Applying AHP on the Sustainable Urban Transport Index Indicator 4 to Assess the Quality and Reliability of Public Utility Jeepneys and Buses in Metro Manila

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Abstract: Urban transport sustainability is measured through the newly emerged sustainable urban transport index (SUTI) constructed by UNESCAP. Using the 4th indicator of the developed index, the assessment of quality and reliability of public utility jeepneys and buses within Metro Manila is conducted to determine which attributes affect passenger travel satisfaction and to showcase the differences in attribute ranking and rating between the modes of public utility jeepneys and buses. Analytic Hierarchy Process (AHP) is applied to see the ranking of attributes through pairwise comparison. The questionnaire was posted on Facebook and gathered a total of 85 respondents for public utility jeepneys and 38 respondents for public utility buses. Students and employed individuals mostly represent the respondents, and the most common trip purpose is for leisure or recreational activities. The top three ranking of attributes based on commuter perception are service reliability, safety, and comfort – respectively. Furthermore, the score of the SUTI Indicator 4 for both modes is only slightly above the satisfied scale, and the overall satisfaction rating for both modes is above neutral.

Keywords: Public Transportation, Sustainable Urban Transport Index, Analytic Hierarchy Process, Quality, Reliability

1. INTRODUCTION

1.1 Background of the Study

1.1.1 Public Transportation for Sustainable Development

The United Nations (UN) Sustainable Development Goal (SDG) 11.2 aims to provide inclusive transport systems. As stated, "By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons." Sustainable transport encompasses much more than regular, convenient, and faster services of public transportation modes, as well as less traffic congestion. Even though developments in sustainable transportation are being implemented worldwide, half of the world's urban population still has very limited access to convenient public transportation. The Philippines has been known for resorting to paratransit systems, such as the public utility jeepneys, which can be seen in all cities throughout the country; in addition, these public utility jeepneys are said to be lacking consistency and safety features (Mead, 2021). To achieve SDG 11.2, the UN Economic and Social Commission for Asia and the Pacific (UNESCAP) has constructed the Sustainable Urban Transport Index that would help measure the progress of urban transport improvement (Gudmundsson and Regmi, 2017).

1.1.2 Metro Manila as the Study Context

Metro Manila is experiencing a mass transportation crisis, yet the government has refused to acknowledge it as such. Their proposed solutions are misaligned with the needs of the capital and its constituents. Presidential spokesman Salvador Panelo has claimed that there is no transportation crisis since people are still able to get a ride (*Manila Transport Crisis: Commuters Outraged by 'Leave Earlier' Advice*, 2019). This problem must extend toward the idea that what is being mobilized are people and goods, as opposed to vehicles themselves (Cruz, 2019).

Pre-pandemic, Metro Manila was named the "worst city to drive in" *(Philippines: Manila Voted Worst City to Drive on Earth*, 2015) and the "most congested city" (Rivas, 2019). During the pandemic, the commuter experience has worsened due to restrictions and less available vehicles which would lead to longer waiting times (Piojo, 2021). Several calls for a better transportation system for commuters have been made, but a lack of commuter-based data hinders these projects from getting started. The worsening traffic congestion in the country has been causing more Filipino commuters to speak up about this issue. Sustainable mobility programs are being drafted by non-profit organizations. Despite this, the country still lacks policies that will support and drive the programs. Diagnosing the satisfaction level of commuters with service quality is a crucial step in creating strategies that encourage the use of public transportation (Vicente et al., 2020), such as Public Utility Jeepneys and Buses which are common modes of public transportation in Metro Manila.

With the increasing urbanization of Metro Manila, the need for mass transportation options is fundamental. Table 1 shows the trip composition by mode based on a JICA study. Despite the operation of these two modes in greater part of Metro Manila, the traffic problem and corresponding mass transportation problem continues to exist (Asian Development Bank, 2012). This study aims to determine the most important attribute of public utility jeepneys and buses using AHP, which affects passenger travel satisfaction, and to showcase the differences between public utility jeepneys and buses in terms of SUTI Indicator 4 and to suggest corresponding improvements for these modes.

1.2 Significance of the Study

Through the Analytic Hierarchy Process (AHP) comparison, the study is conducted to assess the quality and reliability of public utility jeepneys and buses in Metro Manila using the attributes listed in SUTI indicator 4. The researchers aim to gather data that will pinpoint aspects of public transportation that need to be improved for the betterment of commuter experience.

Table 1. Trip Composition by Public Transportation Mode (JICA, 2014)

Mode	No. of Trips	% of Public
Public Mode	17337	100
Train	1485	8.6
Bus	2352	13.6
Jeepney	6763	39
Tricycle	5687	32.8
UV/HOV	261	1.5
Pedicab	631	3.6
Others	156	0.9

1.3 Scope and Limitations

The SUTI has not been conducted in the Philippines based on UNESCAP records, so the researchers used this opportunity to conduct the study in Metro Manila. Only SUTI indicator 4 is to be analyzed in the research, given that the addition of the other indicators would excessively broaden the research. The specific scope of our research is based on consumer obtained information which, out of the ten SUTI indicators, is only applicable to indicator 4.

The study area is within Metro Manila and its adjacent provinces, and the target survey respondents are commuters who have had trips within the given study area and have been commuting since February 2022. To ensure the validity of the respondents, their origin and destination must be located within the given study area and will be asked for in the survey in the "City" format.

1.4 Study Flow

The attributes mentioned in SUTI indicator 4 were modified so that it would be more appropriate in the setting of Philippine public utility jeepneys and buses. The format of the Analytic Hierarchy Process (AHP) was adopted in the questionnaire to incorporate the pairwise comparison of the attributes. The questionnaire was then published on social media sites, with most respondents coming from Facebook transportation groups. The assessment will result in a score that shows the commuters' perception on public transportation. The results of the study will determine which attribute is considered the most important by commuters through the AHP. Furthermore, it will also provide a score on the quality and reliability of public utility jeepneys and buses within Metro Manila. See Figure 1 below for the flow of the study.

