User Mode Choice Behavior in Public Transportation: A Systematic Literature Review

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ABSTRACT

With the staggering concerns in environmental pollution caused by the transportation industry, researchers have ventured their studies to identify the primary factors that may affect an individuals' propensity to choose public transportation as more sustainable transportation. Numerous research studies are surrounding this subject; however, no effort has been made to systematically review them for a synthesized analysis. There is also a lack of study in identifying contributing factors that may potentially affect each other to determine the propensity to take public transportation and identify their relationships to each other to provide a guide for future researchers to analyse and consider for future work. With the motivation to tackle the existing research inadequacies, we conducted a study that focuses on using a systematic literature review methodology with validated analyses on existing studies. This study found that demographic factors are the most analysed aspect, followed by transportation, trip-related and environmental. Secondly, our study provides new insight into several contributing factors affecting each other in predicting public transportation ridership. Thirdly, our findings also demonstrate the trends and gaps that occur in different geographical areas. The outcomes of our research present a consolidated view for relevant authorities to cater their strategies tactically according to each geographical area and identify potential opportunities for future research.

INTRODUCTION

The rapid overpopulation of the world has provoked expeditious urbanization, diversification, and increased density to developing cities globally. To accommodate the density of large populations, the need for a sustainable transportation system becomes imperative every day. This is due to the dependence on automobile transportation which contributes to major environmental problems such as traffic congestion and the emission of greenhouse gases (Majumder et al. 2019). To reduce these transportation ramifications, it is necessary to encourage the public to change their behavior in mode choice from private vehicles to public transportation (Ercan et al. 2017).

Public transportation (PT) has been recognized as a more sustainable and environmentally friendly option for transportation needs compared to cars (Litman 1999).

Therefore, numerous studies have taken an approach to advance public transportation into smart public transportation to accommodate a smart city concept. For example, Naik et al. (2019) suggest that electrified public transit can reduce motor vehicle usage which leads to better air quality. Mohamed et al. (2021) examined the factors affecting the travel time reliability of bus transport, while Tuan (2015) assessed people's travel behavior patterns to anticipate mode choice for better policymaking towards sustainable public transportation development. Gohar et al. (2018) has designed a structure for a smart transportation system that incorporates "city-wide traffic management, smart parking assistance, public transportation services, logistics, real-time traffic, and road speed limit monitoring and management" (p. 117). Jang et al. (2020) investigated how pricing schemes affect mode choice on sustainable transportation.

Before urban planners implement any transportation architecture into a city, it is important to understand the area of study and if the contributing factors in the area are suggestive enough to confirm a positive acceptance or preferred mode choice from its users to take public transportation more often. Identifying the factors that influence public transportation mode choice is important because it helps in better strategies in implementing a more sustainable transportation system structure to suit users' needs and preferences.

Based on our literature study, it shows that research conducted in different countries demonstrate different mode choice. Although there are numerous literatures review related investigation on public transportation mode choice, there is lack of study systematically review how different demographics in different regions may influence mode choice. The current state of a literature review regarding public transportation use although several, but is widely scattered across different locations, perspectives, time, and analytical approaches (Hanssen et al. 2019; Unworth et al. 2019). We consider a systematic literature review is required to provide a synthesized view of the data and a guide for academics to perform further research to extend the findings to directly address how different demographic aspects in the different regions impact each influential factor as well as the gaps that lie within the field of study. Furthermore, urban planning authorities would be able to use our research outcomes to structure their strategies accordingly based on their regional and demographic characteristics to map out the mode choice factors to be considered for the development of public transportation infrastructure.

To fill the research gap, this study aims to examine the influential factors that cause individuals to take public transport from systematic literature reviews, and how different regional characteristics impact the influential factors. This study also investigates the evolving trends of mode choice factors studied through time as well as systematically highlights the gaps that have not been studied by literature. The objectives of the study are to address the research questions (RQ) listed below with the following contributions to each research question:

RQ 1: What are the individual significant factors identified by prior studies that influence public transportation mode choice and how do they evolve through time?

Motivation for RQ 1: Provide a consolidated view and contextual view of mode choice factors in different settings for transportation planning authorities and policymakers to consider to encourage public transportation use. This study also analyses mode choice factors that have evolved in the past 15 years to suggest potential factors underlined within the trends, gaps, and opportunities for future research.

RQ 2: Are there any combined factors that occur frequently and how can we demonstrate their potential relationship?

Motivation for RQ 2: Identify potential contributing factors that may affect each other to determine the propensity to take public transport and identify their relationships to each other to provide a guide for future researchers to analyze for future work.

RQ 3: What are the underlying trends and gaps that can be found from influential factors to take public transportation from different parts of the world?

Motivation for RQ 3: Provide thorough descriptive statistics of the studies which address factors affecting public transportation ridership and provide an overview of the range of time, area of coverage, and the main categories mentioned in these articles. Furthermore, this study aims to identify any trends that vary geographically over time.

The remainder of this study is organized as follows. Section 2 presents a literature review on the background of public transportation, common contributing factors to use public transport such as demographic effects, environmental effects, trip-related and transportation-related effects as well as a background of systematic literature reviews. Furthermore, this study continues with an in-depth research methodology of the study in Section 3, followed by the results in Section 4 which are displayed by each research question with a detailed discussion on the review. We discuss the results and recommendations in Section 5. Finally, Section 6 concludes our study and gives suggestions for future study.

LITERATURE REVIEW

INFLUENTIAL FACTORS TO USE PUBLIC TRANSPORTATION

There have been many different studies addressing public transportation mode choice from various disciplines and points of view. Mode choice analysis consists of analyzing the factors that may affect an individual's decision to take a transportation mode. The following presents the relevant studies analyzing common factors from the effects of demographic attributes, environmental attributes, trip-related attributes, and transportation-related attributes.

Demographic data is one of the most common and contributing factors that can be used to analyze human behavior. Some studies that addressed specialized demographic variables like age, specifically elders, noticed a positive response to public transportation use as age increases (Böcker et al. 2017; Habib 2015) whereas others showed negative responses (Moniruzzaman et al. 2013). Some research papers indicated that individuals from

higher economic income choose public transportation less (Molin et al. 2016; Myung-Jin et al. 2018). Asgari et al. (2017), as well as Tal and Handy (2010), analyzed the mode choice behavior of immigrants based on survey data. In this case, both studies showed similar responses indicating that immigrants are more likely to use public transportation compared to migrants. Raveau et al. (2014) emphasized that it is vital to understand the behavior of the demographic in public transportation planning. Generally, when an individual is favorable of public transportation, they will be more motivated to take public transportation. However, along with those effects, a positive evaluation of cars could also produce a negative effect on public transportation use (Schoenau & Müller 2017).

