Evaluating Mobility and Access to Public Utility Vehicles of Senior Citizens in Quezon City, Philippines

Lance Christopher P. LELIS [a], Vharbielyn S. DE GUZMAN [b], Dr. Jose Regin T. REGIDOR [c]

[a,b,c] *Institute of Civil Engineering, University of the Philippines Diliman, Quezon City, Metro Manila, 1101, Philippines*
[a] *E-mail: lelis.lancechristopher@gmail.com*
[b] *E-mail: deguzmanvharbielyn@gmail.com*
[c] *E-mail: jfregidor@up.edu.ph*

Abstract: Public utility vehicles (PUVs) serve as transport mechanisms which provide people access to various socioeconomic opportunities. However, due to physiological changes caused by aging, senior citizens experience vulnerability to public transport inaccessibility. Therefore, this study examined the gaps in mobility and access to PUVs of senior citizens residing in Quezon City based on five identified dimensions of accessibility– geographical accessibility (GE), availability (AV), affordability (AF), acceptability (AX), and accommodation (AC). For each dimension, a sample of senior citizens and adults aged 25 to 59 were interviewed about their actual and desired ratings. Then, based on the desirability gap values, the structural equation model (SEM) analysis showed that AC, AV, and GE have significant direct relationships on the mobility and access to PUVs for senior citizens. Moreover, the t-test results revealed that the said values of the senior citizens were observed to be greater than those of the adults. According to the findings, this study provided engineering solutions and policy recommendations to address the identified gaps.

Keywords: Public Utility Vehicles, Senior Citizens, Accessibility, Mobility, Structural Equation Modeling (SEM)

1. INTRODUCTION

Public utility vehicles (PUVs) function as an essential mechanism in urban areas by offering all individuals access to various social opportunities (United Nations, 2021); insomuch that their transport service quality has been recognized as a crucial metric for sustainable development. The 2030 Agenda for Sustainable Development has included among its targets the need to address the lack of development towards the sustainability of public transport systems for the mobility of individuals and goods. As a key indicator of transportation sustainability, inclusive public transport drives the agenda of providing the vulnerable sectors with the same ease of moving and access to all public transport infrastructure alongside everybody else.

Consequently, contemporary policies are being shaped towards achieving such a target (Ivers, n.d.). Recently, the focus of transportation-related initiatives in the Philippines has largely shifted towards transforming the policy framework concerning the PUVs to attain people-oriented mobility. Such examples include the Public Transport Modernization Program (PTMP), formerly known as PUV Modernization Program (PUVMP), Service Contracting for Public Utility Vehicles (PUV), and Davao High Priority Bus System (Nacino, 2021).

Senior citizens are identified among the vulnerable sectors due to their high susceptibility to diverse transportation challenges brought about by the physiological changes caused by

human aging. In addition, several studies including those of Chuenyindee et al., (2022) and Kim et al., (2020) revealed that transportation planning is heavily built upon the needs of the median age group. These challenges were determined to have impacts to their overall quality of life (Kim et al., 2020). Furthermore, the unprecedented impacts of the COVID-19 pandemic heavily constrained the transport systems and its users alike since the use of public transport posed the risk of spreading the virus. In Quezon City, senior citizens (i.e., individuals aged 60 and older), who comprised around 8% of the city's total population in the last 2020 Census, were among the "high-risk" population who faced travel restrictions for the longest time starting March 2020 until only two years after when restrictions were lifted (Philippine Statistics Authority, 2022; Inter-Agency Task Force, 2022).

Fransen et al. (2016)'s five-dimensional framework defines the accessibility of services as having five dimensions —Geographic accessibility (GE), Availability (AV), Affordability (AF), Acceptability (AX), and Accommodation (AC). In this study, the said framework was adopted in understanding the PUV service as findings from recent studies showed the necessary links between the two concepts. Park et al. (2017) identified that vehicle boarding locations shall be optimized based on distance from the users' origin, and noted that keeping an adequate number and capacity of public vehicles can significantly reduce stress for senior citizens. Tirachini & Cats (2020) found that unlike the high-income groups, those with lower income are the main users of public transportation. Chuenyindee et al. (2022) and Remillard et al. (2022) determined that the cognitive (e.g., status, memory, speed of processing, executive functioning) and psychosocial determinants (e.g., self-efficacy, coping behaviors, depression, fear, and relationships with others) are some of the top indicators affecting the acceptability of certain modes for senior citizens. Furthermore, Gumasing & Dela Cruz (2018) assessed the public utility buses in the Philippines and mentioned challenges experienced by senior citizens and PWDs (e.g., difficulty in boarding themselves in high elevated platforms and stairs, inability to carry heavy luggages, inability to reach safety handrails, no provided spaces for wheelchair users).

The existing body of literature which focused on understanding the relationship of the Filipino senior citizens with the public transportation system brought about developments in the ergonomic design of certain PUV types in favor of the Filipino senior citizens. However, based on Fransen et al. (2016)'s framework for accessibility, the former falls under only one of the mentioned dimensions. Thus, this study aimed to investigate the mobility and access to PUVs of the senior citizens in Quezon City based on the five dimensions from the adopted framework. An extensive review was performed to identify and explore the measures that can explain these dimensions of mobility and access to PUVs. To formulate substantial engineering solutions and policy recommendations for transport inclusivity and equitability, this study analyzed the desirability gap of a sample of Quezon City residents composed of senior citizens and adults aged 25 to 59 using structural equation modeling (SEM). Additionally, this study sought to identify the impacts of the COVID-19 pandemic to their specific transport-related position.

2. METHODOLOGY

This study employed a descriptive-correlational approach in analyzing senior citizens' mobility and access to PUVs in Quezon City, Philippines, collating data from senior citizens or, as defined by R.A. 7876, the individuals aged 60 and above, and a control group consisting of adults aged 25 to 59. A combination of convenience sampling techniques (i.e., face-to-face and

online surveying) was employed from February 24 to March 23, 2023. In line with this, the acceptable sample size was computed through Slovin's Formula at a 5% error.

By adopting Villaraza et al.'s (2018) methodology, the desirability gap (DG) (refer to **Equation 1**) served to measure the extent of how the respondents' actual experiences on certain aspects of PUV accessibility compare to their individual desired experiences. It was primarily gathered through a structured survey questionnaire formulated along the five exogenous constructs, also referred to in this study as dimensions of accessibility. The specific measures (refer to Table 1) were determined based on reviewed existing related studies.

$$\textbf{\textit{Desirability Gap}} = \frac{|Desired\ Rating - Actual\ Rating|}{Actual\ Rating} \quad (1)$$

The structured survey questionnaire was divided into two sections: the respondent profile and the assessment of their actual and desired mobility and access to PUVs. For the second section, 5-point Likert scale questions were formulated along the five constructs with their measures identified. Meanwhile, the mobility and access to PUVs (MO) was treated as the endogenous construct and measured through the overall rating for the constructs.

