Investigation on Various Land-Use Factors that Influence Trip Attraction

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ABSTRACT
Transportation planning plays a major role in upgrading the transportation system, which includes identifying the travel demand and implementing plans accordingly. Travel demand models are used for forecasting the response to transportation demand of changes both in the attributes of the transportation system and the people using the transportation system. More specifically, travel demand models are used to predict travel characteristics and usage of transport services under alternative socio-economic scenarios and land-use configurations. The very first step in traditional travel demand modeling is the trip generation which is classified into trip production and trip attraction. Among this, it is important to find out trip attraction rate as infrastructure development, activity center, and settlement causes disturbance to the smoothness of traffic and safety. The trip attraction modeling capture influence of land use factors like accessibility, land use mix, number of employees, floor area, type of commodity sold, distance from residence, etc on trip attraction. Urban centers play a pivotal role in attracting various trips. As the trip attraction rate increases, it results in urban transportation problems which can be rectified with the help of the trip attraction model. The present paper aims to investigate the trip attraction rates for the different regions and developing countries and the methodology adopted by researchers to develop trip attraction models.

Keywords: Trip Attraction, Socio-Economic, Travel Demand, Land Use Factors, Regression Analysis

I. INTRODUCTION

Transportation plays a vital role in the growth and economy of a nation. Due to the fast-growing population and travel development for a country like India, there should be an efficient transportation system and infrastructure. So for the design of transportation facilities and services, transportation planning is a very essential process that relies on travel demand forecasting. Planning is highly related to demand modeling. Travel demand modeling had trip-based four-step modeling as its pioneer, which was developed in the late 1950s. That period was characterized by a rapid increase in car use followed by major investments in new road infrastructure. To assess the impact of these investments, models that could be used to predict travel demand, in the long run, where needed. This resulted in the development of trip-based models, which predicted traffic flows between traffic zones, i.e. aggregate models. These models are also known as four-stage models. The travel was assumed to be the result of four subsequent decisions, i.e. trip generation, trip distribution, mode choice, and route choice. Trip generation is the first step in travel demand forecasting which is classified into trip production and trip attraction. Trip
production is defined as the number of trips produced by households in the trip analysis zone whereas trip attraction aims at predicting the total number of trips attracted to each zone of the study area.

Trip attraction modeling plays a pivotal role in the planning area. Several studies carried out found that trip attraction has shown a strong correlation with the land use types and its activities such as land use distribution, floor area, number of employees, number of shops, number of schools, and school enrollment rates, number of employees in the commercial node, number of offices in the commercial node, number of employment opportunities, number of stores in the shopping centers, the volume of retail sale, number of parking lots and land use parameters like accessibility and entropy. Land use parameter like accessibility refers to a measure of the ease of reaching and interacting with destinations or activities distributed in space around a city or count associated with a place of origin. A place with high accessibility is one from which many destinations can be reached, or destinations can be reached with relative ease in this case trip attraction rate increases. Whereas trip attraction rate decreases with low accessibility which implies that relatively few destinations can be reached for a given amount of time, effort, cost or that reaching destinations is more difficult or costly from that place.

Land use mix is the other factor affecting trip attraction which enables a range of land uses including residential, commercial, industrial, and institutional to be co-located in an integrated way that promotes sustainable forms of transport such as public transport, walking, and cycling, and increases neighborhood amenity. Mixed land use developments can improve the economic vitality and perceived security of an area by rising the number of people on the street and in public spaces. The need for greater land use mix, and in particular the closer integration of residential development with commercial, civic, and recreational uses, has been adopted as the conventional wisdom among urban planners as well as public health professionals. The benefits of mixed-land use include promoting active travel, increasing the viability of transportation alternatives, reducing private vehicle use and its associated impacts, raising property values, and helping to build a sense of place for local communities where trip attraction rate increases in different zones of a city. As a result of deviation in the above factors, urban centers are developing at a rapid pace and consequently, the majority of infrastructure projects may increase the number of trips attracted which causes transportation problems and traffic impacts. Formulating a trip attraction model helps in foreseeing the number of trips attracted to the study area.

A. Objectives
- To identify the various land-use factors that influence trip attraction
- To find the relationship between various land use factors and the rate of trip attraction.

