basis for modeling travel behavior, where individuals are assumed to choose the alternative with the highest perceived utility, consisting of both observable attributes such as cost, travel time, comfort, safety and unobserved random components. Parameters are estimated through Maximum Likelihood Estimation (MLE), which maximizes the likelihood of the observed choices and ensure statistical consistency in the estimation process.

Within this framework, the Multinomial Logit (MNL) model is adopted as the primary estimation tool. The MNL framework incorporates both deterministic components, including mode attributes, socio-demographics and random components, with alternative-specific constants (ASC) normalized for comparative analysis while it is acknowledged that more advanced approaches such as Nested Logit (NL) or Mixed Logit (ML) model may better address correlations among alternatives or capture unobserved heterogeneity across individuals, The MNL was selected for several practical and theoretical reasons. It offers transparency and interpretability, which is crucial for policy analysis, and it provides computational efficiency, making it well-suited for handling the large-scale RP-SP datasets in this study. Moreover, the MNL has widely applied in transportation studies, enabling results to be benchmarked with earlier findings, Nonetheless, the limitations of the MNL model are recognized, and future extensions of this research may employ NL and ML to capture correlations and individual-specific preference heterogeneity more effectively.

3.2 Survey Design and Data Collection

Survey data were collected through RP and SP questionnaires, integrating actual travel behavior with hypothetical MRT7 scenarios. In this study, RP evaluates existing travel patterns while SP assesses the potential adoption of MRT7, thereby providing a comprehensive framework for analyzing modal shifts: e.g., Figure 2.

To minimize respondent burden, a Fractional Factorial Design with blocking was used, reducing treatment combinations while retaining main effects and selected interactions (e.g., in-vehicle and access time). Model outputs

were validated through statistical indicators (signs, p-values, t-tests, log-likelihood ratios, McFadden's R^2) and predictive accuracy measures, ensuring robustness in estimating choice probabilities, elasticities, and substitution effects.

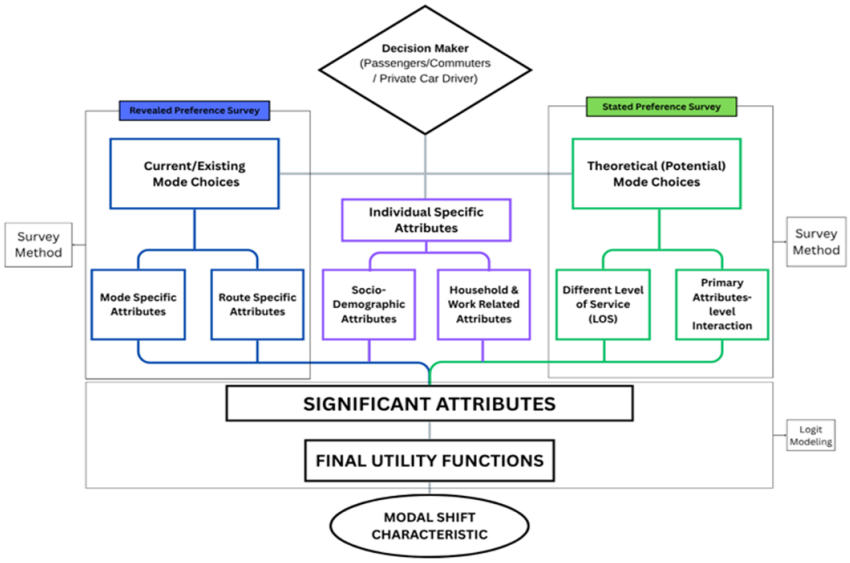

Figure 2. Conceptual framework of the study

Respondents aged 18 and above were surveyed to ensure reliability in scenario-based questions. A Discrete Choice Modeling (DCM) framework, specifically the logit model, was employed to capture individual travel decisions. Key variables include in-vehicle travel time, out-of-pocket cost, access time, comfort, and safety, alongside socio-demographic and household factors. To manage complexity, only the interaction between in-vehicle time and access time was tested. While private car use is recognized as dominant, it is included for comparative analysis.

3.3 Data Transformation and Estimation

The survey instrument comprised four sections: personal information, travel details, revealed and SPs, and residential/work data. The SP experiment was designed using Fractional Factorial and Orthogonal Designs, with five attributes (access time, in-vehicle time, cost, comfort, safety) and an interaction between access and in-vehicle time. IBM SPSS generated 18 orthogonal treatment combinations, divided into two blocks to reduce respondent burden. Pilot testing refined attribute definitions and ensured clarity. The final survey, administered online via Google Forms between May-June 2025, applied a convenience sampling strategy, yielding 5,200 responses across two blocks. Data validation involved completion checks, logical consistency, outlier removal, geographic and fare verification, and multicollinearity tests. Cleaned datasets were transformed into binary choice format for analysis in LIMDEP NLOGIT 5 and Rstudio, using MLE to develop robust RP-SP integrated mode choice models.

