Impact Analysis of Aerial Ropeway Transport System as a Form of Mass Transportation in Baguio City

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Abstract: This study aimed to assess the impact of integrating a new form of mass transportation, which is the Aerial Ropeway Transport (ART) system, into the current transportation network of Baguio City. Currently, there is only limited mass transportation available in Baguio and residents have to take private vehicles or public transportation in the form of jeepneys, metered taxis, or provincial buses. Vehicle congestion is one of the reasons for traffic in Baguio and introducing a new form of mass transportation, that will only require a limited amount of structure footprint, will improve the current situation. The objective of this study was to assess the acceptability of a proposed ART system in Baguio City. Also, this study looked into the current characteristics of transportation in the city, proposed the most appropriate route based on travel demand, and formulated mode choice equations to determine the significant factors affecting the commuters' choice to switch to ART as an alternative mode of transportation. The study included surveys and data analysis in order to completely assess the integration of the system. The proposed ART, which is a unique mode of transportation, will reduce traffic congestion since more residents will prefer to use the ART over any other mode of transportation.

Keywords: *aerial ropeway transport system, cable cars, urban mass transportation, mode choice analysis*

1. INTRODUCTION

1.1 Background of The Study

Known as the "Summer Capital of the Philippines," Baguio City is a popular destination for tourists. Currently, the Central Business District caters to many local and even international businesses as a result of the flourishing tourism industry. The Department of Tourism aims to maintain the level of competence of Baguio in terms of tourism. However, issues such as rapid population growth, traffic congestion, and pollution plague the city. Despite several traffic experiments and proposed solutions, officials have not completely addressed the congestion in the area as problems linked to public transportation and lack of wide roads surface. There is a thriving source of jeepneys and private cars in Baguio City and majority of these parked vehicles occupy the road networks, which make it even more congested. In taking one's private

vehicle, looking for a parking space could be an inconvenience.

The World Health Organization (WHO) has conducted a study in major Philippine cities to see which had the most polluted air. Experiments have proven that Baguio City has the dirtiest air, leading Manila and Cebu significantly. WHO has set the limit of particulate matter present in the air as 10. Baguio City has reached a reading of over 49, which is above and beyond the limit set by WHO (2014).

An Aerial Ropeway Transport System (ART) that has the capacity of 8 people per gondola was first introduced in Steamboat Ski Resort, Colorado in 1986 but the concept has been applied for over a century. The system is composed of suspended cabins or gondolas that pass through support towers being pulled by cables in between two stations located in different areas (Swallow, 2013). It is commonly located in mountainous areas, especially ski resorts, to transport visitors and guests into areas with great elevation and distance. Today, these cable cars can be found in places all over the world like Colombia, Singapore, and London. The system increases tourism while providing an effective mode of transport to areas that are difficult to reach.

1.2 Problem Statement

The City of Baguio is a profoundly urbanized metropolitan in the Province of Benguet, Northern Luzon. Unlike Metro Manila, the space that can be developed has a topography of terrain which is mountainous and steep as shown in Figure 1.5. This renders it suitable for the ART system since the expansion of its road network to reduce traffic is extremely difficult. The traffic in the area is among the worst in the Philippines (Tan, 2007). There is currently limited mass transportation system in Baguio City. Private vehicles or public transportation in the form of jeepneys or metered taxis are the only options for residents and tourists. Despite the congestion on Baguio's roads, private vehicle ownership is still increasing and worsening the existing predicament. There is a pressing demand to address the mass transportation options for the city through a profound understanding of the travelling population. This impact analysis of Aerial Ropeway Transport System as a form of mass transportation aims to resolve the prevalent traffic congestion in this area.

1.3 Methods

In order to determine the acceptability of the ART within Baguio City, the researchers adapted two types of surveys - revealed preference and stated preference. Revealed preference surveys assess the current factors, such as ingress and egress time, cost, comfort, and safety, that affect the mode choice of the commuters. It is followed by the stated preference surveys which provides 9 cases wherein the trip characteristics that were evaluated in the preceding survey are compared to characteristics of the proposed ART. The data gathered from the survey, both Revealed Preference (RP) and Stated Preference (SP), were analyzed through Mode Choice Models and the most appropriate route for the ART was determined from origin and destination trips of respondents.

1.4 Related Literature

According to the Philippine Statistics Authority (PSA) (2015), the population of Baguio City as of 2015 is around 345,000 residents. The annual increase in the population, however, has brought many issues contributing to the congestion of Baguio ("Lakbay Baguio"). Mark De Guzman (2012) says the city has 345.6 kilometers of inner city and suburban roads, which were

not designed to serve the current volume of Baguio's vehicles. With road widening, a larger amount of cars can pass through the streets of Baguio, however, the cost of widening is a large restriction (Thompson, 2010). A project entitled "Rev-Bloom Baguio" studies a proposed monorail possessing the capability to transport 720 passengers at once (Polonio, 2015).

An article in Palaubsanon (2015) introduces a new and unique mode of transportation, which is the Aerial Ropeway Transport system. One of the disadvantages in its implementation would be the uncertainty of the weather conditions that might cause damage to the system if it is not be stored well under extreme conditions (Werny et. al, 2011). Only a few cities such as Caracas, Venezuela; Constantine, Algeria; Rio de Janeiro, Brazil; La Paz, Bolivia and Medellin, Colombia have fully integrated cable propelled transit into their transportation system (Manzi, 2014). In Medellin, Colombia, marginalized communities have been using the Metro Cable because of its relatively cheap fare (Hidalgo et al. 2015). It is unique in a sense because it caters to residents with low-income (JICA Research Institute, n.d.). When taking a long journey, riding the cable car saves about 33% of the money compared to riding two buses towards the same destination. (Bernet et al. 2014). In Tyrol, Austria, glaciers are common along the route so cable cars are the most suitable mode of transportation for access along mountainous areas (Felline et. al, 2007). According to Manzi (2014), perception plays an important role in the integration of the Aerial Ropeway Transit system as a form of mass transportation since most people view it as an amusement park ride rather than a viable and effective way to reach a destination.