II. METHODS AND MATERIALS

Different journals have huge information regarding the subject which is mandatory that helps in gaining a clear idea about trip attraction modeling, surveys, variables considered, how sampling can be done, how the analysis of the obtained data can be done, etc. Study area delineation is one of the most important tasks. The study area has been fixed based on the simple criteria that it should be easily accessible. Based on the data obtained from the secondary survey on the population and the total dwelling units in the premises of the CBD area, the study area has been finalized and after this sampling is done. The main problem in every survey is that the survey can't carry out for the whole study area due to limitations of funds as well as human power. Due to this problem, the alternative way is to go for sampling. Sampling enables us to collect and analyze data for a smaller portion of the population (sample) which must be representative of the entire population and then apply
the results to the whole population. It permits us to conclude very complex situations. Adequate care needs to be taken when selecting the sample because if the sample is not representative, the results being applied to the entire population will be misleading. The sample should be collected randomly. Next is the most important part which is the data collection. It can be done by the survey which is classified into two, secondary survey and primary survey. Here establishment survey is considered to be the Primary survey. Before the primary survey, it was essential to create a questionnaire form to collect the necessary details from the establishments which are done by interview survey using face to face technique. This questionnaire includes data set such as number of employees, floor area of establishment, number of offices in the commercial node, number of stores in the shopping centers, the volume of retail sale, number of parking lots, and land use parameters like accessibility and entropy. After the data collection, the next important step is the preliminary analysis which is carried out using Microsoft excel or with the help of the Statistical Package for Social Science (SPSS). This helps to give initial information regarding the obtained data that can be found out. Modeling is done after preliminary analysis. The main objective is to create a model with the help of data obtained from the survey. The studies use regression analysis to identify various land-use factors that influence trip attraction and to develop the trip attraction model.

III. TRIP BASED MODELS

Trip-based travel models have evolved over many decades. As their name suggests, trip-based models use the person trip as the fundamental unit of analysis. Trip-based models are widely used in practice to support regional, sub-regional, and project-level transportation analysis and decision making. Trip-based models are often referred to as “4-step” models because they commonly include four primary components. The first trip generation components estimate the numbers of trips produced by and attracted to each zone (these zones collectively represent the geography of the modeled area). The second trip distribution step connects where trips are produced and where they are attracted to. The third mode choice step determines the travel mode, such as automobile or transit, used for each trip, while the fourth assignment step predicts the specific network facilities or routes used for each trip.

IV. RELATIONSHIP BETWEEN VARIOUS LAND USE FACTORS AND TRIP ATTRACTION

B Yulianto, Setiono, Sugiyarto, S Purnomo, and R A Prasetyo (2020) studied to determine standard trip attraction models of various land uses including hotels and minimarkets in Surakarta City. The magnitude of traffic impact that occurs due to the building construction is influenced by the amount of trip generation and attraction made by the building activities. Modeling analysis requires data such as vehicle volume in and out of land use and land use parameter such as the number of rooms for hotels and size of building floor area for minimarket. The result showed that regression trip attraction models of 3-star hotels, 4 and 5-star hotels, and minimarket are valid models that give linear regression equations with a sufficient coefficient of correlation and coefficient of determination. For calculating values of land use trip attraction for consultants who conduct traffic impacts analysis the obtained trip attraction can be used.

Y Basuki, S Rahayu, and N W Rahmawati (2020) developed a trip attraction model in small scale commercial and service areas in road corridor in Sukun Road, Banyumanik, Semarang City. The trip attraction model in this was carried out using multiple linear regression with the backward method. Variables considered were number of visitors attracted by outlet, number of store employees, Area of the shop floor, Storehouse parking area, sales...
income which were collected through interviews with store managers on outlets commercial and services. The result showed that the travel attraction in the small-scale trading area and services is influenced by socio-economic character, namely sales income in the total attraction of the visitor's car and motorbike and store areas, parking areas, sales income. This model can be used as input in planning and structuring trade areas and small-scale service to anticipate transportation problems because they contribute to the flow of traffic.

The changes in land use had a pivotal role to change trip attraction in terms of the number and characteristics of the visitor of the Cinde Traditional Market area. Variation in trip attraction before and after construction processes of the market area was studied by Marice Agustini, Erika Buchari, and Melawaty Agustien (2019). The questionnaire method was carried out to collect the data. The analysis method of the attraction used was multiple linear regression analysis with a stepwise method to generate a model of visitor attraction to the market. For travel zone-based, the linear regression analysis method will examine the correlation between criterion variables in the form of social-economic characteristics of the zone. The predictor variables in form of total traffic flow from the observed zone to the observed destination zone give the estimation number of trips from and to destination generated by the characteristics of the social-economic zone for zone-based travel. Analysis carried out showed that more influenced trips attraction visitors to this market area are profession, transportation mode, and retail item and found a significant change in trip attraction rate after construction processes.