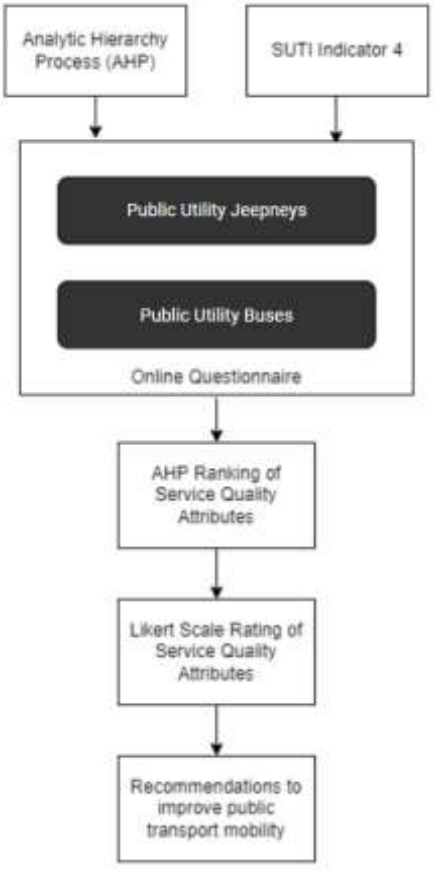

Figure 1. Flow of the Study

2. LITERATURE REVIEW

2.1 Commuter Travel Satisfaction

Commuters' overall travel satisfaction is seen as one of the most important factors in assessing public transport service quality (Sukhov et al., 2021; Vicente et al., 2020). Satisfaction is defined as the result of holistic and cumulative assessment of both intrinsic and extrinsic service aspects (Yuda Bakti et al., 2020). Two main attributes that directly affect user satisfaction have been narrowed down to, namely, perceived attributes and physical attributes. Perceived attributes are described as those which are perceived subjectively by commuters, while physical attributes are those with definite values independent from commuter interaction (Sukhov et al., 2021).

As a result, multiple assessment models have been established to weigh how the combinations of the service quality attributes affect overall travel satisfaction of the public (Sukhov et al., 2021; Zhang et al., 2020). A few studies have been conducted to determine the most important factors which contribute to commuter satisfaction. One study conducted by [Vicente et al., 2020] uses the following eight criteria to judge the overall quality of public transport and are as follows: (i) availability, (ii) accessibility, (iii) information, (iv) time, (v) customer care, (vi) comfort, (vii) security, and (viii) environmental impact. This research concludes that safety is inherent in travel satisfaction; and that overall travel satisfaction is not associated with one defining attribute but is instead generated from a complex configuration of service quality attributes.

Another study conducted in Weinan, China by [Li et al., 2020] determined that the factors affecting passenger satisfaction are the following: (i) age, (ii) daily average waiting time, (iii) perceived waiting time, (iv) transfer convenience, (v) driver attitude, (vi) intelligent travel info service, (vii) hygiene in bus, (viii) fare level, (ix) bus route setting, and (x) bus stop setting with the most exciting factors, otherwise known as factors which contribute the most either positively or negatively to commuter satisfaction, being factors (iii), (iv), (vi), (viii), (ix), and (x).

A study by [van Oort, N., 2011] provides the aspects of (i) price, (ii) accessibility, (iii) travel time, (iv) comfort, (v) image, and (vi) service reliability with the primary focus of his paper being service reliability and how it may be improved upon in the context of urban public transport design.

In addition, several more local studies have been made to determine the most significant factors which affect commuter satisfaction. In a study by [Chuenyindee et al., 2022] conducted during the COVID-19 pandemic, the most important factor which contributed to passenger satisfaction are the strict COVID-19 protocols that are being observed by the PUVs.

A case study conducted in Metro Manila, Philippines showcases the influence of mental adaptation in the analysis of a consumer's perception of the quality and reliability of a public transport system. The quality of the public transport system is measured with the following factors: (i) waiting time, (ii) in-vehicle travel time, (iii) fare, (iv) air quality, (v) risk perception, and (vi) adaptation, with the commuter perception of these factors being affected by one's mental adaptation, to a certain degree (Mijares et al., 2016).

Another case study in Metro Manila, Philippines uses exploratory factor analysis and structural equation modelling to analyze 7 different factors to determine whether they significantly contribute to commuters' perception on public transport service quality. The 7 factors are as follows: (1) vehicle condition, (2) reliability, (3) information, (4) convenience, (5) availability, (6) customer care, and (7) stop's condition, with the first 5 attributes having significant contributions to service quality perception while the latter 2 otherwise (Tiglao et al., 2020).

2.1.1 Analytic Hierarchy Process

In addition, further studies conducted used the Analytic Hierarchy Process (AHP) in order to determine the hierarchy and rating of service quality factors. One such study in Ningbo, China used a combination of the analytic hierarchy process (AHP), entropy weight method (EWM), and fuzzy comprehensive evaluation (FCE) method to improve the accuracy and objectivity of passenger satisfaction evaluation for conventional bus and rail transit. The results showed that, specifically for bus transit, comfort was ranked lowest and passenger waiting time was ranked second lowest (Zhang et al., 2020).

Another study, conducted in Cebu, Philippines uses the Analytic Hierarchy Process to rank five factors in order of importance which are determined to have a significant relationship with the public transport system. The five factors are as follows: (i) availability, (ii) comfort, (iii) cost, (iv) safety, and (v) concern for the environment with the ranking from most important to least important factor being safety, availability, cost, comfort, and concern for the environment (Mayo and Taboada, 2020). Table 2 shows the list of all relevant related literature used in this section.

The next section will discuss the Sustainable Urban Transport Index and will incorporate certain aspects of commuter travel satisfaction to produce the design variables to be used in this study.

2.2 Sustainable Urban Transport Index (SUTI)

The Sustainable Urban Transport Index (SUTI) is a guideline prepared by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). It is a quantitative tool used to identify applicable policies and strategies for mobility improvement with the goal of summarizing, tracking, and comparing the performances of Asian cities in terms of urban transport sustainability and in pursuit of the fulfillment of specific Sustainable Development Goals (SDGs) (Gudmundsson and Regmi, 2017).

Table 2. Related Research on Commuter Travel Satisfaction

AUTHOR/S	ARTICLE TITLE	ATTRIBUTES	ASSESSMENT MODEL
Chuenyindee, T., Ong, A., Ramos, J., Prasetyo, Y., Nadlifatin, R., Kurata Y. B., Sittiwatethanasiri, T. (2022).	Public utility vehicle service quality and customer satisfaction in the Philippines during the COVID-19 pandemic	Tangibility; Responsiveness; Reliability; Assurance; Empathy; Service Quality; COVID-19 Protocols	SERVQUAL
Li, X., Fan, J., Wu, Y., Chen, J., & Deng, X. (2020).	Exploring Influencing Factors of Passenger Satisfaction toward Bus Transit in Small-Medium City in China.	Age; Daily average waiting time; Perceived waiting time; Transfer convenience; Driver attitude; Intelligent travel info service; Hygiene; Fare level; Bus route setting; Bus stop setting	Multi-objective optimization by a ratio analysis plus full multiplicative form method (MULTIMOORA)
Mayo, F. L., Taboada, E. B. (2020).	Ranking factors affecting public transport mode choice of commuters in an urban city of a developing country using analytic hierarchy process: The case of Metro Cebu, Philippines	Availability; Comfort; Cost; Safety; Concern for environment; Mode of transportation	Analytic hierarchy process (AHP)
Mijares, A. C., Suzuki, M., & Yai, T. (2016).	Passenger Satisfaction and Mental Adaptation under Adverse Conditions: Case Study in Manila	Fare; Travel time; Waiting time; Consistency; Air quality; Risk; Mental adaptation	N/A
Van Oort, N. (2011).	Service Reliability and Urban Public Transport Design	Price; Accessibility; Travel Time; Comfort; Image; Service Reliability	N/A
Vicente, P., Suleman, A., & Reis, E. (2020).	Index of Satisfaction with Public Transport: A Fuzzy Clustering Approach	Availability; Accessibility; Information; Time; Customer care; Comfort; Security; Environmental impact	Fuzzy clustering approach
Zhang, X., Liu, H., Xu, M., Mao, C., Shi, J., Meng., G, et al. (2020).	Evaluation of passenger satisfaction of urban multi-mode public transport	Waiting time; Transfer convenience; Service; Information; Passenger comfort; Station environment; Interior sanitation	Analytic hierarchy process (AHP), entropy weight method (EWM), fuzzy comprehensive evaluation (FCE)

