DEVELOPMENT OF A MODE TRANSFER QUALITY INDEX: THE CASE OF EDSA BUSWAY

Ann Camille FAJARDO [a], Sandy Mae GASPAY [b]

[a] *National Graduate School of Engineering, University of the Philippines-Diliman, Quezon City, 1101, Philippines*
[b] *Institute of Civil Engineering, University of the Philippines-Diliman, Quezon City, 1101, Philippines*
[a] *E-mail: acbfajardo@gmail.com*
[b] *E-mail: sagaspay1@up.edu.ph*

Abstract: To improve the multimodal transfers through adequate physical infrastructure in Metro Manila, this study conducted a review of indicators used in measuring the quality of transfers for urban multimodal passenger transport systems and developed an index for assessing the quality of transfer between different transit modes in selected EDSA Busway stations. The relevant indicators were validated with experts and stakeholders and were used to develop a public realm survey. Through the scoring methodology adapted from Krambeck (2006), the results revealed that the station design indicator is consistently the lowest rating in all the stations. The station design indicator is followed by accessibility, proximity, convenience and transfer walking from lowest to highest rated indicator. Using correlation analysis, the research identified that thermal comfort, covered waiting area/resting stop and proximity sub-indicators affect the passenger mode transfer satisfaction. These results can be used to identify disadvantaged EDSA Busway stations to prioritize for improvement.

Keywords: Multimodal transfers, Mode transfer quality index. EDSA Busway

1. INTRODUCTION

1.1 Background of the study

Multimodal trips occur when urban residents frequently utilize multiple transportation modes to travel across a city (Woldeamanuel & Olwert, 2016). Multimodal transportation is the use of two or more modes to move people or goods from an origin to destination (DeWitt & Clinger, 2000). In Metro Manila, there are five different kinds of trip choice chain in addition to access and egress showing that there is a significant number of people who use two or more modes in transportation (Fillone et al., 2020). One of the important parts of a multimodal system is public transit (ITDP, 2016).

In a Metro Manila survey of Fillone (2020) with 51, 000 respondents, apart from air conditioning as the top amenity favored by commuters, it was followed by easy transfers or connections. All commuters must be able to safely walk, wheel, bike or use micro-mobility options to and from the station for any public transport to be equitable (Bridgwater et al., 2022). The transition between modes of transport is significant since this is a substantial part of the commuter's journey. This is a good determinant of travel alternatives for commuters and can also shorten the travel time especially for long distance trips leading to passenger satisfaction (Brons et al., 2009, Givoni and Rietvald, 2007). Passenger satisfaction is important since this enhances ridership and subjective well-being (Zhen et al., 2019). Furthermore, daily travel satisfaction is said to positively influence subjective well-being, directly or indirectly (Bergstad et al., 2011, De Vos, 2017). Thus, improving the quality of transfer will encourage commuters and more citizens to use public transportation more, therefore achieving an overall optimal travel performance and passenger satisfaction.

Multimodal connectivity allows transportation users to minimize travel time, improve quality of life, smooth transitions between origins and destinations and provide more options to improve resiliency, making response to extreme events easier and more effective (Zimmerman et al., 2015). It was also discussed in Zimmerman et al.'s study that the types of multimodal connectivity depend on proximity since facilities can be adjacent to each other, not adjacent or shared. The research also reported that 400m is considered as an adequate radius for a transit stop to make a multimodal connection since that is the distance that most people will walk (or about a 5- min walk).

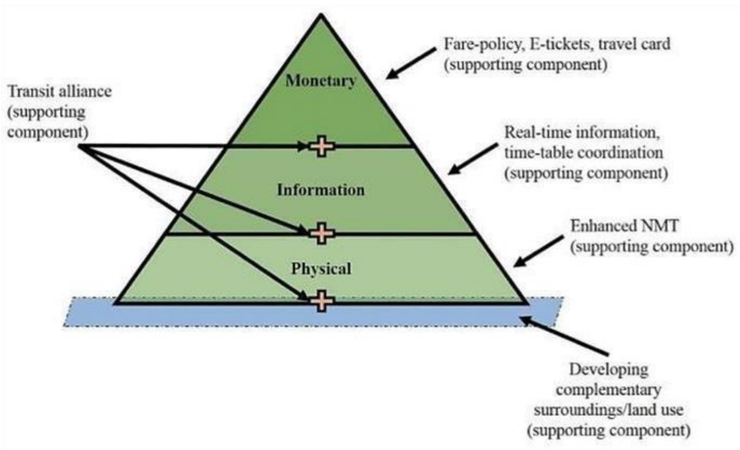

Figure 1. Integrated Public Transport Hierarchy of needs (Source: Nag et al., 2019)

To improve the multimodal connectivity in transit, Nag et al. (2019) proposed an integrated public transport hierarchy of needs. Much like the hierarchy of needs as proposed in psychology by Maslow in 1943, a commuter's need will entail convenience, easy access, comfort, affordability, competitive travel times and safety (Berlepsch et al., 2018). Figure 1 shows that during multimodal transportation planning, it is important that the physical integration must be in place first before the other components. To increase the convenience for the commuters, physical integration between public transit modes would be a good intervention. There would be easy accessibility for the commuters if the different modes of travel were in proximity to each other.

When COVID-19 hit the Philippines, commuters and the working force were affected especially in terms of mobility. The government implemented strict lockdowns which made public transportation inaccessible. A dedicated median bus lane service, Epifanio Delos Santos Avenue (EDSA) Busway was constructed during the community quarantine imposed by the Inter- Agency Task Force for the Management of Emerging Infectious Diseases (IATF-EID) due to the pandemic.

The traffic in the EDSA Busway is restricted to authorized buses as well as emergency vehicles like ambulances. Thus, the EDSA Carousel, a dedicated busway route running along Metro Manila's Epifanio Delos Santos Avenue (EDSA) was launched under the LTFRB Memorandum Circular No. 2020- 019 during the imposition of General Community (GCQ) last 2019. The EDSA Carousel is now part of the 35 bus routes in Metro Manila and has an exclusive right-of-way on a dedicated bus lane which is separated from the normal road traffic in EDSA by concrete barriers and steel bollards.

The Department of Transportation believes in the effectiveness of the EDSA Busway as it offers the "seamless" or uninterrupted and faster movement of buses "like a train on a railroad" and faster travel time for commuters and a more predictable route schedule (Zurbano, 2020). The EDSA Busway is modeled to serve as an extension of the MRT and other mode transfers. The EDSA Carousel is meant to be an express bus that goes around the EDSA Busway in a merry- go-round fashion. Therefore, it does not necessarily bring passengers to key destinations, and they will need to transfer to other modes of available public transportation like the Metro Rail Transport (MRT), Light Rail Transport (LRT), jeepney, tricycle etc

Since the EDSA Carousel was created on a 'pop- up' basis, the EDSA Busway system remains to be low-capacity and low-quality (Sunio & Mateo- Babiano, 2022). In a news article by Lacsamana (2022), Eduardo M. Yap, Infrastructure Committee Chair of the Management Association of the Philippines said that the busway is functioning, but the problem is that the infrastructure is delayed for the stations have not been built. Since there is a lack of stations, commuters use the MRT stations as passage to get on the bus which results to overcrowding. It was also emphasized that the EDSA Busway's bus stations should include convenient pedestrian access with no mountain-like footbridges and waiting platforms that will allow commuters to literally hop on and off the bus without stepping onto the road itself.