To model and evaluate the individual effects of the constructs to the respondents' mobility and access to PUVs, covariance-based structural equation model (CB-SEM) analysis via IBM SPSS AMOS software with the Maximum Likelihood estimation (MLE) approach was adopted in the methodology. With this, the constructs are assumed as common factors and the correlations between dependent and independent variables are estimated using MLE (Ringle, et al., 2024). MLE is commonly used for capturing the model, which describes the data gathered from the sample based on normality assumptions (Savalei & Rosseel, 2021; Maydeu-Olivares, 2017).

The data for DG of the two sample groups were used to generate an initial Measurement Model (MM) approach. Three sets of tests were used to assess the MM's fit to the real-life, empirical data: full model, goodness of fit, and badness of fit tests (Hair et al., 2006). Furthermore, the calculated standardized regression weights corresponding to each measure shall be 0.5 to be considered acceptable (Hair et al., 2010).

Afterwards, the structural equation model (SEM) was developed from the final MM iteration and subjected to multi-group SEM analysis with age as the categorical moderator. With this, the significance and strength of the structural relationships among constructs for each pre-defined sample group were investigated using the unconstrained SEM. Afterward, by constraining the model's structural weights with age as the categorical moderator, the significance of the difference in these relationships between the two groups was also determined. Furthermore, to gain insights regarding age equity in PUV accessibility, the significance of the difference between the weighted means of DG-values of the two sample groups was assessed using a one-tailed t-test at a 5% significance level.

Table 1. List of Measures and their Descriptions

Construct	Code	Measures	References
Geographical Accessibility (GE)	GE1	Distance of residential establishments from transport terminals	Park, et al. (2017), Abad, et al. (2019), Shaer & Haghshenas (2021), Remillard, et al. (2022)
	GE2	Distance of residential establishments from waiting sheds or loading zones	
	GE3	Distance of commercial establishments from transport terminals	
	GE4	Distance of commercial establishments from waiting sheds or loading zones	
Availability (AV)	AV1	Number of available vehicle stops and waiting sheds	Park, et al. (2017), Lidasan (2022), Remillard, et al. (2022), Roquel, et. al. (n.d.)
	AV2	Number of PUVs during regular hours	
	AV3	Number of PUVs during rush hours	
	AV4	Number of the PUVs headed towards a person's destination in relation to their travel purpose	
	AV5	Seating capacity of the PUVs headed towards a person's destination in relation to their travel purpose	
	AV6	Seating capacity of the PUVs during regular hours	
	AV7	Seating capacity of the PUVs during rush hours	
	AV8	Capacity of PUVs amidst the implementation of Alert Level 1 health and safety protocols	
Affordability (AF)	AF1	Travel fare	Villaraza, et al. (2018), Abad, et al. (2019), Kim, et al. (2020), Wilbur, et al. (2020), Tirachini & Cats (2020), Cahigas, et al. (2022), Remillard, et al. (2022), Jiang, et al. (2022)
	AF2	Ability to choose a PUV mode based on income	
	AF3	Adequacy of the social pension as a support for travel budget	
	AF4	Adequacy of the senior citizen discount as a support for travel budget	
Acceptability (AX)	AX1	Effects of accident risks on PUV mode choice	Park, et al. (2017), Pajarin, et al. (2017), Villaraza, et al. (2018), Kim, et al. (2020), Tirachini & Cats (2020), Cahigas, et al. (2022), Remillard, et al. (2022), Chuenyindee, et al. (2022), Jiang, et al. (2022), Roquel, et. al. (n.d.)
	AX2	Discriminations from drivers due to age	
	AX3	Assistance from other passengers for safe entry to and exit from PUVs	
	AX4	Assistance from other passengers for easier communication with the driver	
	AX5	Courtesy of other passengers to give seats for the elderly	
	AX6	Attitudes and reactions of other passengers during loading and unloading	
	AX7	Experienced standing during travel	
	AX8	Safe and smooth driving	
	AX9	Quiet and peaceful environment inside the PUVs	
	AX10	Absence of commuting stress during travel	
	AX11	Compliance to the designated loading and unloading zones	
	AX12	Travel duration	
	AX13	Choosing PUVs over private cars	

Accommodation (AC)	AC1	Proximity and number of safety handrails	Dorado, et al. (2015), Pajarin, et al. (2017), Gumasing, et al. (2018), Gumasing, et al. (2019), Wilbur, et al. (2020), Adeke, et al. (2021), Shaer & Haghshenas (2021), Lidasan (2022), Cahigas, et al. (2022), Remillard, et al. (2022), Chuenyindee, et al. (2022)
	AC2	Stair height	
	AC3	Space inside the PUVs for comfortable seating	
	AC4	Proximity of doors from priority seats	
	AC5	Space inside the PUVs for walking aids	
	AC6	Space inside the PUVs for wheelchairs	
	AC7	Size and clarity of signboards	
	AC8	Design of the seats	
	AC9	Cleanliness of the seats	
	AC10	Ventilation	
	AC11	Compliance of PUV operations to health and safety protocols	
	AC12	Compliance of drivers and operators to health and safety protocols	
	AC13	Compliance of passengers to health and safety protocols	
	AC14	Safety against COVID-19 transmissions during travel	
	AC15	Effect of pandemic to the attitudes of passengers towards PUV use	
	AC16	Effect of social distancing with a more comfortable seating position	
Mobility and Access to PUVs (MO)	MO1	Overall rating for Geographical Accessibility (GE)	Fransen et al. (2016)
	MO2	Overall rating for Availability (AV)	
	MO3	Overall rating for Affordability (AF)	
	MO4	Overall rating for Acceptability (AX)	
	MO5	Overall rating for Accommodation (AC)	

3. RESULTS AND DISCUSSION

3.1. Desirability Gap

From the valid responses, the mean actual and desired ratings for each of the 42 measures, as well as their corresponding desirability gap (DG) values, were calculated and tabulated in Table 2. Descriptive statistical data were observed for the analysis of the values.

Considering the mean actual ratings, the senior-citizen group showed a greater range (i.e., 2.24 to 3.91) than the control group with the standard deviations ranging from 0.92 to 1.33. Meanwhile, in terms of the mean desired ratings, each measure for the former received at least 4.50, except for AF1 which had 4.30. Interestingly, the control group's set of values was characterized to be all less than 4.50. The measures under the AF construct generally received the lowest actual and desired ratings. On the other hand, for both respondent groups, the highest ratings were observed in the measures under AX and AC.

