

## **Analysis of the First- and Last-Mile Options of LRT/MRT Users in Metro Manila**

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**Abstract:** The first-mile and last-mile problem in transportation pertains to the need for more interconnectivity between the initial leg of the trip (first mile) and the final leg of the trip (last mile) when using the main transport mode like the LRT or MRT system in Metro Manila. In the Philippine context, this dilemma has not yet been properly studied due to the lack of research. Through an online survey, 582 LRT/MRT users were asked about their trip information - access and egress. Based on the users' revealed modal choice preferences, a multinomial logit model was developed about these access and egress modes. For both the access and egress trips to and from the LRT/MRT station, time and cost were found to be significant. Along with this, an individual's gender, income, and age were also found to have a relationship with one's modal choice decision. In addition, it was found that users consider attributes of safety, time, cost, and reliability of modes as factors that greatly influence their choices.

*Keywords:* modal choice, first mile, last mile, LRT, MRT, revealed preference

### **1. INTRODUCTION**

An efficient railway transit system promotes public transportation by encouraging private vehicle users to shift to this mode. In Metro Manila, there are three main transit lines: Metro Rail Transit Line 3 (MRT-3), Light Rail Transit Line 1 (LRT-1), and Light Rail Transit Line 2 (LRT-2). Even with the presence of these three lines, there are still problems with accessibility and flexibility in the transit system in the region (Yang *et al.*, 2021). To assess the inaccessibility of the transit system, this paper aims to study the first-mile/last-mile problems of the users in Metro Manila.

The current rail transit lines of the Metro Manila LRT/MRT systems are shown in Figure 1 below.



Figure 1. Rail Transit System in Metro Manila (© <https://www.deville.com/>)

The first mile and last mile refer to the first and last leg of the trip, respectively, one needs to take to get from their starting point to the nearest public transportation station and from the nearest station to their final destination. This problem highlights the need for an effective, efficient, and accessible system.

In the Philippines, public transportation faces many issues and challenges. According to Chang *et al.* (2021), overcrowding and long lines, long travel times, and the lack of access and connectivity between different modes and terminals pose daily issues to commuters. It is no surprise that with these problems, Metro Manila has become a car-centric city, where car-centric policies have been developed that further contributed to the collapse of the use of public transportation in the country. The importance of the quality of public transportation comes into play when analyzing the first-mile and last-mile choices of users; according to Rahman *et al.* (2022), factors that users typically consider for their choice of access and egress are trip-related factors, socio-economic factors, and service attributes. These include the length of travel and waiting time, the cost of travel, and the comfort, availability, and accessibility of these modes to the users.

Generally, there is a lack of in-depth research on the first-mile and last-mile options available to access and egress Metro Manila's LRT and MRT stations. Fillone & Mateo-Babiano (2018) studied the first- and last-mile options in historical sites in Manila, however, this purely focuses on two options: walking and riding the rickshaw (tricycle/pedicab). The study focused on the LRT line 1, specifically the stations Central Terminal, United Nations, and Pedro Gil. Still, this focuses on limited modes of transportation. The existing research could not sufficiently analyze most options available with regard to the LRT and MRT systems. With this said, the study's main objective is to determine and characterize the significant factors affecting the first-mile and last-mile options of the users of the LRT/MRT. Identifying and understanding how these attributes influence one's inclination to ride the LRT/MRT can encourage more people, especially those who travel by private vehicles or cars, to use the said mode.

The study is significant as it determines how users' first- and last-mile options impact their willingness to use public transportation. From that, different regulations or improvements can be made to the country's public transportation system with the knowledge of how certain factors influence one's decision to use a certain mode. Ultimately, it can encourage more people, especially those who travel by private vehicles or cars, to use the said mode; the desire is for

more people to shift from using private vehicles to public transportation.

The main objective of this study is to determine and characterize the significant factors affecting the first-mile and last-mile options of LRT/MRT users. In order to achieve the main objective, it aims to determine which factors users consider when choosing their first-mile or last-mile option to get to and from the LRT/MRT.

This study focuses on the first- and last-mile options of Metro Manila LRT-1, LRT-2, and MRT-3 users. The respondents of this study are LRT and MRT users who reside within Metro Manila. Users will be asked through a survey for their trip information, socio-economic profile, and their ratings of how certain factors influence their decision to make use of their chosen mode to access and egress the LRT or MRT with the use of a Likert scale.