To fully utilize the busway and increase the quality of mode transfer, it is imperative to evaluate its current multimodal connectivity with the other urban transportation systems through the evaluation of physical integration indicators. The evaluation of the physical integration of the busway will lead to more improvement on the commuters' public transportation convenience.

1.2 Problem Statement

The problem that this research wishes to address is to identify the mode transfer quality index of selected EDSA busway stops with other urban public transportation modes through the identification and assessment of physical integration indicators that affect the quality of mode transfer.

1.3 Objectives of the Study

The primary goal of this research is to measure the quality of transfer between selected bus stops along EDSA busway and other modes of transit through evaluation of physical integration features. In accordance with this aim, this study pursues the following objectives:

1. Conducting a systematic review of indicators used in measuring the quality of transfers for urban multimodal passenger transport systems;
2. Developing an index for assessing the quality of transfer between different modes of transit in selected EDSA busway stations; and
3. Determine the relationship of index results with the passenger mode transfer satisfaction.

1.4 Significance of the Study

This study is significant because it will help relevant transport agencies and local government units in the design and planning stage of future transportation projects that promote usage of public transportation. The index developed can be used as a communication tool to explain the gaps in mode transfer in our current public transportation system. The indicators that will be determined can serve as a guide to identify which of the physical infrastructure should be prioritized first and be improved. And by improving the present physical infrastructure, this will improve the connection between different transportation modes and encourage more commuters to use public transport. On this line, the results of this study will be helpful in the formulation of policies in other countries as well and can be modified depending on their need.

1.5 Scope and Limitations

The study will be conducted in the National Capital Region and will only focus on commuters who use the EDSA Busway as their intermediary mode of transfer to and from their destination. The EDSA Busway stops will be selected based on the following criteria: (1) number of mode types connected, (2) number of lines/routes available, (3) busway queue, and (4) passenger activity transfer. The research will rely on primary data from surveys that will be acquired from the responses of stakeholders/transport experts and commuters. Data gathering from commuters will be conducted face to face while data gathering from stakeholders and transportation experts can either be online or personal depending upon their availability.

2. LITERATURE REVIEW

2.1 Multimodal Connectivity Measures

Multimodal connectivity measures are well studied in the literature but their application to mode transfer quality is rare. Multimodal connectivity studies often look on how to improve multimodal accessibility to increase multimodal ridership (Woldeamanuel & Olwert, 2016). Teng et al.’s (2014) study focused on identifying the relationship of multimodal connectivity with ridership. Meanwhile in Yang et al.’s (2019) study, it discussed the relationship of air and rail connectivity’s impact on the domestic tourist flows and concluded that air transport has a higher impact on the tourist flows. Table 1 represents a summary of multimodal connectivity measures found in the literature. As seen on the table, at most one study by Chowdhury et al. (2014) discussed smoothness of mode transfers. In their study, a framework was constructed to determine the interconnectivity among public transport routes using the information provided by

Google Transit and to apply that framework to appraise and compare the network connectivity of Auckland, London, and Paris. In another study by Chowdhury and Ceder (2013), the importance of integration in a public transportation network to improve connectivity of the network and user perception of transfers was discussed. The study proposed a definition- based framework to assist policymakers and planners in designing “seamless” transfer in an integrated network.

Table 2-1. Literature on multimodal connectivity measures in urban public transportation

Measure	Definition	Application
Node, place & feeder transport indicators		**Land use and public transport** (Nigro et al., 2019)
Direct connections, single and multi-modal indirect connections	Sum of connections	**Transport Infrastructure** (Zhu et al., 2019)
Bus counts for each station stopping withing a 0.1 mi-radius, geographic information systems		**Transit resilience** (Zimmerman et al., 2015)
Assessment of sidewalks, bikeways, parking, bus connections & taxi/kiss-n-ride facilities	Weighted average used for index calculation	**Transit accessibility & convenience** (Woldeamanuel & Olwert, 2016)
No. of facilities and services	Linear regression model to identifyrelationship with ridership	**Transit ridership** (Teng at al., 2014)
Average & variance of ride time, waiting time; average walking time, smoothness of transfer, availability of information	Sum of connectivity measures	**Quality of transfer comparative study between cities** (Chowdhury et al., 2014)
Geo-tagged Sina Weibo data	Estimate several gravity models with a negative binomial distribution	**Relationship of transport with domestic tourist flows** (Yang et al., 2019)
Level-of-Service rating factors	Sum of points after evaluating indicators	**Multimodal transportation planning** (Litman, 2021)
Node connectivity, line connectivity, transfer center	Graph theoretical approach	**Evaluation connectivity of transit** (Mishra et al., 2012)

2.2 Quality of Mode Transfer Measures

Integration is one of the transit level of factors considered in multimodal transportation planning (Litman, 2021). To evaluate the quality of each transit mode in multimodal transportation planning, tools such as Level-of-Service standards are used to indicate problems and ways to improve each mode.

According to the MMUTIS Update and Enhancement Project (MUCEP 2015), public transport routes and services must have physical integration such as integration of mass transit lines through provision of common stops and stations. The paper also discussed that to improve bus convenience, there should be improvement of inter-modal facilities to facilitate easy transfer and proper connections with railway (ALMEC Corporation, 2015).

There are several published methodologies in evaluating multimodality index but those for physical integration are rare. In a study by Woldeamanuel and Olwert (2016), a multimodality index (MI) was developed to evaluate the accessibility and convenience of transit use by investigation the connectivity of a Bus Rapid Transit (BRT) with other modes of travel. To create the MI, the integration of the Orange Line BRT system in Los Angeles with other travel modes including bicycles, pedestrians, regular buses and private automobiles was analyzed using field observations and the Los Angeles Metro data.

In a study by Chowdhury et al. (2014), connectivity measures selected for analysis were based on those determined by Ceder (2007). The indicators used for the smoothness of transfer measures were: (1) ease of transfer walking times, (2) presence of comfort provisions when making transfers, (3) level of fare integration, and (4) security at terminals. According to Guo and Wilson (2004), the penalty imposed for transfer walking time can be reduced by the presence of escalators, longer ramps and same-level interchange.