Henny Indriyani Abulebu, Bleiser Tanari, and Muhammad Isran Ramli (2018) aimed to define significant factors that influence people in obtaining their choice of frequency. Variables considered were socio-demographic, properties of the trip to shopping centers, nature of selecting a trip time, and ways to travel. They attempt to develop a trip attraction model of the central market in Poso City for Visitor Movement Attraction on Holiday and workday. Sampling size adopted based on Slovin’s formula. Multiple linear regression models were developed in both cases. The findings showed that on holiday, no variable has a significant influence on the trip attraction of visitor movement at the Poso Central Market, while on the workday, shopping cost has become the most influential variable.

Trip Generation and Attraction Models for Hyderabad Metropolitan Development Authority Area to estimate the horizon year trips was developed by Bollini Prasad and Dr. Kumar Molugaram (2018). Data collected regarding population, employment potential, vehicle ownership, number of students, and the number of earning-members. Multiple linear regression analyses were carried out to develop trip production and trip attraction model. The result showed trip generation model developed for the data shows that the trips attracted to a zone and produced from a zone depend on population, employment, and registered number of vehicles in the zone. The gravity model is developed for estimating the trip interchanges, with a less RMSE value and error between the calculated and observed percentage trips for an average travel time was found to be less for passenger vehicles and goods vehicles.

The study aimed to estimate trip attraction by using connectivity, local integration, and global integration values as endogenous variables with an acceptable level of accuracy. The centrality values were derived from the road network using Space syntax tools, and a GIS-based kernel density estimation method was carried out by Amila Jayasinghe, Kazushi Sano, and Kasemsri Rattanaporn (2017). The method can be utilized as a suitable modeling tool particularly in developing countries where transport models are severely constrained by the virtual lack of land use data. Results revealed that among the four centrality parameters, global integration has a very high correlation, while local integration and connectivity have a strong correlation with trip attraction density.
values, centrality values have a strong exponential relationship with trip attraction density values compared to a linear relationship. Thirdly, the model with the global integration and local integration as explanatory variables gives a fair estimation of the trip attractions at the aggregate level in TAZs, and finally, the study noted estimation errors due to the influence of industrial zone, special education and development restricted land uses. Researchers suggested that further study can be made to investigate possible methods to improve accuracy while eliminating errors.

Md. Shamim Al Razib and Faysal Ibn Rahman (2017) estimated trip attraction rates of the shopping centers at Uttara Road, Uttara area of Dhaka by using the trip rate analysis method. Few behaviors were considered such as for shopping, fitness centers, and other services for the people and vehicles attracted to the shopping centers when they visit the particular building. The surveyed data deals with the relationship between trip attraction rates of the shopping center as a whole. The result revealed the maximum and a minimum number of people and cars enter the shopping centers during the peak hour. The main demerit of the study was a limited number of data and they considered only physical features of trip attraction rate of shopping centers. It will create complication if two shopping centers with different composition of stores exists similarities in physical features.

Imma Widyawati Agustin and Budi Sugianto Waloeya (2017) created a trip attraction model of land use for industrial areas. The study aimed to determine the effect of industrial vehicle movement on the road’s level of service in an industrial area. The variables considered for developing the trip attraction model for Malang city include the number of movement, building area, number of employees, number of shifts, frequency of delivery, and visitor counts. Sampling carried out is stratified random sampling. Correlation analysis to determine the influence variables and multiple linear regression analysis were applied to identify the trip attraction model of land use. The results showed that the most affected variables of the industrial vehicle movement are the number of employees and the delivery frequency.

Karuturi Sasidhar, Yeluri Vineeth, Vineethreddy, and S. S. V. Subbarao (2016) analyzed the trip attraction rates of commercial land use in different cities of Andhra Pradesh and Telangana states. Various variables considered were area, parking spaces, number of employees, number of stores, number of people attracting. Due to the variations in the trip attraction rates the complexity of analysis is increased. By observing overall statistics, it can be concluded that weekend trip attraction rates of shopping areas are more than the weekday trip attraction rates. Further, male trip rates are more when compared to female and children on both weekdays and weekends. The major limitation of this study is the limited number of commercial areas. By considering more number of the commercial area the accuracy of this analysis can be improved.

Radial Basis Function Neural Networks (RBFNN) method is used in modeling trip attraction in Palembang by Joni Arliansyah and Yusuf Hartono (2015). It gives the shortage of ANN models which take a long time to achieve convergent conditions and can be trapped in the minimum local condition in selecting the optimal criteria during the learning procedure of the network. The study aimed at comparing the RBFNN modeling results with the regression analysis model was made using the SPSS statistical package. Independent variables considered are population size, number of schools, number of students, number of teachers, areas of school buildings, number of offices, and number of houses. The radial basis function neural network model trained to predict trip attraction using seven predictors performed better than the ordinary regression model using the least square approach. Violation of assumptions for the regression model, such as normality of error items and linearity, must be one of the reasons for the worse performance of
the regression model. However, the results from both models show that the number of students, number of teachers, total areas of school buildings, and number of offices are the most significant predictors for trip attraction.