## **2. REVIEW OF RELATED LITERATURE**

### **2.1 First-Mile and Last-Mile**

The first-mile and last-mile dilemma is closely related to the accessibility of public transportation and one's out-of-vehicle movement. To improve commuters' first-mile/last-mile travel, preferred modes of transportation and the factors affecting their choices should be examined. In 2023, Eom *et al.* researched the micro-mobility modes of residents living in Seoul and Gyeonggi, South Korea. According to the study, married people ride electric scooters more, while those who aren't married ride bicycles. Additionally, a similar pattern is found for people who are younger than those who are older.

Furthermore, a study conducted by Rahman *et al.* (2022) revolved around the transit commuters of Dhaka, Bangladesh, who regularly travel from suburban areas to the central city. Upon analysis of the data from the study, it was found that the respondents' choice of access and egress modes highly depends on three main factors: trip-related, socio-economic, and service attributes.

Additionally, Venter's 2020 study on the first- and last-mile shows that the top three most important criteria of the first- and last-mile attributes are (1) safety from crime, (2) cost of access trip, and (3) ease of finding information.

### **2.2 LRT/MRT**

Filipinos use the Metro Rail Transit (MRT) and the Light Rail Transit (LRT) as two of their primary forms of transportation. Since the LRT and MRT are the quickest ways to travel between destinations in Metro Manila, most people use them for transit. The LRT is divided into two chains - LRT-1 and LRT-2. The former, LRT-1, has 19 stations, beginning with Baclaran Station and extending towards Roosevelt/FPJ Station. On the other hand, LRT-2 has 11 stations, from Santolan to Recto. Lastly, MRT is home to 13 stations, from North Avenue Station to Taft Avenue Station.

The Light Rail Transit Authority reported over 31.64 million ridership in 2022, a 167% increase from the previous year's 11.84 million ridership. According to official records, there were around 159,382 riders on the LRT per day in 2022. According to the Department of Transportation's records, 98,330,683 persons traveled on the MRT-3 train. Daily ridership rose from 127,276 in 2021 to 273,141 in 2022—a gain of more than 100%. According to the respondents' responses, the bus and train were the nation's most popular forms of transportation. This indicates that people depend more on these modes of transportation than other means to get where they're going.

### 2.3 Modal Choice of Users

Various factors affect the users' modal choice. One of these factors is the distance one must travel to a particular place. According to Keijer *et al.* (1999), the respondents' choice of access and activity-end part of the trips strongly depended on the distance one needed to travel. For instance, people living near the train station typically walk there. Bicycles generally are the primary mode of transportation for trips between 1.5 and 3.5 kilometers from the train station. When traveling more than 3.5 kilometers, people ultimately shift to public transit. Aside from the distance, the surrounding areas and built environment can also affect the users' modal choice. A study by Biona *et al.* in 2019 analyzed the travel mode choices of the users in Metro Manila. According to the study, people who live in areas with many bus stops are more likely to use a variety of public transport and non-motorized modes. In contrast, those who live in areas with higher street density are more likely to use non-motorized modes of transport, such as walking and biking.

## 3. METHODOLOGY

### 3.1 Framework

Figure 2 below shows the theoretical framework of the study. This addresses the current first- and last-mile modal options. Historical data and future surveys can measure travel time and cost variables. Conversely, latent variables include the opinion of commuters about accessibility, comfort, safety, and reliability. These variables can be deduced using numerous observations. The revealed modal choice preferences of the LRT and MRT users for their first- and last-miles are based on the survey results.

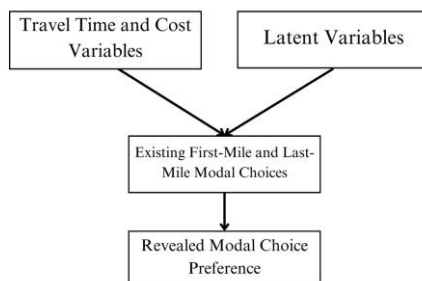


Figure 2. Theoretical Framework of the Study

On the other hand, Figure 3 below displays the conceptual framework of the study. Public transportation in the Philippines serves as the moderating variable; modal choice and multimodal trips as the independent variables; first-mile and last-mile options of users as the dependent variable; LRT and MRT as the confounding variables; and surveying of LRT/MRT users as the control variable.