The trip characteristics can also be a contributing factor to the travel behavior of each person. For trip purposes, Currie and Delbosc (2011) and Meloni et al. (2013), and many others found that there is a significant positive use of public transportation for work purposes, whilst other scholars found a negative use for shopping trips (Chikaraishi et al. 2011). Other than that, researchers concluded that individuals tend to use public transportation for longer distances trips (Zhang et al. 2017; Ahern et al. 2017; Goel & Tiwari 2016). Michelson and Lachapelle (2016) argue that the traveling period of public transportation is highest during the morning and afternoon rush whilst Böcker et al. (2013) argue that the traveling period is higher at night. Besides that, Ahmad Termida et al. (2016) mentioned that the summer period has a positive effect on public transportation use whilst Pronello et al. (2017) mentioned that the summer period has a negative effect. It is useful to note that these areas may have different environmental changes during the summertime as they are studied in different countries.

Many transportation system characteristics can drive an individual to use public transportation or not. Based on past research, good quality, comfort, safety, and reliability are the few types of service quality attributes of public transportation that would encourage more public transportation use. Individuals would be more likely to take public transportation if the cost for taking public transportation is lower, either from cost deductions (Abou-Zeid et al. 2012; Desai & Joshi 2016) monetary discounts (De Vos et al. 2016), or by a using a public transportation card (Hasnine et al. 2018). The effects of transportations other than public transportation may independently affect a person's choice to take public transportation regardless of the quality of public transportation. With car ownership, the accumulative costs of car usage for parking, fuel rates, a congestion fee may induce a person's decision to switch to a cheaper option like public transportation (Delsaut 2014; Levin et al. 2017).

Concerning environmental related factors, findings show that a general effect of good weather tends to increase public transportation use in some studies (Ahern et al. 2017; Etminani-Ghasrodashti et al. 2018; Outwater et al. 2011). However, this finding was opposed to a study by Anta et al. (2016) which concluded that on the occasion of favorable weather, individuals choose public transportation less. Most studies concluded that snow and rainfall provide a negative impact on public transportation use. De Abreu Silva et al. (2012) and Guerra et al. (2018) proved that residents who are concentrated in dense, urban areas are highly likely to take public transportation in Canada, Belgium, and Mexico respectively. Fatmi and Habib (2017) as well as Frank et al. (2008) derived similar views regarding areas with mixed land use as a suggestive factor for public transportation propensity. Mixed land use is an urban planning strategy that incorporates residential, commercial, and industrial sectors in one single area with accommodating transportation such as public transportation to benefit the citizens in the area (Mohammed et al. 2016; Appleyard et al, 2020). The social influence of an individual's environment such as employment social construct and school-related attributes have also been highlighted from previous studies. Grimsrud and El-Geneidy (2013) along with Guerra et al. (2018) and Ding et al. (2017) studied the travel behavior of individuals that are affected by the employment density of the area to positively affect public transportation.

SYSTEMATIC LITERATURE REVIEW (SLR)

An SLR is one of a qualitative approach that adopts meticulous identification and synthesis of a collection of empirical data which are mined according to a set of predefined research questions (Higgins & Green 2011; Moher et al. n.d.). The history of the implementation of SLRs started in the medical science and education field and was formally referred to as a "meta-analysis" research (Smith and Glass, 1980). Although it appeared as a common medical method of analysis, this methodology was not shyly adjusted into other areas of interest, proving that it ranks itself as a reliable and transparent process to analyze qualitative studies (Tranfield et al. 2003).

The main difference of an SLR to narrative reviews is the application of a pellucid scientific standard of methodology which produces unbiased deductions by exhaustive and specifically protocol-driven screening of literature studies to address an objective or research question (Cook et al. 1997; Burgers et al. 2019). Traditional narrative reviews are not directed with a purpose or intention other than to give a summary of the specified topic (Kysh Lynn, 2013). Unlike narrative reviews, this

approach proved a more legitimate data analysis which in turn would produce more legitimate results (Parris & Peachey 2013).

The outcomes of an SLR can be useful to academics, practitioners, or managers to provide a dependable source of information collated from many different studies (Tranfield et al. 2003; Kushwah et al. 2019). Burgers et al. (2019) gathered a list of applications of SLR in interdisciplinary research. Firstly, an SLR can describe a specific subject matter that has been addressed by many different disciplines. Furthermore, it acts as a data mining approach to collate different insights and analyze the interactions between opposing or agreeing on opinions. As there is no one fixed standard to approach theoretical study, there are numerous methodologies adapted to confront a particular research question. An SLR acts to synthesize and define the different approaches as well as identify opportunistic gaps to approach the problem statement. Finally, the ability to expand quantitative meta-analysis on weighted effect sizes on SLR reveals new insights across varying disciplines.

RESEARCH METHODOLOGY

SLR MODEL

The motivation behind using an SLR model is to provide a comprehensive view to obtain general conclusions that can be made given the number of prior researches obtained. The following steps were conducted:

1) Developing an SLR Protocol and identifying the research questions

To provide a clear aim to lead the systematic review, an SLR protocol is formed to list each step of the reviewing process. A review protocol is defined as a structured scheme to guide the entire SLR methodology (Kitchenham, 2007). The research questions, selection and deselection criterion, search strategy, quality assessment, and reliability are all specified within the protocol (Dybå & Dingsøyr, 2008; Kitchenham, 2004). This protocol adopts some of the practices from Higgins and Green's (2011) Cochrane Handbook for Systematic Review of Interventions as well as the process based on Kitchenham (2004) to systematically review literature that outlines influential factors that correlate to the propensity of public transportation mode use. The classification of a transportation mode which would be defined as public transportation will be referred to the definition given previously by APTA (American Public Transportation Association 2019). The SLR began by outlining a set of research questions along with

contribution objectives to provide a clear guide during the research for considering the inclusion of literature papers that have been included in the introduction (Higgins & Green 2011).

2) Search Strategy and Selection Criteria

The resource collection was obtained from several electronic sources and databases. The search strategy of the literature extraction is to obtain journals from databases according to a set of keywords used as a search criterion through legitimate e-journal database resources as follows:

1.   ScienceDirect (http://www.sciencedirect.com/)
2.   IEEE Xplore (http://ieeexplore.ieee.org/)
3.   ACM online library (http://dl.acm.org/)
4.   Springer (http://www.springer.com/)
5.   Google Scholar (https://scholar.google.com)

A variety of keywords as well as combination strings of keywords were used to mine the relevant work. Different combination strings or keywords with different synonyms are used to increase the probability of obtaining the most pertinent papers (Pang et al. 2017; Miteniece et al. 2017). The keywords are as follows: "transit", "travel", "commute", "transport", "behave", "intention", "pattern", "smart card", "trip", "route choice", "path choice", "prefer", "mobility", "flow", "journey"," attitude", "trajectory", "public", "characteristics".