Sinha (2021) evaluated the physical integration of Indian cities using an assessment tool, Maturity Matrix for Multi-Modal Integration (4MI) Tool. The tool determined the extent of integration achieved across the five core areas of multi-modal integration; one of them is physical integration. To measure the multi-modal integrated public transportation journeys with transfers, the proportion of total trips was used as a unit of measurement.

Existing studies which dealt with quality of transfer measures are summarized in the table below. The studies below mostly focused on basing their origin to destination as home to work. In this study, instead of home to work as the origin to destination, it will be mode to mode instead. Aside from that, this study will be utilizing the measures below and integrate it all into the study.

Most of the studies measuring physical integration only consider indicators involving the quality of transfer in motorized mode transfers (e.g. bus to MRT/LRT). The studies have disregarded that in between those motorized mode transfers, lots of walking are involved. However, walkability indicators were not considered in their calculations. Thus, in this study, several walkability indicators from Litman (2021) will also be used in calculating the physical integration indices of the EDSA Busway stations to integrate the motorized and nonmotorized transfer.

Table 2-2. Literature on quality of transfer measures in transportation

Measure	Definition	Application
No. of transfers of attribute, no. of times passenger has to cross a street in making all the transfers required for a given OD	Ease of transfer weight attribute multiplied to no. of transfers	Public-transit network spatial repository (Hadas & Ranjitkar, 2012)
Departure and arrival time	Time difference between departure and arrival times	Optimization of transfer quality (Schroder & Solchenbach, 2006)
Node and place properties, experience value	Multiply the scores for the different criteria with the corresponding weights	Improvement of transit node quality (Groenendijk, Rezaei& Correia, 2018)
Proximity of stops, accessibility within the interchange zone, last mile connectivity	Level of maturity scoring per indicator	Evaluation of public transport integration (Sinha, 2021)

Since this study will only focus on the physical integration of the EDSA Busway with other urban public transportation modes, only physical integration indicators will be used. For the scoring system and evaluation of the physical integration index, the methodology adopted in the "Global Walkability Index" by Krambeck (2006) will be used. Krambeck's index was a result of an evaluation of more than 20 different established methodologies for evaluating urban non-motorized transport, consultations with experts from a multitude of fields including urban planning, pedestrian planning, transportation engineering, urban transport policy, pedestrian safety, accessibility for disabled persons, urban design, and economics and comments from field testers in Alexandria, VA; Washington, DC; Hanoi, Manila, Bangkok, Beijing and Delhi. Aside from that, Krambeck's calculation is simple that it can be easily replicated and used in other case studies and practical implementation instead.

2.3 Walkability Indicators & Measures

Walkability can be explained as the suitability that the urban road environment offers to pedestrians. (Galanis & Eliou, 2011). Citizens desire to live in a city where they will be able to walk with safety and convenience. Cities that are suitable to walking (walkable city) are beneficial for their citizens since it offers a road network safe for pedestrians, better accessibility to destinations for all, selection of multiple transportation modes and better health for their citizens. In Krambeck's (2006) study, walkability is considered in its most basic sense: the safety, security, economy, and convenience of traveling by foot. Thus, in their study, the aspects of walkability targeted were those that can be improved upon in the short and medium terms. Meanwhile in Schlossberg & Brown (2004)'s study, the walkability indicators considered in the pedestrian access between the transit stop and the immediately surrounding area are geographic information systems (GIS) based walkability measures (e.g. quantity of accessible paths, quality of impedance paths, intersection density, density of dead ends).

2.4 Methods of Index Creation

In Zheng et al.'s study in 2013, their paper provided guidance in the issues of selecting an appropriate index or developing their own. According to Zheng et al. (2013), index creation begins by reviewing the existing literature on indicators selection criteria, examining the construction of composite indices, and exploring rating systems. Kranjc & Glavič, (2005) and Singh et al. (2007) also said that the first step is to develop a framework for identifying and organizing the components. The structure of existing composite indices varies and the terminology associated with their components has not been standardized. Using the following components: sub-indices, indicators, and variables is one common approach. The indicators and variables are selected with consideration for the intended audience and potential policy implications (Booysen, 2002, Esty et al., 2005, Singh et al., 2009). Iterative procedures for selecting variables and identifying indicators include reviewing prior research, assessing the quality of available data, doing empirical analysis, and consulting with experts. Alternative variables and indicators can be chosen to serve as proxy measures in situations where measurements and data monitoring are unavailable. Hardi & Desouza-Huletey (2000) stated in their study that proxy measures are commonly used when evaluating sustainable development due to the lack of available data and the difficulty associated with measuring qualitative concepts.

To develop the Walkability index and data collection methodologies, Krambeck (2006) had two phases. For Phase I, she conducted background research and multiple literature reviews. After which she drafted survey methods and the survey implementation guidebook to test the survey materials in developed and developing countries to refine the methodology. The refined survey materials were used to conduct the full-scale pilot in select developing cities. Through these results, Krambeck was able to finalize the survey methodology and implementation guidebook. Phase II of the index development started with the completion of a rough method for data aggregation to transform the data into index rankings. The implementation of the index survey materials was being promoted while the Global Walkability Index was being constructed. After which the generic counter-measure guidebook that outlines steps was developed so that city planners and leaders can take to improve upon areas deemed insufficient by the index. Phase II was concluded by analyzing the Index data and producing the final report.

2.5 Research Gaps in the Existing Literature

Most of the existing literature which dealt on measurement of physical integration dealt with their origin to destination as home to work instead of mode to mode (e.g. jeepney to tricycle). Thus, the integration between the modes of transportation wasn't closely evaluated. Aside from this, the indicators from existing literature lack walkability indicators. This shouldn't be the case since lots of walking is involved in multimodal transportation.

Studies on evaluating physical integration are occasional for most of the available research focuses on multimodal transportation in general. While it is important, it is better to focus first on the physical integration aspect following the integrated public transport hierarchy of needs (Nag et. al, 2019). At the same time, it is often stated in technical reports and news that the quality of mode transfer should be considered during planning and design in public transport planning but there is no existing tool yet which can be used. This research would like to address that gap by developing an index which can be easily replicated by transport planners and local government units.

The indicators that will be considered in this study are categorized into five: (1) area & facilities accessibility, (2) design of facilities, (3) transfer walking, (4) proximity of stops and (5) accessibility of transit stations. The EDSA Busway will be used as a case study. There will be two types of data to be collected: objective physical measurement data from field survey and subjective perception data from questionnaire surveys. These indicators which are captured either through field survey or questionnaire survey will then be combined and result to the physical integration index. The physical integration index will be used as basis if how connected are the different public transportation modes with each other. In this study, the physical integration index was computed in selected EDSA Busway stations to identify how integrated is the EDSA Busway with the available modes of transportation.