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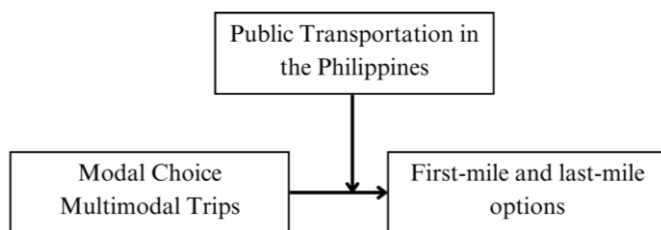


Figure 3. Conceptual Framework of the Study

### 3.2 Sampling Method and Data Collection

An online survey was conducted to determine users' first-mile and last-mile options of Metro Manila's LRT and MRT stations. To determine whether the survey could accurately gather the respondents' data, it was first pilot-tested on 50 respondents. It was determined that the survey was sufficient, and the data collected were scattered. In totality, the survey was administered to 582 respondents from the different cities of Metro Manila, ensuring regional diversity. The survey was posted on online platforms such as Facebook and Instagram. The survey respondents were chosen through simple random sampling. Respondents were asked about their demographic characteristics as well as their trip information. Respondents should be those who use the LRT or MRT at least once a week and those who reside within Metro Manila.

### 3.3 First Mile and Last Mile Attributes

In addition to this, respondents were also asked to rate how different factors may influence their choice in making use of their said mode by using a Likert Scale (0 being the lowest, 5 being the highest). These factors are comfort, cost, accessibility, reliability, cleanliness, and safety, encompassing several attributes. Table 1 shows a summary of the characteristics and their specific attributes.

Table 1. Factors and Attributes Linked to First-Mile/Last-Mile Analysis

Factors	Specific Attributes	References
Comfort	- Assured seat	- Li and Hensher (2011)
	- Air-conditioned vehicle	- Newinger, H. and de Lapparent, M. (2019)
	- Less crowded	- Ngoc, A. M., <i>et al.</i> (2016)
Accessibility	- Easy transfer between modes or stations	- Aitken, I., <i>et al.</i> (2020)
	- Walkable areas between transfers	- Saif, M., <i>et al.</i> (2018)
	- The presence of escalators and elevators	- Van Soest, D., <i>et al.</i> (2019)
	- Well-guided with informational signs	
Reliability	- Frequency of the mode	- Soza-Parra, J., <i>et al.</i> (2022)
	- On-time arrivals	
Cleanliness	- Properly maintained	- Friman, M., <i>et al.</i> (2020)
	- Seats are clean	

Safety	-	Presence of security personnel	-	Joewono, T. and Kubota,
	-	Well-lighted area		H. (2006)
	-	No dark corners at night	-	Szczukowski, M. (2017)
	-	Safety from accidents and crimes	-	Van Soest, D., <i>et al.</i> (2019)

For the cost and time of access modes, the study used data gathered from the surveys and data from different sources. For the chosen access mode of the users, they were asked to select from the given ranges of cost and time, the fare they pay, and the total travel time they usually experience.

The other modes of the users were part of the modes available to them, but they did not make use of them; the cost was based on the fare systems published by the Land Transportation Franchising and Regulatory Board (LTFRB) for public vehicles. At the same time, the researchers manually checked the fare for ride-hailing through different applications such as Grab, Angkas, Moveit, and more. The estimated travel time was obtained using Sakay.ph wherein the origin or the location and the LRT or MRT station were pinned. Moreover, the travel time was obtained for ride-hailing from the estimated time given in the applications. Because of this, there may be some discrepancies concerning the actual travel time and cost users would experience and pay when they use the other modes available to them instead of the one they choose.

### 3.2 Data Analysis

The data analysis was done in the form of descriptive analysis in Excel and logit choice analysis through NLogit. The users' socio-economic profile, trip information such as distance traveled, fare paid, and time consumed in traveling, as well as their modal choice, were summarized in a descriptive statistical analysis. Along with this, the users' rating of the attributes or factors for their decision to use their modal choice (refer to Table 1) was also summarized and analyzed through statistical analysis.

A logit choice analysis through NLogit was done to analyze the significance of specific variables in affecting one's modal choice. Two separate analyses were done for the respondents' access and egress data. The following data were input into the software: age, gender, personal income, occupation, total fare, total travel time, and total distance traveled by their chosen access/egress mode to the LRT or MRT.