According to Alshalalfah et al (2012), it must be technologically and operationally sound and must have a performance/cost package at least equal to that of an existing mode of transportation in order to be considered a viable transit mode. The term Aerial Ropeways is defined any form of aerial transportation system wherein riders are transported by a cabin that is suspended and hauled by a combination of ropes (Ropeways Transport Ltd., 2016). In a study entitled "The demand for public transport: the effects of fares, quality of service, income and car ownership", by N. Paulley, R. Balcombe, R. Mackett et al. (2006), there are three main attributes of transport that affects the mode choice of an individual. These are the characteristics of the traveller, the characteristics of the trip, and the characteristics of the transport facility.

2. THEORY/CONCEPTS

2.1 Sample Size

The sample size of the survey respondents can be computed using the equation:

$$SS = \frac{Z^2(p)(1-p)}{c^2} \quad (1)$$

where;

Z : Z - Value for 95% Confidence Interval
p : percentage picking a choice
c : confidence interval

2.2 Logistic Regression Analysis

To determine the significant attributes affecting the choice of an individual, the Logistic Regression Analysis was used. It evaluates the relationship between dependent variables and independent variables. The dependent variables are the mode usage (private

vehicle, public transportation, ART) while the independent variables are the attributes that influence each mode. A software called NLOGIT was used for the analysis of the data.

2.3 Utility

The utility function for transport mode x can be formed from the weighted sum of a set of attributes of choice. The utility of a mode of transport can be expressed as:

$$U_x = \sum a_i X_i \tag{2}$$

where,

Ux : utility of mode x
Xi : attribute value (time, cost, and so forth)
ai : coefficient value for attributes i

2.4 Multinomial Logit Model

The Multinomial Logit Model explains and predicts a traveller's choice between two or more alternatives. It statistically relate the choice made by each person to the attributes of the person and the attributes of the alternatives available to the person. It was used to investigate the tendency of tourists to change their travel behavior in relation to the choice of mode available for their trips. The Logit Model that was used in this study was discussed by Ortuzar and Willumsen (2011) in the Modelling Transport.

2.4.1 Probability

The probability of selecting a mode x can be written as:

$$P_x = \frac{\exp(U_x)}{\sum_{i=1}^{n} \exp(U_i)} \tag{3}$$

Where,

Px : probability of x mode
Ux : utility of mode
x : sum of exponential function of utility per mode

3. DATA, RESULTS, AND ANALYSIS

3.1 Preparation of Data

The study on the impact analysis of the Aerial Ropeway Transport System was designed to evaluate the current factors to a commuter's mode choice and determine the acceptability of the ART. The research consulted on data collection methods and survey design of Alcantara, Garrido, Moya, and Pimentel (2015) in their thesis. The previous study in Iloilo presented data that are essential in the evaluation of the mode choices of a commuter. For this reason, the study on the ART adapted two types of surveys - revealed and stated preference surveys.

Revealed preference surveys assess the current factors that affect the mode choice of the commuters. On the other hand, stated preference surveys takes into account the trip characteristics that were evaluated in the latter survey to determine if the commuter is willing to

switch to another mode choice. The two survey data allows the assessment of the trip characteristics such as cost and time of travel, access and egress times and level comfort of the commuter.

The software to be used in the data analysis is NLOGIT, which assess the Multinomial Logit Model. The data is programmed in NLOGIT, where complete analyzation is done. The Multinomial Logit Model is used in the data analysis because it estimates the probability of the responses based on the trip characteristics. The result of the model will yield to the evaluation of the factors that affects commuter's acceptability of the ART.

3.2 Current Transportation Characteristics

In the Revealed Preference (RP) Survey, the respondents were asked to indicate the origin and destination of their usual everyday trip. Most of the recorded origins are from residential areas such as Irisan, South Drive, Pacdal, and Gibraltar. Meanwhile, most destinations are concentrated in the Central Business District (CBD) and in areas with commercials establishments, schools, offices, markets, and tourist spots.

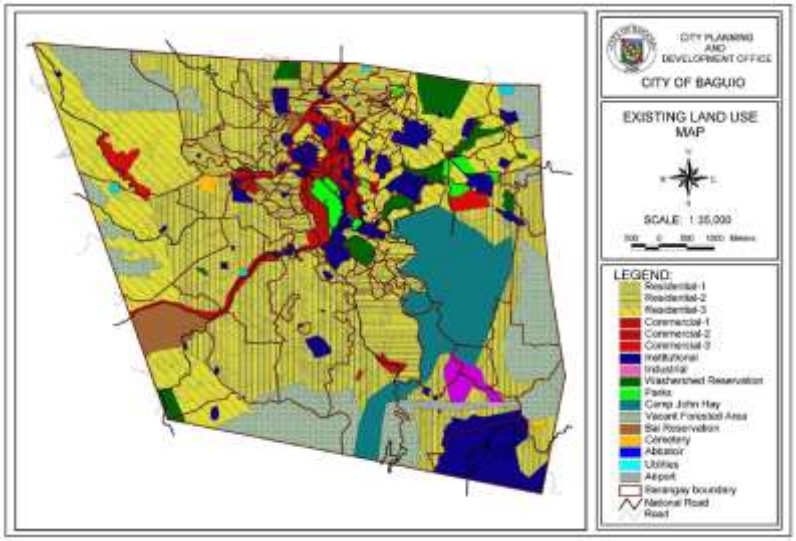


Figure 1. Land Use Map of Baguio City

Based on the preceding figure, the residential areas such as Upper Quirino Magsaysay, Session Road Area, Abanao and Kayang Extension are situated surrounding the CBD, this extends all the way to the perimeter of the city with barangays Irisan, Dontogan, Fort Del Pilar, and Mines View Park. The Central Business District caters to the most number of commercial establishments and institutions. The purpose of correlating the origin and destination map to the land use map is to verify that the answers obtained from the survey are indeed correct and information will become usable in the determination of the most appropriate route for the ART. This map is also relevant in certifying that the survey locations such as malls, parks, and schools which are densely populated areas are fittingly accounted for.

3.3 Descriptive Statistics

The revealed preference survey data also contains the basic information on the demographics of the respondents. This information is evaluated and taken into consideration

as these might affect the mode choice of the commuter. The distribution of the different groups of respondents are evaluatef based on the following information: gender, age, employment, monthly income and private vehicle ownership. From the 535 respondents, 63% are female while 37% are male, the age distribution of the respondents is presented and it can be observed that majority of the respondents belong to the 20 to 29 age group with 37%, the below 20 and 30 to 39 age group both with 21%. This could be due to the number of student and worker commuters throughout the city and since the 20 to 29 age group is also composed of both students and working individuals. For the employment distribution, it can be observed that it yielded to an almost equal distribution, 52% of the total number of respondents are employed while 48% are unemployed.