3. METHODOLOGY

3.1 EDSA Busway and EDSA Carousel

The EDSA Busway is a dedicated bus lane along EDSA wherein buses would continuously run along a loop called the EDSA Carousel. This was formed to provide the initial demand of 600, 000 trips during the mandatory lockdown and halting of all forms of public transportation from March 16-May 30, 2023, in Metro Manila in response to the increasing number of Covid-19 infections.

3.2 Selection of EDSA Carousel Stations

To represent the EDSA Carousel Stations with varying number of public transport types connected to it, the stations considered for this study are the following: Monumento, North Avenue, Quezon Avenue, Buendia, Guadalupe and Taft Avenue which are highlighted in red in Figure 3. All these stations have varying number of transport types connected to it as seen on Table 3-1 (Moovit, 2024).

Table 3-1. Summary of Public Transport Routes Per EDSA Carousel Bus Station

EDSA Carousel Bus Stations	No. of Routes Connected	No. of Public Transport Types Available	Population (Queue)
Monumento	29	3	8, 660
Guadalupe	26	2	1, 923
Quezon Avenue	21	4	6, 349
Buendia	20	4	2, 157
North Avenue	11	5	8, 028
Taft	10	3	12, 028

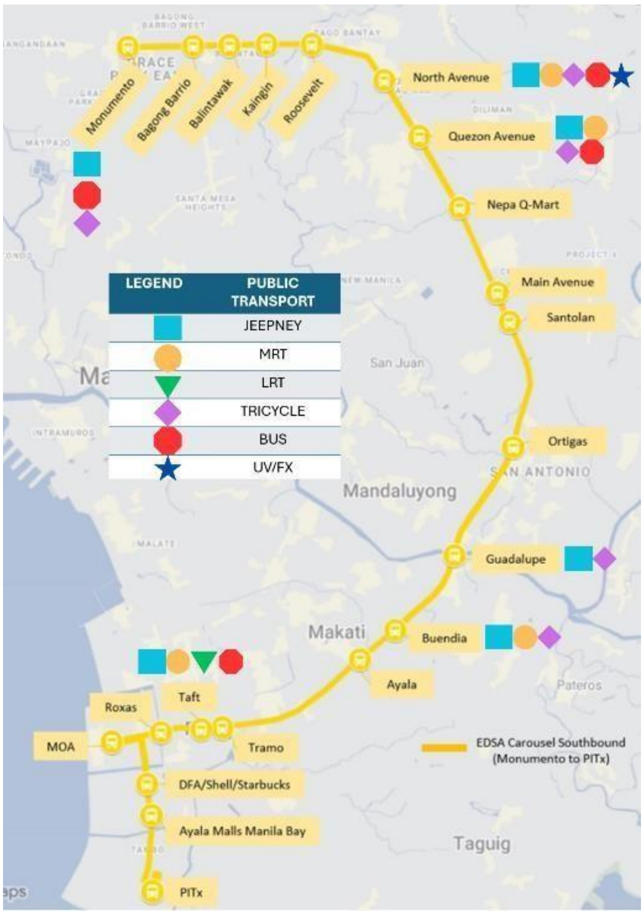

Figure 3. Selected EDSA Carousel Stations and Public Transport Connections. Produced by the author.

3.3 One-on-one Interview

As an aide in drafting the public realm questionnaire, i.e., confirmation of the risks associated with the indicators to physical integration identified in related literature or identification of differences in perspectives since most of the related studies were conducted in foreign setting, one-on-one interviews were held. Snowball sampling procedure was used where emails were sent to the recommended experts given by the adviser. The participants were from the following sectors: (1) civil/society organizations, (2) local government units, (3) academe/research and

(4) persons with disabilities (PWD) sector. The experts were asked to share their definition of "smooth transfer". The indicators to walking identified in related literature were confirmed, and the differences in perspective thereto with the use of cognitive interview process (Wolcott & Lobczowski, 2021). The interview results were coded (Mateo-Babiano, Recio, Ashmore, Guillen, & Gaspay, 2020) and thematically analyzed to identify the similarities and differences among the responses (Braun and Clarke (2006) as used by (Chawla, Eijdenberg, & Wood, 2021);) Accessibility, convenience, transfer walking, station design and proximity were among the themes.

The transcription and content analysis were made possible since the meetings were recorded; nevertheless, for the privacy of the participants, the recordings were made available only to the author. The names of the participants reflected in this study were either altered, or nicknames were provided by the participants for anonymity.

3.4 Public Realm Survey

Using the perspectives identified through the interview, the survey aimed to determine the level of influence of each identified indicator in the related literature. Random sampling techniques were used to get the samples. Face-to-face survey was used as the primary method of data collection. The questions were written in both English and Filipino.

The questionnaire was divided into four parts. The first part contained general questions on the respondents' personal and socio-economic profile and the respondent's trip information, e.g. location of origin, location of destination and frequency of commuting. The second part contained accessibility questions, mode of transport used before EDSA Carousel (private, bus, jeepney, tricycle, UV/FX etc.). The third part has convenience questions, and the last part contained the passenger mode transfer satisfaction survey. With the use of the 5-point Likert scale, the respondent's answers were given a value ranging from 1 – 5, the questions were based on perspectives obtained during the cognitive interviews during the interviews.

3.5 Converting Data into Index

To translate the results of the Public Realm Survey, the points assigned to each response are summed and then averaged. The point allocation used is based on Krambeck's index calculation methodology (2006) and is summarized in Table 3-2. On Table 3-3, there is a sample index calculation.

Table 3-2. Point Allocation for Public Realm Surveys

Question	Point Assignments
1	1-5 Scale; Non-Existent = 1
2	One point for each box checked
3	Divide percentage by 10
4	Yes = 5, No = 1
5	3 for each 'usually' to 1 for each 'rarely', divided by 2

Table 3-3. Sample Scoring Calculation

Indicator	Answer	Point/s
Pedestrian Accessibility within a 500-m radius	Y/N	5
Pedestrian congestion in sidewalk	1-5 scale	3
Presence of walkalators/escalators	Y/N	1
PWD-accessible	Y/N	1
Directness of route	1-5 scale	4
……….		
Directness to Next Transfer Point	1-5 scale	4
	TOTAL (AVERAGE)	**3.12**

It is relevant to mention that equal weights were assigned to all five indicators for the physical integration index calculations. The approach in this research follows what was adopted by Krambeck (2006), who justifies that assigning equal weights to all variables solved the issue of determining which variable had significance, given it can vary from group to group. For example, persons with disabilities believe that supporting infrastructure (e.g., accessibility ramps and blind paths) should receive the highest weight, whereas bicycle commuters find that bicycle facilities (e.g., bike racks and shower area) should be weighted more.

3.6 Validation with Stakeholders and Experts

After index computation, the data results were shown to stakeholders and transportation experts for validation. One-on-one interviews were conducted through Zoom online meetings. During this occasion, the researcher was able to verify the data results and was supported by the interviewees. This also enabled the researcher to review which best statistical tool to be used in the statistical analysis and to also identify the effective data results presentation for easier understanding of the results for the stakeholders.