To obtain an improved significance in the analysis, the data were pre-processed. Data cleaning techniques were used to improve the model. This includes the grouping of the specific modes of transportation into three categories: (1) Private vehicles: drop off, ride-park, ride-hailing (Grab, Angkas, etc.), (2) Auxiliary transportation: walking, biking, pedicab, and tricycle, and (3) Public transportation: modern and traditional jeepneys, bus, taxis, UV, and FX.

Though the users were asked to select all possible modes of transportation available to them to get to and from the LRT/MRT, these were narrowed down into the 3 groupings mentioned above to get a better logit model. Considering the different value of travel time and fare for each mode that can be found in one group, the researchers made use of the following method or assumptions in order to set a specific fare and travel time: if the selected specific mode of the user is in the group, the set fare and travel time for that certain group category will automatically be equal to the value from the specific mode. However, if no mode was selected within the group by a user as their modal choice, the fare and travel time of the modes within the group will be averaged; this will then be the value of the travel time and cost for the said group.

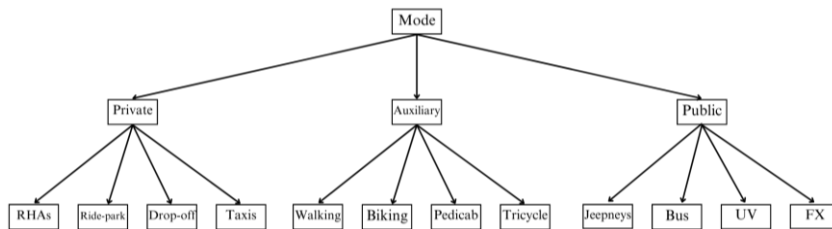


Figure 4. Multinomial Logit Structure

#### 4. RESULTS AND FINDINGS

The data from the survey given to the 582 respondents were analyzed using NLogit and Excel. NLogit was used to determine the significance of certain variables concerning one's modal choice. A utility model was built to display the relationship of variables to a user's choice of mode and how these variables negatively or positively affect an individual's decision. On the other hand, Excel was used to summarize and show how important the respondents perceive the factors listed in Table 1 regarding their modal choice.

##### 4.1 Respondents' Profile

The socio-economic and demographic characteristics provide valuable insights into the factors associated with selecting transportation modes.

Table 2 summarizes the socio-economic characteristics of the 582 respondents. It displays that among the respondents, the proportion of female users (56%) was marginally higher than that of male users (44%). Over half of the respondents (65.64%) are either students or unemployed, while the remaining 34.36% are employed or working. The average age of the respondents was determined to be 24.86. As for the income, the average personal monthly income of the respondents is Php 21,769.54, while the average household monthly income is Php 57,503.75. Lastly, the average days per week that the respondents use the transit system were determined to be 3.28 days.

Table 2. Socio-economic Characteristics of Respondents

Variables	Parameters	No. of Respondents
Gender	Female	326 (56%)
	Male	256 (44%)
Occupation	Working	200 (34.36%)
	Non-working	382 (65.64%)
Education	High school or below	39 (6.70%)
	Bachelor's degree or equivalent	489 (84.02%)
	Master's degree or above	54 (9.28%)
Residence Type	Rented	179 (30.75%)
	Family-owned	344 (59.11%)
	Self-owned	59 (10.14%)
License Ownership	For a car	272 (46.74%)
	For a motorcycle	148 (25.42%)
	For both a motorcycle and a car	32 (5.49%)
	None	130 (22.34%)
Trip Purpose	Work-related	186 (48.69%)
	School-related	344 (59.11%)
	Leisure	42 (7.26%)
	Others	10 (1.89%)
Average Age (years)		24.86
Average Personal Monthly Income (Php)		21,769.54
Average Household Monthly Income (Php)		57,503.75
Average Days per Week Using the LRT/MRT		3.28
Total Number of Observations		582

## 4.2 Travel Characteristics

### 4.2.1 Access Trip Information

Public transportation (bus, jeepneys, and UVs) is the most used for the users' first mile or access trips, with 55.33%. In addition to this, public transportation is also the most likely mode to be chosen by a user, given that it is an option for their first-mile leg; out of 475 respondents with access to the different modes of public transportation, 67.79% would end up making use of the said mode.