For the monthly income data, a large percentage in the group has a monthly income or allowance below 5000 pesos, which is around 46.92% of the total number of respondents. This is due to the combined group of people, which comprises mostly of students who have an allowance below 5000 pesos per month. This is also in relation to the large percentage of the 20 to 29 age group, which comprises of students and workers. The group of 5000 – 9999 comprises the 24.30% and the 10000 – 14999 group made up the 16.44%. While the other groups of 15000 – 29999, 30000 – 49999 and above 49999 have a percentage of 8.41%, 1.87% and 1.5% respectively.

Private vehicle ownership was also included in the revealed preference survey in order to identify the number of respondents who had their own vehicles, either car or motor. This is also to assess the number of people who owned private vehicles but still chose to commute during their daily trips. The mode of transportation data, which will be presented in the latter, will show the main transport used by the following respondents. As for the 535 survey respondents, 66% did not have any private vehicles which meant that they commute for their daily trips while 34% owned private vehicles, which meant that they had a choice whether to commute or use their private vehicles. Out of the 34% of the respondents who owned private vehicles, 71% owned cars while the 29% owned motorcycles. From this data, we can assess that majority of private vehicle owners are car owners and only a few are motorcycle owners.

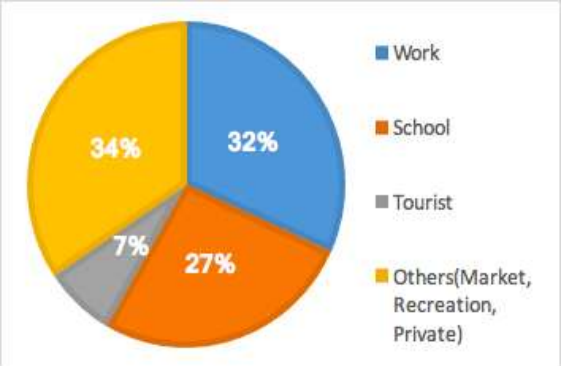


Figure 2. Distribution of Trip Purpose

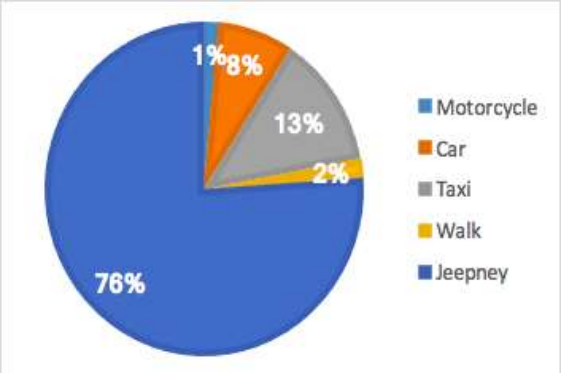


Figure 3. Distribution of Primary Trip Modes

The trip purpose determines the respondent's reason forgoing on that trip. It is chosen according to the most usual trip one takes. The usual trips considered in the survey are work, school, private or personal, tourist, market or mall, and recreation. Figure 2 above shows the chart of the trip purpose of the respondents. Looking at the chart, there are only four divisions: work, school, tourist and others. Those respondents who chose private or personal, market or mall and recreation are combined into a single classification called others. The trip

purpose with the most significant values belong to work, school, and others. With this knowledge, the busiest areas or districts in the city can be determined.

The modes of transportation considered in the survey are jeepneys, taxis, private cars, and motorcycle. Since some of the origins and destinations are located near each other, walking is also considered. During the ocular visit, it was observed that most forms of public transportation that are present in Baguio City are jeepneys and taxis. The survey validated that the two are the largest used modes. Figure 3 presents that majority of the respondents use the jeepney more because it is common and cheap. The chart shows that there is a significant number of people who use cars as well.

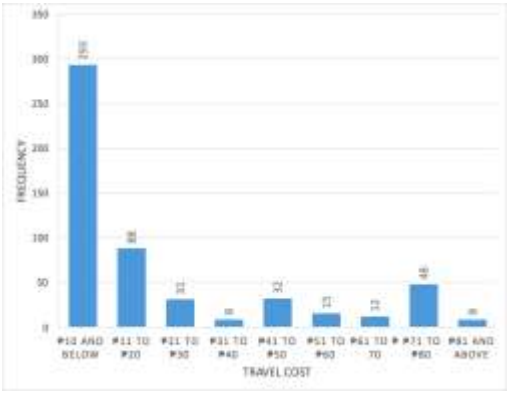


Figure 4. Distribution of Travel Cost

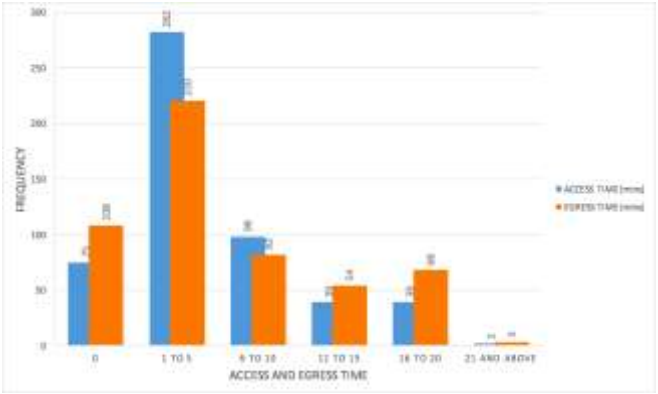


Figure 5. Distribution of Access and Egress Time

The travel cost of each mode of transportation is evaluated to assess the acceptable price range that can be considered by commuters. For private cars and motorcycle, the gas price spent to travel from the designated origin to the destination is taken as the value for the travel cost. Figure 4 present the range of the cost of the respondent's current mode preference. It shows that the usual range is from 1 - 10 Php followed by 11 - 20 Php. This can be justified by the observation that the jeepney is the most used form of public transportation. Another significant range in the chart is 71 - 80 Php. This is justified by the number of private cars and motorcycle that are used by the respondents.

Figure 5 presents a graph of the usual access and egress times of the respondents. The access time considers the time it takes to walk or wait for their mode of transportation from the origin while egress time is the time it takes to arrive to their destination after alighting the vehicle. The range that the respondents have chosen the most is from 1 - 5 minutes.