3.1.1. Geographical Accessibility

Geographical accessibility, adopting Fransen et al.'s (2016) definition, pertains to the proximity of transportation supply with the passengers. By examining the desirability gap values, GE2 and GE1 obtained the highest (i.e., 2.22) and lowest (i.e., 1.99) mean DG values for senior citizens, respectively. Thus, the distances of their houses from waiting sheds or loading zones (GE2) were revealed to be the biggest concern under the Geographical Accessibility dimension. Meanwhile, the adult respondents showed more concern about the distances of certain establishments from transport terminals (GE3) after having a mean value of 1.67.

In comparison, the distances of the senior citizens' houses from transport terminals (GE1) were tolerable according to their needs. Similar measure received the lowest mean DG value of 1.47 for the control group.

3.1.2. Availability

The second dimension, availability, concerns the compatibility of the transportation capacity and type of existing services with the passengers' volume and travel purposes (Fransen et al., 2016). Under the Availability dimension, the seating capacities of PUVs during rush hours (AV7) were revealed to have the highest mean DG value (i.e., 2.79) for senior citizens. The control group also recorded the highest gap (i.e., 2.04) in this involved measure.

Moreover, the number of available PUVs during regular hours (AV2) and the seating capacity of the PUVs during regular hours (AV6) obtained the lowest mean DG values of 2.11 and 1.45 for senior citizens and for the control group, respectively.

3.1.3. Affordability

Affordability entails the relationship between the cost of a specific service and the income or the consumers' capacity to pay (Fransen et al., 2016). The social pension provision under R.A. 9994, while it offers itself as an additional support for travel budget (AF3), recorded the highest mean DG value (i.e., 2.88) for senior citizens. Hence, this indicates that the senior citizens desired a higher amount and expressed its influence in alleviating the issue in terms of affordability of PUVs. AF3 also obtained the highest mean DG value for the control group.

On the other hand, for the senior citizens, the effect of their income on their PUV choices (AF2) was observed to be less regarded than other measures as indicated by its lower gap value

(i.e., 1.69). Moreover, the current travel fare (AF1) was determined to be among the least concerns of both respondent groups.

3.1.4. Acceptability

According to Fransen et al. (2016), acceptability refers to the consumers' personal travel satisfaction in consideration to their multiple personal and social factors. Under this dimension, the senior citizens expressed a high desirability gap value of 2.23 concerning the absence of stress during travel (AX10). This indicates that the senior citizen respondents were also aware of the inevitable stressors brought about by traveling via PUVs. However, on a positive note, the results also showed that they are satisfied with the expressed courtesy by other passengers (AX5).

As for the control group, the DG value is highest (i.e., 1.96) for the AX7 measure, highlighting the fact that they are currently dissatisfied with the frequent standing during travel using PUVs. Moreover, the control group generally evaluated that the practice of assisting one another as passengers in communicating with the driver have relatively reached their desired results.

3.1.5. Accommodation

Accommodation refers to the relationship between how the physical and health needs of consumers are accommodated by the transport sector with their presentation and organization of their services (Fransen et al., 2016). Under this dimension, senior citizens were revealed to be highly dissatisfied with the lack of allotted space inside PUVs for those who have wheelchairs (AC6), which obtained A DG value of 2.66. Meanwhile, they only recorded a DG value of 1.63 regarding the visibility of signboards for the users (AC7).

As for the control group, similar results were observed for the highest and lowest mean DG values of 2.41 and 1.35, which were AC6 and AC7, respectively.

Table 2. Descriptive Statistics per Post-preliminary CFA measure for Senior Citizens and Control Group

Construct	Measure	SENIOR CITIZENS								CONTROL GROUP							
		Actual		Desired		Desirability gap				Actual		Desired		Desirability gap			
		Mean	Std Dev	Mean	Std Dev	Min	Max	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Min	Max	Mean	S
GE	1	3.03	1.20	4.55	0.90	0.00	4.00	1.99	1.63	3.03	0.95	4.24	0.93	-0.67	4.00	1.47	
	2	2.84	1.24	4.56	0.97	-0.25	4.00	2.22	1.78	2.87	1.00	4.20	1.00	-0.50	4.00	1.60	
	3	2.89	1.16	4.53	0.91	-0.35	4.00	2.12	1.69	2.82	1.05	4.17	1.00	-0.50	4.00	1.67	
	4	2.92	1.17	4.50	1.02	-0.67	4.00	2.01	1.63	2.85	1.02	4.16	1.02	-0.50	4.00	1.56	
AV	2	3.02	1.09	4.59	0.81	-0.50	4.00	2.11	1.75	2.98	1.00	4.26	0.95	-0.68	4.00	1.62	
	3	2.52	1.06	4.51	0.84	-0.33	4.00	2.58	1.94	2.53	1.04	4.17	1.08	-0.67	4.00	2.00	
	4	2.90	1.04	4.60	0.80	-0.33	4.00	2.16	1.71	2.88	0.91	4.27	0.95	-0.40	4.00	1.67	
	5	2.85	1.20	4.66	0.70	-0.33	4.00	2.47	1.94	3.03	0.87	4.27	0.89	-0.50	4.00	1.51	
	6	2.92	1.25	4.66	0.70	-0.20	4.00	2.47	1.99	3.08	0.90	4.28	0.93	-0.50	4.00	1.45	
	7	2.49	1.17	4.63	0.71	0.00	4.00	2.79	2.03	2.55	1.03	4.17	1.02	0.00	4.00	2.04	
	8	2.94	1.23	4.66	0.73	0.00	4.00	2.33	1.87	2.88	0.99	4.24	0.97	-0.50	4.00	1.68	
AF	1	3.03	1.10	4.30	0.87	-0.25	4.00	1.72	1.47	2.76	0.90	3.98	0.99	-0.50	4.00	1.52	
	2	3.03	0.99	4.50	0.90	-0.25	4.00	1.69	1.30	2.71	0.96	4.10	1.03	-0.50	4.00	1.78	
	3	2.24	1.14	4.50	0.90	0.00	4.00	2.88	2.04	2.47	1.04	4.14	1.07	-0.40	4.00	2.14	
	4	2.99	1.38	4.36	1.13	0.00	4.00	1.85	1.62	2.88	1.04	4.22	0.98	-0.40	4.00	1.71	
AX	1	3.01	1.21	4.56	0.85	0.00	4.00	2.05	1.68	2.91	0.97	4.05	0.99	-0.33	4.00	1.44	
	2	3.16	1.37	4.43	0.96	-0.80	4.00	1.95	1.71	3.11	1.10	4.19	0.94	-0.33	4.00	1.51	
	3	3.64	1.16	4.61	0.78	0.00	4.00	1.39	1.28	3.30	1.04	4.20	0.95	-0.50	4.00	1.18	
	4	3.73	1.11	4.61	0.79	0.00	4.00	1.14	1.01	3.46	1.05	4.26	0.91	-0.40	4.00	1.08	
	5	3.77	1.05	4.57	0.87	-0.80	4.00	1.12	1.06	3.04	1.10	4.04	1.04	-0.75	4.00	1.32	
	7	3.35	1.24	4.59	0.87	-0.75	4.00	1.81	1.58	2.79	1.21	4.20	1.02	-0.33	4.00	1.96	
	8	3.48	1.16	4.73	0.75	-0.25	4.00	1.65	1.40	3.21	1.04	4.39	0.92	-0.33	4.00	1.48	
	9	3.51	0.99	4.63	0.78	-0.25	4.00	1.33	1.06	3.00	0.95	4.29	0.92	-0.50	4.00	1.64	
	10	2.90	1.33	4.47	0.97	0.00	4.00	2.23	1.85	2.72	1.10	4.18	1.03	-0.33	4.00	1.89	
	11	3.91	1.12	4.78	0.65	0.00	4.00	1.27	1.17	3.53	1.07	4.45	0.90	-0.67	4.00	1.22	
	12	3.64	1.17	4.71	0.78	0.00	4.00	1.49	1.34	3.19	1.15	4.37	0.90	-0.50	4.00	1.68	
	13	3.31	1.31	4.70	0.72	0.00	4.00	2.12	1.85	3.23	1.04	4.30	0.90	-0.33	4.00	1.40	
AC	1	3.21	1.13	4.70	0.62	0.00	4.00	2.02	1.66	3.06	0.87	4.33	0.87	-0.33	4.00	1.48	