4 Results and Discussion

4.1 Descriptive Analysis

After validation, the dataset comprising trip attributes, socio-demographic information, mode-specific variables, and individual preferences was processed using Microsoft Excel. This software was selected due to its availability, ease of use, and capacity to manage large-scale numeric data. The cleaned data resulted in an analysis of 4600 RP and SP surveys.

4.1.1 Socio-demographic attributes

The online survey captured the sociodemographic characteristics of respondents, showing a relatively balanced gender distribution as seen in Figure 3. However, more males reported possessing driving skills and valid licenses for motorcycles or cars compared to females, as summarized in Table 2.

The age distribution of respondents indicates that younger individuals (15–30 years old) dominate the sample, with Block 1 having more from the 15–20 group and Block 2 from the 21–30 group. Representation decreases steadily for older age groups, with those above 60 comprising the smallest share, seen in Figure 4. This concentration of younger respondents is significant for transport behavior research, as this demographic tends to be more mobile, adaptable, and open to adopting new transport options such as MRT7.

Figure 3. Gender composition of the respondent

Table 2. Similar studies using revealed preference and stated preference methods

Gender	Driver's License Holder	
	Yes	No
Male	1042	1148
Female	314	1825
Lgbtgi	51	187
Others	9	24
Total	1416	3184

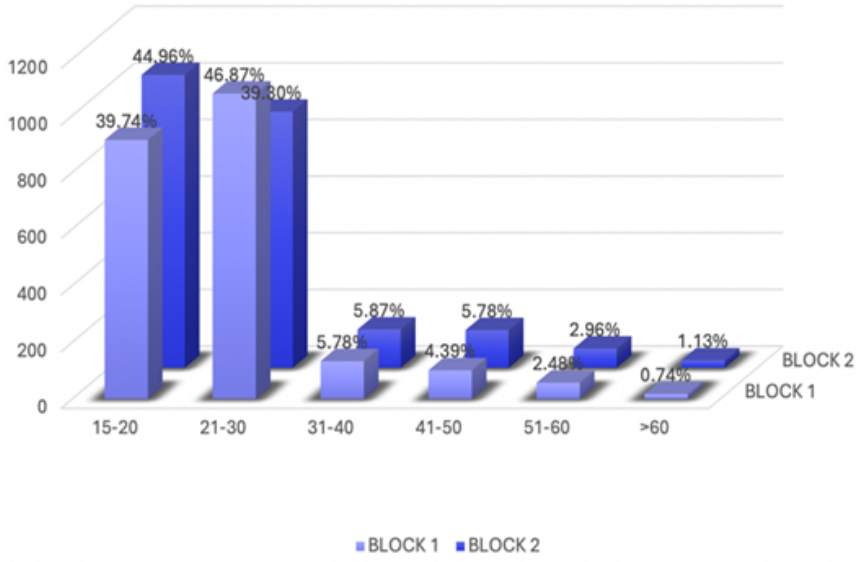

Figure 4. Age profile of the survey respondent

Most respondents are single (84.43%), with only 14.15% married/live-in and less than 1% in other categories; see Figure 5. This reflects the young (15–30) age profile of the sample, a group typically mobile, flexible, and more likely to adopt new transport options like MRT7.

Most respondents belong to medium-sized households of 4–5 members (about 47%), while smaller (1–2) and larger (7+) households make up less than 7% each, see Figure 6. Such household sizes often generate higher travel demand, highlighting the importance of affordable and reliable options like MRT7.

Over half of respondents reached college (53.54%), with most others completing high school (31.13%) or vocational training (12.43%), showing a generally well-educated sample likely to value efficient transport options like MRT7 (Figure 7).

Most respondents (62.28%) earn below Php10,000/month, reflecting a predominantly low-income sample likely to prefer affordable and accessible transport options (Figure 8).