Table 3. Modal Choice of Respondents to Access the LRT

Modal choice	Number of users	Percentage
Auxiliary Transportation	162	27.84%
Public Transportation	322	55.33%
Private Vehicles	98	16.84%

Table 4. Available Modal Choice of Respondents to Access the LRT

Modal choice	Number of respondents with	Number of respondents who	Percentage of people who make use of the
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	access to said mode	make use of said mode	mode
Auxiliary Transportation	354	162	45.76%
Public Transportation	475	322	67.79%
Private Vehicles	368	98	26.63%

Based on the survey results, the average distance of one's origin to the LRT/MRT station is 3.12 kilometers, the average fare paid is 38.82 pesos, and the average travel time is 21.42 minutes. Moreover, depending on a specific range of distance, a particular mode of travel is chosen more than others. For the distance to the LRT/MRT station, if one would need to travel less than 1 kilometer to get to the station, auxiliary transportation is the most used mode, with 132 out of 243 respondents choosing the said mode (54.32%). It was observed that as the distance increases, more people opt to use public transportation instead; for distances above 1 kilometers, 233 out of 339 users (68.73%) make use of the said mode. In correlation to this, the average cost of fare paid by the respondents can be explained by the fact that, based on the data, most people use public transportation to access the LRT/MRT station.

Table 5. Descriptive Statistics for the Access Trips to the LRT/MRT Station

	Mean	Standard Deviation	Mode
Distance of the origin to the station (km)	3.12	3.16	2.01 to 5.00
Fare paid for the mode (Php)	38.82	59.71	16 - 30
Travel time for the mode (minutes)	21.42	20.09	21 - 30

#### 4.2.2 Egress Trip Information

Based on Table 6, it is observed that the most prevalent mode for the users make use of to egress from the LRT/MRT station is auxiliary transportation, which is walking, biking, and riding the pedicab/tricycle, with 46.56% of the respondents stating that it is their preferred choice. Even when other available modes are considered, users are still more inclined to choose auxiliary transportation modes. As shown in Table 6, 65.30% of the respondents who have access to the different auxiliary transportation modes would make use of these modes.

Table 6. Modal Choice of Respondents to Egress From the LRT

Modal choice	Number of users	Percentage
Auxiliary Transportation	271	46.56%
Public Transportation	242	41.58%
Private Vehicles	69	11.86%

Table 7. Available Modal Choice of Respondents to Egress From the LRT

Modal choice	Number of respondents with access to said mode	Number of respondents who make use of said mode	Percentage of people who make use
Auxiliary	415	271	65.30%

Transportation			
Public Transportation	410	242	59.02%
Private Vehicles	312	69	22.12%

To identify the factors that influence their modal choice, Table 8 is studied. The average distance of the destination from the station is 2.03 kilometers, and its standard deviation is 2.14 kilometers. For the fare the respondents paid for their egress mode, the mean is 30.919, while the standard deviation is 48.909. Lastly, the average travel time of the respondents for their egress mode is 21.447, while its standard deviation is 24.225.

As for the most frequent range of distance traveled, it was 0.51 - 1.00 kilometers, which may be why most of the respondents opted for auxiliary transportation. It was observed that as the distance increases, the users are more likely to choose other modes, especially public transportation. Additionally, out of 300 respondents who had their destination within 1 kilometer of the LRT/MRT station, 246 or 82% of them would make use of auxiliary transportation.

Table 8. Descriptive Statistics for the Egress Trips from the LRT/MRT Station

	Mean	Standard Deviation	Mode
Distance of the destination from the station (km)	2.03	2.14	0.51 - 1.00
Fare paid for the egress mode (Php)	28.97	49.73	0 - 15
Travel time for the egress mode (minutes)	17.88	20.36	0 - 5

Comparing the data for the access and egress trips to and from the LRT/MRT stations, it can be observed that, generally, the distance between one's destination to the station is relatively shorter to one's origin to the station. Because of this, auxiliary transportation is the most used mode of transportation to get to one's destination from the LRT/MRT. However, both access and egress trips to and from the LRT displayed similar patterns when it comes to the LRT/MRT's proximity to one's origin and destination respectively: for distances within 1 kilometer, people will opt to make use of auxiliary transportation the most. This is in line with different studies, such as Jiang and Mondschein (2019), Keijer, et al. (2019), and Syafrihati (2018), that show how distance to a train station plays an important role when it comes to people making use of auxiliary transportation.