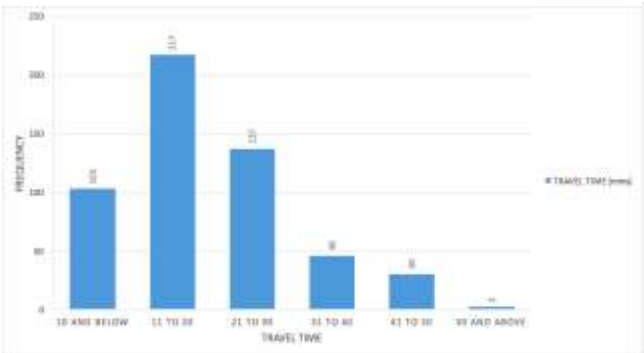


Figure 6. Distribution of Travel Time

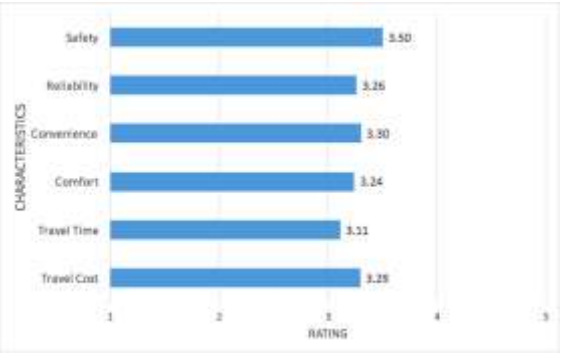


Figure 7. Mean Rating of Mode Characteristics

The knowledge of the respondents' travel times is a vital component of the survey because it determines the amount of time spent on the road in relation to their mode of transport. Figure 6 shows a graph of the ranges of travel times in Baguio City. According to the respondents, the usual range of travel time from an origin to a destination is 11-20 minutes.

The mode characteristics assess the respondent's evaluation of their current mode of transport with respect to safety, reliability, comfort, convenience, comfort, travel time, and travel cost. Figure 7 shows the mean rating of the following factors based on the surveys and the respondents rated safety and travel cost the highest. This implies the respondents are satisfied with the security and fare of their respective current mode choice. The lowest rated according to satisfaction is the travel time. The respondents feel discontented with the time spent on the road with their current mode. Knowing this, the highest range of travel time found in Figure 6, which is 11-20 minutes, seem to cause dissatisfaction amongst the travelers.

3.4 Variable List

The following are the possible variables that will be used in Choice Modelling for both revealed preference and stated preference:

- A_ART - alternative constant for the mode ART
- A_CAR - alternative constant for the mode car
- A_TAXI - alternative constant for the mode taxi
- TCOST - Travel cost per trip of ART, car, taxi and jeepney
- ACCTIME - access time of ART, car, taxi and jeepney
- TTIME - Travel time of ART, car, taxi and jeepney
- EGRTIME - Egress time of ART, car, taxi and jeepney
- TIME – Total Travel time of ART, car, taxi, and jeepney
- COMFOR - Level of comfort for ART, car, taxi, jeepney
- COSTIM – Travel cost divided by the total travel time of all mode
- ARTxAGE1 - Age specific variable for mode ART
- CARxAGE2 - Age specific variable for mode Car
- TAXxAGE3 - Age specific variable for mode Taxi
- ARTxGEN1 - Gender specific variable for mode ART
- CARxGEN2 - Gender specific variable for mode Car
- TAXxGEN3 - Gender specific variable for mode Taxi

3.5 Revealed Preference Survey Data

The data gathered from the survey were placed in an excel worksheet such that it can be readable to the NLOGIT software. The results are shown in Table 2

Table 2. Multinomial Logit Model of Revealed Preference

Log Likelihood		-626.209
R^2		0.43107
R^2adj		0.42790
Chi^2		122.534
Variable	**Coefficient**	**p-value**
COSTIM	-0.12115685	0.284

COMFOR	0.68827639	0
A_CAR	-0.82137638	0.0002
A_TAXI	-0.86397564	0

The p-value is used to determine whether a variable is significant or not. Since the confidence level is set to 95%, the p-value should not exceed 0.05 in order for the variable to be statistically significant. In the model, no variable has a p-value greater than 0.05, therefore all variables are significant.

For the mode specific constants of the modes, A_CAR and A_TAXI have a coefficient value of -0.82138 and -0.86398. A negative value means that it has negative impact on a person's choice. One reason could be that respondents could not afford to pay a lot just to travel. As for car, it has a negative coefficient could be because it is not available to all respondents. Based from the survey results, only 143 out of 535 respondents have car. Another possible reason could be because using a car requires a parking space, which is a problem in Baguio especially in Baguio Central District.

Results shows that the coefficient for the COSTIM is -0.12116. it has a negative value because a person would prefer to spend less over a particular distance. As for COMFOR, it obtained a positive value because during the duration of the trip, a person is more likely to choose a mode with high comfortability such as having own private space, air-conditioning, safety and facilities.

Shown below are Equations 4, 5, and 6 that can be used to calculate the probability of the revealed preference.

$$U_{CAR} = -0.12116(COSTIM) + 0.68828(COMFOR) - 0.82138 \quad (4)$$

$$U_{TAXI} = -0.12116(COSTIM) + 0.68828(COMFOR) - 0.86398 \quad (5)$$

$$U_{JEEP} = -0.12116(COSTIM) + 0.68828(COMFOR) \quad (6)$$

A crosstab displays the frequency distribution of the variables. By using the crosstab function of NLOGIT, a probabilistic matrix that discusses the correctness of the model's predictions can be determined.

Table 3. Crosstab Matrix of Various Mode Alternatives in the Revealed Preference Survey

	CAR	**TAXI**	**JEEPNEY**	**Total**
CAR	**9**	6	19	34
TAXI	8	**29**	86	123
JEEPNEY	17	88	**308**	413
Total	34	123	413	**570**

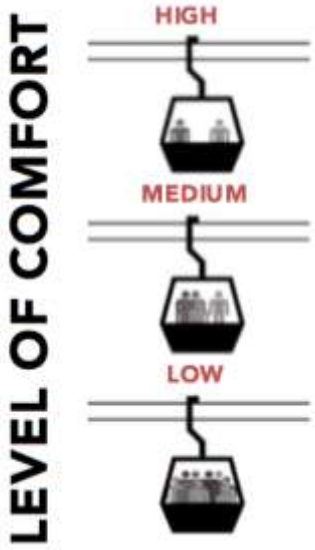
Table 3 displays the contingency table derived from the Revealed Preference Model. The matrix shows the number of correct predictions of each alternative. These values are highlighted in bold numbers. The car, for example, has 9 out of 34 correct predictions, which gives a 26.47% correctness. The taxi and jeepney have a correctness prediction of 23.58% and 74.58%, respectively. To get the overall percentage, the cumulative correctness of the three mode choices is divided by the total. Therefore, the revealed preference model has a correctness

prediction of 60.70%.