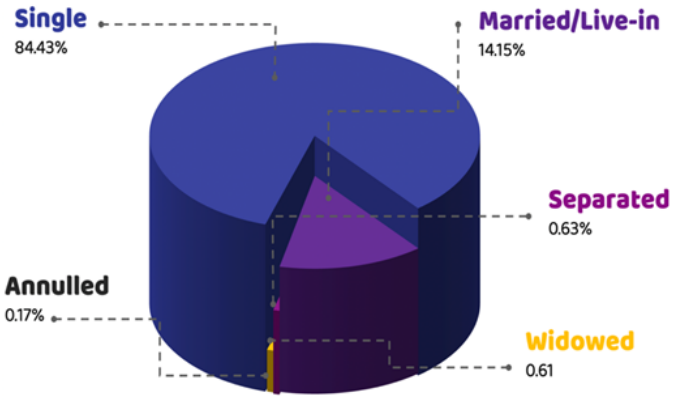

Figure 5. Civil status of the respondents

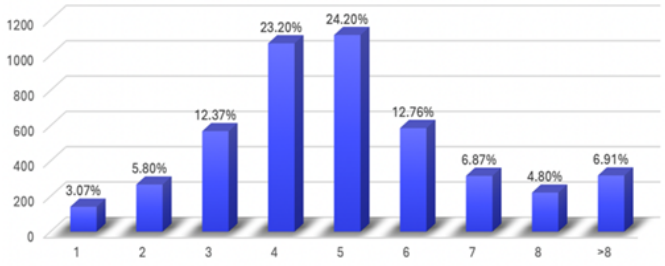

Figure 6. Household size distribution of the respondents

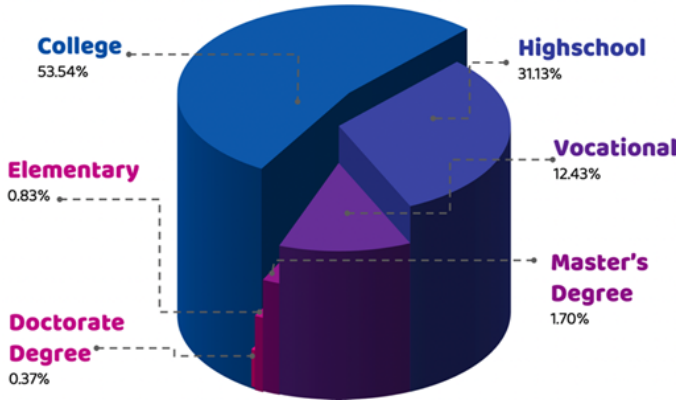

Figure 7. Educational attainment profile of the respondents

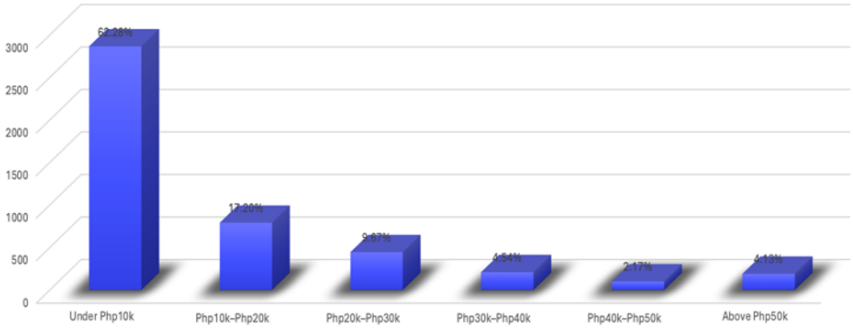

Figure 8. Income profile of the respondents

4.1.2 Travel characteristic

Most respondents travel for school (46.02%) and work (21.92%) (Figure 9), showing that routine commuting dominates and underscoring the need for safe, reliable, and affordable public transport like MRT7.

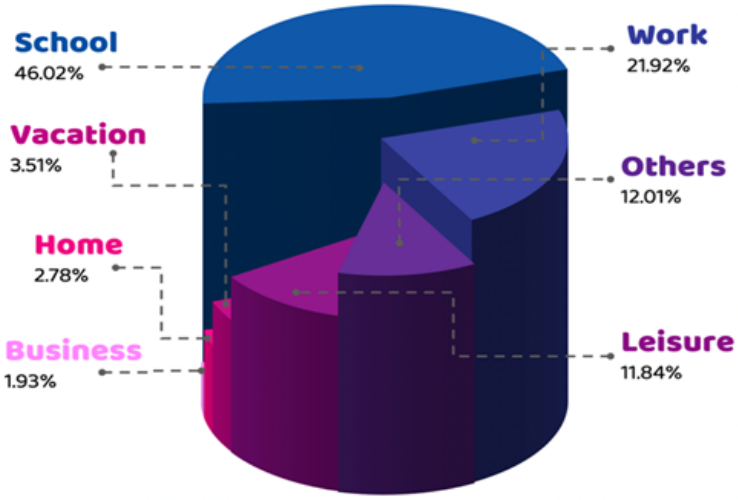

Figure 9. Trip purpose of the respondents

Nearly half of respondents travel daily (43.83%) and another 23.83% weekly (Figure 10), showing a high share of frequent commuters and underscoring the need for reliable, high-capacity transport like MRT7.

