Study on the analysis of travel behavior: A review

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Abstract. Travel behavior analysis involves the utilization and examination of travel demand through the application of theories and analytical techniques derived from diverse scientific disciplines. There are many methods used by researchers in analyzing travel behavior. Mode selection is the stage where the transportation planning process is responsible for determining the travel load or knowing the number of people and goods, then selecting the available transportation models that serve as the starting point of the destination. Travel factors have a strong influence on a person's travel behavior, (trip maker behavior), including income, vehicle ownership, vehicle condition, settlement density of one's socioeconomic conditions. This paper describes the disadvantages and advantages of travel behavior modeling analysis and factors that influence the choice of modes based on travel behavior, so that in the future researchers can use it as an illustration in determining the right analysis.

1. Introduction

The most important aspect to support community activities is transportation. Because if it is not supported by good transportation, community mobilization will be disrupted. The purpose of travel will influence society in choosing a mode of transportation People pay attention to the choice of travel mode according to their travel goals that must be fulfilled [1] In transportation planning, modeling mode selection is very important to plan [2]Modelling of Transportation is the most important aspect of daily life for the average person. The characteristics of the general populace's social demographics, such as their ethnicity, gender, status in life, place of employment, and level of education, are closely related to these characteristics. The activity is based on several goals, such as those for work, education, shopping, and recreation [3]

A sustainable urban transportation system possesses the capability to facilitate the expansion and seamless operation of local, national, and regional economies. Among the most formidable challenges encountered by major cities in establishing sustainable transportation systems are the rapid increase in population and the escalating rates of car ownership [4] The demand for transportation services is experiencing a notable and substantial increase across a majority of cities worldwide [5] So planning and policies are needed to overcome the high number of requests where to reduce urban mobility such as congestion, accidents, air pollution and noise [6] Enhancing the advancement of transportation infrastructure and services entails a requisite for research focused on long-term travel patterns and travel behavior. A comprehension of the factors that exert influence on travel demand, including individuals' travel choices, preferences, and the mechanisms by which they can be influenced, serves as a foundation for the formulation of effective and well-informed policies. [7]

Factors that must be examined to determine travel behavior in terms of decision making and travel choices are travel frequency that Done, the purpose of the trip, Mode of Transportation Used, Number of groups, Which route to take [8] Related research behaviour trip closely related to analysis and travel demand modeling, and based in theories and methods of analysis from various disciplines [9] The purpose behind analyzing travel behavior is to gain insights into facilitating commuter mobility and establishing a secure, environmentally friendly, and sustainable transportation system [10]. Currently, the concept of transportation planning is often completed using a model usually called the "Four-Stage Transportation Planning Model" which is a gradual process of several sub-models carried out separately and sequentially. Four-stage models are very complex, require a lot of data and take a long time in the process of developing and calibrating them. This model can be simplified to meet the needs of transportation planning in areas that have limited time and cost. According to many studies, this stage of approach naturally answers the questions

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"How many moves will the journey make, where they will go, in what mode will the trip be made, and what route will the trip take." A fundamental flaw of the four-step modeling framework is that the motivations that drive travel are not adequately represented [11]

Table 1. Factors influencing travel behavior

NO.	AUTHOR	VARIABLE
1	Roya Etminani-Ghasrodashti, Mahyar Ardeshiri	Lifestyle, and land use
2	Assunta di vaio,, ana lopez-ojeda´, casiano manrique-de-lara-penate, lourdes trujillo	characteristics of tourists, use of modes of transport, frequency of visits, travel behavior of tourists, Level of satisfaction.
3	Xinyi Tang, Dianhai Wang, Yilin Sun, Mengwei Chen, E. Owen D. ,Waygood	age, gender, type of companion, car ownership, length of vacation and purpose of travel
4	Chanittha Chansuk, Tosporn Arreeras, Chalailuk Chiangboon, Canteen Phonmakham, Nattawat Chotikool, Ratthanan Buddee, Sorrawich Pumjampa, Thanmit Yanasoi ,Saharat Arreeras	gender, age, education, occupation, income, vehicle ownership, number of family members, status, and residence
5	Berhanu Esubalew Bayih,, Apar Singh	The level of tourist satisfaction, the frequency of domestic tourist visits, the motivation of domestic tourists to visit again, and the willingness of tourists to recommend.
6	Ali Mahdi , Jamil Hamadneh , Domokos Esztergár-Kiss	Socio-demographics, travel time, travel expenses, age, gender, income, and car ownership.
7	Ricky Yao Nutsugbodo, Edem Kwesi Amenumey, Collins Adjei Mensahc	Factors of affordability, accessibility, mode availability, socio-demographic safety and comfort of tourists, and mode preferences.
8	Bartosz Exchange, Markus Mailer, Kay W. Axhausen	travel time, travel expenses, composition of the travel group, purpose of the trip, fitness level of respondents, their knowledge of long-distance travel to destination and mobility options at the destination, and selected weather elements.

