

Review paper – effect of land use on travel behavior

¹Patel Sahid Alli, ²Bhagat Sejal S.

Student, M.E. (Town and Country Planning), Assistant Professor
Civil Engineering Department,

Sarvajanic College of Engineering & Technology, Surat, Gujarat, India.

Abstract: - The transportation planning and management is an important factor in town planning scheme and in development plan. To relate the various socio-economic variables with travel demand using different modelling technique is the main objective of this review paper. Technique will help to forecast future travel demand for different purpose trip and will guide for proposal of Mass Transit System and also in management of existing Mass Transit System by route identification.

I. Introduction

The study of the interaction between land use and travel behavior is becoming increasingly important as governments consider using land use as a trigger to change travel behavior. This is particularly important when one considers travel behavior as the derived demand from the need to participate in activities and the necessity to reach locations where different activities may take place and thus it is possible to envision changing the relative location of activities to change travel.

Growing vehicle ownership and personalized vehicle use had change the travel behavior in urban areas of developing countries. This change in travel behavior is in the change in number of trips, trips length, purpose wise trips and mode choice. The travel behavior means movement of peoples from one place to other place for their purpose by choosing any travel mode. In any transportation planning process it's very important for urban planner or transport planner to have statistic of travel pattern of city. The travel pattern of the city will depends upon no. of household, family size, personalized vehicles, and majority on land use mix. As the land use change the travel behavior of citizen also changing.

Land use mix is one of the land use factors that affect intra-urban travel. It affects the intra-urban travel behavior specifically, and it can have a profound influence on urban transport planning and management in general. Land use mix is the term used to describe the mixture of land uses in the same urban tract. This is in contradiction to the tradition and practice of the urban physical planning in which attempts are made to separate different land uses in different locations.

Urban travel behavior is main factor in transportation planning. Urban travel demand is growing at an exponential rate as a result of multitude of activities in urban centres coupled with population growth. The travel demand of an urban area is influence by the various attributes of the area grouped under main two heads (1) Urban area characteristics (2) Urban population characteristics. Urban area characteristics include land area urban form, floor area ratio, edge of area, transportation network, land use pattern, employment density and economic based of the city. Urban population characteristics includes socio-economic attributes like total population, family size, Age structure of family, family income, vehicular ownership, and population density, etc.

For any cities hence it's important to have travel characteristic which lead to sustain land use and transport planning. It's challenging task for urban planner to have travel pattern in absence of household characteristics. It is very difficult to have Survey of all citizens and hence sampling technique will help to have city level travel characteristics.

II. Literature Review

(1) Partha Pratim Sarkar and C. Mallikarjun B. (2013)

Study was carried out of Agartala city, the capital of Tripura state for effect of land use on travel behavior. Out of total population of 3.99 lakh, 1% sample size of total number of household was decided. Socio-economic and demographic data like age, gender, education qualification, family size, vehicle ownership, driving license holding status, income etc. have also been collected. To get detail of land use GPS device and ArcGIS 10. Software has been used. Area Index was framed which was based on land use functional and spatial complementarity. A number of binary choice models have been prepared for work trips, shopping trips and all the trips. In this study an attempt was made to understand their respective relevance in the choice of non-motorised and private motorised vehicles, while making different type of trips. In case of non-motorized and motorized mode choice for shopping trips, land use variables were found to be significantly influencing the goodness of fit of the model. Area Index values, for both origin and destination, were found to be significant. Further, the intersection density was also found to be influencing the choice of motorized/non-motorized modes.

(2) Bashirul Haque, Mufuzar Rehman, Abu shayad khan, Muhammad Nahid Parvez (2013)

Study was carried out to find out extent of influence of socio-economic and land use factors on households travel behavior. Linear regression models have been developed in this regard. Data used to develop these models have been collected from household survey among different zones of Sylhet City Corporation (SCC) area and other secondary source. Effect of land use parameters on trip generation and household kilometres travelled has been modelled using SPSS (Statistical Package for the Social Science). Study area was divided into 5 zones and 27 traffic analysis zone (TAZ). Floor space share by residential and commercial and others is considered as land use parameters. In both the model some hypothesis was also formed to check relations between parameters. From research findings it can be concluded that urban planning ensuring the balance uses of spaces where an individual can meet their demand from closet distance can reduce the commuter trip length and total number of person trips.

