

Integrated Land Use-Transport Model Approach in Town Planning for urban Areas

Pathik Chaudhari¹ Sejal Bhagat²

¹M.E. Student ²Assistant Professor

²Department of Civil Engineering

^{1,2}Sarvajanik College of Engineering & Technology, Surat, Gujarat, India

Abstract— Increased travel demand and improper distribution of population is the result of rapid urbanization. These issues are arising in developing countries which are facing growth in urban population and planning profession is seeking different solutions to overcome the problems like poor transport service. Land use and transportation are the sectors that are connected to each other with their integral parts. Separate planning in both sectors has been leading to problems like ineffective transport system and uncontrolled traffic for the urban areas. Integrated Land Use Models created in way that this integration can be achieved in more scientific and effective manner. This paper gives a brief introduction to this models with connecting parameters between land use and transportation planning and furthermore it elaborates the need of integration. This paper focuses on giving the brief overview about Integrated Land Use Transport models. In concluding remark applications of ILUT is discussed in context to urban areas of India.

Key words: Integration, ILUT (Integrated Land Use Transport) Model, Land use, Planning, Transportation, Travel demand, Urbanization

I. INTRODUCTION

At present world is facing the problem of rapid urbanization and managing the urban areas has become one of the most important development challenge of 21st century.

According to the United Nations since 1950 to 2014 urban population has grown from 746 million to 3.9 billion. And out of world's total population 53 percent urban population lives in Asia. UN predicts that in 2050 world will have urban population more than six billion. Most of the urban growth will take place in developing countries. As the result these countries will have to face problems to meet the needs of their growing urban population.

Urbanization leads to changes in forms of change in life style, employment, and economic growth and that creates the increase in travel demand. Thus for developing countries proper distribution of population with land use and creating effective transportation system is directly related to the urbanization.

Life style of urban population is demanding a better transport services in order to gain more accessibilities and convenience. Private vehicle ownership is increasing day by day in absence of ineffective public transport services. With proper land use planning usage of public transport can be increased. Thus the need of integration essential for urban areas.

Urbanization in India is also rapidly increasing. UN has predicted that urban population of India will increase from around 400 billion at present to 600 billion by year of 2031 which is about 40 percent of total population of India. As per The World Bank India was having 26 percent urban population in 1990 which shows the growth of 14 percent in

four decades. As developing country India is already facing issues like shortage of liveable housing and poor transport services. Thus for the future development to cope up with urbanization, India need comprehensive solutions to overcome these challenges.

This paper gives overview of information about ILUT model and their background. In this paper brief review of implementation of relocation activity model is added as example. Link between transportation and land use and need of integration between both is also explained in this paper.

II. NEED OF INTEGRATION

Land use that is responsible for activity generation and distribution of land use determines the demand for transport. On smaller perspective Transport service influences land use and activity distribution. Planning for each sector is done mostly by different agencies and that means to separate planning exercises. Lack of integration leads to un-intended consequences.

Both sectors influences each other at very fundamental level. Cities with proper mixed land use distribution reduces the trip length and encourage quality public transport and a better transportation can affect the land value and affordability. Good transport service can give improved access to employment, facilities and amenities. Complete network of road and streets can provide efficient and safe traffic movement.

Linkage between land use and transportation Land use creates the activity and that demands accessibility which is provided by transportation.

Interdependency and linkage between different parameters of both sector is shown below (Figure 1). These figure represents the parameters from land use that are connected in accordance with parameters of transportation services.

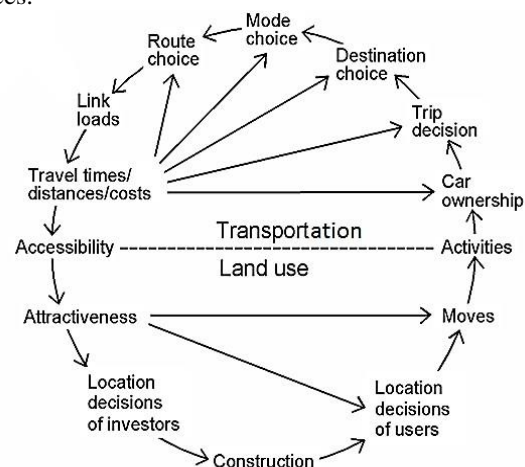


Fig. 1: Linkage between Land use and Transportation

Source: Overview of land-use transport models” by Michael Spiekermann

III. HISTORY AND BACKGROUND

In mid-19th century transport planners started using travel demand models which were basically use for predicting spatial flows and movement for people and commodities. They were aggregate approaches with using gravity based models. At the end of 20th century urban and transport planners started using aggregate model for predicting travel demand. They were four step aggregate models and today at present disaggregate version of this four step model is widely used with necessary modifications.