In this research study, we only focus on public transportation on lands, such as road transportation (bus, taxi, e-hailing, etc.) and rail transportation (intercity rail, intracity rail, etc.) instead of water or air transportation because land-related transportation is more relevant to the implementation of more sustainable transportation architecture into a city based on our findings in PT mode choice as we explained in the Introduction section.

The following selection criteria are implemented during the extraction of papers to ensure that all the related works are relevant and suitable:

1.   English Language Papers
2.   Published between 2004 to mid-2019
3.   Peer-reviewed papers
4.   Published in the listed online databases

3) Study Selection Process

Referring to Figure 1, Stage 1 produced 2732 journal papers just by extraction using keywords from the chosen databases. The stopping criteria for the searching and scraping process were determined when three consecutive pages of the database contain less than 2 relevant articles.

As Higgins and Green (2011) suggest, two different reviewers were involved in the screening of the 2732 papers separately in the next processes. In Stages 2 and 3, Duplicate papers and non-peer-reviewed papers were removed. In Stage 4, the title and abstract are reviewed and excluded if the literature fell under the exclusion criteria. The abstract was screened only if the title did not include evidence of any exclusion criteria. In Step 5, both reviewers independently assess eligibility according to the inclusion and exclusion criteria. Papers that did not fell under the selection criteria were discarded from the analysis. Any disagreement was discussed with rationale evidence to decide inclusion or exclusion. The final stage of screening obtained 280 pieces of potential literature for analysis.
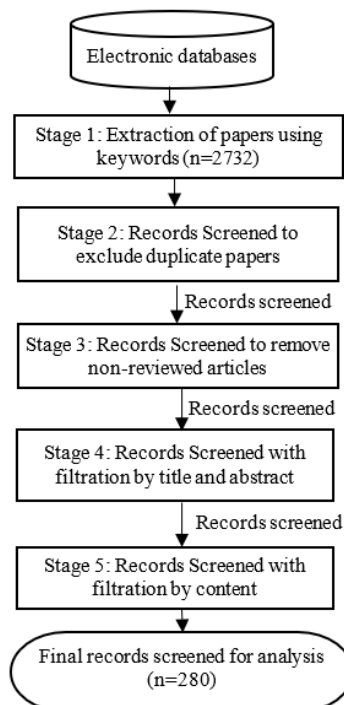

FIGURE 1. Study Selection Process

4) The Validity of the Data Collection Process

A triangulation test was done to increase the confidence in the selection criterion of both reviewers (Hartley & Sturm 1997). To ensure the validity of the data collection process, Cohen's κ was run to determine if there was an agreement between two researchers' judgment on whether the 2732 articles were qualified according to the selection criteria for analysis. The selection validation was reflective of Cohen Kappa's statistic which shows the agreement of selected papers based on both reviewers to evaluate the quality of the selection method. There was strong agreement between the two researchers' judgments, κ = 0.890 (95% CI, 0.300 to 0.886), p < .0005 based on Kappa's statistic.

5) Data Extraction, Aggregation, and Analysis

The final 280 chosen studies were reviewed systematically for data extraction using a data extraction form, one at a time both reviewers to extract the influential factors that influence individuals to take public transportation along with research settings of the chosen studies. The aggregation of the factors of interest, excluding the paper's metadata was collated according to their relevance to each other or a categorized level. To allow a better evaluation of the summarized results, all the factors were aggregated into categories that share similar topics. In this study, we have obtained 4 different levels of aggregation: i) Demographics; ii) Trip characteristic; iii) Transportation system characteristic and iv) Environmental aspect.

RESULTS

DESCRIPTIVE STATISTICS

The findings of this study were found to span 6 major continents around the world, including mixed or unspecified continents. Most of the studies come from Europe (35.0%), Asia (29.6%), and North America (25.7%) which covers slightly more than 90% of all the prior studies found. The prior studies have been conducted in over 43 countries, with the top 10 that cover more than 77% of the relevant studies are listed in Table 1.

TABLE 1. Top 10 list of percentage of analysed articles by country

Country (Continent)	Percentage of all articles found
USA (North America)	17.5%
China (Asia)	15.4%
UK (Europe)	8.9%
Canada (North America)	7.9%
Netherlands (Europe)	7.1%
Germany (Europe)	6.3%
Australia (Oceania)	5.7%
Spain (Europe)	3.2%
India (Asia)	3.2%
Japan (Asia)	2.1%
Others	22.7%

Figure 2 displays the distributions of the included articles by their publication date. The publications of the analyzed articles range from 2005 up to 2019 (till the end of March 2019). As we can see from the graph, there is a general increase through the years, a spike of articles addressing factors that affect public transportation ridership

around 2012 to 2014 extensively in Asia and Europe followed by an exponential growth to 2018 (data from 2019 January-June is not included in Figure 2 to avoid misleading visualization as we are comparing whole year data) from studies around Asia, Europe, and North America.
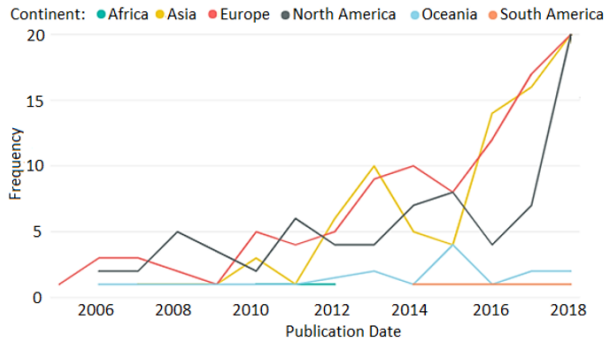

FIGURE 2. Frequency of published articles through time by continent

In total, there were 157 individual factors obtained which were significant predictors for people to take public transportation. Based on the 157 factors identified from the 280 articles, we further mapped and aggregated the factors into Level and 1 and Level 2 as listed in Table 2 to enable further generalized analyses. A detailed description of the rationale for the aggregation mechanism can be obtained from the Additional Materials provided in the earlier section.

From Table 3, we can observe that demographic factors gained the most attention from prior studies, followed by public transportation characteristics and trip-related factors.