4. RESULTS & DISCUSSION

4.1 Results of the One-on-one Interviews

As guide and added reference in the drafting of the public realm survey questionnaire, One-on- one Interviews were held from May to June 2023. A total of twenty (20) – twelve (12) transportation experts and eight (8) stakeholders – individuals participated in the discussions.

Due to the differences in the work schedules and availability of the interviewees, some of them were face-to-face and mostly online through Zoom meetings. The interviews were informal, and conversations were made friendly establishing rapport. The participants were asked to share their own definition of “smooth transfer” and the physical indicators that ensure smooth transfer. Aside from that, the participants were also asked what the challenges are that commuters faced during their mode transfer in EDSA Busway and the solutions to address these challenges.

<u>Transfer walking</u> – the results of the interviews revealed transfer walking is the most influential indicator affecting the quality of mode transfer. The participants cited presence of escalator/stairs (n=8), same-level transfer/number of level changes (n=6), physical comfort (n=5), and time to travel from one mode to another (n=5).

There was one who mentioned that it would help if the stairs were “gentle” or easy to traverse so that it would be easier for the commuters to use. Another interviewee also cited that aside from stairs or escalators, walkalators should also be implemented to improve the connection between the walkways. It was suggested that it would also be better if the next mode of transfer was on the same platform or in view of the commuter.

Station design – In connection with the previous indicator, there were four (4) interviewees who highly emphasized the presence of wayfinding signages. One participant mentioned that it would help if there were route maps and timetables at the station so it would be possible to gauge how long would be their travel time. Aside from maps, another participant said that it would be best if there were posters or signs of important public destinations within the station. This will enrich the commuter's knowledge of some possible landmarks in the city.

Convenience – Three (3) participants said that paths or sidewalks should be convenient with little to no obstruction to ensure the directness and ease of their travel from one mode to another. This is also made relevant due to two (2) stakeholders mentioning ease of reaching the station.

Accessibility – The participants highly emphasized that the transfer between stations should be accessible not just to able-bodied commuters but to people with disabilities and people with limited mobility. This can be made possible if there are elevators, escalators and ramps for mobility-impaired individuals and tactile paths and audible pedestrian signals for vision- impaired individuals. According to one participant, it would also help if there were elevator Braille buttons for the blind.

Proximity of Stops – Only one participant mentioned that the distance should be little during mode transfer.

4.2 Summary of Results of the Interviews

The results of the interviews initially showed that most of the sub-indicators identified in the related literature also applies to the participants with some being more pronounced than the others such as availability of bicycle & PWD facilities, presence of escalator/stairs, physical comfort, and distance between the stops. Other factors such as walking path and same-level transfer, or number of level changes and crossings were also mentioned during the discussions but were generally deemed by the participants as inconsequential. The results of the interviews also showed that there are additional indicators which needed to be considered and are presented in Table 4-1.

4.3 Details of Public Realm Survey

Over a period of one week last July 31 – August 7, 2023, three surveyors and the author conducted over 257 commuter surveys and conducted physical infrastructure surveys in the six stations. The summary of the key characteristics of the respondents is shown in Table 4-3.

Table 4-3. Key Characteristics of Respondent Survey Sample

Characteristic of Sample	Value
Number of Respondents	257
Percent Female	40.08%
Percent Disabled	0.78%
Percent with Small Children Travelling	0.78%
Percent of Respondents Aged 51 y/o & Above	7.8%
Percent of Respondents Travelling for Work	46.5%

Percent of Respondents Using Jeep Before/After EDSA Busway	74%

Typical respondents were between the ages of 21-30 years old and were travelling for work. Interestingly, only 0.78% of respondents (n=2) were people with disabilities and 0.78% (n=2) were persons travelling with small children. Around 7.8% of the respondents were aged 51 years old and above and 46.5% were respondents travelling for work. Many respondents, 74%, used jeep as a mode of travel before or after using EDSA Busway.

Table 4-1. Consolidated List of Indicators

Indicator	**Initial Sub-Indicators in Related Literature**	**Additional Sub-Indicators from Interviews**
Area & Facilities Accessibility	• Convenient walking path • Pedestrian accessibility within a 500-m radius	• Good connecting walkway • Little to no congestion in sidewalk • Walkalators/escalators
Design of Facilities	• Availability of bicycle & PWD facilities	• Presence of air conditioning • Covered walkway • Wayfinding signs (route maps, timetable maps, important landmark destination)
Transfer Walking	• Presence of escalator/stairs • Same-level transfer/No. of level changes & crossings • Type of mode transfer • Comfort • Time	• Transfer walking distance • Comfort/Physical Exhaustion • Thermal comfort • Little obstruction
Proximity of bus stop to transport terminal	• Distance between stops	• Travel time
Accessibility of transit stations	• Ease of reaching stations and • stops	• Directness and flexibility of route

4.4 Results of the Index Computation

Using Krambeck's methodology (2006), the overall physical integration index per station was determined. As shown in Table 4-4, the station with the highest rating was the Buendia station with a rating of 3.23 out of 5. The station with the highest rating was Taft Station, followed by Monumento and Guadalupe respectively. The stations tied with the lowest ratings are North Avenue station and Quezon Avenue station.

Referring to Table 4-4, it is seen that among the five indicators, *station design* was the one consistently with the worst score, with a value of 1.5 for North Avenue station. The results reflect the absence of adequate infrastructure to facilitate the mobility of persons with disabilities and the elderly. Escalators and elevators were only distributed in other transportation stations but wasn't present in the route in going to the EDSA Carousel station. Other types of infrastructure such as accessibility ramps, tactile path and dropped curbs were not observed. This is also because there are no bicycle facilities such as bike rack & shower area in the EDSA Carousel station. There is only one bike rack in Quezon Avenue and it was located just by the entrance to the MRT station. There were no resting area or seats at the EDSA Carousel stations and little to no presence of wayfinding signages from the other transportation stops. Therefore, some commuters even said that they must ask the nearby locals in the city for directions.

Table 4-4. Overall Physical Integration Indices by Parameter of All Surveyed EDSA Busway Stations

Station	**Accessibility**	**Convenience**	**Transfer Walking**	**Station Design**	**Proximity**	**Overall**
(weight)	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*1.0*
Monumento	2.24	3.38	3.41	2.0	3.53	2.91
North Ave	1.97	3.77	3.53	1.5	3.26	2.81
Quezon Ave	3.0	3.31	3.37	1.75	2.59	2.81
Buendia	3.5	3.65	3.64	2.5	2.87	3.23
Guadalupe	2.5	3.32	3.62	2.0	2.7	2.84
Taft	2.25	3.54	3.48	2.0	3.58	2.97

The indicator *accessibility* had the second-worst score among the five, with an average of 2.58. This is because there is no infrastructure for the mobility impaired to help them access the EDSA Carousel station such as elevators or accessibility ramps. At the same time, there is too much pedestrian congestion in the sidewalk due to pedestrian obstructions (e.g., telephone poles, vendors and peddlers) which halts their movement. As for the indicator *proximity*, a score of 3.09 indicates a need for some transportation stops to be placed closer to the EDSA Carousel stations.