The resulting nature of travel demand is not adequately reflected by the four-step modeling approach. The behavior of travel requests, derived rather than direct requests, is now better captured by more complex modeling frameworks such as the "activity-based" model and the "tour-based" model.[12] In addition to travel behavior models, intercity travel mode selection models are often divided into categories such as destination (business versus leisure), day trips (weekdays versus weekends), portion sizes (solo travel versus group travel), etc. These models often contain buses, trains, and planes [13] Urban travel demand and behavior are largely influenced by a number of variables, including land-use patterns, socioeconomic conditions, travel costs, means of transportation, and demographic traits. It can be seen in table 1 regarding the explanation of these factors [14] According to Van Wee and Banister, various factors have complex effects on demand or travel behavior. These complex causal relationships result in a variety of methods and interpretations of data analysis. [15] Understanding, modeling, and predicting travel behavior in these complex systems is one of today's most pressing research problems [16]. The development and advancement of Intelligent Transport System (ITS) technology, which will be the cornerstone of the future multimodal network information space, has become the basis of transportation policy in industrialized countries [17] however, The problems within transportation systems in developing countries encompass,Weaknesses in transportation planning and regulatory bodies, Inadequate and deteriorating transportation infrastructure, Limited walking and cycling facilities, Decline in the standards of public

transportation, As a result, transportation systems in developing countries are not yet prepared to implement the Intelligent Transport System (ITS, Increased dependence on the use of private cars, Expansion of the unregulated informal transport sector, including minibuses, taxis, and motorcycles, and Insufficient availability of alternative modes of transportation. [18] The unsustainable transportation system arises due to various factors, including high levels of air pollution and noise, traffic congestion, accidents, and other negative factors that can potentially harm both humans and the environment. Therefore, the key aspect in sustainable transportation systems and transportation management is to integrate transportation planning with urban design in order to implement appropriate policies. [19] Therefore, this is an opportune moment to assess the progress that has been accomplished thus far in the study of travel behavior in developing nations and to consider what additional advancements are required to steer transportation policy initiatives. The substantial demand for public transportation in developing urban areas has propelled the expansion of informal or paratransit systems, predominantly characterized by the utilization of motorcycles. [20] In the study of travel behavior reviews various aspects, one of which is aspects of land use, lifestyle, socio-psychological aspects, especially in terms of choosing modes of transportation. [21] Thus, this paper discusses and explains various empirical analysis approaches related to modeling travel behavior, especially in developing countries, and discusses the factors that influence travel behavior in choosing modes of transportation. The purpose of this paper is to be used as a reference for researchers in determining the right analysis for modeling travel behavior.

2. Analysis Results

The first step of the method the researchers used regarding travel behavior modeling was to distribute offline and online questionnaires to the respondents reviewed. It is used to collect data on travel characteristics and personal attributes of respondents. The data is used to find out what influences the choice of mode for travel, a logit model is made by choosing a mode that is set as a dependent variable with independent variables, namely age, gender, type of companion, car ownership, length of trip. vacation and travel destinations etc. as well as analyze the relationship between variables . Analysis for modeling is by using structural analysis with multinomial logit (MNL), nested logit (NL), structural equation models (SEM) and qualitative methods (QM).

Discrete choice modelling

Travel behavior modeling that is often used is multinomial logit analysis (MNL), nested logit (NL). Discrete selection models ar e disaggregated to analyze mode preference preferences when they choose modes from origin to destination. Model attributes are based on respondent characteristics and travel habits [22] The basic problem of discrete selection analysis is the modeling of a choice of alternatives that are mutually detached, but include all possible options. To make discrete modeling not always successful, the concept of random utility is used. In this concept the actual utility of an alternative is considered a random variable, so the probability of an alternative being chosen as the probability of an alternative having the greatest utility [23]

Structural equation modelling

Hypothesis testing for the research is conducted using the Structural Equation Model (SEM) approach based on Partial Least Square (PLS). PLS is a component-based or variance-based Structural Equation Model (SEM). Structural Equation Model (SEM) is a statistical field that allows testing complex relationships simultaneously. According to Ghazali (2013), SEM is a multivariate analysis technique that combines factor analysis and regression/correlation analysis, aiming to explore relationships between indicators and constructs, as well as connections among latent constructs/variables or theories. On the other hand, PLS is more of a predictive model. However, there is a distinction between covariance-based SEM and component-based PLS, which lies in the use of the structural equation model for theory testing or theory development with predictive purposes [24] The advantages of Structural Equation Modeling (SEM) include, SEM has the capability to estimate interrelated relationships among various variables. These relationships are organized within a structural model, which maps the interactions between dependent and independent constructs. and SEM has the ability to depict the pattern of relationships between latent constructs (variables that cannot be directly measured) and manifest variables (directly measurable variables) or other indicator variables. [25]

The drawback of Structural Equation Modeling (SEM) lies in the model's inability to generate unique estimates. If identification issues arise every time estimation is performed, it is advisable to reconsider the model by reevaluating and expanding the number of constructs [26] In conclusion, various methodological techniques are employed in the research of travel behavior in developing countries. Most of the analyzed studies utilize mathematical models to identify key variables that influence travel demand. The most commonly used modeling techniques are Multinomial Logit (MNL) and Structural Equation Model (SEM).