TABLE 2. Aggregated Levels of Factors Identified

Aggregation Level 1	Aggregation Level 2	Factors studied
Demographics	Basic Demographic	Immigrant Related
		Basic demographic
		Economic/social status
		Education
		Work-related
		Physical health
		Parent Information
		Household related
		Car/Bike usage attributes
	Behavioral /beliefs	Car/Bike behavior/belief/Perception
		PT related behavior
		Social influence
		Value of Time/Energy
		General behavior
		Perceived safety
Trip Related	Trip Related	Other Trip details
		Traveling period
		Destination related
Transportation	Car or other transportation	Car Parking
		Car costs
		Car characteristics
		Alternatives for PT
	Public Transportation (PT) characteristics	PT service quality
		Accessibility of PT
		Cost/Discounts of PT
		Stations/Route Related
		PT characteristics
		PT amenities
Environment	Location Structure	Basic Environment Characteristics
		Environment Sizes
		Area density
	Traffic Congestion	Traffic Congestion
	Road	Road-related
		Non-Automobile Road
	Social Structure	Employment-related
		Government Regulations
		School Environment
	Weather-Related	Weather-related

TABLE 3. List of the occurrence of factors by category and continents in the second level of aggregation

1st Level	Continent 2nd Level Aggregation (*%)	Africa	Asia	Europe	Mixed/ Unspecified	North America	Oceania	South America
Aggregation (*%)	Basic Demographic (65.7%)	2	157	141	1	184	31	4
Demographics	Behavioral /beliefs (12.9%)	1	28	36	2	16	3	0
	Trip Related (24.3%)	1	68	62	3	38	12	0
Trip Related	Car or Other Transport (6.1%)	0	14	17	4	9	5	0
Transportation	PT Characteristics (42.5%)	5	122	119	15	109	19	3
	Location Structure (19.3%)	1	19	54	3	50	8	0
Environment	Traffic Congestion (1.1%)	0	1	3	3	3	2	1
	Road (3.6%)	0	6	1	0	10	2	0
	Social Structure (3.6%)	0	4	2	1	10	0	0
	Weather-Related (2.1%)	0	4	6	0	4	3	0

* Percentage of total distinct articles over 280 articles studied

RESULTS AND DISCUSSION BASED ON RQS

RQ 1: What are the individual significant factors identified by prior studies that influence public transportation mode choice and how do they evolve through time?

The results for the following research will follow per the aggregated groups to give a more substantial and summarized finding.

1) *Demographic. Findings for demographic factors are summarized in Table 4.*

It is found that 33.9% of the total studies mention age group and 31.8% mentioning economic or income factors, making them the most mentioned significant factors of all 157 factors. This shows that the adoption of taking public transportation differs for different age groups and different income groups. The results obtained are not far from the expectations as younger individuals are more likely to be of lower income and better physical health to take public transport.

TABLE 4. Summarized table for Demographic factors

Level 2 Aggregated Category	Factor	Percentage (%)*	Characteristics contributing to the positive response to taking public transport
Basic Demographic	Gender		Out of 54 studies on gender: For males: 12=positive (9 from Asia), 7=negative, 35=insignificant (14 from North America) For female: 25=positive, 10 = negative, 19=insignificant (11 from Asia) Overall observation: Comparatively females are more favorable of public transport
	Age group	27/34(79.41%)	Age groups below 30 and above 50
	Economic Status	52/89(58.43%)	Lower economic status and income
	Education	16/28(57.14%)	Individuals with higher education especially higher than high school or university level
	Physical Health	4/4(100%)	Better physical health and physical activeness without medical conditions or disabilities
	Household related	2/2(100%)	If parents of riders are less available and less willing to drive their children around
		21/39(53.85%)	The smaller household size especially if households are children
	Immigrant Related	6/6(100%)	Immigrants with a short settlement period (all 6 studies from North America)
	Car Related	2/2(100%)	High immigrant concentration areas (all 2 studies from North America)
		35/36(97.22%)	Non-car or bike owners (With the exception for car owners who 'Park and Ride')

Behavioral / Beliefs	Behavior towards public transportation	45/50(90.00%)	Lesser cars owned in household
		5/5(100%)	Lower car dependency
		20/23(86.96%)	Non-licensed drivers
		3/3(100%)	High familiarity
		4/4(100%)	A longer history of usage
		6/6(100%)	High habit to take public transport
		8/8(100%)	Positive social influence from parents of other household members
		11/11(100%)	Positive self-evaluation and satisfaction with public transportation
		2/2(100%)	High acceptability on wait time
		17/18(94.44%)	High concerns for the environment
	Public transportation safety	8/8(100%)	Low concerns for privacy, crime, terrorist attacks on public transport, and safety
			More concerns for pedestrian crashes

*Percentage = (number of articles that showed a specific factor positive response to take public transport/number of articles that address the specific factor with positive and negative responses to take public transport)

Besides that, findings indicated that if the immigration concentration in an area is high, the individuals are more likely to take public transport. However, the longer the settlement period of the immigrant, specifically longer than 10-15 years the less likely they will be to take public transportation. All studies that analyzed immigrant-related information are from the USA, which holds an immigrant percentage of 28% of the whole population according to the recent 2019 Current Population Survey (CPS).
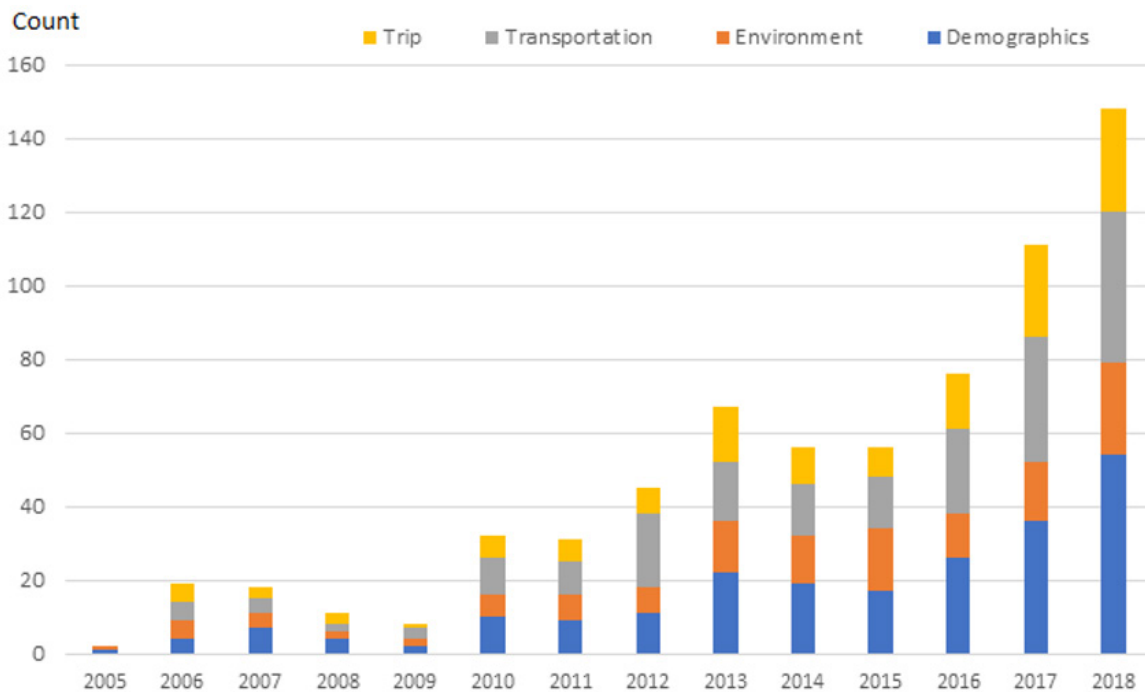

FIGURE 3. Aggregated factors studied through years 2005-2018

The proportion of researched aggregated factors seems consistent throughout the years, which demographic and transportation-related factors attracted more attention compared to others as shown in Figure 3.