Even if there are walking paths available, most of them are filled with pedestrian obstructions hindering the movement of the people. Most of it were utility poles, trees, vending stalls and peddlers which occupied the entire sidewalks. And since there are no elevators or escalators present, the commuters had to traverse lengthy footbridges to get to the EDSA Carousel stations. Even though this is the case, the indicator *convenience* had the second-best weighted score among the five, with a final value of 3.50. To improve the convenience indicator, the local government should develop strategies to remove the barriers and widen the pedestrian paths to at least 1.20m.

Regarding the *transfer walking* indicator, this parameter the best score among all the five, with a final value of 3.51 which is close to the convenience indicator. This indicator has the best rating since most of the sidewalks to the EDSA Carousel station were shaded. It was only on Monumento Station and Quezon Avenue Station which had lower presence of covered sidewalks. Due to this, the commuters were comfortable during their transfer since they were not covered in the heat of the sun. At the same time there were some stops in other stations which only took 0 – 5 minutes of transfer time.

4.5 Statistical Analysis Between the Physical Integration Index and Passenger Mode Transfer Satisfaction Score

To determine the relationship between the physical integration index and passenger mode transfer satisfaction score, correlation analysis was used. Passenger mode transfer satisfaction score was defined as dependent variable, and the physical integration index as independent variable. To closely assess the relationship between the two values, the correlation was done per sub-indicator to be more specific. Table 4-5 shows the summary of the results for physical integration versus passenger mode transfer satisfaction. Adjusted R-Square values from the t- test are presented to show the relative explanatory power of each model developed, where the decimal value corresponds to the approximate percentage of the variation that is explained for each model.

Among the independent variables, the thermal comfort, covered waiting stops/resting area and proximity stood out the most when interrelated with the satisfaction scores (see Table 4-6). This would mean that the sub-indicators thermal comfort, covered waiting stops/resting area and proximity affect the passenger mode transfer satisfaction the most. Meanwhile, the sub- indicators: directness of route, presence of physical infrastructure and presence of wayfinding signages do not have much effect on the passenger mode transfer satisfaction of the commuters.

Table 4-6. Statistical analysis results for Physical Integration.

Model	R-Square
PWD Accessibility	0.5146
Directness of Route	0.0746
Presence of Physical Infrastructure	0.4392
Thermal Comfort	0.8154
Covered Waiting Area/Resting Stop	0.7432
Presence of Wayfinding Signages	0.1688
Proximity	0.7044

4.6 Discussion

The focus of this study is to measure the quality of transfer between selected stops along the EDSA Busway and other modes of transit through evaluation of physical integration features. In addition, it specifically aims to conduct a systematic review of indicators used in measuring the quality of transfers, to develop an index for assessing the quality of transfer and to determine the relationship between the physical integration index and passenger mode transfer satisfaction.

The outcomes of this research have provided insight that the following: accessibility, convenience, transfer walking, station design and proximity are physical integration indicators which can be measured to measure the quality of mode transfer. Based on the results of this study, station design had the lowest rating out of all the indicators, and it was followed by accessibility, proximity, convenience, and transfer walking. The Buendia station had the highest rating on mode quality transfer and after that was Taft Avenue station, Monumento station, Guadalupe station, and North Avenue station tied with Quezon Avenue station. The study demonstrates that the sub-indicators: thermal comfort, covered waiting stops/resting area and proximity affect passenger mode transfer satisfaction.

The results of the study suggest that Buendia station have the best station among the six selected stations, and this met my expectations since this was the only station where there was an escalator which can be used to access the EDSA Busway. Also, the travel time to and from the Busway to other modes of transportation such as jeepney and MRT only took 0 – 5 minutes. All the other EDSA Busway stations didn’t have facilities such as elevators, escalators and ramp which added to the physical exhaustion of the commuters during their mode transfer. Since there were lots of facilities lacking, this led to very low scores on the station design indicator of EDSA Busway. Although it was unexpected that the transfer walking indicator was the highest-ranking indicator even with the absence of elevators and escalators in the other five stations. This was probably due to the high number of physically able commuters which answered the questionnaire survey leading to a higher comfortability with transfer walking and less physical exhaustion. Aside from this, the commuters have been used to this normalcy of mode transfer thus they have become impartial to it. But even if the commuters are on the average satisfied with it, this doesn’t mean that the physical infrastructure should remain as is. It should be noted that the respondents in this study are from mostly physically able commuters. During the data validation with PWD Advocate, Ms. Lalaine Miranda Guanzon, she stated that the reason there were only 0.02% commuters who were PWD that answered my questionnaire survey was because the EDSA Busway isn’t PWD-friendly at all so she herself doesn’t even use it and encourage the others to use it. To encourage other commuters to use the EDSA Busway and have it as one of their travel mode alternatives, it is imperative that we cater to all groups: PWDs, persons with limited mobility and even senior citizens.

These data results should be considered on how to improve the EDSA Busway stations. As per the results, the station design of EDSA Busway must be first improved to facilitate better mode transfer for the commuters. This can be achieved by installing elevators, escalators, and ramps for wheelchair access for the PWDs or even parents using strollers for their kids. Aside from that, it is also suggested that tactile paths and Braille signages be installed to help the blind commuters navigate to the EDSA Busway station.

During the public realm survey, there were instances where we had problems with getting a survey respondent since they didn’t meet the requirement of having at least one mode of transport before or taking the EDSA Busway. Due to this, we had to turn away some of the commuters since the criteria wasn’t met. Aside from this, the weather was also rainy since a typhoon was approaching the following week which led to possibly lower EDSA Busway commuters. And since there is also a limited budget for the study, the public realm survey can only be done on a specific time frame. It is recommended that further studies should do the public realm survey for at least two weeks to accommodate possible variables which can hinder data gathering.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

A simplified physical integration index based on indicators from related literature and one-on- one interviews with stakeholders and experts was used to evaluate the physical integration of EDSA Carousel stations between nearby other transportation modes. The interviewees provided invaluable feedback which was used to refine the index components and methodology. The indicators identified for measurement of mode quality transfer are accessibility, convenience, transfer walking, station design and proximity. The EDSA Busway was used as a pilot study area and it was found out that among the physical integration indicators used, station design got the worst scores due to the absence of facilities supporting the movement of persons with disability and reduced mobility. In order of increasingly higher ratings, this was followed by accessibility, proximity, convenience, and transfer walking.