3.6 Stated Preference Survey Data

Table 4. ART System Cases

Trip Factors	ART System								
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
Fare (Php)	10	10	15	15	15	20	20	10	20
Travel Time Reduction(%)	40	30	50	10	40	30	15	50	40
Access/Egress Time (min)	5	15	5	10	15	5	15	10	10
Comfort	Low	Med	Med	Low	High	High	Low	High	Med



Travel Time Reduction Sample			
Assumed Travel Time	Reduced Travel Time		
	30 %	40 %	50 %
10 minutes	7	6	5
20 minutes	14	12	10
30 minutes	21	18	15
40 minutes	28	24	20
50 minutes	35	30	25
60 minutes	42	36	30

Figure 8. Level of Comfort and Travel Time Reduction Guide for Respondents

Table 4 shows the trip factors and the different cases of the ART System. In addition, the travel time reduction, which is shown in terms of percentage, is explained in Figure 8. The Access/Egress Time is the amount of time it takes for a person to access his/her mode, and to go to his/her destination from alighting point. The nine cases for the ART System was made using the Orthogonal Design of the software SPSS. It was made sure that there will be no same combination in all cases. The travel cost of ART, which are Php 10, 15, and 20, are converted into local currency from the prices of other ART systems abroad. The access and egress time of ART are based on the average access and egress time of the respondents in the pilot survey. The travel time reduction of ART are a comparison between speeds of existing international gondola installations and the average speed of local public transport during peak hour, which are 22-25 kph and 16 kph respectively.

The data obtained from the stated preference survey was used and the model is shown in Table 5

Table 5. Multinomial Logit Model of Stated Preference

Log Likelihood	-7099.213
R^2	0.38635
R^2adj	0.38592
Chi^2	1301.54

Variable	Coefficient	p-value
TCOST	-0.03863	0
ACCTIME	-0.01442	0.0187
TTIME	-0.03062	0
EGRTIME	-0.03378	0
COMFOR	0.41332	0
A_ART	0.35513	0
A_CAR	-0.75583	0
A_TAXI	-0.50174	0.0001

Analyzing the model, the specific constants for the alternatives are 0.35513, -0.75583, -0.50174 for ART, car, and taxi respectively. A negative value means that it has negative impact on a person's choice. A reason why car has a negative coefficient could be because it is not available to all respondents. Based from the survey results, only 143 out of 535 respondents have car. Another possible reason could be because using a car requires a parking space, which is a problem in Baguio especially in Baguio Central District. Also, the mode taxi also yielded a negative value, which means that it has a negative impact on travel choice. On the other hand, ART has a positive value which means that choosing these modes have a positive impact on the choice of mode of a traveller. This could mean that travellers need a reliable public transportation around the city.

The factors that affect a traveller's choice are TCOST, ACCTIME, TTIME, EGRTIME, and COMFOR, which has a value of -0.03863, -0.01442, -0.03062, -0.03378, and 0.41332 respectively. TCOST has a negative value because a person would prefer to travel without spending that much money. Therefore, having to pay a bigger amount of money would cause a negative impact on a traveller's travel choice. Other variables that have negative coefficient are ACCTIME, TTIME, and EGRTIME. This could be because travellers would want to reach their destination as fast as possible. Therefore, it would have a negative impact on a person if a mode will take a longer time to reach his/her destination. As for COMFOR, it has a positive value because comfort leads to traveller's satisfaction. Thus, a mode with higher satisfaction will give a positive impact in travel choice.

Shown below are the equations to solve for the utility of each mode of transportation:

$$U_{ART} = -0.0386(TCOST) - 0.0144(ACCTIME) - 0.0306(TTIME) - 0.0338\ (EGRTIME) + 0.4133(COMFOR) + 0.3551 \quad (7)$$

$$U_{CAR} = -0.0386(TCOST) - 0.0144(ACCTIME) - 0.0306(TTIME) - 0.0338(EGRTIME) + 0.4133(COMFOR) - 0.7558 \quad (8)$$

$$U_{TAXI} = -0.0386(TCOST) - 0.0144(ACCTIME) - 0.0306(TTIME) - 0.0338(EGRTIME) + 0.4133(COMFOR) - 0.5017 \quad (9)$$

$$U_{JEEP} = -0.0386(TCOST) - 0.0144(ACCTIME) - 0.0306(TTIME) - 0.0338(EGRTIME) + 0.4133(COMFOR) \quad (10)$$

Table 6. Crosstab Matrix of Various Mode Alternatives in Stated Preference

Crosstab	ART	CAR	TAXI	JEEPNEY	Total
ART	1368	79	126	912	2485
CAR	58	20	7	71	155
TAXI	123	11	27	117	278
JEEPNEY	936	46	119	1102	2203
Total	2485	155	278	2203	5121

Table 6 displays the crosstab matrix of the stated preference model used. The ART, car, taxi, and jeepney has a correctness prediction of 55.05%, 12.90%, 9.71%, and 50.02%, respectively. By taking the cumulative values of each correct prediction and dividing it by the grand total of 5121, the percentage of correct predictions is obtained. The calculated percentage is 80.06%; therefore, the model accurately predicted the choice 80.06% of the time.

3.7 Revealed Preference and the Probabilities

Using Equations 4, 5, and 6 from the revealed preference, the utilities of each mode can be calculated, which can be used to simulate actual probabilities of an individual in choosing his/her mode. The significant attributes of a respondent are shown in Table 7 these attributes are used to calculate the utilities and probabilities that are shown in Table 8.