	2	2.94	1.04	4.55	0.76	0.00	4.00	1.99	1.53	2.91	0.89	4.24	0.95	-0.60	4.00	1.60
	3	3.02	1.07	4.64	0.75	0.00	4.00	2.05	1.62	2.82	1.00	4.29	0.96	-0.67	4.00	1.88
	4	3.34	1.13	4.71	0.68	0.00	4.00	1.71	1.35	3.02	1.00	4.36	0.92	0.00	4.00	1.67
	5	2.94	1.22	4.70	0.71	0.00	4.00	2.25	1.71	2.69	1.04	4.33	0.96	-0.50	4.00	2.04
	6	2.45	1.19	4.61	0.85	0.00	4.00	2.66	1.89	2.44	1.11	4.33	1.01	-0.67	4.00	2.41
	7	3.61	1.20	4.77	0.69	0.00	4.00	1.63	1.42	3.31	1.02	4.42	0.91	-0.33	4.00	1.35
	10	3.11	1.22	4.78	0.62	0.00	4.00	2.26	1.80	2.98	0.98	4.39	0.92	-0.50	4.00	1.75
	11	3.18	1.11	4.82	0.67	0.00	4.00	2.11	1.72	2.93	1.07	4.43	0.91	-0.20	4.00	1.95
	13	3.27	1.15	4.80	0.67	0.00	4.00	1.96	1.57	3.00	1.01	4.42	0.95	-0.67	4.00	1.77
	15	3.12	1.21	4.56	0.86	0.00	4.00	1.91	1.57	2.95	1.00	4.21	0.98	-0.33	4.00	1.64
MO	2	3.14	1.03	4.64	0.77	-0.54	4.00	2.00	1.64	3.21	0.86	4.40	0.85	-0.33	4.00	1.39
	3	3.04	0.94	4.51	0.80	0.00	4.00	1.80	1.45	3.11	0.92	4.29	0.91	-0.33	4.00	1.46
	4	3.63	0.92	4.75	0.55	0.00	4.00	1.39	1.16	3.55	0.83	4.47	0.79	-0.33	4.00	1.04
	5	3.39	0.92	4.77	0.58	-0.25	4.00	1.73	1.41	3.40	0.83	4.41	0.89	-0.25	1.50	1.08

3.1.6. Synthesis

Among the five indicated dimensions, the highest mean DG values (≥ 2.10), were recorded under AV, while AF and AC obtained the lowest. Then, after performing a one-tailed t-test at a 5% significance level via IBM SPSS Statistics, the desirability gaps for the senior citizens in GE, AV, AC, and MO were found to be significantly larger than those of the control group.

Table 3. T-test between the sample groups' desirability gaps

	GE	AV	AF	AX	AC	M
p-value	**0.00028**	**0.00010**	**0.45788**	**0.30311**	**0.03588**	**0.02**
Analysis[a]	Reject Ho	Reject Ho	Fail to reject Ho	Fail to reject Ho	Reject Ho	Rejec

[a] Ho declares that there is no significant difference between the desirability gap values of the senior-citizen group & control group

Interestingly, cases with negative DG values revealed that a number of respondents experienced more than what they prefer (i.e., Desired rating < Actual rating), and this can be observed more from the control group. 17 out of 42 measures had negative minimum DG values for senior citizens, while 40 out of 42 measures were from the control group.

As seen in Table 4, 14 out of the 42 measures included in the measurement model discussed in Section 3.2 were identified as the candidates for priority areas of concern. They were characterized as having a mean Actual rating less than 3 (Neutral) from the senior citizens and a mean Desirability Gap value above the 50th percentile (i.e., 2). Notably, a higher range of mean values of Desired ratings (i.e., 4.298 to 4.817) were recorded for the senior-citizen group as compared to the control group.

Table 4. Measures with a mean Actual rating of less than 3 and their corresponding mean DG values for senior citizens

	Measure	Actual Rating	DG
GE2	Distance of residential establishments from waiting sheds/ loading zones	2.84	2.22
GE3	Distance of commercial establishments from transport terminals	2.89	2.12
GE4	Distance of commercial establishments from waiting sheds/ loading zones	2.92	2.01
AV3	Number of PUVs during rush hours	2.52	2.58
AV4	Number of the PUVs headed towards a person's destination in relation to their travel purpose	2.90	2.16
AV5	Seating capacity of the PUVs headed towards a person's destination in relation to their travel purpose	2.85	2.47
AV6	Seating capacity of the PUVs during regular hours	2.92	2.47
AV7	Seating capacity of the PUVs during rush hours	2.49	2.79
AV8	Capacity of PUVs amidst the implementation of Alert Level 1 health and safety protocols	2.94	2.33
AF3	Adequacy of the social pension as a support for travel budget	2.24	2.88
AX10	Absence of commuting stress during travel	2.90	2.33
AC2	Stair height	2.94	1.99
AC5	Seating space for passengers with crutches	2.94	2.25

AC6	Seating space for passengers in wheelchairs	2.45	2.66

3.2. Multi-group SEM Analysis

Table 5. Goodness of Fit

Parameters	Values	Cutoff values	Source
Chi-square / DF	3.32	< 5.0	Hair et al. (2010)
GFI	0.849	> 0.8	Gefen et al. (2000)
AGFI	0.815	> 0.8	Gefen et al. (2000)
RMSEA	0.071	< 0.07	de Oña et al. (2013)