Figures 4 – 9 compare the aggregated factors studied between different continents. Based on observation of this comparison, PT mode choice research is scarce in both Africa and South America before 2019, where the related research was only conducted between 2010-2012 in Africa, and the years 2014 and 2018 in South America. Trip-related factors were found not studied in South America before the year 2019. North America, Europe, and Asia demonstrate a similar pattern in terms of the proportion of different factors studied, which demographic-related factors gain the highest numbers of research throughout most of the years, followed by transportation-related

factors. After the year 2010, the Oceania continent consistently shows research interest in the impact of environment-related factors on mode choice and follows by the other factors throughout the years.

In summary, it is observed that the mode choice contributing factors are affected spatially and temporally. The mode choice contributing factors are differ based on the geographical locations (spatially) and with time (temporally). Most of the studies were carried out in Europe and North America as compared to Asia in the early years (2005-2010). However, when more cities are developed in Asia, more studies are catching up since the year 2013.
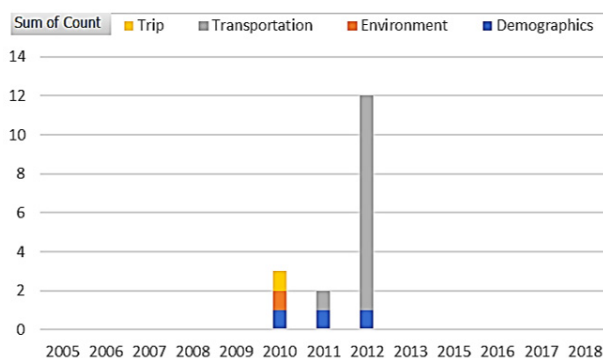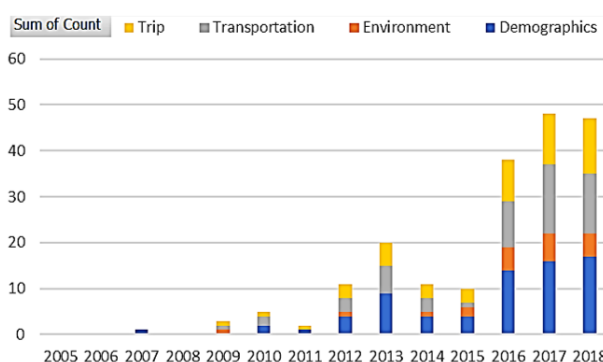

FIGURE 4. Aggregated factors studied in Africa

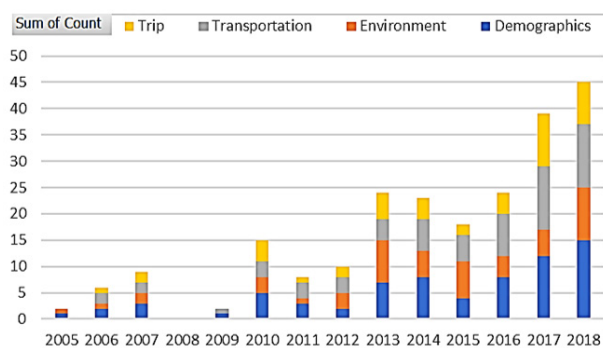FIGURE 5. Aggregated factors studied in Asia

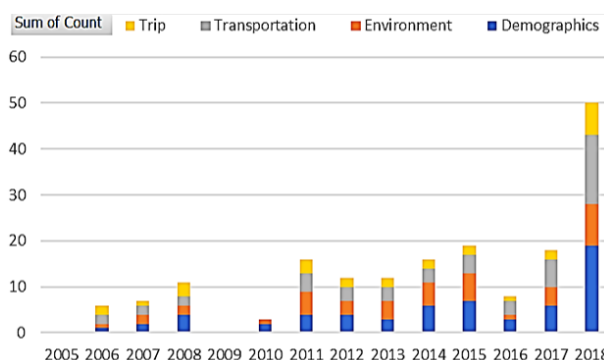FIGURE 6. Aggregated factors studied in Europe

FIGURE 7. Aggregated factors studied in North America

2) Trip Related. Findings for trip-related factors are summarized in Table 5.

Overall, there are many conflicting opinions on trip distance, with some favoring public transportation with an increase in distance and others with a decrease in distance.

Most of the articles analyzed in Asia and Europe specifically seem to favor public transportation more with an increase in trip distance. Several studies agree that there is a positive correlation to take public transportation on long journey trips. However, further analysis into journey duration shows that there is a negative correlation to take public transportation when the journey time is longer in Asia, North America, and Europe.
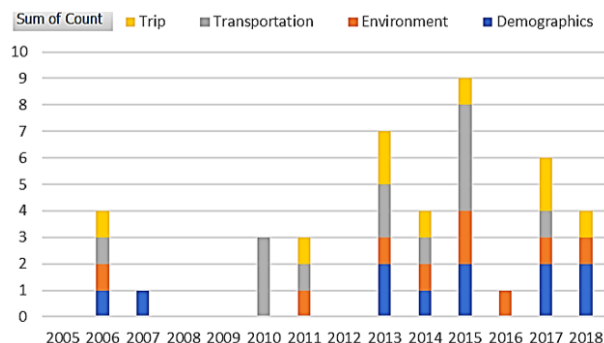

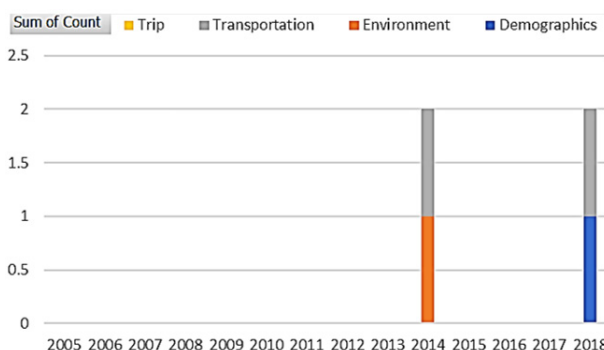FIGURE 8. Aggregated factors studied in Oceania

FIGURE 9. Aggregated factors studied in South America

Our findings show that leisure trips have both positive & negative effects on public transport, with more studies who favor public transportation for leisure especially in Asia, whilst some who do not favor public transportation for leisure in Europe.