Generally, amenities that would help provide comfort to commuters and, consequently, encourage using EDSA Carousel, such as elevators, escalators, benches are lacking. The most observed obstructions were vending stalls, utility and lighting poles which reduced the available walking width and pushed pedestrians to the street causing a safety concern. Regarding transfer walking, most routes had footbridges connected to it and were covered.

Among all six EDSA Carousel stations, the station with the highest rating was EDSA Carousel Buendia station. This is because this station had the nearest distances to their transfer points and there is additional physical infrastructure such as escalator and elevator to facilitate access to the EDSA Carousel station. The second highest rated station is EDSA Carousel Taft Avenue station followed by Monumento, Guadalupe and North Avenue and Quezon Avenue tied respectively.

Based on correlation analysis, it was found that there is a positive correlation between the physical integration sub-indices and the passenger mode transfer satisfaction sub- scores. Directness of route, presence of physical infrastructure and presence of wayfinding signages sub-indicators were also correlated, but less significantly than thermal comfort, proximity and covered waiting area/resting stops.

The result of this study tells us that there are certain elements during urban transport planning and design that get overlooked. In this case, it’s the connection between the different public transport stations and stops. This only means that planners and designers must be updated and evaluate first the needs of the users of the proposed infrastructure and to see if it is still relevant.

5.2 Recommendation for Future Studies

Since the study is limited to the evaluation of selected sub-indicators to limit the time needed to answer the questionnaire survey of the commuter, it is recommended that the other sub-indicators mentioned in this study should also be evaluated to check their consistency with the passenger mode transfer satisfaction. It is also suggested to further study if some sub-indicators can be measured directly through fieldwork rather than through questionnaire survey.

The identified indicators in the study can be used as a guide in questionnaire surveys targeted at non-users of the EDSA Busway. This will help the relevant local agencies and transport planners evaluate the needs of the other commuters to increase the population of EDSA Busway commuters. It is also highly advised to include non- physical indicators such as information and monetary in the calculation of the MT quality index.

Since the study is a pilot project limited to the EDSA Busway, it is recommended to replicate the methodology for other major transportation hubs in Metro Manila and possibly create a general weight per indicator through further studies. It is accepted that the procedure can take some time. Therefore, more research may look for methods to make the process simpler.

ACKNOWLEDGEMENT:

This research study is funded by the Department of Science & Technology through the Engineering Research and Development for Technology (ERDT) fund. The researchers would like to acknowledge Ms. Maria Gloann Basco and her team during the conduct of the public realm survey

REFERENCES

ALMEC Corporation & Oriental Consultants Global Co., Ltd. (December 2015). The project for capacity development on transportation planning and database management in the republic of the philippines: MMUTIS update and enhancement project (mucep). Retrieved from https://openjicareport.jica.go.jp/pdf/12247615.pdf.

Bergstad, C.J., Gamble, A., Gärling, T., Hagman, O., Polk, M., Ettema, D., Friman, M., Olsson, L.E. (2010). Subjective well-being related to satisfaction with daily travel. Transportation 38, 1–15 (2011). Retrieved on https://link.springer.com/article/10.1007/s11116-010-9283- z.

Berlepsch, H.-J. von, Bottger, C., Brehl, S., Breithaupt, M., Dewes, M., Ebel, S., Versemann, N. (2018). Public transport integration and transit alliances. Frankfurt:GIZ- SUTP, Transformative Urban Mobility Initiative. Retrieved from https://smmr.asia/wp-content/uploads/2020/03/3f_Transit_Alliances_SUTP_TUMI_GIZ_final.pdf.

Booysen, F. (2002). An overview and evaluation of composite indices of development. Retrieved from https://link.springer.com/article/10.1023/A:1016275505152.

Bridgwater, L., Rajpurohit, S., Kennedy, K. & Herbert, M. (2022). For vibrant us cities, invest in multi-modal transportation. Retrieved from https://www.wri.org/insights/us-cities- multi- modal-transportation-benefits.

Brons, M., Givoni, M. & Rietveld, P. (2009). Access to railway stations and its potential in increasing rail use. Retrieved from https://www.sciencedirect.com/science/article/pii/S0965856408001456 ?fr=R R-2&ref=pdf_download&rr=8bca39c3dc9840de.

Ceder, A. (2007). Public transit planning and operation: Theory, modeling and practice. Oxford, UK, Elsevier.

Chawla, T., Eijdenberg, E., & Wood, J. (2021). Chapter 11 - Environmental Resilience of Bottom of the Pyramid Strategies Toward Single-Use Plastics: A Recipe From an Emerging Economy. In T. Chaiechi (Ed.), Economic Effects of Natural Disasters (pp. 161-178 https://doi.org/10.1016/B978-0-12-817465-4.00011-X). Academic Press.

Chowdhury, S. & Ceder, A. 2013. Definition of planned and unplanned transfer of public- transport service and users' decision to use routes with transfers. Journal of Public Transportation 16(2): 1- 20.

Chowdbury, S., Ceder, A., & Velty, B. (2014). Measuring Public-Transport Network Connectivity Using Google Transit with Comparison across Cities. Retrieved from https://digitalcommons.usf.edu/cgi/viewcontent.cgi?article=1005&context=jpt

Dewitt, W. & Clinger, J. (2000). Intermodal freight transportation in the new millennium. Transportation Research Board (TRB).

De Vos, J.: Analysing the effect of trip satisfaction on satisfaction with the leisure activity at the destination of the trip, in relationship with life satisfaction. Transportation. Published online: 23 August 2017.

Esty, D., Levy, M., Srebotnjak, T. & de Sherbinin, A. (2005). Environmental sustainability index.Yale Center for Environmental Law and Policy.

Fillone, A., Dadios, E., Billones, R.K., Roxas, N.Jr., Era, M., Lucas, K.J., Abad, R.P. & Roquel, K.I.D. (2020). Metro manila transportation network: big data analytics and applications.

Galanis, A. & Eliou, N. (2011). Evaluation of the pedestrian infrastructure using walkability indicators. Retrieved from 54-653-libre.pdf (d1wqtxts1xzle7.cloudfront.net).

Givoni, M. & Rietvald, P. (2007). The access journey to the railway station and its role in passengers' satisfaction with rail travel. Retrieved from doi:10.1016/j.tranpol.2007.04.004(sciencedirectassets.com).

Groenendijk, L., Rezaei, J. & Correia, G. (2018). Incorporating the traveller's experience value in assessing the quality of transit nodes: A Rottercam case study. Retrieved from https://www.sciencedirect.com/science/article/pii/S2213624X17303577.

Guo, Z., and Wilson, N.H.M. (2004). Assessment of the transfer penalty for transit trip. Transportation Research Record 1872: 10-18.

Hadas, Y. & Ranjitkar, P. (2012). Modeling public- transit connectivity with spatial quality-of- transfer measurements. Retrieved from https://www.sciencedirect.com/science/article/pii/S0966692311002274.