There are 10 indicators involving the transport system, as well as social, economic, and environmental aspects which reflect the current state of urban transport performance in a city. It also covers planning, access, safety, quality and reliability, affordability, and emissions. The UNESCAP Committee on Transport recognizes its significance and recommends its use for assessment and improvement of urban policies. These 10 indicators may be found in the Appendix under Table 7.

Among these 10 indicators, SUTI Indicator 4 measures public transport quality and reliability which corresponds to SDG 11.2–Access to safe, affordable, accessible, and sustainable transport systems for all (Gudmundsson and Regmi, 2017). This study will focus on SUTI Indicator 4 to measure commuters' perception on public transportation in the context of Metro Manila. The SUTI guidelines outline the use of the following 8 variables to measure public transport quality and reliability, namely–(i) frequency of service, (ii) punctuality, (iii) comfort and cleanliness of vehicle, (iv) safety. (v) convenience of stops and stations, (vi) availability of information, (vii) personnel courtesy, and (viii) fare level.

3. RESEARCH METHODOLOGY

Using Metro Manila as the context of this study, an online questionnaire was developed to determine commuters' perception on public transport service quality. The study uses quantitative research methodology based on the SUTI Indicator 4. UNESCAP recommends the

reconstruction of attributes that would be appropriate to the location of study, simplifying the original 8 attributes of SUTI Indicator 4 to 6 attributes (see Table 3 below). Two of the original attributes, namely "Frequency of Service" and "Punctuality," are condensed into a single attribute under "Service Reliability"; while the attribute of "Personnel Courtesy" has been completely removed following the study of Tiglao, N. C., et al. (2020), which concludes that a similarly defined attribute known as "Customer Care" does not provide strong basis for its contribution towards commuter perception of public transport service quality. By reducing the number of attributes from 8 to 6, this subsequently reduces the number of pairwise comparisons by nearly half, which is helpful in reducing the respondents' fatigue when accomplishing the survey.

To evaluate the data, the Analytic Hierarchy Process (AHP) is used to rank the given service quality factors. Their corresponding weights are then used in conjunction with a collection of statements taken from the SUTI Data Collection Guideline to produce a quantitative measure of public transport service quality which may be used as a starting point to begin development on specific aspects of the public transport system. The following sections will discuss specific details of our methodology which includes the data collection and participants, questionnaire design, and the AHP.

3.1 Data collection and sample respondents

The data collection conducted by the researchers started from February up until May of 2022. The survey received answers from respondents who regularly commute within Metro Manila and its adjacent provinces using public utility jeepneys (PUJs) and public utility buses (PUBs). Further, respondents were asked to choose a more specific mode of PUBs and PUJs – Traditional Public Utility Jeepney, Modernized Jeepney, Public Utility Bus (with aircon), and Public Utility Bus (EDSA Carousel) – where photos were attached for ease and accuracy of choosing. The survey was constructed through Google forms for simplicity and was distributed only through online social media platforms, mainly on Facebook groups for commuters and groups which advocate for sustainable public transportation.

3.2 Questionnaire Design

To make the survey more accessible to potential survey respondents, the 6 attributes indicated above have been simplified by integrating the travel satisfaction aspects discussed in the previous section as well as considering the geographical and cultural context of the study. The respondents can choose the language of the online survey using a different online link. It was available in English and *Taglish* (a combination of English and Tagalog).

The survey is divided into three main parts, mostly containing close-ended questions. The first part of the survey aims to obtain information about the survey respondent. The first page is a consent form that shows the purpose of the survey, procedure, and confidentiality of the study. Since the survey will be conducted online, the respondents will be asked if they agree to provide their answers and participate in the study. The second section aims to obtain the respondent's travel information which includes the types of PUJs and PUBs that the respondent uses and asks questions used to filter out respondents who have not commuted during the given study period and to remove other responses that are outside the scope of the research. The proceeding sections aims to obtain the respondent's personal information–such as the respondent's age and city of residence; socioeconomic characteristics–such as their average monthly income and occupation; and travel behavior–such as their frequency of public transport use, most frequent trip purpose, and origin and destination of this trip.

The second and third parts of the survey ask questions that will allow the researchers to make comparative analyses between modes. The second part aims to obtain the respondent's hierarchical ranking of public transport service quality attributes through the AHP and does this through a pairwise comparison between attributes. The third part aims to obtain the respondent's rating of the service quality attributes through their level of agreement to statements corresponding to specific attributes. This is done through a Likert scale to rate each of the statements presented–typically ranging from 1 to 7, but the guidelines permit the usage of a 5-point scale for simplicity with 1 being the lowest rating and 5 being the highest.

Table 3. Public Transport Service Quality Attributes

Attributes	Description
Service Reliability	Having a reasonable waiting and travel time
Comfort	A pleasant or satisfying atmosphere inside the vehicle
Safety	The feeling of safety while riding the vehicle
Availability of information	Easily accessible travel information such as location of stations, route of vehicles, and payment methods
Convenience of stops and stations	The ease of going to stations
Fare level	The amount paid per public transport service

3.3 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is used to determine the ranking of the six public transport attributes by performing a total of fifteen pairwise comparisons between these attributes. These six public transport attributes are derived from the review of related literature in the previous section in conjunction with the SUTI Data Collection Guideline and can be found in Table 3 alongside a brief definition of each. The AHP produces a hierarchy of importance of these attributes alongside a percentage distribution of the relative weights of the said attributes.

To perform the AHP calculations, this study uses the AHP online software tool (AHP-OS) designed by the Klaus D. Goepel (Goepel, K., 2018). This tool is in the form of a Microsoft Excel worksheet in which the data from the survey will be tabulated on. Figure 3 shows the data input section of the tool and is used to perform a pairwise comparison between every two attributes, selecting A or B depending on which between the two is more important and selecting a number depending on the magnitude of importance. These magnitudes of importance and their corresponding numerical equivalent are as follows: **1** – Both attributes are equally important, **3** – One attribute is more important over the other, **5 –** One attribute is much more important over the other, with magnitudes **2** and **4** corresponding to intermediary values.

For example, using the comparison of Service Reliability and Fare Level in Figure 3, it can be seen from the data input that Service Reliability is more important than Fare Level with a magnitude of importance of 3.