TABLE 5. Summarized table for Trip related factors

Factor	Percentage (%)	Characteristics contributing to the positive response
Trip Distance	34/47(72.34%)	Longer distance trips
Journey duration	39/48(81.25%)	Short journey
Multimodal travel	2/2(100%)	More modal of transport is preferred in Europe
Trip Purpose	39/48(81.25%)	Types of a trip that are purposed for:
		(21/48=Work and school)
		(18/48=Non-work/Leisure Trips)
Travelling Period	5/8(62.5%)	A travel day on a weekday
	6/8(75%)	Travel during daytime

3) Transportation System Related. Findings for transportation system-related factors are summarized in Table 6.

The transportation system factors play a key role in influencing public transportation usage. This is because the choice to use public transportation laid on the ground comparison between public transportation and private vehicle. This means that both modes of transportation are competitive in getting travelers which are reflected in the findings as shown in Table 7. The car/bike-related factors show that the attractiveness of private vehicle usage reduced when there are more negative aspects in the system. It was shown that higher parking charges, higher fuel rates, and lesser parking availability at destinations discourage travelers from using a private vehicle. These are identified as the push factors, which discourage (push away) the travelers from using private vehicles.

TABLE 6. Summarized table for Transportation factors

Category	Factor	Percentage	Characteristics contributing to the positive response
Car or bike related factors	Parking Rates	12/13(92.3%)	Higher parking rates for cars except in Park and Ride situations
	Parking Availability	11/11(100%)	Lesser parking availability in settlements and destinations
		3/4 (75%)	More parking in railway stations or park-and-ride facilities
	Car use costs	10/10(100%)	Higher fuel rates
Public Transportation (PT) related	Public Transportation Service quality	10/10(100%)	Highly convenient
		23/23(100%)	Reliable
		7/7(100%)	Flexible
		32/33(96.97%)	Comfortable
		24/24(100%)	High Quality
		19/19(100%)	Safe
	PT Accessibility	62/65(95.39%)	Highly accessible to shopping, work, or other facilities
		16/19(84.21%)	Shorter distance to Public Transportation
	Cost of PT	54/55(98.18%)	Cheaper fee
		20/20(100%)	More concession cards for students and the elderly
	Station and Route Related	2/2(100%)	A higher number of routes
		9/9(100%)	A higher number of transfers
		4/7(57.14%)	A higher number of stops
	Characteristics of PT	2/2(100%)	Higher seat availability
		2/2(100%)	A higher level of Public transportation connectivity
		17/18(94.44%)	Higher frequency of public transport
		9/10(90%)	The higher speed of public transport
		11/11(100%)	Shorter wait time
	PT Amenities	3/3(100%)	Contains air conditioning
		2/2(100%)	Contains Wi-Fi
		5/5(100%)	Contains Real-Time PT Information
		1/1(100%)	Contains surveillance

TABLE 7. Summarized table of Environmental factors

Factor	Percentage	Characteristics contributing to the positive response
Basic Environmental Characteristics	54/78(69.23%)	Urban neighborhoods (trend increases from 2002 to 2015)
	5/5(100%)	Shorter distance to the central business district and shopping areas
	22/27(81.48%)	A denser and more compact city
	2/2(100%)	Higher residential density
	7/8(87.5%)	Areas of mixed land use
	12/13(92.31%)	More Congested traffic
Traffic Congestion and Road Related	6/6(100%)	More road intersections, higher road density, and longer lengths of highways
	2/2(100%)	More sidewalks
Non-Automobile Road	4/4(100%)	More weather-protected walkways
	8/8(100%)	Areas of high employment rate especially in North America
Employment-Related	2/4(50%)	Individual works from home or near retail locations
	11/14(78.5%)	Better weather especially with areas of lesser rainfall is more favorable
Weather	2/3(66.67%)	Higher temperature (in North America and Europe)
	2/3(66.67%)	Higher temperature (in North America and Europe)

On the other hand, improvements to the public transportation system act as pull factors that attract more ridership. This includes enhancing public transportation service quality (such as convenience, reliability, flexibility, comfort, and safety). Nonetheless, these are soft aspects of the system as they involve travelers' perception of service quality. Different passengers on the same public transportation system may perceive differently as everyone has a different standard perception. The hard aspects of the system could influence travelers as well that include public transportation accessibility and distance, availability of park-and-ride facilities, route numbers, transfers, connectivity, frequency, speed, waiting time, and others. These are from the supply-side which are controlled variables by the system provider or operator. Some of these (such as the location of transit stations, connectivity, park-and-ride facilities, and others) required careful consideration during the planning stage.

Other important factors that could attract ridership are the existence of Wi-Fi on public transportation and real-time information about public transportation. The existence of Wi-Fi on-board allows the passengers to access the internet for leisure and work-related affairs. The dissemination of real-time information allows passengers to plan their journey. These are new factors that could affect travelers' mode choice behavior in this digital era.

Several articles expressed that a type of neighborhood could greatly influence if an individual would take public transport. Findings show that urban areas are known to positively respond to public transportation in Europe, Asia, and North America. The results show that this is an increasing trend from the years 2002 to 2015. In the same timeline, we may also notice an increase in a negative response to public transportation in suburban areas

especially in Europe and North America. We can compare and notice that each continent responds differently to each type of neighborhood.

As there are many references to trip purposes to work or shopping, accessibility to shopping areas, and high propensity to take public transportation in urban areas, it is also essential to ensure that there are accessible walkways from the public transportation to these areas. With higher sidewalk density, Whalen et al. (2013) found that users are less likely to take public transportation as they would be more likely to walk than to take public transportation in Canada. However, a surprising finding from Spears et al. (2013) in Los Angeles found that more pedestrian lanes in neighborhoods result in a high propensity to take public transportation. This could be because most individuals in Los Angeles are required to walk to public transportation stations. Furthermore, many studies have extended their studies that it is also a contributing factor to have weather-protected walkways to increase the propensity to take public transportation.

RQ 2: Which combined factors are found to occur most frequently and how can we interpret their relationship?

The direction behind this question is to analyze deeper and isolate any findings that may not provide a clear split of opinions. This is because, many contributing factors may not just revolve around one individual factor, but rather two or more factors in combination. Overall, the type of transportation and age are the most occurring contributing factors. This is an important insight that should be taken by future researchers to ensure that they can analyze these contributing dimensions. There is an even split of studies

that found that as individuals age, they have lesser likeliness to take public transportation, and contradictorily also discovered that as individuals age, they have more likeliness to take public transport. Since the results did not give a certain answer, there could be a contributing factor that influences this outcome. For example, several studies shared similar views that there is a positive likeliness for older males to take public transportation more. 75% of these findings are only prevalent in Asia, which can prove that there is a positive correlation that older males in Asia prefer public transportation more. Jana and Varghese (2017) proposed a finding that positive propensity for elders only occurs when the type of transportation is rail while having opposing views for buses. Hess et al. (2018) on the other hand noticed a positive propensity for elders towards rail only. This suggests that age, continent, and type of transportation may be contributing factors to the ages that take public transportation.