Table 7. Sample Data Attributes of a Respondent for Current Choice

MODE	TCOST	ACCTIME	TTIME	EGRTIME	TIME	COSTIM	COMFOR
CAR	36.00	0	4	0	4	6.4842	0
TAXI	81.00	5	7	0	12	6.75	0
JEEP	8.00	32	9	8	49	0.1643	0

Table 8. Utilities and Probabilities of a Respondent for Current Choice

Variable	Utility	Probability
Car	-1.60728504	14.67
Taxi	-1.6821	13.61
Jeepney	-0.01991316	71.73

3.8 Probabilities of each Cases

The equations 7, 8, 9, and 10 was used to identify the utilities and probabilities when ART is introduced as another option for means of transportation. The relevant variables to their mode choice are given in Table 5.8.

3.8.1 Case 1

Table 9. Case 1 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.7768	47.11
Car	-2.2986	10.29
Taxi	-3.9145	2.04
Jeepney	-0.9266	40.56

Analyzing the results from the current choice of transportation to the ART, it is observed that the probability of selecting the car has significantly decreased from 14.67% to 10.29%. Similarly, the taxi and jeepney options decreased from 13.61% to 2.04% and 71.73% to 40.56% respectively. It illustrates that the rider is essentially guaranteed to select public transportation instead of the private transportation choice due to low ratings in the car and taxi. Whereas, the transportation which is highly favored for this case is the ART with the leading value of 47.11%. Although the comfort is low, the ART is favorable because the access, travel, and egress times are shorter in comparison to their current choice. This depicts the importance of time over comfort to the riders.

3.8.2 Case 2

Table 10. Case 2 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.8611	45.02
Car	-2.2986	10.69
Taxi	-3.9145	2.12
Jeepney	-0.9266	42.16

The results of probabilities for case 2 are shown in Table 10. In comparison to case 1, case 2 has an increase in access, travel, and egress time while other attributes such as cost have remained the same. Despite the increase in comfort from low to medium, the ART was still not favorable due to the lengthy commute time. The probability of selecting the car and taxi is typically in the same range as Case 1 from 14.67% to 10.69% and 13.61% to 2.12% against the RP probabilities respectively. Results with the jeepney were consistently in the same range as well, differing only in 1.6% from the value in the previous case. Despite the slight 2.1% decrease in the ART from its value in case 1, it is still the preferred mode in the given situation.

3.8.3 Case 3

Table 11. Case 3 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.5415	52.99
Car	-2.2986	9.14
Taxi	-3.9145	1.82
Jeepney	-0.9266	36.05

Case 3 as shown in Table 5.13 is one of the scenarios with the most costly fare at 15 Php. It is given with a medium comfort rating and the lowest combination of access, travel, and egress times in comparison to the other 8 cases. An increase in the favorability of the car from 8.07%

to 9.14% is observed while a there is slight decrease in values for taxi from 2.96% to 1.82%. A notable increase in the inclination towards the ART from 47.11% in Case 1 and 45.02% in Case 2 to 52.99% in Case 3 emphasizes the concern of time over cost and comfort.

3.8.4 Case 4

Table 12. Case 4 Utilities and Probabilities

Variable	Utility	Probability
ART	-1.2261	36.24
Car	-2.2986	12.40
Taxi	-3.9145	2.46
Jeepney	-0.9266	48.90

ART at 36.24% trails behind jeepney at 48.90%, this is in result to the high cost in combination with low comfort. Access, travel, and egress times have all increased in comparison to case 3. Thus, causing the decrease in demand of the ART. jeepney and Taxi have again remained in the same range while an evident increase in the car's probability is detected at 12.40% from 8.07% in the RP survey. Case 4 is the second lowest percentage of ART probability in comparison to all other cases due to this combination of undesirable qualities in the variables of commuting.

3.8.5 Case 5

Table 13. Case 5 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.6258	50.88
Car	-2.2986	9.55
Taxi	-3.9145	1.90
Jeepney	-0.9266	37.67

The cost from Case 4 was retained but the access and egress times were increased to 15. Travel time was slightly decreased and comfort was placed at high. Respondents have exhibited that they are willing to pay marginally more as long as the transportation they are taking is comfortable, safe, and efficient. The 50.87% value of the ART is almost equivalent to the sum of all other options; 9.55% car, 1.90% taxi, and 37.67% jeepney equal to 49.12%. The increase in probability can be attributed to the change in time and comfort.

3.8.6 Case 6

Table 14. Case 6 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.3521	57.67
Car	-2.2986	8.23
Taxi	-3.9145	1.64
Jeepney	-0.9266	32.47

High comfort in combination with shortened access and egress times in comparison to the preceding case cause the probability of the ART to increase by 6.78%. The likelihood of

selecting the ART is again well over half the sum of the other options at 57.67% from car at 8.24%, taxi at 1.64%, and jeepney at 32.47%. Despite the fare being one of the highest in Case 6, it is still the preference against the current available public and private transportation. When correlated to the RP survey values, taxi and jeepney have decreased while Car remained almost the same.

3.8.7 Case 7

Table 15. Case 7 Utilities and Probabilities

Variable	Utility	Probability
ART	-1.6295	27.52
Car	-2.2986	14.10
Taxi	-3.9145	2.80
Jeepney	-0.9266	55.58

The unsatisfactory combination of high cost and low comfort has decreased the normally high probability of the ART, bringing it down to 27.52%. The current available forms of transportation such as car and taxi have both increased by 6.03% and 0.16% respectively relative to RP survey. On the contrary, the jeepney has decreased significantly from a value of 88.97% to only 55.58%. Despite the short travel time, the access and egress times are disadvantageous to the commuters because it would take them a longer time to find a means of transportation than the actual trip from origin to destination. These reflect the rider's attraction to options that are affordable, efficient, and comfortable at the same time.

3.8.8 Case 8

Table 16. Case 8 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.1765	61.88
Car	-2.2986	7.41
Taxi	-3.9145	1.47
Jeepney	-0.9266	29.23

There are various cases demonstrated in this SP survey and the ART leads in 7 out of 9. This case in particular presents the highest probability in favor of the ART at 61.87%. It is associated to the economical fare and relatively low access, travel, and egress times. Commuters are also presented with the highest possible comfort. The tendency to select thecCar decreased from 8.70% to 7.41% while there is a similar decline in jeepney from 88.97% to 29.24%. Only taxi has made an increase from 2.96% to 1.48%. As mentioned, the ART is not constructed to compete with the other forms of mass transportation, rather, complement the existing options in order to provide residents with competent system.