The next step performed by the AHP-OS would be to determine the relative weight distribution of the six attributes. This is done by first converting the input data into the pairwise comparison matrix as shown in Figure 4, with the letters from A to F representing one of the six attributes, and each pairwise comparison matrix corresponds to one respondent. The tool performs the computation and produces the relative weights of each attribute as shown in Figure 4.

	Criteria		more important ?	Scale
i	A	B	A or B	(1-5)
1	Service Reliability	Comfort	A	1
1		Safety	A	1
1		Availability of	A	5
1		Convenience	A	2
1		Fare Level	A	3
2	Comfort	Safety	A	1
2		Availability of	A	3
2		Convenience	A	4
2		Fare Level	A	1
3	Safety	Availability of	A	5
3		Convenience	A	4
3		Fare Level	A	5
4	Availability of Information	Convenience	B	2
4		Fare Level	A	1
5	Convenience	Fare Level	A	1

Figure 2. Analytic Hierarchy Process Input Data

	A	B	C	D	E	F	
A	1	1	1	5	2	3	24.03%
B	1	1	1	3	4	1	21.88%
C	1	1	1	5	4	5	29.81%
D	0.20	0.33	0.20	1	0.50	1	6.01%
E	0.50	0.25	0.25	2	1	1	8.74%
F	0.33	1	0.20	1	1	1	9.52%

Figure 3. Pairwise Comparison Matrix and Relative Attribute Weights

This process is repeated for every respondent to produce their corresponding relative attribute weights. The overall relative attribute weights for the AHP are then computed by taking the average weight of each attribute from the entire sample.

After computing for the relative attribute weights, the next step of the analysis would be to determine the satisfaction rating of the given public transportation modes based on SUTI Indicator 4.

For attributes with more than one statement describing it, such as "Availability of information" which has three (3), its final rating will be the average score from all its associated statements.

Once this has been accomplished for all individual commuter surveys, the average rating for each attribute, as well as the overall commuter satisfaction rating, are determined. The average rating per attribute is simply the average rating across all respondents, while the overall average rating per transportation mode is determined by taking the weighted average of the ratings per attribute, considering the relative attribute weights. This process is done twice–one for each transportation mode. The Welch's T-test is used to determine whether there is a significant difference between samples of the two modes–considering the mean of each of the six public transport service quality attributes.

The decision-making process of commuters based on the results will be scrutinized to find out what are the crucial factors and their relationships among the other variables.

4. RESULTS AND DISCUSSION

4.1 Respondents

The targeted survey respondents for this study are commuters who have ridden either PUJs or PUBs since February 2022. Since the online survey was posted on Facebook, the researchers posted on multiple groups that are closed and require administration approval for posting; the survey was also shared to the Transportation Science Society of the Philippines and UP National Center for Transportation Studies. Listed in Table 4 below are the following Facebook groups where the questionnaire was posted.

Table 4. List of Facebook Groups and Pages for Commuters within Metro Manila

Group Name	URL
Commuters of the Philippines	https://www.facebook.com/groups/commutersph
COMMUTERS @ BYAHEROES GROUP™	https://www.facebook.com/groups/commutersatbyaheroes
The Manila Commuter FB Group	https://www.facebook.com/groups/684537535001432/
Transportation Science Society of the Philippines	https://www.facebook.com/Transportation-Science-Society-of-the-Philippines-TSSP-558897707617935

A total of 123 survey responses were recorded. Given that our total survey responses did not meet the recommended sample size of 250 to 300 respondents set by the SUTI Data Collection Guidelines, this study will simply be a case study of the perception of the obtained sample and will not be generalized for the entire population. The breakdown of the respondents' specific PUJ and PUB modes is shown in Table 5 with Traditional PUJs and Modernized jeepneys considered under the PUJ category, while PUBs with aircon and EDSA carousel buses considered under the PUB category. Given that there was only a single respondent for the mode public utility bus without aircon, this mode will not be considered for analysis. As a result, the number of valid respondents for the analysis of PUJs is 85, while the number of valid respondents for PUBs is 38.

Table 5. Number of Respondents per Specific Transportation Mode

Specific Mode	No. of Respondents
Traditional Public Utility Jeepney	70
Modernized Jeepney	15
Public Utility Bus (with aircon)	24
Public Utility Bus (EDSA Carousel)	14

Respondents' personal information such as age, city of residence, average personal monthly income, and occupation are gathered. This research is a specific case study context, and not generalizable to the entire Metro Manila population, since the respondents for both PUJs and PUBs are dominated by the age range of 18 to 24 years old as seen in Figure 5 below; students and employed individuals make up most of the respondents as shown in Figure 6

because the survey was posted online, in which a lot of the youth use frequently. These respondents have a personal average monthly income range of below PhP 5,000 and between PhP 10,000 to PhP 49,999. See Figure 7 below for a detailed breakdown of the average personal monthly income.