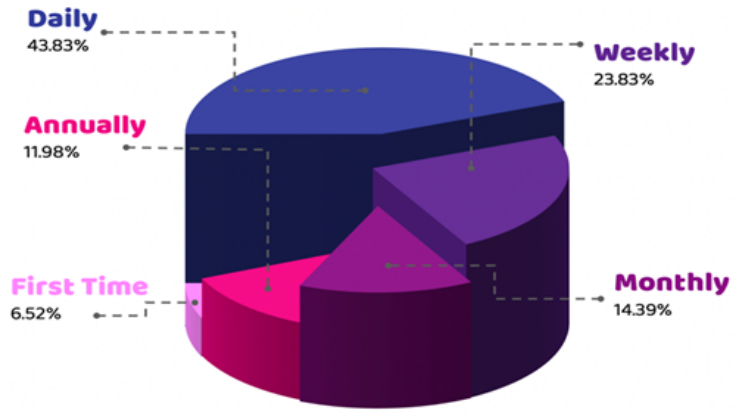

Figure 10. Trip frequency of the respondents

Over half of respondents (55.04%) access transit within 15 minutes (Figure 11), while only small shares report longer access times, highlighting the importance of station proximity in travel behavior.

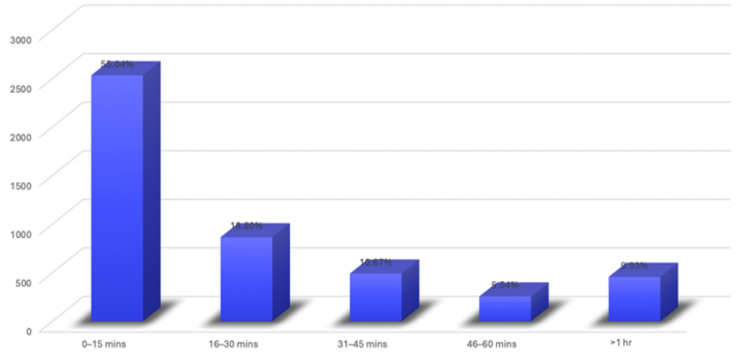

Figure 11. Revealed access time of the respondents

Most respondents come from Quezon City (30.38%), Caloocan (26.34%), and San Jose del Monte (25.29%), with smaller shares from nearby cities and Bulacan areas (Figure 12). This concentration reflects large populations and proximity to MRT7, making these cities key in modal analysis.

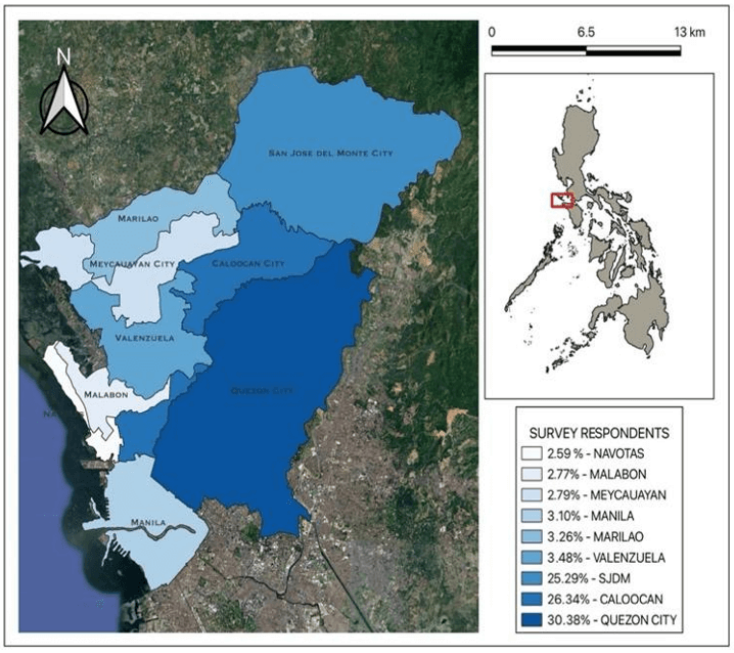

Figure 12. Trip frequency of the respondents

In Figure 13, one can see that most respondents access terminals via PUVs (32.07%), tricycles (27.13%), or walking (20.04%), highlighting reliance on informal and active modes and stressing the need for safe, integrated first-mile connectivity to support MRT7.

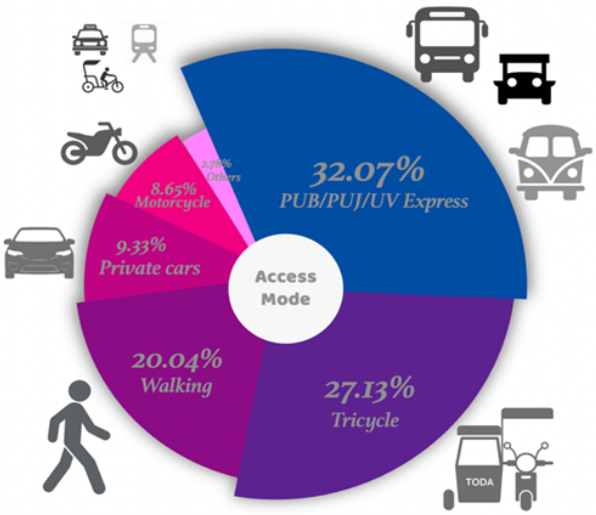

Figure 13. Revealed access mode of the respondents

Most respondents travel less than 1.5 hours, with 29.13% under 30 minutes, 23.57% at 31–45 minutes, and 18.54% at 46–60 minutes, while very long trips are rare (Figure 14). This highlights manageable commute times and sets performance benchmarks for MRT7 in ensuring reliable and consistent travel.