On the other hand, public transportation is the most prevalent mode of transportation for one to get to the LRT/MRT station from their origin. This can be attributed to the fact that distances from one's origin to the LRT/MRT station is longer and averages past 1 kilometer.

#### 4.3 User's Perception on the Influence of the Given Attributes

The respondents were asked to rate how the attributes listed in Table 1 influenced their decision as to which mode to choose for their access and egress trips to the LRT/MRT. Each attribute or factor was rated by the respondents using a Likert Scale, with values of 1 to 5 (1 - Not important, 2 - Less important, 3 - Neutral, 4 - Important, 5 - Very Important). All attributes had an average of 4 and above; users perceive all factors as important in making their decision to make use of a certain mode.

From the seven factors given, safety had the highest average with 4.70, followed by time with 4.65, and cost and reliability with 4.53. Accessibility falls in the middle, with an average of 4.25. Comfort and cleanliness rank last, with averages of 4.03 and 4.02, respectively. Table 9 below shows the summary of the attributes and their corresponding averages.

Table 9. Summary of Factors

Factors	Average
Comfort	4.03
Cost	4.53
Accessibility	4.25
Time	4.65
Safety	4.70
Reliability	4.53
Cleanliness	4.03

While respondents consider all factors to play a role in their decision-making for their modal choice, the travel and waiting time, the safeness of the environment and the mode itself, as well as the cost of fare have the most influence. The reliability or the frequency of a certain mode, along with accessibility or the presence of areas that make transfers and accessing the mode easier for a user, also plays an important role in one's modal choice. On the other hand, while the cleanliness of the mode and its environment and comfort are considered important by users, they have the lowest influence based on the observed average on the sample. Figure 5 below shows a detailed breakdown of how people rated each factor corresponding to their perception of importance when choosing a mode to use to access the LRT or MRT stations.

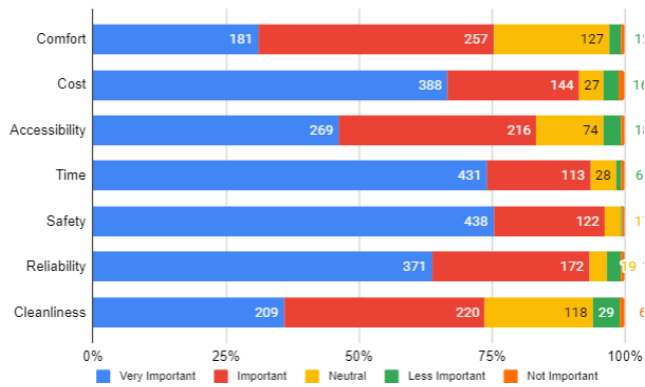


Figure 5. User's perception of attributes in choosing a mode to access and egress from the LRT/MRT stations

#### 4.4 Utility Models

The trip information variables contain access time (TIMEAC), egress time (TIMEEG), cost of access (COSTAC), cost of egress (COSTEG), access distance (DISTAC), and egress distance (DISTEG). As for the socio-economic profile variables, these include age (AGE), gender (GENDER), personal income (PINCOME), occupation (OCCUP), and license (LICENSE).

The mode-dependent variables are TIMEAC, TIMEEG, COSTAC, and COSTEG. On the other hand, DISTAC, DISTEG, AGE, GENDER, PINCOME, OCCUP, and LICENSE are constant variables that are dependent on the user.

Table 9 below summarizes the variables and their corresponding model names and descriptions.

Table 11. Variables Considered in Modeling

Variable	Model Name	Description
<b>TRIP INFORMATION</b>		
Choice	CHOICE	Different modal choices (Auxiliary, Public Transportation, Private Vehicles)
Access Time	TIMEAC	Travel time of the mode used to access the LRT/MRT station (minutes)
Egress Time	TIMEEG	Travel time of the mode used to egress from the LRT/MRT station (minutes)
Access Cost	COSTAC	Cost of the mode to access the LRT/MRT station (PHP)
Egress Cost	COSTEG	Cost of the mode to egress from the LRT/MRT station (PHP)
Access Distance	DISTAC	Distance of one's origin to the LRT/MRT station
Egress Distance	DISTEG	Distance of one's destination from the LRT/MRT station
<b>SOCIO-ECONOMIC PROFILE</b>		
Age	AGE	Age of respondents
Gender	GENDER	Gender of respondents
Personal Income	PINCOME	Personal income of respondents
Occupation	OCCUP	Occupations of respondents
License	LICENSE	Whether one has a driver's license or none

An initial model was run to determine which variables would be significant and which would be insignificant concerning the data obtained. From the results, only those that are significant at 85% or less were used.