While developing the four step travel demand model urban planners started to identify the factors of urban transport system that can affect the transportation. At core of urban system is transportation and that is affected and manipulate by the land use configuration with meeting the travel need of people. This whole system is regulated by government plans.

Location choices of the population for residential purpose and for work and business purpose is strongly influenced by the changes that are made in transport supply.

Further the demographic processes that are independent of the transportation system that also influence land use mechanism and that again indirectly affects the demand for transportation. Environment factor is always there which is directly or indirectly connected to each of the sector mentioned above because of energy consumption and harmful emission. This link between environment and transportation was not paid attention to in long past but at present some of the advance Integrated models included consideration of environment parameter in modelling system.

Development of integrated land use transport models was started in the mid-19th century by the urban planners. One of the very first model that was gaining popularity was Lowry model (1964). This was the first generation model that has now become the base for models that are present today and many versions of Lowry model was developed. Many of the integrated models has been came to practice since then and this models has evolved rapidly from 4 step static model to complex dynamic models.

In 21st century next generation Integrated LU-T models are activity based models which dynamic and disaggregated. This models are made considering the various components of urban system. UrbanSim and TELUM are example of advance model. This advances models has capability to consider factors like economics, policy making, environment etc and they are created with technologies like GIS that enables them to give very effective results. ILUTE (Salvini and Miller, 2003) and RAMBLAS (Veldhuisen et al., 2000) are the example of next generation integrated LU-T models.

IV. INTEGRATED LAND USE TRANSPORT MODELS

Evolution of Land use transport models came in three phase as discussed in previous section first phase was developing 4 step travel demand model, second stage was developing integration between land use and 4 step travel demand

model and third phase is at present creation of next generation Integrated land use transport model which are dynamic in nature and use microsimulation approach and that are real time activity based models.

Most basic classification can be done for this models is as per data they use and as per their nature. So first classification is done as per data that is used in model that is

- 1) Aggregate models
- 2) Disaggregate models

Aggregate models were mainly trip base models where total number of trips were considered despite of bifurcation of that trips. They were simple mathematical models in which total number of trips generated from zone was considered as proportional to the population of zone and number trip attracted to that zone was considered proportional to the number of attraction sources in particular zone.

Disaggregate models uses the disaggregated data that means this models sees the trip of and household or firm as individual and use the bifurcation in modelling method. Now a days modelling techniques shifting towards disaggregate trip based models as they provide much deeper analysis of study area which ultimately results into better suitable solution. Furthermore there is disaggregate tour based models which divides tours into home and non-home based trips. Home base tours includes purposes- work, shopping education etc. and non-home base trips includes trips like work to lunch, business trip, shopping from one location to another. Within the model the frequency of trips and tours are analysed and predicted.

Other major category in which these models are divided is

- 1) Static models
- 2) Dynamic models

First generation of Land use transport models were static models that were built on gravity formula. They were not very effective upon policy analysis. Static models were not able to capture the changes that were influence by spatial process. They were unable to capture the dynamic motion of urban are, however despite of static nature some of the model were applied by adding the land use dimension to existing transport system and that can be said as dynamic modelling approach.

Dynamic model are cable of performing agent based analysis and they were capable of models that considers urban area's spatial process. Some of the dynamic model uses agent based microsimulation. Microsimulation is highly detailed analysis of activities like traffic at road intersection or trips classified by its purpose and location.

V. CONCEPT OF NEXT GENERATION MODELS

Next generation models includes the micro simulation of various components that were not included in pas modelling methodologies like policy making , economics, land use market and pricing and further its impact on environment.

Only model that is attempting to create the simulation of activity for land use and transport combine is UrbanSim. Main objective to building next generation Integrated LU-T model is to developing system that can analyse travel behaviour, corporate behaviour and behaviour of real estate market separately as well with reference to each of them. The most important task is to identify the link

between the different sectors like land market, policy making and global warming-environment changes, fuel shortage with the transport sector. Most complex link among them is between transportation and economic productivity. Comprehensive research is needed to identify these links.

Two ILUT models are noted below, one Relocation activity model was specifically developed for the city of Rome and other UrbanSim modelling software is widely used and well known software that used by urban planning profession.