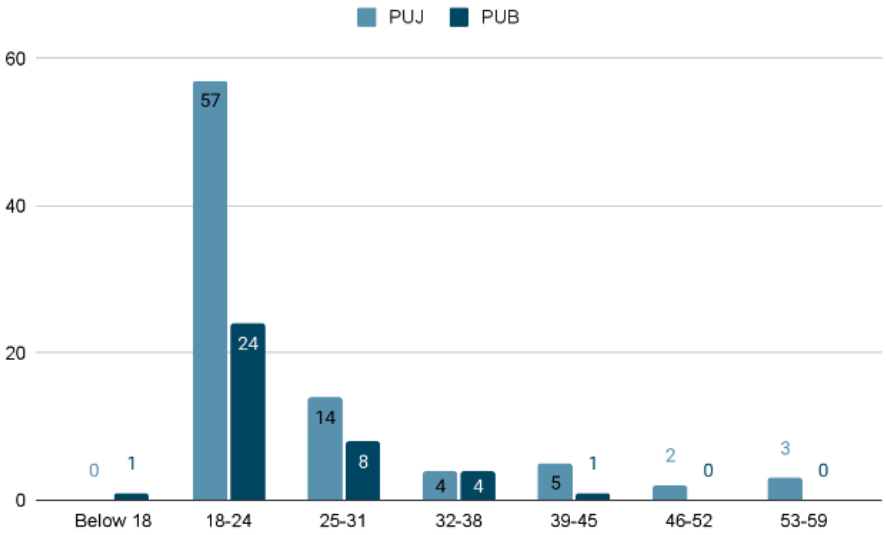

Figure 4. Age of Respondents

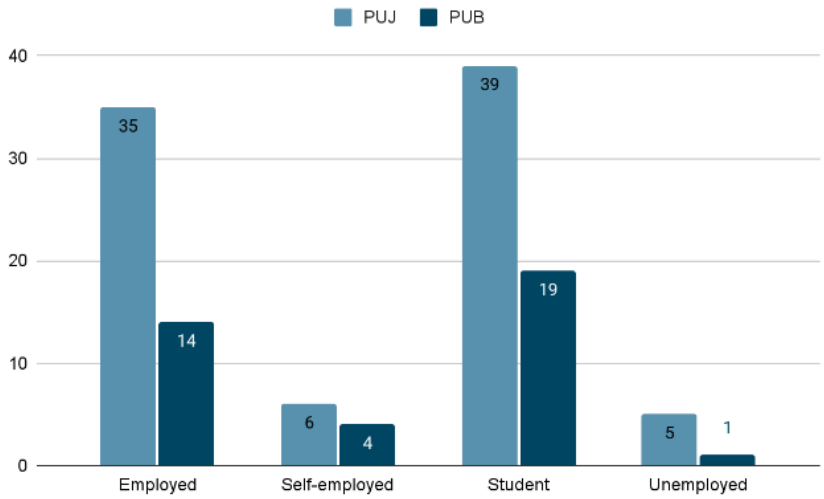

Figure 5. Occupation of Respondents

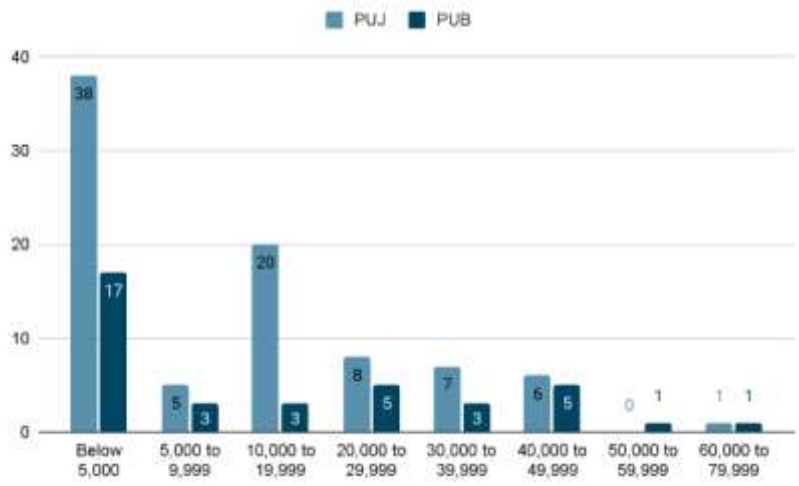

Figure 6. Average Personal Monthly Income of Respondents

4.2 Travel Frequency and Trip Purpose

The travel frequency of respondents ranged from once a month up to 7 days a week. Respondents have been commuting using PUJs at a frequency of once every 2 weeks up to 3 to 6 times a week. The most common travel frequency for PUBs are the ranges of once a month and 3 to 6 times a week. This breakdown can be seen in Figure 8.

Metro Manila has been on Alert Level 2 since February 2022, restaurants, malls, and parks have been operational taking in 70% of customers under their capacity. In addition, face-to-face classes for students are still temporarily suspended considering the lack of regulations from educational institutions, resulting in a rather low percentage of trips for educational purposes. Thus, the most frequent trip purposes of the respondents are for recreational and work purposes, with the former having the greatest number of respondents. Other trip purposes involve doing errands, visiting government offices and hospitals, and going to religious gatherings. It is to be noted that this study does not analyze the attributes per trip purpose, and further studies would be necessary in order to determine specific trip characteristics, service quality rankings and ratings per individual trip purpose. Figure 9 shows the breakdown of the trip purposes.

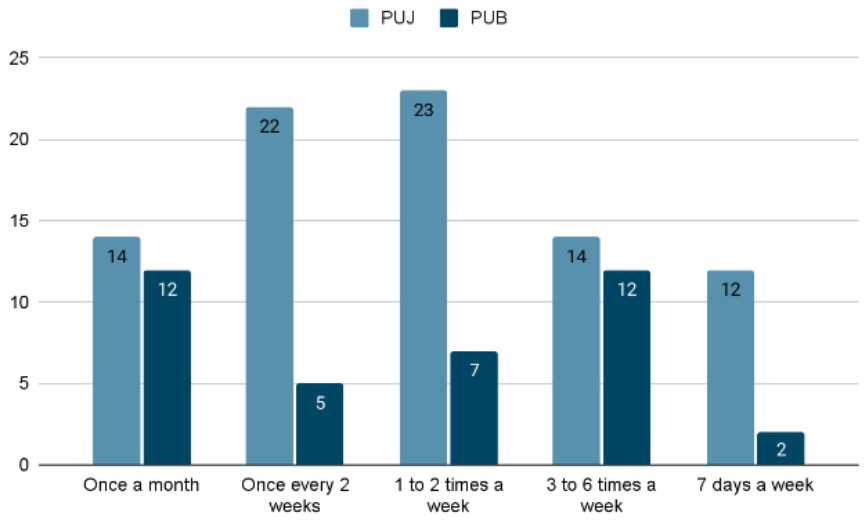

Figure 7: Travel Frequency of Respondents

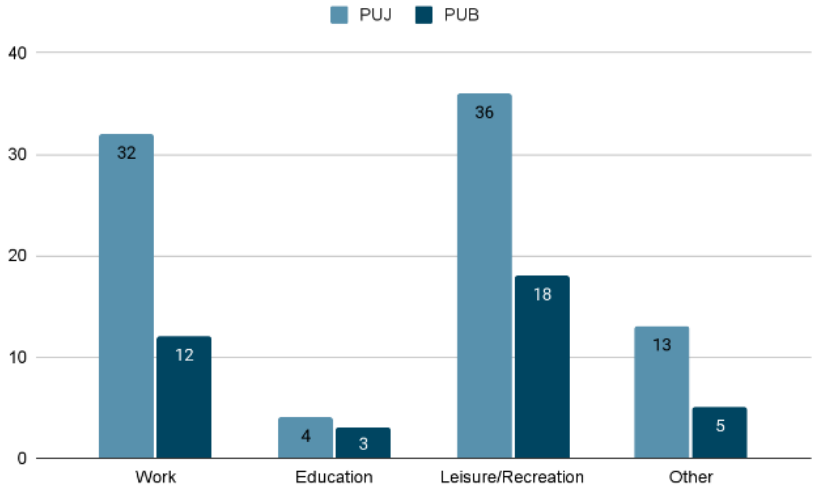

Figure 8. Trip Purpose of Respondents

4.3 AHP Analysis of Attribute Ranking

Using the software AHP-OS, the ranking of attributes for PUJs and PUBs is obtained. The compilation of the attributes and their corresponding relative weights per mode can be found in Figure 10.