On average, commuters spend 23 minutes accessing transport, 53 minutes in-vehicle, and 63 pesos on fares, though high variability shows some face much longer and costlier trips as seen in Table 3. This underscores the need for equitable and cost-sensitive planning for MRT7. This pattern reflects what accessibility-based frameworks emphasize: transport should not only maximize efficiency but also ensure fairness in how time and cost burdens are distributed [32].

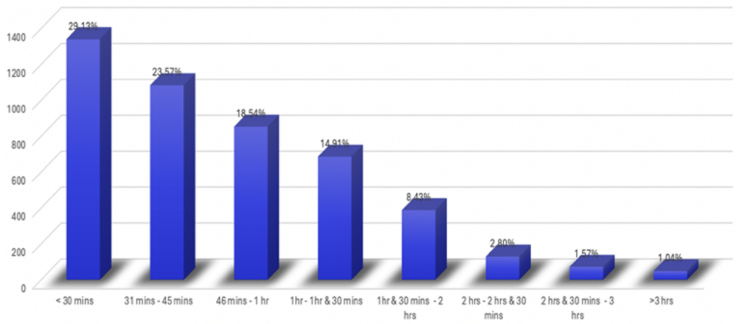

Figure 14. Revealed In-vehicle travel time of the respondents

Table 3. Mean, median, mode of the main attributes

	Access Time (mins)	In-Vehicle Travel Time (mins)	Out-of-Pocket Cost (php)
Mean	22.90	53.21	63.16
Median	7.50	38	40.00
Mode	7.5	20	15
Standard Deviation	21.79	36.23	63.16

Also, survey results show clear differences in comfort and safety across transport modes. UV Express has a balanced comfort profile, with most respondents labeling it as moderately comfortable (55.63%), some labeling it as optimally comfortable (30.35%) and a few labeling it as uncomfortable (14.02%), reflecting moderate satisfaction. PUBs also lean toward moderate comfort (46.54%), with 30.20% labeling it as optimally comfortable and 23.26% as uncomfortable (often linked to overcrowding and aging fleets). Public Utility Jeepneys (PUJs) perform worst, dominated by most labeling it as uncomfortable (56.30%), while only 9.48% label it as optimally comfortable. In contrast, private cars deliver superior comfort, with a large majority of respondents labeling it as optimally comfortable (90.63%), underscoring their strong appeal. These survey results echo the central role of service quality and end-user experience in shaping mode choice [34, 35].

Safety perceptions follow a similar trend. PUB users mostly feel neutral (74.33%), with 17.35% unsafe and 8.33% safe. PUJs record 65.74% neutral, 29.13% unsafe, and only 5.13% safe, the lowest positive score. UV Express fares better, with 74.70% neutral, 16.09% safe, and 9.22% unsafe.

Overall, public transport is associated with mid- to low-level comfort and weak safety perceptions, particularly in PUJs and PUBs. Private cars remain the benchmark, highlighting the challenge of shifting commuters. Private cars deliver superior comfort compared to other modes of transport [34]. MRT7 must ensure high comfort and safety standards to attract riders and drive a successful modal shift. These results show that modal shift improvements are greatly influenced by comfort, safety and reliability [16].

4.1.3 Work-related and household-related characteristic

Most respondents are students, followed by those in private and self-employment, with smaller shares from government and unemployed groups, see Figure 15. Nearly half likely have fixed schedules or on-site work.

Further, more than half of the sampling population responded that they find or perceive it difficult to find a similar job to their current one, and only a quarter of them perceives it easy to find a similar job.

4.2 Stated Preference Multinomial Logit Model Results

The study used five SP models to analyze transport mode choice. Model 1 (base) included only alternative specific constants (ASC), while Model 2 added main effects of mode attributes. Model 3 introduced an interaction between access and in-vehicle time, Model 4 incorporated work-related and household factors, and Model 5 included relocation attributes and MRT7 influence. Based on SP survey data from travelers surveyed, these models estimated mode utilities and predicted choice probabilities.