Hardi, P. & DeSouza-Huletey, J.A. (2000). Issues in analyzing data and indicators for sustainable development. Retrieved from https://www.sciencedirect.com/science/article/pii/S030438000000202 7.

Institute for Transportation & Development Policy. 2016. What is brt?. Retrieved From https:// bus-rapid- transit-standard/what-is-brt/.

Krambeck, H. (February 2006). The global walkability index: Talk the walk and walk the talk. Retrieved from https://www.gtkp.com/assets/uploads/20100110- 055641-2412-articles-60499_paper.pdf.

Kranjc, D. & Glavič, P. (2005). A model for integrated assessment of sustainable development. Retrieved from https://www.sciencedirect.com/science/article/pii/S092134490400120X.

Lacsamana, B. (October 2022). Privatization of the edsa carousel. Retrieved on https://www.bworldonline.com/the-nation/2022/10/24/482495/explainer- transportation-privatization- of-the-edsa-carousel/.

Litman, T. (2019). Introduction to multi-modal transportation planning. Retrieved from https://www.vtpi.org/multimodal_planning.pdf.

Mateo-Babiano, I., Recio, R., Ashmore, D., Guillen, M., & Gaspay, S. (2020). Formalising the jeepney industry in the Philippines – A confirmatory thematic analysis of key transitionary issues. Research in Transportation Economics, 83, https://doi.org/10.1016/j.retrec.2020.100839.

Mishra, S., Welch, T. & Jha, M. (2012). Performance indicators for public transit connectivity in mulit-modal transportation networks. Retrieved from https://www.sciencedirect.com/science/article/pii/S0965856412000705.

Moayedi, F., Zakaria, R., Bigah, Y., Mustafar, M., Che Puan, O., Zin, I.S. & Klufaallah, M. (2013). Conceptualising the indicators of walkability for sustainable transportation. Retrieved from https://journals.utm.my/jurnalteknologi/article/view/2151/1716.

Moovit. (2024). TFRB - Schedules, Routes and Stops. Retrieved from https://moovitapp.com/index/en/public_transit-lines-Manila- 1022-9969.

Nag, D., Manoj, B.S., Goswarmi, A.K. & Bharule, S. (2019). Framework for public transport integration at railway stations and its implications for quality of life. ADBI Working Paper Series, No. 1054, Asian Development Bank Institute (ADBI), Tokyo. Retrieved from https://www.econstor.eu/bitstream/10419/22282 1/1/168 6371632.pdf?fbclid=IwAR2m8gT5u2bTcEUvv2J--dO2n30B9rEqeHbDygcgRSBeB9i7- g3fUV6L7A8.

Nigro, A., Bertolini, L. & Domenico Moccia, F. (2019). Land use and public transport integration in small cities and towns: Assessment methodology and application.

Nogueira, A.C.C.S. & Diaz, C.E. (2023). Evaluating public transport accessibility and walkability in Pasig City (Philippines) and their correlation to socioeconomic factors at the barangay level.

Retrieved from https://www.sciencedirect.com/science/article/pii/S2185556023000226.

Saliara, K. (2014). Public transport integration: The case study of Thessaloniki, Greece. Retrieved from https://www.sciencedirect.com/science/article/pii/S2352 14651400324X

Schlossberg, M. & Brown, N. (2004). Comparing transit-oriented development sites by walkability indicators. Retrieved from https://journals.sagepub.com/doi/epdf/10.3141/1887-05.

Schroder, M. & Solchenbach, I. (2006). Optimization of transfer quality in regional public transit. Retrieved from https://kluedo.ub.uni-kl.de/frontdoor/index/index/docId/1709.

Singh, R.K., Murty, H.R., Gupta, S.K. & Dikshit, A.K. (2006). Development of composite sustainability performance index for steel industry. Retrieved from https://www.sciencedirect.com/science/article/pii/S1470160X0600055 0.

Singh, R.K., Murty, H.R., Gupta, S.K. & Dikshit, A.K. (2012). An overview of sustainability assessment methodologies. Retrieved from https://www.sciencedirect.com/science/article/pii/S1470160X1100024 0.

Sinha, S. (October 2021). Evaluation of public transport integration in Indian cities. Retrieved from http://www.urbanmobilityindia.in/Upload/Conference/5 1feecda-9cc7-4301- b372- 621acdcb3845.pdf.

Telega, A., Telega, I. & Bieda, A. (2021). Measuring walkability with gis - methods overview and new approach proposal. Retrieved from https://www.mdpi.com/2071- 1050/13/4/1883.

Teng, H., Toughrai, T., Yu, T., Ozawa, R. & Hu, B. (2014). Developing seamless connections in the urban transit network: A look toward high-speed rail interconnectivity. Retrieve from https://transweb.sjsu.edu/mntrc/research/Developing- Seamless-Connections- Urban- Transit-Network-Look- Toward-High-Speed-Rail- Interconnectivity.

Wolcott, M., & Lobczowski, N. (2021). Using cognitive interviews and think-aloud protocols to understand thought processes. Currents in Pharmacy Teaching and Learning, 12(2), 181-188. https://doi.org/10.1016/j.cptl.2020.09.005.

Woldeamanuel, M. & Olwert, C. (2016). The multimodal connectivity at bus rapid transit(brt) stations and the impact on ridership. Retrieved from https://www.researchgate.net/publication/337468651_The_Multimodal_Connectivity_at_Bus_Rapid_Transit_BRT_Stations_and_the_ Impact _on_Ridership.

Yang, Y., Li, D. & Li, X. (2019). Public transport connectivity and intercity tourist flows. Retrieved from https://journals.sagepub.com/doi/full/10.1177/0047287 517741997.

Zimmerman, R., Restrepo, C., Sellers, J., Amirapu, A., Pearson, T. and Kate, H. (2015). Multimodal transit connectivity for flexibility in extreme events. Retrieved from https://journals.sagepub.com/doi/epdf/10.3141/2532-08.

Zhen, F., Cao, X. Tang, J. (2018). The role of access and egress in passenger overall satisfaction with high speed rail. Retrieved from https://link.springer.com/article/10.1007/s11116- 018- 9918-z.

Zheng, J., Garrick, N., Atkinson-Palombo, C., McCahill, C. & Marshall, W. (2013). Guidelines on developing performance metrics for evaluating transportation sustainability. Retrieved from https://www.sciencedirect.com/science/article/pii/S2210539513000047.

Zhu, Z., Zhang, A. & Zhang, Y. (2019). Measuring multi-modal connections and connectivity radiations of transport infrastructure in China. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/23249935.2019.1642966?journalCode=ttra21.

Zurbano, J. (June 2020). Edsa busway seamless and faster–dotr. Retrieved from https://manilastandard.net/news/top- stories/326856/edsa-busway-seamless-and- faster- dotr.html.