#### 4.4.1 Utility Model for the Modes to Access the LRT/MRT (First-mile)

An initial model was done with all the variables to see which of these are significant. After removing those that are insignificant to the model, the final utility model was designed. For the access trips to get to the LRT, the variable for private vehicles was used as the base.

Based on the utility model for the modes to access the LRT/MRT, the following were found significant at 85% or greater: TIMEAC, COSTAC, AGE, and PINCOME. Time and cost are significant at 99% and 95% respectively. Additionally, both of these displayed a negative value for its coefficient, considering the fact that these are considered disutilities; the longer the travel time and the higher the fare to pay, the higher the disutility. TIMEAC has a higher coefficient in comparison to COSTAC, meaning that the respondents consider the travel time to get to the LRT from their destination more than the travel cost.

For both auxiliary and public transportation, AGE was found to be significant at 95% and 90% respectively. For both modes, it displayed a positive coefficient, meaning that those who are older would most likely make use of these two modes. PINCOME was also found to be significant for auxiliary transportation at 90% confidence interval. For both modes, a negative coefficient can be observed for the said variable, meaning that those with lower income would most likely choose auxiliary and public transportation as their modal choice; this can be attributed to the fact that private vehicles are typically higher in fare in comparison to the other

two modes. Added to the fact that cost was found to be a significant variable in one's modal choice, that could explain why those lower in income would make use of modes that would have lower fares.

Table 12 shows the summary of the utility model for modes to access the LRT/MRT.

Table 12. Utility Model Variables for Modes to Access the LRT/MRT

No. of observations		582
Pseudo R-squared		0.49861
Variable	Coefficient	P[ Z >z]
TIMEAC	-0.05136	0.0001
COSTAC	-0.00739	0.0123
AUXxAGE	0.02820	0.0581
AUXxPINCOME	-0.13045D-04	0.0669
PUBxAGE	0.02876	0.0740

The following equations are obtained based on the utility model that was done for users' access mode or the first mile options.

$$U_{auxiliary} = -0.05136TIMEAC - 0.00739COSTAC + 0.02820AGE - 0.13045 \times 10^{-4} PINCOME \quad (1)$$

$$U_{public} = -0.05136TIMEAC - 0.00739COSTAC + \quad + 0.02876AGE \quad (2)$$

$$U_{private} = -0.05136TIMEAC - 0.00739COSTAC \quad (3)$$

Table 11 shows the crosstab matrix for the access modes or the first-mile leg of users; It accurately predicted 62.96% for auxiliary transport, 73.60% for public transport, and 39.79% for private vehicles.

Table 13. Crosstab Matrix of Predicted Access Modes

	Auxiliary	Public	Private	Total
Auxiliary	102 (62.96%)	41	19	162
Public	45	237 (73.60%)	40	322
Private	16	43	39 (39.79%)	98
Total	163	321	97	582

#### 4.4.2 Utility Model for the Modes to Egress from the LRT/MRT (Last-mile)

With the data for the egress modes, the base used was auxiliary transportation. The model was run through NLOGIT and Table 12 shows the significant variables with at least a 90% confidence interval. Only time and cost are significant for the egress mode, compared to the access mode, which had additional factors such as comfort, reliability, and safety.

With TIMEEG AND COSTEG being significant, LRT/MRT users in Metro Manila are concerned with saving time and money; both of these variables are significant at 100%. Similarly with access trips, it can be observed that time has a higher negative value than cost, meaning that the respondents take into account the travel time more than the fare to pay.

Additionally, GENDER was also found to be significant at 100% and 95% for both private vehicles and public vehicles respectively. For both modes, it displays a negative coefficient meaning that a male user from the respondents would most likely not opt to make use of these said modes.