The base model shows that MRT7 is the most preferred mode, with a 53.21% choice probability, followed by private car use (16.93%), PUJs (14.28%), PUBs (10.76%), and UVs (4.81%). ASCs indicate all non-MRT7 modes are less preferred, with UV (-2.4038) the least and private car (-1.1451) the least negative among them. All estimates are highly significant ($p < 0.0001$). The model yields a log-likelihood of -53,829.54 and a McFadden R^2 of 0.1939, reflecting an acceptable fit for discrete choice models. While the results confirm MRT7's strong appeal even prior to operation, incorporating travel attributes and socio-demographic factors would further improve explanatory power.

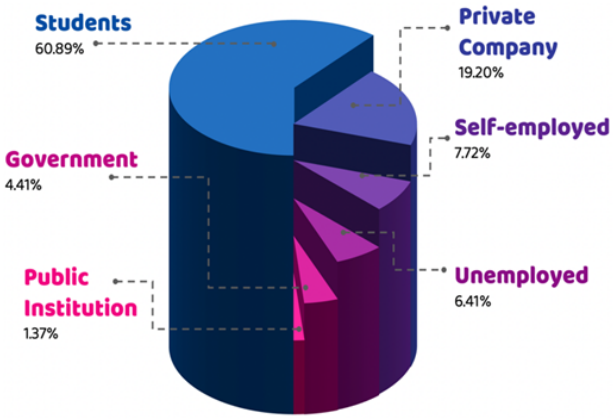

Figure 15. Occupational and institutional groups

Model 2 integrates access time, in-vehicle travel time, cost, comfort, and safety into the mode choice framework. All variables are statistically significant, with access time (-0.00498) and in-vehicle travel time (-0.01115) showing that longer trips reduce utility. Cost-over-income (-0.06044) strongly decreases mode choice likelihood as fares rise relative to income. In contrast, comfort (0.19212) and safety (0.16853) positively influence mode utility, highlighting their importance in transport preference. The model achieves a log-likelihood of -53,643.01, a Chi-squared value of 373.06, and a McFadden R^2 of 0.197, indicating a relatively strong fit. Computed probabilities using MNL show MRT7 remains the leading choice, while PUB, PUJ, UV, and private car follow in decreasing preference. The model yields an accuracy of 53.21%, but improvements are possible with additional socio-demographic and interaction effects.

Model 3 introduced AXTIME, an interaction term between access time and in-vehicle travel time, but results showed it had no significant effect (coefficient = 0.0002, p = 0.485). The model's performance remained unchanged from Model 2, with a log-likelihood of -53,643.77, McFadden R^2 = 0.1967, and accuracy at 53.21%. Key variables like in-vehicle travel time (-0.0158), cost-over-income (-0.0605), comfort (0.1951), and safety (0.1647) stayed significant, while access time became insignificant due to overlap with AXTIME. Overall, the interaction term failed to improve explanatory power, confirming that commuter choices are still best explained by the original main effects.

Model 4 improves fit (R^2 = 0.2119; log-likelihood = -52,629.09) by adding socio-demographic and household attributes to the main effects. Core variables (time, cost, comfort, safety) remain significant, with cost showing the strongest effect. Larger households prefer PUB/PUJ, females lean toward PUJ and UV, and flexible workers favor private cars. Satisfaction with MRT7 facilities and willingness to relocate both increase MRT7 adoption. Higher-income commuters prefer cars but could be attracted by premium MRT7 features. With 52.88% accuracy, this is the best-performing model so far, highlighting the combined influence of travel attributes and personal factors on mode choice.

Model 5 extends prior models by adding relocation willingness, MRT7 facility satisfaction, and income group to main effects. The model shows good fit (LL = -52,780.57; R^2 = 0.2096; X^2 = 1635.6) with 52.11% accuracy. Core variables remain consistent: higher costs, longer access/in-vehicle times reduce mode utility, while comfort and safety increase it. Satisfaction with MRT7 facilities strongly decreases the likelihood of choosing road modes, underscoring its service advantage. Relocation intention is positively linked to PUB, PUJ, and UV use, confirming that willingness to relocate enhances MRT7's appeal. Income effects reveal that higher-income groups prefer private cars and PUB, but avoid PUJ, while UV has moderate positive ties to income. Survey results further show that job opportunities (27.24%), proximity to work (16.91%), and homeownership goals (8.96%) drive relocation, with over half (51.31%) considering MRT7 a factor in moving. Most respondents own homes (71.89%) or live rent-free (70.02%), suggesting relocation flexibility.

Overall, Model 5 highlights that affordability, safety, and MRT7's quality drive mode choice, while relocation and income segmentation reinforce MRT7's potential role in shaping long-term residential and commuting patterns.