Table 6. Reliability and convergent validity of constructs

Constructs	ρ_c	α	AVE
GE	0.823	0.837	0.549
AV	0.922	0.918	0.627
AF	0.734	0.663	0.331
AX	0.810	0.797	0.423
AC	0.899	0.902	0.450
MO	0.682	0.702	0.426

Table 7. Divergent validity of constructs

Construct Pairs	HT-MT Ratio
GE-AV	**0.305**
GE-AX	**0.000**
GA-AC	**0.140**
GE-MO	**0.293**
AV-AX	**0.410**
AV-AC	**0.486**
AV-MO	**0.597**
AX-AC	**0.610**
AX-MO	**0.332**
AC-MO	**0.438**

Based on the conducted preliminary confirmatory factor analysis, an initial measurement model (MM) was generated with 42 identified measures. An iterative process of modifying the MM to improve its fitness, reliability, and validity was in model together with the AX measures with factor loadings less than 0.5. Based on the final MM iteration, only four constructs and 31 measures were observed to have acceptable parameter values for their reliability, convergent validity, and divergent validity.

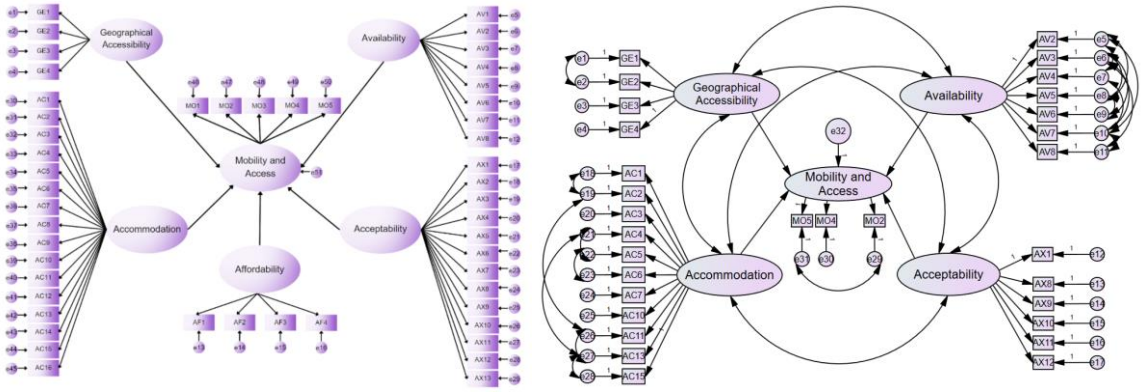

Figure 2. Initial and Final SEM

By analyzing the unconstrained models, the direct effects of GE, AV, and AC constructs with MO for senior citizens were observed to be statistically significant ($p < 0.05$) and their critical ratios (CR) were greater than 1.96. Thus, GE, AV, and AC were the only constructs considered to have significant direct relationships to the mobility and access to PUVs of senior citizens. On the other hand, for the control group, GE, AV, and AX were the constructs with significant effects for the control group.

Considering only the significant, direct relationships for the senior-citizen group, the estimated weights ranged from 0.113 to 0.475 which were higher than those for the control group (i.e., 0.048 to 0.154). Accommodation was found to have the strongest relationship among them which signified that it is the most contributing factor to the gaps experienced by senior citizens in Quezon City. It was followed by Availability and then, by Geographical Accessibility.

Meanwhile, after analyzing the constrained model which aimed to compare the observed relationships of these four constructs on mobility and access to PUVs for the two age groups, they were not proven to be statistically different. The lack of significance in the differences in path coefficients revealed that the individual constructs serve as common indicators of the mobility and access to PUVs for the two age groups, supporting the findings reported above.

Table 8. Unconstrained Model and Multi-Group Analyses

UNCONSTRAINED MODEL ANALYSIS						MULTI-GROUP ANALYSIS		
Path			**Estimate**	**S.E.**	**C.R.**	**p**	**Path**	**p-value**
SENIOR-CITIZEN GROUP								
MO	←	GE	**0.113**	0.031	3.594	<0.001	**MO** ← GE	**0.226**
MO	←	AV	**0.25**	0.048	5.216	<0.001	**MO** ← AV	**0.123**
MO	←	AX	**-0.432**	1.698	-0.254	0.799	**MO** ← AX	**0.789**
MO	←	AC	**0.475**	0.16	2.966	0.003	**MO** ← AC	**0.181**
CONTROL GROUP								
MO	←	GE	**0.048**	0.022	2.204	0.028		
MO	←	AV	**0.154**	0.031	4.94	<0.001		
MO	←	AX	**0.137**	0.062	2.227	0.026		
MO	←	AC	**0.094**	0.051	1.85	0.064		

3.3. Priority Areas of Concern

Based on the combined results of the multi-group analysis and desirability gap analysis, only 12 measures (see Section 4) belonging to the three identified constructs (i.e., GE, AV, AC) having a significant direct relationship to the mobility and access to PUVs of senior citizens

were acknowledged as the priority areas of concern and served as basis for the formulated engineering solutions and policy recommendations (see Section 4).

In the list of the determined priority areas of concern, the COVID-19-related factors turned out to be not considered by the sample. The systematic lifting of COVID-19 restrictions, which was observed by the population, could have caused the observed decline in their impacts on the residents' mobility and access to PUVs. Thus, the public transport situation's return to normalcy also restored the necessary emphasis of the spatial and non-spatial accessibility dimensions in policymaking.

Overall, the mobility and access to PUVs of senior citizens residing in Quezon City was determined to have significant gaps, which can be linked to the existing PUV framework's lack of inclusivity and equitability towards senior citizens. The determined relationships of the indicated dimensions to their mobility and access to PUVs apply to both senior citizens and adults aged 25 to 59 years. Nonetheless, the findings of the study clearly showed how the disadvantages brought by the old age of senior citizens affect their assessment of the PUV system and framework, which was consistent with Fransen et al.'s (2016) findings.