(3) Houshmand E. Masoumi (2013)

The effects of neighbourhood-level land use characteristics on urban travel behaviour of Iranian cities are under-researched. The present paper examines such influences in a microscopic scale. In this study the role of socio-economic factors is also studied and compared to that of urban form. Two case-study neighbourhoods in west of Tehran are selected and considered, first of which is a centralized and compact neighbourhood and the other is a sprawled and centre less one. A Multinomial Logit Regression model is developed to consider the effects of socio-economic and land use factors on urban travel pattern. In addition, to consider the effective factors, cross-sectional comparison between the influences of local accessibility and attractiveness of the neighbourhood centres of the two case-study areas are undertaken. Also the causality relationships are considered according to the findings of the survey.

The findings indicate significant effects of age and household income as socio-economic factors on transportation mode choice in neighbourhoods with central structure. On the other hand, no meaningful association between socio-economic or land use variables are resulted by the model for the sprawled case. The most effective land use concept in micro-scale is considered to be satisfaction of entertainment facilities of the neighbourhood.

Also the descriptive findings show that the centralized neighbourhood that gives more local accessibility to shops and retail generates less shopping trips. In considering the causal relations, the study shows that providing neighbourhood infrastructures that increase or ease the accessibility to neighbourhood amenities can lead to higher shares of sustainable transportation modes like walking, biking, or public transportation use.

(4) Vaibhav Agrawal and Ashish Verma (2010)

The model was developed based on Mass Rapid Transit (MRT) data and each zone under study area are classified mainly as Residential or Central Business District (CBD) zone. Trip generation and distribution regression model was developed by considering 22 socio economic parameters like age, gender, residential worker, school going children etc. The trip generation and distribution was forecasted for the year 2031. Around 3500 household samples were collected to generate model and the whole city was divided into 95 traffic analysis zones (TAZ).

(5) Abhiram R. Superkar (2010)

The study was carried out to address very chaotic and crucial conditions at road junctions due to lack of commensurate development of infrastructure, particularly roads, road transport and inadequate public transport system. Study steps are provided before the way out of congestion problem like its analysis of the deteriorated and parametric transport environment. Paper also suggest transport options for mega cities like light rail, mono rail, magnetic levitation, tramways, trolley buses, sky buses, underground metro, urban rail. Paper focused on present scenario of Pune city and address lack of transportation management by ULB. Author also provide solutions to problems with different alternatives with view to experts.

(6) Abreu e Silva, Golab, and Goulis (2006)

Authors examined the relationship among socioeconomic and demographic characteristics, landuse characteristics around the residence and work locations and variety of travel behavior indicators are examined employing Structural Equations Model. They

consider Lisbon metropolitan Area as study area. 30680 interviews were conducted for 101337 persons. Conceptual model were prepared to relate landuse, socio-economic characteristics, residential location and travel behavior. Landuse characteristics: - shapes and location of activities. Travel behavior:- car ownerships, transit pass ownership, amount of time out of home, modes selected, travel distance, and number of trips. Socio-economic variables describes both the interviewed person – gender, age and working schedule and his household – total income, number of persons, family with adults and teenager, average of family.

Results provide quantitative evidence of the extent to which worker living in denser, central, compact and mixed zones makes more intense use of transit and non-motorised modes and tend to have lower car ownership levels.

(7) Leck, Eran(2006)[Berkeley Planning Journal,19(1)]

Author offer an application of statically meta-analysis in an attempt to settle the contradictory findings reported in the single studies. The findings reaffirm the role of residential density as the most important built environment element influencing travel choice. Meta-analysis is a package of stastical procedures designed to accumulate and integrate experiment results across independent studies. Meta-analysis uses the summary statics (correlation coefficients, P value, Z score, T test, sample size etc)

In model five urban form variables (residential density, employment density, landuse mix, sidewalk ratio, and grid percentage) and seven travel variables,(VMT, VHT, Vehicle trips, non-work vehicle trips, probability of commuting by automobile, transit or by walking) were included.

(8) Carey Curtis and Tim Perkins (2006)[Review paper-3]

Authors reviewed the relationship between major factors affecting travel behavior like

1. Urban form and travel behavior
2. Socio-demographic variables and travel behavior
3. Psycho-social variable and travel behavior
4. The influence of pricing on travel behavior

The most important socio-demographic variables that influence travel behavior include age, household composition, income, and gender and car ownership.