3.8.9 Case 9

Table 17. Case 9 Utilities and Probabilities

Variable	Utility	Probability
ART	-0.6048	51.41

Car	-2.2986	9.45
Taxi	-3.9145	1.88
Jeepney	-0.9266	37.26

A minor increase in the travel time comfort made the probability for the ART drop by 10.48% from 61.87% to 51.41%. Other attributes such as travel cost, access time, and egress time were retained. It is reasonable to conclude that riders look to time and comfort the most when it comes to selecting the mode of transportation for daily activities. Probabilities for car have increased from 8.70% to 9.45% while there is a decline in taxi from 2.96% to 1.88% and jeepney from 88.97% to 37.26%. Majority of the probability lost in the ART was distributed between the next in line contenders Car and jeepney.

3.9 Proposed Route

The most appropriate route will be determined mainly from the origin and destination trips provided by the respondents in the survey. By identifying the most trip concentrated areas throughout the city of Baguio, the researchers were able to come up with the most efficient route to accommodate the commuters.

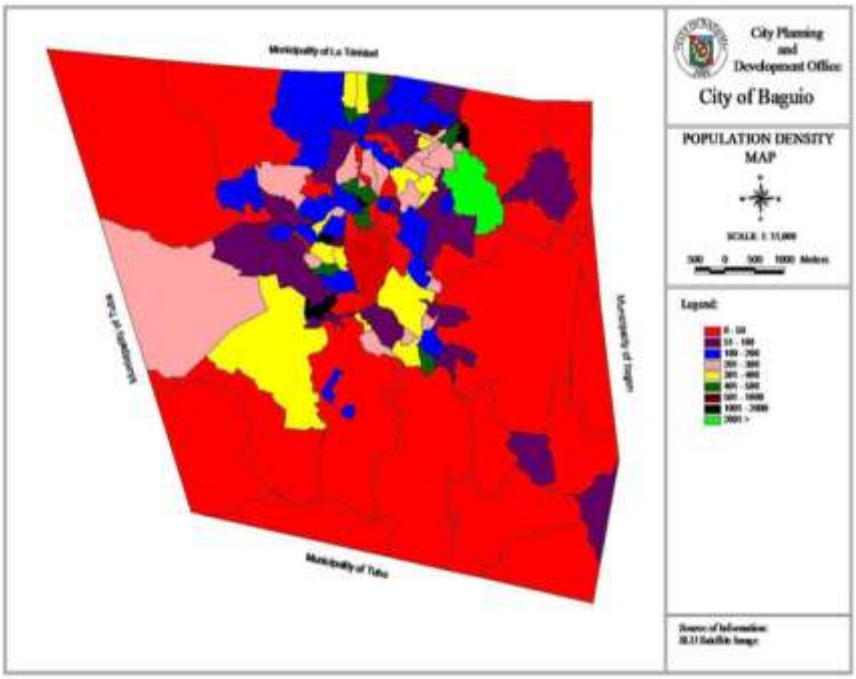


Figure 10. Population Density Map of Baguio City

There are a total of 129 barangays comprising Baguio City and based on Figure 10, it can be observed that the population density is high at the barangays surrounding the central business district area. Numerous factors are considered in determining the population density of a city like quality of housing, infrastructures and access to resources. Lands such as parks, forests, and the like tend to be inhospitable to human habitation thus the population tends to cluster around areas closer the central business district, where a lot of resources are available to them. The middle part of the city, which is where session road is located, has a low population density since most of the infrastructure found in this part of the city are for businesses and establishments. This serves as an additional factor in considering the route of the ART since through this data, the researchers were able to determine where the most

densely populated areas in the city are and where the demand for a mass transportation is necessary.