Income is another factor that shows opposing views across different studies. Several other conditional factors apply to income such as how a few researchers observed a positive propensity to take public transportation for high-income individuals but only for metro and rail, suggesting that income and type of public transportation may influence each other.

General studies have shown similar findings to prefer public transportation during the daytime. However, some articles analyzed that night and overnight travels on rail are favorable. This may indicate that combining the factors of traveling time and type of public transportation can be a stronger predictor of preference. Most travel periods are positive for public transportation around the weekday. This finding is in line with prior literature that weekends are less traveled for most individuals unless if they are younger. This could indicate that age may be a contributing factor to the time of travel if on the weekends or weekdays.

Conclusively, we can observe that factors do not always affect individually, rather a collection of several factors which can make a situation favorable or unfavorable for public transport. The most occurring contributing factor from our findings is the type of transportation and age. Table 8 presents the summary of all the contributing factors addressed in this study.

RQ 3: What are the underlying trends that can be found from influential factors to take public transportation from different parts of the world??

The results from clustering each of the influential factors according to continents revealed some underlying trends that may emerge specifically in these geographical areas. Amongst continents, North America and Asia revealed different perspectives of influential factors to take public transport. Asia showed characteristics regarding trip-related factors such as the purpose, journey, destination, and length of the trip.

TABLE 8. Summarized table of contributing factors

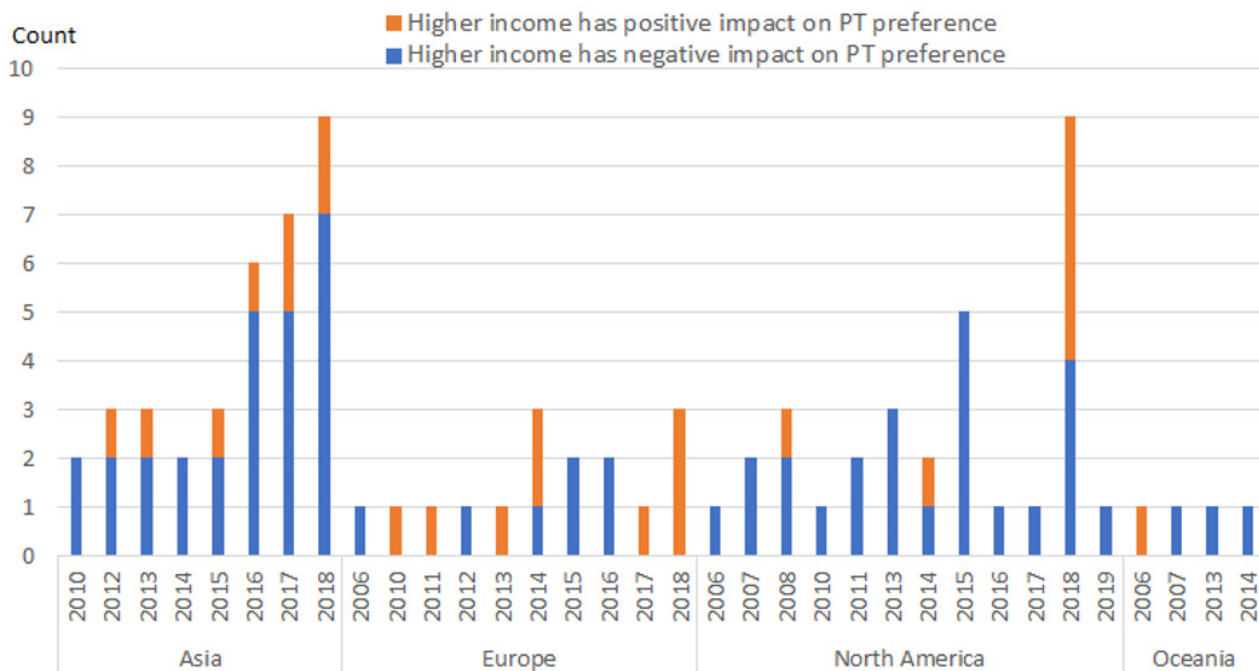| Co-occurring Factors	Remarks
Age, Gender, Continent	In Asia, collectively 86% of the relevant studies show older Males Prefer Public Transportation (Guo et al. 2018; Ji et al. 2018; Sanko, 2014; Ding & Zhang, 2016; Rahman & Baker, 2018; Gadepalli et al. 2018, Szeto et al. 2017), whereas younger females are likely to take PT (Can, 2013; Yagi & Mohammadian, 2010).
	In Europe, 78% of the relevant studies show females prefer PT to males, and the older ages increase the likelihood to choose PT (Arbués et al. 2016; Tyrinopoulos & Antoniou, 2013; Böcker et al. 2017; Prillwitz & Bar, 2011; Clayton et al. 2014; Garcia-Sierra et al. 2018).
	When comparing relevant studies on North Americans, the results do not show a consistent tendency between the association of age groups and gender in mode choices, though 60% of the studies indicates females prefer PT (Grimsrud & El-Geneidy, 2013; Pasha et al. 2016; Habib, 2015; Habib & Weiss, 2014; Li et al. 2018; Hasnine, 2018).
	Similar to North America, studies on Oceania and South America also demonstrate inconsistent tendency between age groups and gender in preference.
Income, Continent	Relevant studies show that lower-income individuals prefer PT in Asia, North America, and Oceania, however, Europeans demonstrate different findings across different years. Figure 10 presents the comparison. Those continents and years that do not contain relevant studies are excluded from Figure 10.
Travel time, Trip purpose, Continent	As shown in Table 9, relevant studies show that North Americans and Europeans have different considerations of trip purpose in choose PT. North Americans tend to consider PT for a work-related trip during daytime rush hours and consider rail for overnight trips. Two European studies consistently show individuals are likely to use PT for shopping/non-leisure trips, and night time is the preferred travel time which this may imply the travel time for non-working-related trip.
Travel period, Age	Three out of three relevant studies in Oceania (Ho & Mulley, 2013; Tao et al. 2017) and Europe (Böcker et al. 2017) show that younger individuals are more likely to prefer to travel on weekends.