Table 14. Utility Model Variables for Egress Modes

Number of observations		582
Pseudo R-squared		0.58391
Variable	Coefficient	P [ Z  > z]
TIMEEG	-0.45864	0.0000
COSTEG	-0.01051	0.0000
RHAXGENDER	-0.86777	0.0000
PUBXGENDER	-0.52157	0.0032

Based on the values in Table 12, the utility equations are then constructed:

$$U_{private} = -0.0459TIMEEG - 0.0105COSTEG - 0.8677GENDER \quad (4)$$

$$U_{public} = -0.0459TIMEEG - 0.0105COSTEG - 0.5216GENDER \quad (5)$$

$$U_{auxiliary} = -0.0459TIMEEG - 0.0105COSTEG \quad (6)$$

Table 13 shows the crosstab matrix of the predicted versus the actual choice for the egress trips of the users. For Auxiliary Transportation, 213 or 78.60% of the modal users were predicted. For Public Transportation, it was 70.66% of the modal users, while for private vehicles, it was 43.48%. The model accurately predicted 414 out of 530 (70.96%) users of the mode choices.

Table 15. Crosstab Matrix of Predicted for Egress Modes

	Auxiliary	Public	PRHAs	Total
Auxiliary	213 (78.60%)	42	16	271
Public	44	171 (70.66%)	28	242
PRHAs	12	27	30 (43.48%)	69
Total	269	239	74	582

## 5. CONCLUSION AND RECOMMENDATIONS

Through this study, the following parameters were found to be significant for respondents in choosing their access and egress modes to and from the LRT/MRT. For mode-specific factors, it was found that both time and cost were considered to be significant in the modal decision of respondents, meaning that respondents would most likely choose a mode that would have a shorter travel time and lower cost of fare among all possible modes. Moreover, the length of travel time was found to be more significant than the cost of fare which shows that users would consider the length of the whole trip more over the cheapness of the fare. In addition, respondents were asked how certain modal factors contribute to the decision to make use of a specific mode for their access and egress trips. It was found that how a user perceives a mode to satisfy a level of safety, reliability, time, and cost were the most important, having the 4 highest averages based on the Likert scale measurement.

Based on these findings, it can be emphasized that users value the length of travel time and the cost of fare the most. Numerous planning and changes can be done to further improve the current state of access and egress options with regard to the LRT/MRT. One example could be integrating a new route within the vicinity of the LRT/MRT station in a location that seems to lack interconnectivity and accessibility to the station; through this, it increases the reliability of

**Commented [2]:** The conclusions need to focus on the particular objectives of the paper. At the moment, the conclusions are relatively shallow because the authors did not use the developed models under specific planning scenarios. The authors seem to lack a perspective on how the models would be practically applied to the exercise of planning for better access or egress.

the mode within the area with respect to the LRT/MRT. Moreover, developing routes that could result in a shorter distance, thus a shorter travel time, with regard to the station may be looked into and studied. Improving the surrounding environment within a station as well can be done to heighten levels of safety, comfort, and accessibility to further cater to the demands of commuters: this can be done through the integration of walkways, proper drop-off points, security cameras, and lighted areas.

Furthermore, looking at the bigger picture, the goal of improving the quality of available access and egress modes to the LRT/MRT is to be able to encourage private vehicle users to shift to making use of public transportation, specifically including the LRT/MRT in their modal trips. Through this, there would be a decrease in private vehicles and traffic congestion on the roads. Making the access and egress options with regards to the LRT/MRT available to an individual attractive and able to cater to their needs can encourage a shift from their current modes to using the rail system.

Though planning for a change in the public transportation system is a complex study that involves numerous factors and components, the goal of this study was to show if existing public transportation can serve as access and egress options to and from the LRT/MRT stations can be further improved to have lesser travel time while having a lower cost of fare, as well as taking into account the different modal factors that are significant to the respondents, then users will be encouraged to continue using the rail transit as part of their trips, and encourage non-users to shift to making use of the rail transit system. Moreover, improvements do not stop with just the access and egress options but extend towards the quality of service of the rail systems themselves to be able to cater to the demands and needs of users.

The study acknowledges the limitation on the number of respondents of the study, which could have affected the results. Along with this, the assumptions made about the fare and travel time for the group of modes could also affect the results; future studies or research can make use of specific modes with their corresponding travel time to have a more detailed and in-depth comparison between specific modes. Subsequent studies with the same field of study are recommended to validate the findings of this study. Additionally, future research should ensure that the geographic distribution of the respondents is wide and shall cover all the cities of Metro Manila. Other factors or attributes could also be used, such as waiting time and comparing in- and out-of-vehicle travel time. It is essential to analyze whether the current transportation modes are sufficient and can cater to the needs of the commuters to create an efficient and sustainable transportation system in Metro Manila.

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