4.3 Sensitivity Analysis

Simulation using Model 4.2 assessed how key factors affect commuter mode choice between MRT7 and road-based transport (PUB, PUJ, UV, and private cars). Results show that access time moderately influences mode shift. Reducing access time to 15 minutes shifts only 1.03% (≈48 respondents) from MRT7 to road modes, while increasing it from 0-60 minutes raises MRT7's share from 49.97% to 58.36%, with sharper gains beyond the 30-minute threshold with an increase from 54.19% to 58.36% (shift of 4.17% or ≈192 respondents) from 30 minutes to 60 minutes of access-time. By contrast, invehicle travel time exerts the strongest effect. As road-based times

increase from 0 to 180 minutes, MRT7's share climbs sharply from 40.46% to 79.46%. Even a moderate increase from 60 to 90 minutes boosts MRT7 ridership from 54.79% to 61.81% (≈2,900 respondents), underscoring the high sensitivity of users to congestion and delays.

Cost relative-to-income also matters but less dramatically. Below the 8% threshold (120.87 pesos), road modes remain competitive, with MRT7 stable at 53–54%. Beyond this, MRT7 gradually gains, reaching 68.82% at cost relative-toincome ratio at 20% (257.18 pesos), as affordability pressures push commuters toward rail. Comfort shows a strong behavioral influence. MRT7's share rises from 34.62% under poor comfort to 80.86% under high comfort, while improved comfort in road modes reduces rail preference. Similarly, safety perception affects choice: MRT7 captures 77.57% when road modes are viewed as unsafe, but only 35.16% when they are seen as safe.

5 Limitations

This study was conducted using a convenience sampling survey method. Only respondents aged 18 and above were included to ensure sufficient travel experience and cognitive capacity to comprehend scenario-based questions. Given the study's objective of modeling individual-level travel behavior, DCM approach was adopted. Also, the logit model is identified as an effective tool for capturing complex travel decision-making patterns through tractable mathematical formulations, making it suitable for this study.

Recognizing the limitations imposed by time, budget, and survey design feasibility, the study includes only a subset of mode attributes that are both statistically significant and commonly cited in prior research. The selected variables include in-vehicle travel time, out-of-pocket cost, access time to boarding points, comfort, and safety ratings. In addition, socio-demographic, work-related, and household characteristics are incorporated to enhance explanatory power.

To manage complexity, only a two-way interaction effect between in-vehicle travel time and access time is considered, as higher-level interactions significantly increase the number of experimental treatments. It should also be noted that, while private car use is acknowledged as a dominant mode along the corridor, it is included from this study's mode choice set to maintain a focused analysis on public and private transport alternatives.

Although this study can provide insight to what affects modal choice in individuals, given that this study examines specific transportation routes and is based on convenience sampling, it may not be generalizable to the general population, different regions or countries. Given the complexity of modal shift behaviors, one cannot assume these results applicable to different rail projects in other areas, though we provide a framework of important factors to consider when developing a new rail-based transportation.

6 Conclusion

Overall, in-vehicle travel time and fare affordability demonstrated the highest sensitivity in determining mode choice, indicating that commuters prioritize the efficiency of their travel time and their financial capacity to afford the fare. Among all the mode attributes examined, it can be concluded that fare affordability reflected through the cost-to-income ratio and in-vehicle travel time exert the most significant influence on the travel behavior of the commuting population. This study reinforces that keeping fares affordable, keeping travel time efficient and enhancing service quality are critical for sustaining MRT7 ridership and promoting a successful modal shift.

This study developed and estimated a series of utility-based models to analyze commuter mode choice behavior along the San Jose del Monte-Quezon City corridor. Validated responses from RP and SP surveys were used, and five models were calibrated using RStudio. Among these, Model 4.2 (which incorporated service-related factors, household and socio-demographic variables, relocation intentions, and MRT7 as an influencing factor) was identified as the most robust and was therefore selected as the basis for simulation analysis.

The descriptive analysis of existing conditions highlights several challenges in road-based transport. Respondents reported an average access time of 22.90 minutes and average in-vehicle travel time of 53.21 minutes, with most trips lasting between 46 and 60 minutes. The average out-of-pocket travel cost was 63.16 pesos, equivalent to 8.54% of monthly income, with minimal variation across respondents. Comfort ratings showed stark disparities: 56.30% of PUJ riders reported discomfort, PUB users expressed moderate satisfaction, and UV Express passengers indicated relatively better conditions, while 90.63% of private car users rated their travel as highly comfortable. Safety perceptions were also mixed: only 8.33% of PUB and 5.13% of PUJ users felt safe, compared with 16.09% of UV Express users, suggesting that many commuters view road-based modes as risky. These findings demonstrate the significant service gaps that MRT7 can address.

The modeling results identified in-vehicle travel time, cost, access time, comfort, and safety as influential factors shaping mode choice. In-vehicle time and cost emerged as the most elastic variables, showing the strongest sensitivity to changes. The interaction effect between access time and in-vehicle time proved statistically insignificant, contradicting one of our hypotheses that this interaction would be significant. This is surprising given that previous studies show shorter access combined with longer overall trips increases modal shift likelihood. This likely indicates that commuters evaluate these attributes separately.