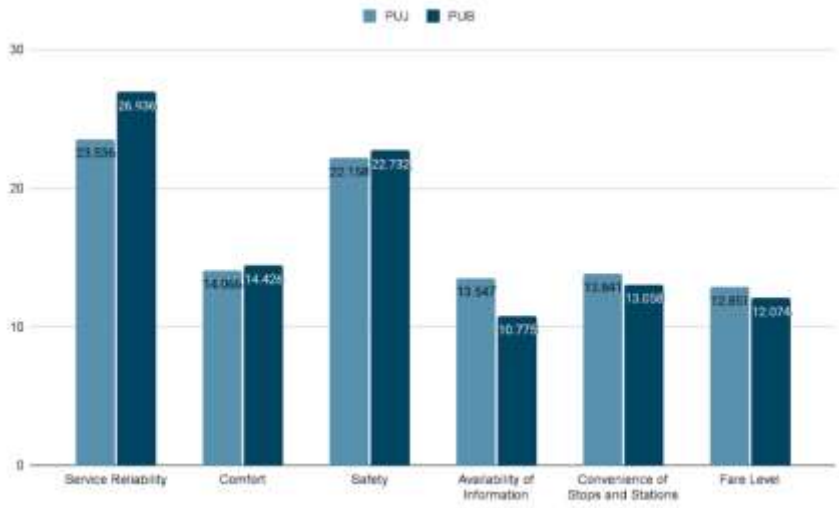

Figure 9. Ranking of Attributes Based on AHP

The ranking of the attributes from the first to the fourth most important is similar for both public utility jeepneys and buses. Service reliability is ranked first and is considered the most important attribute by the respondents. In China, there exists a dissatisfaction by passengers towards the punctuality of the first and last shift of their conventional bus transits. It was said that the problem lies in the setup of the waiting environment and the bus station (Zhang et al., 2020). However, there is no specified set of schedules for arrival and departure for both public utility jeepneys and buses in Metro Manila; thus, commuters almost always rely on their subjective perception of the waiting and travel times. In contrast, bus systems of other Asian countries have fixed and strict schedules for buses. Metro Manila traffic is the third worst in Southeast Asia because commuters spend an average of sixty-six (66) minutes stuck in traffic. Senate Bill No. 775 or *The Dignity in Commuting Act* deems the public transportation adequate if the waiting time at stops and terminals of the commuters does not exceed ten (10) minutes even during peak hours of commuting (Abraham and Paala, 2019).

Secondly, commuters' safety is seen as the second most important attribute for both public utility jeepneys and buses. Passengers consider possible road accidents caused by factors like the driver's driving behavior and dangerous actions from other commuters. Thirty-two percent (32%) of deaths are caused by road crashes. Drivers of such modes are known to exhibit unsafe driving practices because of the commission-based revenue system. Another facet of safety in public transportation in today's context is the risk of catching COVID-19. State anxiety negatively affects the perceived safety of passengers (Dong et al., 2021). As a result, passengers are practicing extra caution because they highly consider the risk of contracting COVID-19 from other commuters. In contrast to the study in Cebu by Mayo and Taboada (2020) which had "Safety" ranked first and "Availability of transportation" ranked third in importance, our sample exhibited a higher preference for "Service reliability" over "Safety."

Next, comfort while riding the vehicle is the third most important attribute based on the result. This means that passengers particularly value the overall atmosphere – temperature, cleanliness, seats, and degree of crowding – of the vehicle. A study in Serbia discussed that the younger generation (ages 18 to 26 years old) highly values the comfort of public transportation (Stojic et al., 2020).

The fourth most important attribute for both modes is the convenience of stops and stations. Public transportation service terminals are deemed adequate if they are within five hundred (500) meters from any residence or activity centers. Public utility jeepneys don't have a specified stop for most parts of Metro Manila. Typically, drivers of such modes gather

commuters from one specific point to then drop these passengers off at a place close to commercial buildings or in a commercial area. As a result, commuters don't feel restricted as it is their choice as to where they can be dropped off by the driver. However, there has been a more organized development in the stops and stations of airconditioned PUBs and EDSA carousels. Buses from the latter have stops and stations along EDSA highway, restricting them the freedom of simply dropping off passengers anywhere along the road–which was commonly the main reason for traffic congestion.

The fifth and sixth ranked attributes differ between public utility jeepneys and buses. The attributes ranked fifth and sixth for public utility jeepneys are availability of information and fare level, respectively. For this mode, availability of information is more important than fare level due to the large number of routes for jeepneys within Metro Manila. This could also be attributed to the fact that jeepneys have passengers in both major and minor roads with their destination commonly found on the jeepney's dashboard. In contrast, the fare level for jeepneys is ranked least important given their affordability to all kinds of passengers–which is also reflected in the results of this study with the fare level of PUJs being rated the highest. In contrast, the attributes ranked fifth and sixth for public utility jeepneys are fare level and availability of information, respectively. This could be attributed to the increase in fare level from PUJs to PUBs given the context of buses in this study to be airconditioned buses.

4.4 SUTI Indicator 4 Likert Rating

After collecting the survey responses, the satisfaction ratings per service quality attribute of both modes are shown as percentage distributions in Figures 11 and 12. For both modes, the attribute wherein most people are left satisfied by is the fare level, while the availability of information and convenience of stops and stations are the attributes with the highest percentage of dissatisfaction for PUJs and PUBs, respectively.