A. Urban land form and travel behavior

- Boarnet and crane studied the travel activities of 7469 household in orange and San Diego in 1986 to 1993 and found extremely complex relationship including that landuse and design proposals will influence the price of travel and hence the type of trip taken.
- Cervero(2002) studied travel behavior in Montgomery country, Maryland using data from the household travel survey(1994). He studied the impact of ‘new urbanist’ areas on travel modes, more specifically either compact, mixed use or pedestrian friendly developments could significantly influence travel modes.
- Goudie(2002) studied travel behaviours of 408 household in Townville and cairns 1996-1997. The research found that location played a large part in fuel consumption and distance travelled. The Participants located in the outer urban area used on average three times more fuel than the more centrally placed participants.
- Naess(2003) and Naess & Jenson(2004) studied the influence of residential location on travel behavior in Norway and Denmark. In particular they studied residential location and the distance from the city centre on travel behaviour and found a number of significant relationships. The closer the participants lived to the centre of the city then the more likely they were to walk or use cycle to get to the facilities located there.

B. Socio demographic variables and travel behavior.

The impact of socio-demographic variable on travel behavior and found some significant relationships between travel behavior and variables such as age, gender, household composition, income.

- Newbold(2005) studied the travel behavior of candidates aged 65 years or more to determine from younger Canadians.(age factor)

- Best & Lanzendorf (2005) attempted to determine if there were gender differences in car use and travel patterns for maintenance travel. No significance difference found.
- Ryley(2005) studied the composition of 2910 household in Edingburgh and research showed that household with children have distinct travel behavior characteristics.
- Dieleman et al (2002) used the Netherlands National Travel Survey from 1996 to 2002 to study the travel behavior. The major finding were that households on higher incomes were more likely to own and use a car.

(9) P.Christopher Zegras (2004)

The analysis focuses on the influence of three gross measures of urban form on travel behavior in Santiago de Chile having area of 600 square kilometer over 5.5 million people

Controlling for Socio-economic and demographic factors, the analysis attempts to demonstrate the influences of population density, relative share of commercial and service land uses, and relative share of vacant land on an individual's propensity to make home-based, non-work, non-school walking trips (HB, NWNS)

Maximize $U = (a, w, b, x)$

Subject to $y = x + aPa + WPw + bPb$

U is a utility function of the benefits of using time for each purpose.

a is a vector of the number of auto trips for each purpose.

W is a vector of the number of walk trips for each purpose.

b is a vector of the number of bus trips for each purpose.

x is a composite variable of the time spent on other activities.

P_i is the respective vector of time for each trip type in each mode i and,

y is the total available time.

Model –I :- Estimates trip behavior based on land use, income and socio demographic.

Model – II:- Introduced trip cost related variables.

Model –III:- The effect of land use on trip prices and the effect of predicted prices on trip generation.

Dependant variables: - (HB NWNS) trips.

Independent variables:-

Socio-economic:- Age, HH income, Gender, Education, person/HH, MV per Driver in HH.

Land use:- Population density, Relative Intensity of commercial service uses, Relative Intensity of vacant land.

Transportation:- Trip cost.

Average reported zonal walk time for all HB NWNS trips

In data analysis and relation regression modelling carried out between parameters. In that Coefficient of Correlation, Z – test, P-value and R^2 .

Following results were observed:-

Model 1:- Socio-economic variable found unaffected.

Land use mixing – significant, positive.

Relative amount of vacant land- significant, negative.

Population density- insignificant.

Model 2:- Walk trip cost – Significant and negative.

Model 3:- Not fully estimated.

(10) Bugley, Michael N, Mokhtarian, Patricia (2001)

Authors empirically examines the relationship of residential neighbourhood type to travel behavior, incorporating, attitudinal, lifestyle, and demographic variables.

Study area is San Francisco Bay Area where 515 samples were collected.

The interrelationship among the key variables of interests was operationalized with a nine equation structural model system. For formulation of structural modelling they use AMOS software.

In terms of total and direct effect, attitudinal and lifestyle variables have the greatest impact on travel demand. Residential location type had little impact on travel behavior. The result suggest that when attitudinal, lifestyle, and socio-demographic variables are accounted for neighbourhood type has little influence on travel behavior.