4. CONCLUSION AND RECOMMENDATIONS

Based on the conducted SEM analysis of the measured gaps on the five dimensions of mobility and access to PUVs, the researchers identified the three dimensions, namely, Accommodation, Availability, and Geographical Accessibility, which highly contributed to the lack of equitability and inclusivity of PUVs towards senior citizens. Despite their statutory privileges, the evaluated gaps concerning the senior citizens were observed to have greater recorded values and estimated regression weights than those by adults aged 25 to 59. Furthermore, the t-test results analyzing the DG values, while being consistent with the SEM analysis findings, proved that age is a factor which disadvantages the senior citizens concerning their mobility and access to PUVs. Furthermore, the recommendations forwarded by this study shall benefit the senior citizens residing in Quezon City wherein the focus shall be on the following identified priority areas of concern:

1. Distance of residential establishments from waiting sheds or loading zones
2. Distance of commercial establishments from transport terminals
3. Distance of commercial establishments from waiting sheds or loading zones
4. Number of PUVs during rush hours
5. Number of the PUVs headed towards a person's destination in relation to their travel purpose
6. Seating capacity of the PUVs headed towards a person's destination in relation to their travel purpose
7. Seating capacity of the PUVs during regular hours
8. Seating capacity of the PUVs during rush hours
9. Capacity of PUVs amidst the implementation of Alert Level 1 health and safety protocols
10. Stair height
11. Seating space for passengers with crutches
12. Seating space for passengers in wheelchairs

To effectively align the PUV system's framework with the demands of the senior citizens, the accommodation of their physical and health needs when riding (Accommodation) should be

prioritized during planning, followed by the improvement of the adequacy of transport supply (Availability), and then by optimization of the PUVs' access distances (Geographical accessibility). The results also indicated the need for modernizing and redesigning the framework for the PUVs, in accordance with the existing policies of the government and identified best practices that can be applied to address such concerns. Likewise, to attain transport inclusivity and equitability, allocating resources for the discussed priority areas of concern is key.

As explained by the existing body of related literature, the social dimensions of transportation accessibility are vital for the improvement of the public transport system of Quezon City and other locations, in general. Furthering this study and implementing similar approaches which involve stakeholder engagement act as an important step to formulate appropriate engineering solutions.

Table 9. Recommended Engineering Solutions

Dimension	Priority Areas of Concern *(Refer to the list above)*	Recommendations
ACCOMMODATION	10-12	● Determine the anthropometric measurements of the senior citizens a vulnerable sectors to perform ergonomic design on high-capacity, four- PUVs. ● In response to Department Order No. 2017-011, the design of the curbs provided in the new PUV designs must also be ramped up and graded tow vehicles' head. ● The entry width and gangway width, at least up to the reserved seats, must according to the wheelchair dimensions. ● Ramped walkways or elevators shall always be included in the design of and terminals, especially the MRT and LRT stations.
AVAILABILITY	4-9	● Adopt the double-decker design for public utility buses. The seats four bottom level, however, are reserved for mobility-impaired individuals (i.e citizens, PWD, pregnant women). ● Spatial accessibility analysis may be performed by DOTr to determ prescribe alternate public transportation routes based on the trip behavi senior citizens. ● Alternatively, transport planning may be implemented with emph incorporating a special point-to-point transport for senior citizens.
GEOGRAPHICAL ACCESSIBILITY	1-3	● Focus on the sustainable transformation of the local roads and pedestria These are significant for urban residents, including senior citizens, beca facilitate the residents' transportation to PUV terminals, loading, and u zones. ● Spatial accessibility analysis and planning may also be performed to determine the optimal number and locations of terminals, loading, and u zones. ● Alternatively, adequate space may be allocated for the street furniture a length of walkways.

To further explore on the topic and obtain specific and targeted insights for transportation planning, a similar research can be replicated on a smaller scale (i.e., investigation on smaller aggregate of areas or a specific PUV type). Likewise, based on the study's findings, performing ergonomic analysis and design on PUVs considering the anthropometric measurements of the senior citizens and other vulnerable sectors provides crucial development in addressing the accessibility of the said vehicles.

In this study, the results must be treated with caution since a convenience sampling approach was utilized due to financial and time constraints. A random sampling of respondents

is therefore advised for future research to acquire a highly representative sample and generate findings that are of low susceptibility to research biases.

Likewise, the researchers also recognized that the use of semi-structured questionnaires would better the qualitative analysis performed. Nonetheless, the methodological framework implemented for this study may be further explored and adopted by future studies on evaluating the gaps in a framework, especially on assessing the affordability dimension of the people's mobility and access to PUVs. In line with this, the reliability and validity of measures, especially when conducting multi-group structural equation modeling analysis can be ensured by increasing the number of measures and checking the generality of measures.

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REFERENCES

Abad, R., Fillone, A., Banister, D., Hickman, R., Biona, J. (2019, March). Investigating the relationship between housing affordability and mobility in Metro Manila, Philippines. *Philippine Transportation Journal*, 2(1), Article ISSN # 2651-7094. http://ncts.upd.edu.ph/tssp/archives/995

Adeke, P. T., Gbagir, K., & Tyogo, M. (2021). Passenger Capacity and Safety: Investigating the Likelihood of COVID-19 Transmission in Public Transport Modes within Makurdi Metropolis. *FUOYE Journal of Engineering and Technology*, 6(4). https://doi.org/10.46792/fuoyejet.v6i4.649

Age and Sex Distribution in the Philippine Population (2020 Census of Population and Housing) (2022, August). Philippine Statistics Authority. Retrieved from https://psa.gov.ph/population-and-housing/statistical-tables

An Ordinance Amending Ordinance No. SP-2337, 2-2014, Otherwise Known as the Quezon City Tricycle Management Code of 2014, by Including a Provisional Fare Rate and Increasing Tricycle Load Up To Four (4) Passengers Including the Driver, and Providing Penalties for Violation Thereof and for Other Purposes (2022). Ordinance No. SP-3131, 2022. Quezon City Council. Retrieved from https://quezoncity.gov.ph/wp-content/uploads/2022/07/SP-3131-S-2022.pdf

An Ordinance Granting All Tricycle Operators and Drivers Associations (TODAs) To Operate Person with Disability (PWD) Friendly Motorized Tricycle-For-Hire Within Their Designated Zone/Route, Authorizing Their Specified Route Measured Capacities (RMC) And Granting Franchises To Their Respective Petitioners, And For Other Purposes (2020). Ordinance No. SP-3001, S-2020. Quezon City Council. Retrieved from http://libros.quezoncitypubliclibrary.org:8080/jspui/bitstream/123456789/41892/1/Ordinance%20No.%20SP-3001%2C%20S-2020.pdf

Batas Pambansa Bilang 344 (2013). Accessibility law and its implementing rules and regulations amendments. https://www.dpwh.gov.ph/dpwh/references/laws_codes_orders/bpb344

Bueno (2020, December). The modernization plan is changing jeepney drivers' lives forever. CNN Life Philippines. Retrieved from https://www.cnnphilippines.com/life/culture/transportation/2020/12/11/jeepney-modernization-deadline.html

Cahigas, M. M., Prasetyo, Y. T., Persada, S. F., Ong, A. K. S., & Nadlifatin, R. (2022, May). Understanding the perceived behavior of public utility bus passengers during the era of COVID-19 pandemic in the Philippines: Application of social exchange theory and theory of planned behavior. *Research in Transportation Business &Amp; Management*, 100840. https://doi.org/10.1016/j.rtbm.2022.100840