W.Y. Szeto, Jonathan Yeung, Ryan C.P. Wong, and W.H. Yang (2015) modeled trip attraction, trip distribution, and mode split of columbarium trips during the traditional grave-sweeping festivals. Headcount survey and revealed preference questionnaire survey was carried out during the Ching Ming Festivals of 2013 and 2014. The variables considered were the number of niches and the number of days deviated from the festival date. This study calibrates and models non-linear regression models for trip attraction and joint logit model for trip production and mode split. The result revealed that the number of niches and the number of days deviated from the festival date significantly affect the number of visitors entering the columbaria. The model results indicated that the number of zones apart, the availability of direct feeder services, the total waiting and walking times, the in-vehicle travel time, and the out-of-pocket cost are the significant factors influencing the visitors’ travel choices of interchange locations and the associated feeder transport modes.

The study by Pretina George (2013) aimed at giving a trip attraction model that can predict the trip attracted to any commercial nodes in the medium-sized towns in Kerala. Socio-economic and commercial land use characteristics variables were considered. A sample size of 10% of trips was randomly selected from each town. They carried out a combination of analytical and descriptive methods. A multiple linear regression model was developed using Microsoft excel. The higher correlation was given by the number of employees and percentage of office in the commercial node which gives a better estimation of trip attraction and other factors like total commercial area, the number of commercial establishment, percentage of shops where food items are sold, percentage of office and shop in the commercial node and percentage of commercial establishment with the year of operation between 5 to 10 years. The model developed will be useful for estimating the trips attracted to new or existing commercial centers and to assess the traffic impact of the commercial center on the geometric design of roadways in the surrounding area. It is mentioned that the accuracy of the model can be increased by considering more commercial nodes from different medium-sized towns in Kerala and more factors affecting trip attraction can be carried out as further research.

Partha Pratim Sarkar and Mallikarjuna (2013) attempted to understand the changes in socio-economic and land use characteristics and their impact on the travel pattern respective significance in the choice of non-motorized and private motorized vehicles while making different types of trips. Travel data, socio-economic and demographic data like age, gender, educational qualification, family size, vehicle ownership, driving license holding status, income, etc were collected by household survey and other land use data were collected with the help of GPS device. ArcGIS 10 Software has been used to digitize land use data. Based on land use, functional and spatial complimentary area index was framed. For all the trips like work trips, shopping trips, and all other trips several binary choice models were prepared. Model output findings showed that socio-economic variables were showing significance influencing utilities of the modes. Land use parameters and intersection were found to show a significant effect. More effective significance was found in socio-economic parameters than land use parameters. Land use parameters when added with socio-economic variables showed significant improvement in models.
V. CONCLUSION

The studies reported on trip attraction variations with numerous land-use factors, software used, types of approaches and techniques used for modeling, and limitations faced by researchers have been presented. The studies focused on determining standard trip attraction models of various land uses including hotels and minimarkets, variation in trip attraction before and after construction processes of the market area, to define significant factors that influence people in obtaining their choice of frequency, trip attraction rates of the shopping centers, to determine the effect of industrial vehicle movement on the road’s level of service in an industrial area, the relative importance of socio-economic and land use factors on trip attraction, to predict the trip attracted to any commercial nodes in the medium-sized towns, etc.

The relationship between the number of visitors attracted by the outlet with the store area, store parking area, and sales income is very influential. The findings showed that on holiday, no variable has a significant influence on the trip attraction of visitor movement while on the workday, shopping cost has become the most influential variable. More influenced trips attraction visitors to this market area are profession, transportation mode, and retail item and found a significant change in trip attraction rate after construction processes. The most affected variables of the industrial vehicle movement are the number of employees and the delivery frequency. Weekend trip attraction rates of shopping areas are more than the weekday trip attraction rates. Further, male trip rates are more when compared to female and children on both weekdays and weekends. Land use parameters like accessibility, retail floor space, and employment opportunity have a significant contribution to trip attraction along with the socio-economic characteristics. Land use mix effect on trip attraction played a minor role. The major limitation of the studies is the limited number of commercial areas and by considering more number of the commercial area the accuracy of analysis can be improved, the limited number of data and researchers considered only physical features of trip attraction rate of shopping centers where it will create complication if two shopping centers with different composition of stores exists similarities in physical features, etc. Providing neighborhood infrastructures that increase the comfort of accessibility to neighborhood amenities can lead to higher shares of sustainable transportation modes like walking, biking, or public transportation where the rate of trip attracted increases and the choice of destination makes people travel less which in turn will be cost-effective practices for people living in the urban and rural area.

VI. REFERENCES