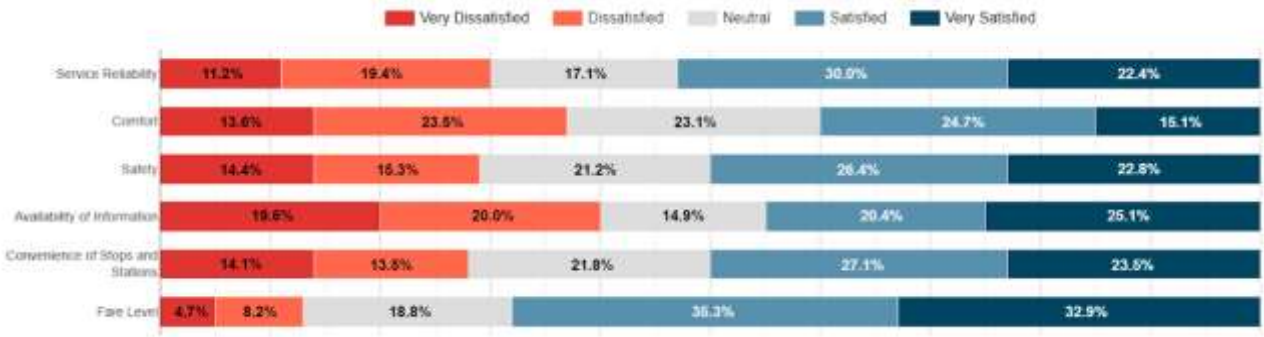

Figure 10. Likert Scale Rating for PUJs

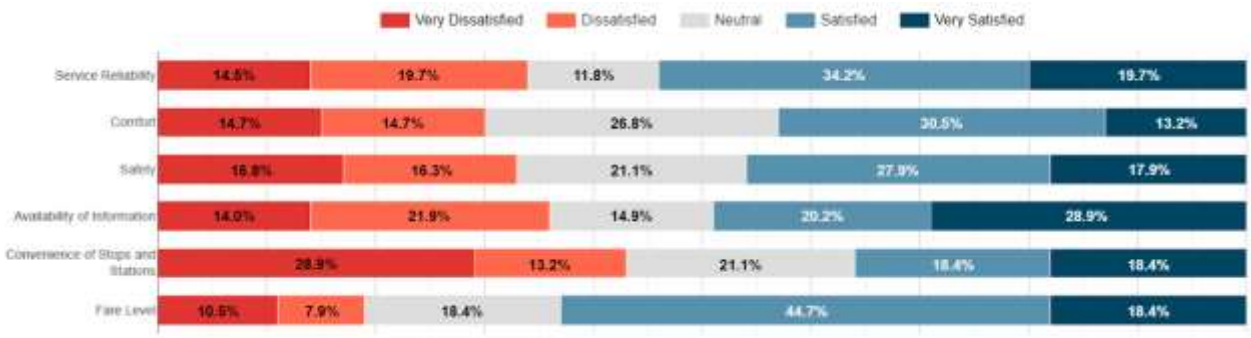

Figure 11. Likert Scale Rating for PUBs

In addition, the average rating per attribute for both modes can be found in Table 6. Out of these twelve attribute ratings, only the convenience of stops and stations for PUBs were found to be unsatisfactory; the rest of the attributes having ratings between three and four which indicate positive feedback–albeit being less than satisfactory.

Table 6. Service Quality Attribute Average Rating Per Mode

Attributes	PUJs	PUBs
Service Reliability	3.329	3.25
Comfort	3.04	3.126
Safety	3.28	3.137
Availability of Information	3.114	3.28
Convenience of Stops and Stations	3.324	2.842
Fare Level	3.835	3.526

In line with the results derived from Figure 10. **Likert Scale Rating for PUJ** and Figure 11. **Likert Scale Rating for PUBs**, the fare levels for both PUJs and PUBs have the highest average rating for their respective modes. For PUJs specifically, the result lines up with another study conducted in Metro Manila wherein passengers consider PUJ fares to be "somewhat cheap" (Okamura et al., 2013). Fare prices are generally lower for PUJs when compared to PUBs, which perhaps could be indicative of as to why PUJs have a higher rating than PUBs specifically under fare level (Mijares et al., 2014).

On the other hand, comfort, and convenience of stops and stations have the lowest average rating for PUJs and PUBs, respectively. From the same study of PUJs in Metro Manila as discussed in the earlier paragraph, it described jeepneys to be "somewhat noisy" as well as "somewhat-neutrally dirty, crowded, and uncomfortable", all of which point to the passengers' discomfort as well as the lack of cleanliness of said mode (Okamura et al., 2013). In addition, a comparative study done among the bus systems of the Philippines, Japan, and Singapore describes the bus systems of both Japan and Singapore as being very strict–following strict regulations that buses have fixed routes, stops, and schedules. For Singapore specifically, the nearest bus stops should be located at walking distances no more than 400 meters away from one's current position regardless of foot traffic and passenger demand. On the contrary, the locations for bus stops in the Philippines are more akin to suggestions as opposed to mandates from the governing transport authority which consequently cause buses to pick up passengers at inappropriate locations along the route (Gomez et al., 2017). The fact that commuters are resorting to hailing for these buses during their route is indicative of–one, poorly enforced regulations on loading and unloading; and two, the inconvenience of bus stops and stations at

present. While this perhaps may be efficient for the specific passenger who is picked up en route the bus stop, this would be quite detrimental to the system as a whole by causing significant delays for commuters waiting in bus stops as well as causing congestion due to inappropriate loading and unloading bays.

Finally, taking note of the disparity between the highest percentage of dissatisfaction and the lowest average rating for PUJs–while there is a higher percentage of people who are dissatisfied with the availability of information, there are also more people who are satisfied with said attribute as compared to comfort. Given that both factors have similar percentages shares in the attribute hierarchy, there would be merits in prioritizing the improvement of either of these attributes.

5. CONCLUSION

The findings of the study determined the hierarchical ranking of attribute importance using the Analytic Hierarchy Process as well as the satisfaction ratings of both public utility jeepneys and buses based on the SUTI Indicator 4–with both results being obtained from the respondents' perception of said public transport service quality attributes. The majority of the questionnaire respondents are students who use either public transport mode for recreational activities.

The top 4 public transport service quality attributes–ranked based on their perceived importance by commuters–are the same for both public utility jeepneys and buses; them being service reliability, safety, comfort, and convenience of stops and stations, correspondingly ranked first to fourth. The fifth and sixth ranked attributes are different for both modes. The attributes ranked fifth and sixth for PUJs are availability of information and fare level, respectively; while the attributes ranked fifth and sixth for PUBs are the opposite which are fare level and availability of information, respectively. Perhaps this shift in the importance of fare level between both modes could be due to the increase in fare price from PUJs to PUBs.

From the Likert scale ratings for each of the statements and their corresponding attributes, it was determined that, with the exception for the convenience of stops and stations for PUBs which obtained a rating of 2.842, all service quality factors for PUJs and PUBs obtained a satisfaction rating of above 3–the threshold for being neutral to satisfied–and with the fare levels scoring the highest rating for their respective modes. In addition, the Welch's t-test is used to check whether there is a significant difference in the mean attribute rating between both modes of the sample and for each of the six service quality attributes–to which it was found that there was no significant difference for all six attributes. Finally, the overall satisfaction rating for both modes is determined by using the relative weights obtained from the AHP in conjunction with the satisfaction ratings per attribute from the Likert scale. The overall rating of PUJs is computed to be 3.313 and is slightly higher than its counterpart, PUBs, with an overall rating of 3.190. From this, the average commuter from our case study is determined to have a slightly above neutral or neutrally satisfied opinion on the service quality attributes of PUJs and PUBs in Metro Manila.

6. RECOMMENDATION

Due to the nature of the survey dissemination being purely online, potential recollection bias may have occurred given the length of time between answering the survey and the trip itself. Coupled with the inadequate number of respondents as proposed by the SUTI Indicator 4 collection guidelines, this study could simply be considered as a case study of the obtained sample which can provide insights on the tiers of perceived importance of service quality attributes as well as on the satisfaction of the available services at present. For subsequent

studies, an ideal sample size per transportation mode would be from 250 to 300 respondents as defined by the SUTI collection guidelines, as well as on-site data collection through the use of trained surveyors. In addition, studies conducting research on more than one mode would ideally require similar sized samples for each mode for a better comparison.

Another point of improvement of the AHP would be to reduce respondent inconsistency across the board. Typically, acceptable values of the consistency ratio should be less than 10%. However, this critical value may vary depending on the context of the study, such as the type of project as well as the required accuracy of the project results. For the purposes of subsequent studies, the consistency ratio may be reduced by conducting supervised on-site surveys to be able to guide respondents based on the difficulty of the survey. Further methods to decrease the consistency ratio would be to (1) change the AHP scale used from a standard linear scale to a balanced-n scale (Goepel, 2017), and (2) use the typical nine-point Saaty's Scale for AHP as opposed to the adjusted five-point scale used in this study.