Chuenyindee, T., Ong, A., Ramos, J. P., Prasetyo, Y. T., Nadlifatin, R., Kurata, Y. B., & Sittiwatethanasiri, T. (2022). Public utility vehicle service quality and customer satisfaction in the Philippines during the COVID-19 pandemic. *Utilities policy*, 75, 101336. https://doi.org/10.1016/j.jup.2022.101336

CNN Philippines Staff (March 2023). Dry run for motorcycle lanes along Commonwealth Avenue starts March 9. CNN Philippines. Retrieved from https://www.cnnphilippines.com/news/2023/3/8/MMDA-motorcycle-lanes-dry-run-Commonwealth.html

Currie, G., Richardson, T., Smyth, P., Vella-Brodrick, D., Hine, J., Lucas, K., Stanley, J., Morris, J., Kinnear, R., & Stanley, J. (2010). Investigating links between transport

disadvantage, social exclusion and well-being in Melbourne – Updated results. *Research in Transportation Economics*, 29(1), 287–295. https://doi.org/10.1016/j.retrec.2010.07.036

Dela Cruz (2022, September). *D*OTr continues to lobby for PUV modernization budget in 2023. Philippine News Agency. Retrieved from https://www.pna.gov.ph/articles/1184888

Dorado, N., Fabros, P., Rupisan, C. (2015). An ergonomic analysis of tricycle sidecars in Quezon City. *Elsevier B.V.* doi: 10.1016/j.promfg.2015.07.757

Expanded Senior Citizens Act of 2010. Republic Act 9994 (2010). https://www.officialgazette.gov.ph/2010/02/15/republic-act-no-9994/

Fernandez, D. (February 2022). Full seating capacity in public transport OK'd under Alert Level 1; barriers no longer required. Inquirer.net. Retrieved from https://newsinfo.inquirer.net/1560732/iatf-oks-full-seating-capacity-in-public-transport-under-alert-level-1-plastic-barriers-no-longer-required

Fransen, K., Deruyter, G., & De Maeyer, P. (2016). *Concepts, reflections and applications of social equity: approaches to accessibility to primary goods and services in the region of Flanders, Belgium.* In L. Boelens, D. Lauwers, & F. Witlox (Eds.), Adaptive mobility : a new policy and research agenda on mobility in horizontal metropolises (pp. 17–44). Groningen: InPlanning. https://doi.org/10.13140/RG.2.1.2896.9049

Gefen, D., Straub, D., & Boudreau, M. C. (2000). *Structural equation modeling and regression: Guidelines for research practice*. Communications of the association for information systems, 4(1), 7.

Gharaibeh, A., Tawil, H., Alomari, A. (2021). Developing an indicative spatial accessibility analysis tool for urban public transportation system, *Case Studies on Transport Policy*, Volume 10, Issue 1, Pages 175-186. https://doi.org/10.1016/j.cstp.2021.11.015

Gumasing, M. J. J., & Dela Cruz, C. H. C. (2018). Ergonomic Design of Public Bus in The Philippines with Provision for Senior Citizens and Persons with Disability. *MATEC Web of Conferences*, 150, 05006. https://doi.org/10.1051/matecconf/201815005006

Gumasing, M. J. J., Zerrudo, M. O. V., & German, J. D. (2019). An Ergonomic Design of Light Rail Transit (LRT) in the Philippines for Persons with Special Needs. *IEOM Society International*, 810–818. http://www.ieomsociety.org/ieom2019/papers/236.pdf

Habib, M., Anik, M. (2021). Impacts of COVID-19 on Transport Modes and Mobility Behavior: Analysis of Public Discourse in Twitter, Transportation Research Record: *Journal of the Transportation Research Board*. https://doi.org/10.1177/0361198121102992

Hair Jr, J. F., Babin, B. J., & Anderson, R. E. (2010). A global perspective. Kennesaw: Kennesaw State University.

Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., Danks, N.P., Ray, S. (2021). *Evaluation of Reflective Measurement Models. In: Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R. Classroom Companion: Business.* Springer, Cham. https://doi.org/10.1007/978-3-030-80519-7_4

High-Level Advisory Group on Sustainable Transport. (2016). Mobilizing Sustainable Transport for Development. In United Nations Department of Economic and Social Affairs. https://sdgs.un.org/publications/mobilizing-sustainable-transport-development-18045

Inter-Agency Task Force. (2022). Guidelines on the nationwide implementation of alert level system for COVID-19 response. Inter-Agency Task Force for the Management of Emerging Infectious Diseases. https://lto.gov.ph/latest-advisory/515-protocol-

guidelines-for-public-transport-operations.html
Ivers, L. (n.d.). *Social Inclusion.* The World Bank. Retrieved from https://www.worldbank.org/en/topic/social-inclusion#2
Japan International Cooperation Agency (2015). The Project for Capacity Development on Transportation Planning and Database Management in the Republic of the Philippines. MMUTIS Update and Capacity Enhancement Project (MUCEP), Project Completion Report. Retrieved from https://openjicareport.jica.go.jp/pdf/12247615.pdf
Japan International Cooperation Agency (2017). Follow-up Survey on Roadmap for Transport Infrastructure Development for Greater Capital Region (GCR). FINAL REPORT. Retrieved from https://openjicareport.jica.go.jp/pdf/1000041638_02.pdf
Kim, J., Schmöcker, J. D., Nakamura, T., Uno, N., & Iwamoto, T. (2020, August). Integrated impacts of public transport travel and travel satisfaction on quality of life of older people. *Transportation Research Part A: Policy and Practice*, 138, 15–27. https://doi.org/10.1016/j.tra.2020.04.019
Litman, T. (2022). Well Measured: Developing Indicators for Sustainable and Livable Transport Planning, Victoria Transport Policy Institute. Retrieved from https://www.vtpi.org/sus_tran_ind.pdf
Local Public Transport Route Plan Manual (2017, October). Department of Transportation. Volume 1 pp. 52-53. Retrieved from https://dilg.gov.ph/PDF_File/reports_resources/dilg-reports-resources-2017112_2cf0f97098.pdf
Land Transportation Office (2019). Annual Report. Retrieved from https://lto.gov.ph/transparency-seal/annual-reports.html
Land Transportation Office (2020). Annual Report. Retrieved from https://lto.gov.ph/transparency-seal/annual-reports.html
Land Transportation Office (2021). Annual Report. Retrieved from https://lto.gov.ph/transparency-seal/annual-reports.html
Land Transportation Office (2022). Annual Report. Retrieved from https://lto.gov.ph/transparency-seal/annual-reports.html
Litman, T. (2023, June 1). Cool Walkability Planning. Planetizen Blogs. https://www.planetizen.com/blogs/123657-cool-walkability-planning?utm_source=newswire&utm_medium=email&utm_campaign=news-06012023&mc_cid=0df2294cc9&mc_eid=9ccfe464b1&fbclid=IwAR1s7j-PZGEg_wdWQpbq8o83W6nYvIx94UDf-T1vGRyAhYBJPPv2XGxFNgQ
Manrique, J., Cordera, R., Moreno, E., Oreña, B. (2020). Equity analysis in access to Public Transport through a Land Use Transport Interaction Model. Application to Bucaramanga Metropolitan Area-Colombia, *Research in Transportation Business & Management*, Volume 42, 100561. https://doi.org/10.1016/j.rtbm.2020.100561
Maydeu-Olivares, A. (February 2017). Maximum Likelihood Estimation of Structural Equation Models for Continuous Data: Standard Errors and Goodness of Fit. *Structural Equation Modeling: A Multidisciplinary Journal*. Volume 24, 2017 - Issue 3. https://doi.org/10.1080/10705511.2016.1269606
Nacino, M. (2021). *Making Sustainable Mobility Sustainable.* United Nations Development Programme. Retrieved from https://www.undp.org/philippines/blog/making-sustainable-mobility-sustainable
National Economic and Development Authority (2017). *National Transport Policy and Its Implementing Rules and Regulations*. Retrieved from https://neda.gov.ph/wp-content/uploads/2020/02/NTP-IRR-Final.pdf
Okochi, J., Takahashi, T., Takamuku, K., Escorpizo, R. (2013). Staging of mobility,