Table 2. Research Approaches used

No	Author	Analysis		
		MNL	NL	SEM
1	Dissanayake, D. and T. Morikawa		x	
2	Etminani-Ghasrodashti, R. and M. Ardeshiri			x
3	Guan, X. and D. Wang			x
4	Guerra, E., et al.	x		
5	Lekshmi, G. R. A., et al	x		
6	Ma, J., et al.	x		
7	Sinniah, G. K., et al.			x
8	Tembe, A., et al.	x		x
9	Yagi, S. and A. Mohammadian		x	
10	Zhao, P. and Y. Zhang			x

Mode choice

Mode selection is a phase in the transportation planning process that determines the way trips will be undertaken or estimates the number of people and goods that will choose various available transportation modes for journeys from one point to a specific destination. This is done with the aim of achieving certain travel objectives. This mode selection phase is an extension of the origin-destination model stage related to trip distribution and also the trip generation stage, as during the trip distribution stage, we determine the number of trips from each origin and destination zone. Transportation mode selection is considered a crucial stage in transportation planning. There are various mode options that can be utilized, such as cars, motorcycles, buses, trains, rickshaws, and walking. Researchers have concluded that factors influencing mode selection include affordability, availability of public transport, age, income, perceptions, attitudes towards travel, and residential preferences. One solution to reduce the use of private vehicles is by implementing parking capacity restrictions and increasing parking fees in city centers [27] Furthermore, individuals and households with higher incomes and education levels tend to use private cars, while those with lower incomes and education levels rely on public transportation and paratransit modes for their daily travels. [28] Gender differences can affect mode selection. Private car mode is more often used by men than women, because women prefer to use taxis and other public transport [29]

Influencing factors

Table 3. Research Approaches used

Travel Characteristics Factor	Trip Purpose
	Time of trip made
	trip length
Traveler Characteristics Factor	(income
	Car Ownership
	density of residential development
	social demographics
transportation of system characteristics factor	Travel time
	Travel cost
	Level of Service
	accessibility
	Reliability
Spacial Characteristics factor	distance
	population density

The mode choice model aims to determine the proportion of individuals who will use each mode of transportation. This process is conducted with the purpose of calibrating the mode choice model in the base year to understand the attribute variables that influence the selection of transportation modes. After the calibration process is completed, the model can be utilized to predict mode choices using attribute variable values in the future. There are four groups of factors

considered to strongly influence travel behavior or prospective users (trip maker behavior). Each of these factors is further divided into several identifiable variables. These variables can be assessed quantitatively and qualitatively. The factors and variables can be observed in Table 3.

Travel Pattern

The structure, framework, and direction of a tourist's journey between two destinations is referred to as their "travel pattern." It includes details about the facilities, events, and services provided to give the travel industry and visitors a range of travel options, affecting their choices to go on vacation. Despite the change, some tourists still find it simpler to plan their own itinerary than to give up control to a travel agent. This is due to certain tourists not liking it, depending on their schedule or agenda. Due of the comparatively cheap cost involved, travellers really prefer creating their own trip plans rather than getting them from travel agents. The designed travel pattern is one that is created, manufactured, and packaged as a valuable good to be experienced. Numerous factors need to be considered, including background knowledge like geography, climate, language, and local culture. Information regarding public institutions including police stations, banks, hospitals, and immigration offices should also be included in the travel pattern. Also included should be lodging amenities including hotel requirements, room amenities, and accessibility to tourist attractions. Tourists rely heavily on these features to assure their comfort while traveling. Movement patterns in the transportation system consist of 2 movement patterns, namely spatial movement patterns and non-spatial movement patterns [30]
The concept of spatial movement is bounded by spatial distribution of land use in a certain region. Essentially, travel is necessary to carry out specific activities or tasks at a destination, and the destination is determined by the urban land use. Spatial movement patterns focus more on why people undertake movements, when these movements occur, and what modes of transportation are used by the community for these movements. Suggests that tourist movement patterns are divided into 3 types, namely single *patterns,* multiple patterns, and *complex* patterns. *Single pattern* is a *single point, multiple pattern* consists of *base site, stopover,* and *chaining loop*. While *the complex pattern* consists of *destination region loop* and *complex neighbourhood*. [31]

3. Conclusion

Based on the research that has been done. There are so many variable variables that affect the choice of modes of tourists, one of which is socio-demographic characteristics, travel modes, travel time (perception), built environment and spatial attributes, travel-based activities, the influence of individual attitudes, the availability of easily accessible modes, and variables of the type of transportation mode. The researchers only discussed the factors that influenced the choice of mode and conducted modeling analysis. It is expected from this paper that researchers can add modeling related to the chain of activities carried out by travelers in accordance with the right modeling analysis method.

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