FIGURE 10. Association between PT preference and Income over time

TABLE 9. Trip purpose, travel time, and PT preference in Europe and North America

Continent	Trip Purpose to choose PT	Preferred Travel Time
Europe	Non-leisure/shopping trip	Night-time (Böcker et al. 2013; Chikaraishi et al. 2011)
North America	Work-related trip	Daytime, during morning and afternoon rush hours (Michelson & Lachapelle, 2016); overnight trips prefer using rail (Hess et al. 2018)

Note: No relevant study between 2005 and 2018 reported in other continents, therefore they are excluded in Table 9

North America showed characteristics to be affected by the social structure of the environment, employment-related factors, economic status, immigrant-related information, and safety-related information as well as the accessibility of public transport. It can be expected that income is a swaying factor to take public transportation as economic status, social structure, immigrant information as well as employment-related factors are all factors related to ones' economic freedom to drive a car or take public transportation as a means to save money. However, it is not the only factor as we may observe that providing good service quality in terms of safety and accessibility is one of the most important factors for people to take public transportation in North America. Upon further analysis of the economic status of the demographic, it can be reasoned that higher-income groups may opt to choose public transportation out of preference however lower-income groups may not have many alternatives due to constraint of household factors and the type and location of their employment.

The development of different areas of study can be found to be a justifying factor of why public transportation adoption differs around the world. The results from classifying countries according to United Nations (2014) list of categories revealed that countries of developed economies are more affected by basic environmental characteristics than the overall studies such as neighborhood type, a mixed land-use area, location, transport oriented, development areas, distance from the central business district and neighborhood accessibility to commercial facilities. This finding can be supported by the justification that developed countries have a higher standard of living, where choosing transportation can be a choice and their decision can change based on the type of neighborhood or the accessibility of the destination. Places in developing countries, however, would have a lower standard of living and may take public transportation regardless of the condition of the environment. The areas of study are varying, and certain areas of study may have received limited attention although it has been proved to be significant in some countries.

Overall, little research has been reported on traffic congestion factors, factors regarding other transportation, social structures, and weather.

DISCUSSION AND RECOMMENDATIONS

The position of the current research brings a wider view of public transportation mode choice factors in comparison to previous research in the past. Hansson et al. (2019) has a similar scope but specializing merely in regional public transportation and mainly focusing on quality attributes. The current research is found to cover the general public transportation mode choice spanning a wider sampling size, year, and country coverage. The range of dimensions of factors covered by this research is also wider than other past research spanning, across demographics. Some of the clear differences can be noted in Table 10.

It is observed from Table 10 that this study is more comprehensive as compared to the previous summary study. It has a length (15 years) and depth (280 articles). It has a wide variety of coverage by considering more than 100 influential factors. This shows the strength of the study by providing an in-depth analysis concerning the mode choice contributing factors. Furthermore, this study reviewed the latest trend in mode choice study by incorporating the latest technology such as travel time information and WIFI facilities on public transport.

The findings from this critical review reveal the important model shift influential factors that can be used as a reference. By proper understanding of these contributing factors, transport experts and policymakers could formulate the appropriate mode shift strategy to encourage more travel via public transportation than private vehicles. The potential strategies are listed as follow:

1. It was shown that mode choice behavior is not spatially transferrable. The travelers in Asia exhibit different concerns and behavior to those in other parts of the world. The traveler behavior is also different for those who resided in developing countries as compared to developed countries. This signals that the mode shifts strategies that could work in America might not be useful in Asia and vice versa. The individual country needs to carry out its research and formulate the necessary strategy to influence the mode shift.

Table 10. Comparison of current research and past research

Research Findings	This Study	Hansson et al. (2019)	Unsworth et al. (2019)
Research purpose	Systematic literature review of public transportation mode choice factors	Systematic literature review of quality attributes of regional public transportation and their influence on modal choice, demand, and customer satisfaction	A systematic review of public transportation accessibility for people using mobility devices
Analysis Method	Qualitative Analysis using a systematic literature review	Qualitative Analysis using a systematic literature review	Narrative analysis using a systematic literature review
Quality Assessment and Validation	Cohen's Kappa Statistic	(Not mentioned)	Checklist with a 5-point scale
Country Coverage	43 Countries (as mentioned in descriptive statistics)	4 Countries	10 Countries
Year Coverage	2005 to 2019 (15 years)	2009-2019 (10 years)	1995 to 2019 (24 years)
Data Sampling size	280 research articles	37 research articles	26 research articles
Influential factors of mode choice investigated	Covers all influential factors found in prior studies worldwide	Covers influential factors related to transportation quality attributes regionally	Covers influential factors related to transportation accessibility issues regionally
Coverage of findings	• 157 Influential mode choice factors ranging from demographic (65), trip-related (14), transportation (43), and environmental (35) factors • Identified combined factors that occur most frequently • Covered the analysis of factors and how they evolve over time	9 main influential mode choice factors ranging from transportation (8) and Environmental (1)	4 main categories of Issues regarding waiting, boarding, alighting, moving within a public transportation, and traveling to and from a public transportation stop

2. The demographic characteristics of the travelers are an important factor in mode choice. Policymakers could formulate specific strategies for the target group. This will improve the strategy efficiency. For example, most of the public transportation users are within the age group of 30-50 years old who belong to an active working group. A monthly fare discount card that reduces their travel cost would be an effective strategy to increase ridership from this group of travelers.

3. The public transportation types (rail or bus) and their locations are found to be significant factors. This indicates that policymaker needs to do appropriate planning on the public transportation types and facilities. These are fundamentals in public transportation planning and design.

4. The utilization of communication technologies could be an important tool to disseminate real-time transport-related information to travelers. This stems from the findings in this study that real-time travel information is one important influential factor. Some studies (Ashita et al. 2020; Khoo and Ashita, 2016) had highlighted that transport-related mobile applications could influence travelers' behavior to some extent. It is thus recommended that more research is needed to look into this aspect as the mobile phone market penetration rate is high in most countries.

CONCLUSION AND SUGGESTION FOR FUTURE STUDY

This study implements a meticulous systematic literature review of articles to provide a condensed overview of factors affecting an individual's propensity to take public transportation all around the world. The results of the SLR revealed in-depth findings to demographic, trip-related, transportation, and environmental factors that play a role as a predictor for individuals to take public transportation.

One of the constraints of this study is lacking the ability to quantify the effects of each factor. This is because, upon the 280 analyzed articles, all studies have used different analytical methods to evaluate their results. Therefore, it would be insignificant to compare the effect size if there are several types of analytical approaches used such as Regression or SEM Models. Further studies are needed to group and compare these analyzed articles to obtain a clear conversion of the effect sizes of each factor to understand the strength of the significant factors.

Furthermore, having understood the influence factors on mode choice could facilitate the formulation of proper travel demand management (TDM) strategies and policies.

These policies could be used as tools to achieve some transportation objectives. For example, to encourage more travelers to shift from private vehicles to public transportation. This can only be done if one has the overall understanding of mode choice contributing factors.

DECLARATION OF COMPETING INTEREST

None

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