Finally, additional analysis may be done to augment the results of this study. First, additional statistical tests may be performed in order to verify the significance of the hierarchical percentage distributions and overall weighted averages between modes. Studies on mental adaptation may also be incorporated into the analysis in order to determine its correlation with commuter satisfaction. Additional surveys may also be conducted on non-commuters in order to provide a comparison between commuters and non-commuters and their perceived importance of service quality attributes.

REFERENCES

Abraham, Z., & Paala, M. (2019, July 31). A new bill wants 'dignified commuting' for Filipinos. *CNN Philippines*. https://cnnphilippines.com/life/culture/transportation/2019/7/31/magna-carta-dignified-commuting.html

Asian Development Bank. (2012). *Philippines: Transport Sector Assessment, Strategy, and Road Map*.

Chuenyindee, T., Ong, A. K. S., 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

Cruz, T. (2019, October 18). *Solving the mass transport crisis*. Manila Bulletin. https://mb.com.ph/2019/10/18/solving-the-mass-transport-crisis-2/

Dong, H., Ma, S., Jia, N., & Tian, J. (2021). Understanding public transport satisfaction in post COVID-19 pandemic. *Transport Policy*, *101*, 81–88. https://doi.org/10.1016/J.TRANPOL.2020.12.004

Goepel, K. D. (2017). Comparison of Judgment Scales of the Analytical Hierarchy Process - A New Approach. Preprint of an article submitted for consideration in International Journal of Information Technology and Decision Making © 2017 World Scientific Publishing Company http://www.worldscientific.com/worldscinet/ijitdm, 6.7.2017

Gomez, G. G., & Su, C. C. (2017). SUGGESTION AND THE FORCE OF LAW: A COMPARISON OF THE PHILIPPINE, JAPANESE, AND SINGAPOREAN BUS SYSTEMS. *International Journal of Real Estate Studies*, *11*(4).

Gudmundsson, H., & Regmi, M. (2017). DEVELOPING THE SUSTAINABLE URBAN TRANSPORT INDEX. *Transport and Communications Bulletin for Asia and the Pacific*, 35–53. https://www.unescap.org/sites/default/files/publications/bulletin87_Fulltext.pdf

Li, X., Fan, J., Wu, Y., Chen, J., & Deng, X. (2020). Exploring Influencing Factors of Passenger Satisfaction toward Bus Transit in Small-Medium City in China. *Discrete Dynamics in Nature and Society*, *2020*, 8872115. https://doi.org/10.1155/2020/8872115

Manila transport crisis: Commuters outraged by "leave earlier" advice. (2019). https://www.bbc.com/news/world-asia-49983397

Mayo, F. L., & Taboada, E. B. (2020). Ranking factors affecting public transport mode choice of commuters in an urban city of a developing country using analytic hierarchy process: The case of Metro Cebu, Philippines. *Transportation Research Interdisciplinary Perspectives*, *4*, 100078. https://doi.org/10.1016/J.TRIP.2019.100078

Mead, L. (2021, May 24). *The Road to Sustainable Transport* . International Institute for Sustainable Development. https://www.iisd.org/system/files/2021-05/still-one-earth-sustainable-transport.pdf

Mijares, A. C., & Regmi, M. B. (2014). Enhancing the sustainability and inclusiveness of the Metro Manila ' s urban transportation systems : Proposed fare and policy reforms 1. *Transport and Communications Bulletin for Asia and the Pacific*, *84*.

Mijares, A., Suzuki, M., & Yai, T. (2016). Passenger Satisfaction and Mental Adaptation under Adverse Conditions: Case Study in Manila. *Journal of Public Transportation*, *19*(4). https://doi.org/10.5038/2375-0901.19.4.9

'No vax no ride' policy lifted by Feb. 1 under Alert Level 2. (2022, January 31). Philippine News Agency. https://www.pna.gov.ph/articles/1166782

Philippines: Manila voted worst city to drive on Earth. (2015). BBC. https://www.bbc.com/news/blogs-news-from-elsewhere-34424367

Piojo, L. M. (2021, May 22). *Terminal: The constant agony of commuting amid the pandemic*. Rappler. https://www.rappler.com/nation/photo-essay-agony-daily-commuting-metro-manila-covid-19-pandemic/

Rivas, R. (2019, September 26). *Metro Manila 'most congested city' in developing Asia*. Rappler. https://www.rappler.com/business/metro-manila-most-congested-city-developing-asia

Stojic, D., Ciric, Z., Sedlak, O., & Marcikic Horvat, A. (2020). Students' Views on Public Transport: Satisfaction and Emission. *Sustainability*, *12*(20), 8470. https://doi.org/10.3390/su12208470

Sukhov, A., Lättman, K., Olsson, L. E., Friman, M., & Fujii, S. (2021). Assessing travel satisfaction in public transport: A configurational approach. *Transportation Research Part D: Transport and Environment*, *93*, 102732. https://doi.org/10.1016/J.TRD.2021.102732

Tiglao, N. C., De Veyra, J. M., Tolentino, N. J., & Tacderas, M. A. (2020). The perception of service quality among paratransit users in Metro Manila using structural equations modelling (SEM) approach. Research in Transportation Economics, 83, 100955. https://doi.org/10.1016/j.retrec.2020.100955

Van Oort, N. (2011). Service reliability and urban public transport design. http://www.narcis.nl/publication/RecordID/oai%3Atudelft.nl%3Auuid%3A68f6dd34-53cf-4792-81e7-799c3d552b94

Vicente, P., Suleman, A., & Reis, E. (2020). Index of Satisfaction with Public Transport: A Fuzzy Clustering Approach. Sustainability, 12(22). https://doi.org/10.3390/su12229759

Yuda Bakti, I. G. M., Rakhmawati, T., Sumaedi, S., Widianti, T., Yarmen, M., & Astrini, N. J. (2020). Public transport users' WOM: an integration model of the theory of planned behavior, customer satisfaction theory, and personal norm theory. Transportation Research Procedia, 48. https://doi.org/10.1016/j.trpro.2020.08.117

Zhang, X., Liu, H., Xu, M., Mao, C., Shi, J., Meng, G., & Wu, J. (2020). Evaluation of passenger satisfaction of urban multi-mode public transport. PLOS ONE, 15(10).

https://doi.org/10.1371/journal.pone.0241004

APPENDIX

Table 7. List of the Ten SUTI Indicators

1	Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes
2	Modal share of active and public transport in commuting
3	Convenient access to public transport service
4	Public transport quality and reliability
5	Traffic fatalities per 100,000 inhabitants
6	Affordability - travel costs as share of income
7	Operational costs of the public transport system
8	Investment in public transport systems
9	Air quality (pm10)
10	Greenhouse gas emissions from transport