transfer and walking functions of elderly persons based on the codes of the International Classification of Functioning, Disability and Health, *BMC Geriatrics*, Article 16. https://doi.org/10.1186/1471-2318-13-16

Pajarin, J. B., Soriano, C. M., & Regidor, J. R. (2018, January). Assessment of Mobility of Persons with Disabilities (PWDs) in Cainta, Rizal. *Philippine Transportation Journal*, 1(1), 60–81.

Park K., Yum, S., Park J., Lee, J., & Yang, H. (2017). Analysis on Stress Experienced by the Elderly in Using Public Transport based on Physiological Signals, *Journal of the Eastern Asia Society for Transportation Studies*, 2017, Volume 12, Pages 709-723. https://doi.org/10.11175/easts.12.709

Philippine National Standard (2017). *PNS 2126:2017*. Bureau of Philippine Standards (BPS). Retrieved from https://drive.google.com/file/d/140TlU2QbxOydlAjtkZttjZGdL3CQ2OJ8/view

Philippine News Agency. (2022, February). IATF approves amended guidelines for Alert Level 1. Retrieved from https://www.pna.gov.ph/articles/1168637

Philippine Statistics Authority (2017). Working Age Population. Retrieved from https://psa.gov.ph/content/working-age-population-1#:~:text=Definition%3A,not%20in%20the%20labor%20force.

Porter, G., & Turner, J. (2019). Meeting Young People's Mobility and Transport Needs: Review and Prospect. Sustainability, 11(22), 6193. *MDPI AG*. Retrieved from http://dx.doi.org/10.3390/su11226193

Remillard, E., Campbell, M., Koon, L., & Rogers, W. (2022). Transportation challenges for persons aging with mobility disability: Qualitative insights and policy implications, *Disability and Health Journal*, Volume 15, Issue 1. https://doi.org/10.1016/j.dhjo.2021.101209

Ringle, Christian M., Wende, Sven, & Becker, Jan-Michael. (2024). *SmartPLS 4. Bönningstedt: SmartPLS*. Retrieved from https://www.smartpls.com/documentation/algorithms-and-techniques/cbsem

Rivas, R. (September 2019). Metro Manila 'most congested city' in developing Asia. Rappler. Retrieved from https://www.rappler.com/business/241119-metro-manila-most-congested-city-developing-asia/

Roquel, K., Aranguren, M., Candelaria, J., De Guzman, F., Sia, A. (n.d.). Impact of the COVID-19 Pandemic on the Operations of Transportation Network Vehicle Services (TNVS) in Metro Manila. Retrieved from http://ncts.upd.edu.ph/tssp/wp-content/uploads/2021/12/09-TSSP2021-Impact-of-COVID19-pandemic-to-TNVS-operations-in-NCR.pdf

Savalei, V. & Rosseel, Y. (October 2021). Computational Options for Standard Errors and Test Statistics with Incomplete Normal and Nonnormal Data in SEM. *Structural Equation Modeling: A Multidisciplinary Journal*. Volume 29, 2022 - Issue 2. https://doi.org/10.1080/10705511.2021.1877548

Senior Citizens Center Act of the Philippines. Republic Act 7876 (1995). https://www.officialgazette.gov.ph/1995/02/14/republic-act-no-7876/

Shaer, A., & Haghshenas, H. (2021, October). Evaluating the effects of the COVID-19 outbreak on the older adults' travel mode choices. *Transport Policy*, 112, 162–172. https://doi.org/10.1016/j.tranpol.2021.08.016

Tirachini, A. & Cats, O. (2020). COVID-19 and Public Transportation: Current Assessment, Prospects, and Research Needs, *Journal of Public Transportation*, Vol. 22 No. 1 [2020] pp. 1-21. https//doi.org/10.5038/2375-091.22.1.1

UITP (2020). Management of COVID-19: Guidelines for Public Transport Operators.

Factsheet. *International Association of Public Transport (UITP)*. Retrieved from https://www.uitp.org/management-covid-19-guidelines-public-transport-operators.

United Nations (2021). Sustainable transport, sustainable development. Interagency report for second Global Sustainable Transport Conference. Retrieved from https://sdgs.un.org/publications/interagency-report-second-global-sustainable-transport-conference

Villaraza, C. M., Mella-Lira, B., Fillone, A., Hickman, R., & Biona, J. B. M. (2018, January). Social Equity in Urban Transport: The Case of Metro Manila, Philippines. *Philippine Transportation Journal*, 1(1), 37–60.

Wilbur, M., Ayman, A., Ouyang, A., Poon, V., Kabir, R., Vadali, A., Pugliese, P., Freudberg, D., Laszka, A., Dubey, A. (2020). Impact of COVID-19 on Public Transit Accessibility and Ridership. Retrieved from https://www.researchgate.net/publication/343498731_Impact_of_COVID-19_on_Public_Transit_Accessibility_and_Ridership

Zhao, Q., Qi, Y., & M.Wali, M. (2022). A method for assessing the COVID-19 infection risk of riding public transit. *International Journal of Transportation Science and Technology*. https://doi.org/10.1016/j.ijtst.2022.07.001