(11) Paul waddell(2001) [9th International Association for Travel Behavior Research Conference]

Author examines the linkage between household, choices of housing and job location, vehicle ownership, and activity and travel patterns to develop a behavior framework for integrating landuse and transportation models.

Author compared allocation of weekly hours to work and leisure.

Comparative study of United States and Norway.

He use Random Utility maximization model (RUM).

(12) Dominic stead and Stephen Marshall [EJTIR.1, NO:-2(2001) P.P:- 113 – 141]

Researcher has examined the relationship between numbers of urban characteristics, ranging from regional to local in scale, travel pattern. They consider nine aspects of urban form ranging from Regional planning level to local planning level.

- Distance of residence from urban centre.
- Settlement size.
- Mixing of landuse.
- Provision of local facilities.
- Density of development
- Proximity to network transport.
- Availability of residential parking.
- Road network type.
- Neighbourhood type.

Five measures of travel pattern

- Travel distance
- Journey frequency
- Modal split
- Travel time
- Transport energy consumption

They use empirical formulas to establish relationship between landuse type and travel pattern. Moreover produce results in table form to identify where research has been concentrated and where these gap in the research.

They also produce the flowchart to understand interactions between socio-economic factors and interactions between land use characteristics.

The interaction between socio-economic factors, urban form and travel patterns have complex relationship and required more concentration.

(13) Ryuichi Kitamura, Patricia L. Mokhtarian & Laura Laidet.(Transportation 24:125-158 1997)

Socio-economic and neighbourhood characteristics were regressed against number and proportion of trips by various modes.

Neighbourhood characteristics provide explanatory power.

In trip generation mode and model split by considering residential density, public transit accessibility, mixed land use and the presence of sidewalks.

Factored analysis of urban life into eight factors: Pro-environment, pro-transit, suburbanite, automotive mobility, time pressure, urban villager, TCM and workaholic.

Mail survey of household carried out in five neighbourhood around San Francisco nearly 1 square mile area of each.

Total area divided in 700 zones and 20 candidate from each zone.

Regression analysis carried out between parameters and value of R^2 , Mean and Standard deviation.

Neighbourhood characteristics are statistically associated with amounts of travel and mode split, and add significant explanatory power when socio-economic differences are controlled for other purpose.

(14) Boarnet, Mardon G, Sarmiento, Sharon (1996)

Author uses travel diary data for Southern California residents to examine the demand for non-work travel. Both non-work automobile trips and non-work miles travelled by car are modelled as function of individual socio-demographic variables and land use characteristics near the person's place of residence.

The research developed in the context of a travel demand model, the location of activities and measures of land use.

The socio-demographic variables are; Gender, Age, Black or White, Graduate from high-school or from college, Household income, No. of Children under age of 16 in the household.

The landuse variables are population density, % grid, Retail employment divided by land area, service employment divided by land area, Total employment divided by total population. The influence of the land use variables is quite weak.

(15) KAY W. AXHUSEN & TOMMY GARLING [TRANSPORT REVIEWS 1992 VOL -12 NO;-4, 323 – 341]

In first step they carried out the conceptualization of activity scheduling as land use type.

And in second step they prepare flowchart of "Dynamic utility maximization framework" and use computer program namely CARLA, STARCHILD AND SCHEDULAR to establish relationship between activities based approaches and travel analysis.

Scopes of model vary from Activity pattern to participation in shopping activities over a week from Washington and Israel in 1968 to 1983.

(16) Kara Mariakockelman (1991)

The model are intended to explore the degree of association between several dimension of landuse and travel behaviors, after controlling for socio-economic factors.

The modelled are titled as: - Density and accessibility, entropy and the "dissimilarity index"

Entropy in terms of land use balance and particularly job-housing balance.

The model explored estimate household VMT, auto ownership, and mode choice as a function of demographic and landuse variables.

Built environment proved to be substantial use in the models of travel behavior, while land use integration and compact development reduce automobile reliance.

III. Concluding Remarks

- In this review paper it was tried to provide the different approaches to relate various socio economic parameters with travel behavior. From simplest most method of linear regression to the latest software of transportation modelling and use of GIS in modelling was highlighted.
- Review paper can guide the new researcher about the approach as well as the selection of different socio economic parameters while modelling.
- But from all review paper it was not seen that any researcher have provide comparative modelling for same study area. So it is very difficult to judge which approach or method is suitable for particular type of study area.

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