Socio-demographic factors also contributed to differences in behavior: larger households tended to prefer PUB and PUJ; women were more inclined toward PUJ and UV; and commuters with flexible work arrangements showed a stronger preference for private vehicles. Importantly, 51.31% of respondents reported willingness to relocate because of MRT7, reinforcing the potential role of transit-oriented development in shaping settlement patterns and enhancing rail adoption. These gender-based variations in mode preference emphasize the need for gender-sensitive transport policies.

Simulation results provide further evidence of MRT7's potential impact. In-vehicle travel time is the most critical determinant: as road-based travel times increased from 0 to 180 minutes, MRT7's predicted market share rose from 40.46% to 79.46%. Comfort was also highly influential, with MRT7's share increasing by 46.24 percentage points when comfort levels improved relative to road-based modes. These results highlight some previous studies that comfort, while being overlooked, is still a significant factor for mode choice.

Safety perception had a similar though slightly smaller effect, raising MRT7's share by 42.41 percentage points when road modes were perceived as unsafe. Out-of-pocket cost had a more modest influence, with MRT7 gaining close to 15 percentage points when road fares became substantially higher. Access time exerted a moderate effect, with significant shifts occurring only when access to road-based modes exceeded 30 minutes.

Willingness to relocate also significantly influences mode choice. Commuters open to relocation are more likely to shift to MRT7, highlighting the importance of residential proximity to stations. Importantly, over half of the respondents (51.31%) are willing to relocate because of MRT7, confirming the rail service's potential to influence long-term settlement patterns. This supports the role of transit-oriented developments in integrating affordable housing, employment, and transport services, especially near MRT7 stations.

The final model achieved 52.68% predictive accuracy, a reliable outcome for DCM with large datasets. Collectively, the findings confirm that time efficiency and affordability remain the strongest drivers of commuter decisions, while comfort, safety, and relocation intentions further reinforce the attractiveness of MRT7. The evidence suggests that under favorable conditions, MRT7 could capture 70–80% of total ridership, equivalent to 3,200–3,700 commuters in the sampled population of 4600.

In conclusion, MRT7 has the potential to serve as a transformative transport project for Metro Manila and Bulacan. By offering faster and more reliable services, ensuring affordability, and providing higher standards of comfort and safety, MRT7 can encourage large-scale modal shift from congested road-based modes. Complementary measures such as transit-oriented development initiatives, family- and gender-sensitive policies, and integration with feeder systems can further strengthen MRT7's role as the backbone of sustainable mobility in the region.

To strengthen the long-term success of rail-based transport systems in the region, country and beyond, urban planners and policymakers should consider service efficiency relative to travel time, affordability, accessibility, comfort, safety and integrate affordable housing and employment near rail stations. Reliable and punctual operations must be sustained to attract commuters facing congestion in road-based modes. Competitive and inclusive fare structures should be maintained to ensure affordability, particularly for low-and middle-income groups. Accessibility can be strengthened through integrated feeder services, walkways, bike lanes, and transit-oriented developments that connect residential and commercial areas directly to stations. Passenger comfort and safety must remain central, with continuous improvements in vehicle design, station facilities, and security measures. Given most respondents reporting willingness to relocate, there is a strong opportunity for coordinated housing-transport initiatives. Rail stations should serve as focal points for mixed-income housing, government-subsidized relocation programs, and strategic employment zones. This study also demonstrates benchmarks where commuter choice shifts. Using benchmarks such as the in-vehicle travel time related to modal shift and the cost-to-income ratio demonstrated can be measures put forward for new projects and existing ones to ensure wider use of rail-based transportation systems.

Furthermore, to guide future research, we recommend longitudinal behavioral tracking after MRT7 becomes operational to assess whether SPs translate into revealed behavior. Future researchers should also conduct spatial analyses using GIS tools to examine land-use transformation around MRT7 stations. The psychosocial aspects of mode choice such as perceived social status, lifestyle compatibility, and personal values—should also be explored to explain residual resistance to modal shift even when technical improvements are in place. Transportation agencies and research institutions must continue to collaborate, innovate, and respond to evolving commuter needs to realize a truly sustainable, people-centered public transport system. Finally, continuous monitoring of commuter behavior, combined with environmental and social impact assessments, will support adaptive policies, and sustain public trust. Together, these measures can foster greater modal shift and long-term urban mobile sustainability.

Author Contributions

Conceptualization, E.J.L. and M.C.R.P.; methodology, M.C.R.P.; validation, A.M.F.; writing—original draft preparation, E.J.L.; writing—review and editing, E.J.L., M.C.R.P. and A.M.F.; supervision, A.M.F. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

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Conflicts of Interest

The authors declare no conflict of interest.

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