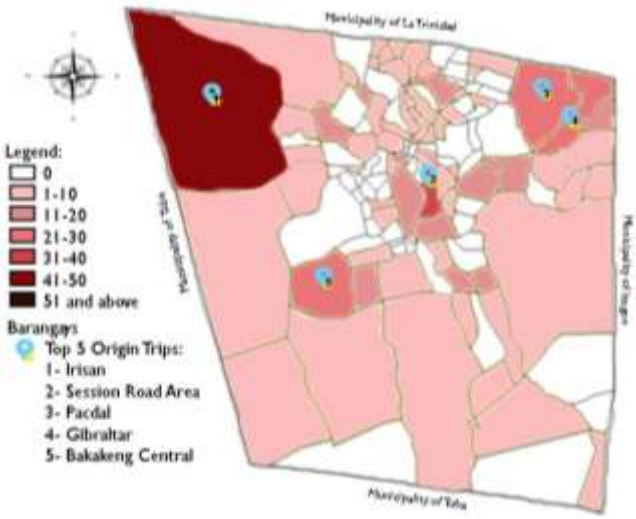


Figure 11. Origin Trips per Barangay

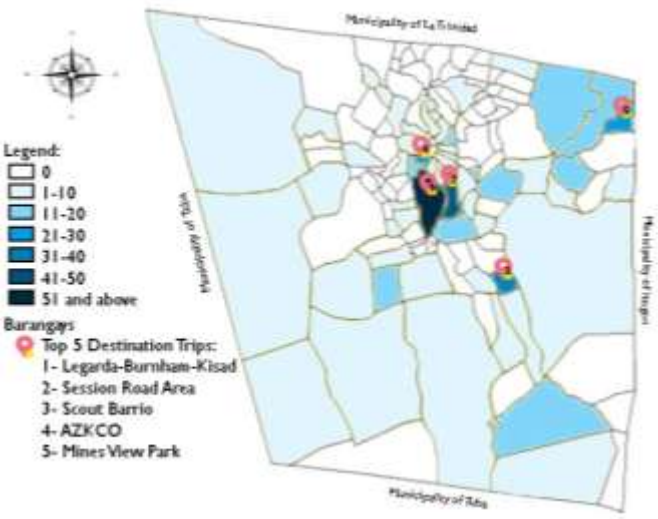


Figure 12. Destination Trips per Barangay

In the Revealed Preference survey, the trip characteristics were obtained from the respondents and included in this is the home address and destination address in order for the researchers to identify the areas where there is a high demand for public transportation. According to the Philippine Statistics Authority, Irisan was the most populous barangay in the city of Baguio based on the 2010 Census of Population and Housing. In Figure 11, it can be seen that the origin trips are distributed throughout the city of Baguio however, the highest number of origin trips came from barangay Irisan with a total of 42 trips from the 535 respondents. The number of origin trips are also high in following areas: Session Road Area, Pacdal, Gibraltar, and Bakakeng Central with 32, 29, 28 and 27 origin trips respectively. Session Road Area is considered as the main hub of the city and is where businesses, shops, hotels, restaurants and etc. are located. Pacdal, Gibraltar and Bakakeng Central have a high number of origin trips since these are all residential areas which are highly populated. In Figure 12, it can be observed that the areas with the highest destination trips are Legarda-Burnham-Kisad and Session Road Area with 60 and 49 trips respectively. This is due to the numerous establishments, tourist destinations, hotels and schools present in these barangays. Burnham Park, SM City Baguio, Session Road, University of the Cordilleras and Hill Station are only some of the famous locations which contributes to the high number of destination trips recorded within these areas. It can be observed that the areas with high destination trips are mostly for commercial use. Abanao-Zandueta-Kayong-Chugum-Otek (AZKCO) also has a high number of destination trips since Abanao Market or Baguio City Market is located within the area. The destination trips are also distributed throughout the city as can be seen in the map.

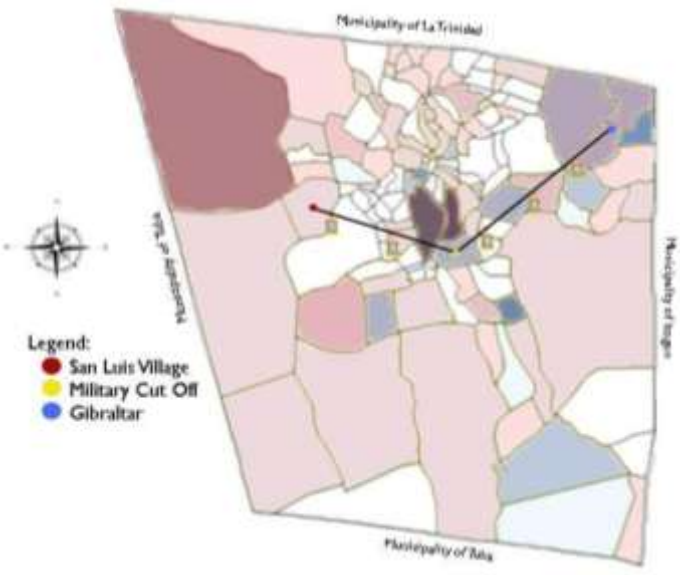


Figure 13. Combined Origin and Destination Trips with Proposed Route

In Figure 13, both the data maps for the origin trips and destination trips were overlapped in order to come up with a diagram that would display the areas with a high demand for public transportation. It can be observed that the trips are highly concentrated in the Legarda-Burnham-Kisad and Session Road due to the different commercial establishments located in those two areas. The barangays of Irisan, Pacdal and Gibraltar are also given emphasis in the map since they have high origin trips or destination trips. The trips however, are still widely distributed all over the city. The proposed cable car line of the ART is strategically located in population-dense areas. The data retrieved from the Philippines Statistics Authority is justified by the origin and destination trips obtained from the survey which was discussed earlier. Figure 13 shows a visual representation of the proposed ART line in Baguio City. A single line route is suggested that would connect the barangays of San Luis Village - Military Cut Off, and Gibraltar. These locations are chosen because it would have a wider range of accessibility to those populous areas. For example, San Luis Village is not significantly populated. However, it is surrounded with barangays with a large population like Irisan. By putting the station in San Luis Village, those residing in its neighboring barangays will have more access to the station due to its proximity from their area. The same scenario was considered for both Military Cut Off and Gibraltar. Military Cut Off is near the highly congested hub of the city which is Session Road Area and Legarda-Burnham-Kisad. Gibraltar is also surrounded by barangays which are mostly residential and also Mines View Park which is a staple tourist location in the city. The proposed aerial ropeway transport system station locations will not only cater to the commuters but also to the tourists considering the range covered by the locations. By placing the stations in the proposed locations, which are not exactly at the center of the population-dense areas, the ART is able to provide a system that would not compete with other existing forms of transportation systems.

4. CONCLUSION

The study revolves around the mode choice of commuters in Baguio City. It highlights the willingness of residents to accept a new form of mass transportation in their travel options. The available public transport at the moment is the jeepney, while there are cars, motorcycles, and taxis for private transport.

The primary objective of this research is to identify the current mode choices of the residents and tourists of Baguio city and analyze the impact of integrating a new mass transportation to complement the existing systems. The revealed preference survey examined the socio-demographic and travel characteristics. From this, it is determined that most of the respondents' trip purpose is work. The jeepney is the most used mode of transportation and the travel cost is within the range of ≤10 php. The usual access and egress time is within the range of 1-5 minutes while the travel time is along 11-20 minutes. The mode characteristics

evaluated the commuter's rating of their current mode of transportation where safety has the highest rating and travel time has the lowest. Those information are used in order to produce a model that resulted to having egress time, cost, travel time, and comfort as the significant characteristics that affect the commuter's choice. This is further justified by a value 73.68% correctness prediction by the use of the crosstab matrix. In addition to the RP survey, the stated preference survey was modeled in order to assess the commuter's preference when the ART is introduced. Model 1 yielded the most significant values to produce equations to solve for the utility of each mode of transportation. The crosstab matrix for the SP survey provided supplementary validation on the correctness prediction of the model as it resulted to 80.06% correctness. Applying these equations to each case, the probability and utility of the ART when it is introduced along the current mode is determined. Seven out of the nine cases are favorable to the ART. With the knowledge of the acceptability of the ART, a proposed route is determined based on the origin and destination trips of each respondent from the revealed preference survey. A single line that runs through the barangays of San Luis Village, Military Cut-Off, and Gibraltar allows accessibility to those areas with large populations and high demand.

A frequent misconception with alternative transportation technology is that it will single-handedly solve all traffic troubles. In reality, there is no singular solution to any given problem. Urban planners, policy-makers, and engineers will acknowledge that public transportation is at its maximum potential when it is multi-modal. In this manner, it leverages the strengths of distinct transport modes in creating an efficient, dense, and viable network. Cable cars will not zip around and overtake the entire city, the ART will fill in existing gaps and complement the current transportation network. The aerial ropeway is only one tool in the transportation engineer's toolbox. With ongoing urbanization and continual increase in population, the ART System is predicted to make a larger impact in the scene of urban mass transit.

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