A. Relocation Activity Model

This model was applied in the city of Rome, Italy which was having poorly connected mass transit system the main aim was to relocate different types of activity in way that can encourage the usage of public mass transport services.

The main variable here was residual capacity and location with intensity of activity and location of activity that can moved. To achieve the balance transport this variable has to be in integration with existing transport system.

This model proposes to modify the existing land use structure and current transport habits through relocation of activities close to the mass transport links.

Model's output are finding location of areas where activities could be moved and analysing the intensity of activities to be moved. This model does not aim to move the residential location because policy exists in Italy. It focuses on moving the business locations-employment volume.

Input of the model are: current activities intensity with location, Access to the destination points, residual capacity of the mass transit system, available space for urban areas where activities can be relocated, private and public transport travel demand, the public transport network. The urban area of Rome has population of 3 million, out this 1.1 million are employee and that produces about 552,000 trips in the morning peak hour. Area has two metro lines for total 45 km network. Before the model implementation model split in Rome was 66 % private transport and 34 % public transport.

After model implementation trips made by private transport were decreased 5 % and the final model split achieved was 38 % by public transport and 62 % by private transport. Thus the expected result encouragement of public transport was achieved.

B. Urban Sim

UrbanSim is at present most advance model and software. It is used to make simulation for metropolitan real estate market, land use and transportation plan. It is open source software and also provides a professional support for developing urbanism applications.

UrbanSim provides the simulation support for analysis and urban planning. Major factors that are considered in it are land use, economy, transportation and environment. It is well known urban planning software and it is mainly used by MPOs, NGOs, real estate professionals and students/researchers for finding out the effects of policy choices on transportation, housing affordability, global warming and protection of green space.

Eugene-Springfield, Oregon metropolitan area was analysed by UrbanSim model and this was the test run for finding out the application effectiveness for UrbanSim

which gave successful results. Model was applied in year of 2000 and land price market model, real estate market model, household-employment mobility and location model were the major input for this and UrbanSim observe the changes in household and employment from 1980 to 1994 and predicted and simulated changes in traffic zones.

VI. COMPARISON OF OPERATIONAL MODEL AND CHARACTERISTICS

Below table shows the comparison between UrbanSim and other software base models like DRAM (Disaggregate Residential Allocation Model), EMPAL (Employment Allocation Model) 1980 and MEPLAN Marcial Echenique & Partners' software package for planners, 1989.

Operational urban Model			
Characteristic	DRAM/EMPAL	MEPLAN	UrbanSim
Model structure	Spatial Interaction	Spatial input-output	Discrete choice
Household location choice	Modeled	Modeled	Modeled
Household classification	Aggregate, 8 categories	Aggregate, user-defined	Disaggregate, income, person, worker, child
Employment location choice	Modeled	Modeled	Modeled
Employment classification	Aggregate, 8 categories	Aggregate, user defined	
Real estate classification	4 land uses	Aggregate, user defined	24 development type
Real estate prices	Not modeled	Modeled	Modeled
Geographic basis	Census tract or aggregate	User-defined zones	Grid cells
Interaction with travel model	Yes	No	Yes
Software access	Proprietary	Proprietary	Open source

Table 1: Comparison of operation model characteristics

Source: Waddell, P. (2002). UrbanSim Modeling Urban Development for land use, transport and environmental planning. APA Journal.

ILUT models has been upgraded today since the development of first generation models from mid- 19th century. Now modern generation's model are featured with technologies like GIS and that gives opportunities to expand the applications.

VII. CONCLUDING REMARKS

Land-use transport modes have been applied on a very limited scale in India, though vast applications and potentialities exist. So far two of the most noticeable work

are Sarna A.C.'s work on the application of the land-use transport model for Delhi and second on is Lowry model has been developed for the MMA (Madras Metropolitan Area) region in order to test alternative development strategies together with their transport implications (year 2011). The main focus was to develop a transport network that supports employment and education purposes with optimum usage of land and reducing the transportation cost.

Result of this model implantation were positive and that indicates the modelling approach in urban planning should be encouraged. India is developing country and it's facing many of the problem and transportation is the issues that needs to be solved very immediately and effectively.

Private vehicle ownership in India is increasing day by day and reason of this increase fell into two categories. First one is to culture that has already developed in people while India's overall economic growth and second is the ineffective public transport that discourages most of the population to use the mass transport system that exists in their city.

First reason lies in social behaviour science but second reason can be countered by the implementing reliable and effective mass transport system. And that can only achieved by studying and analysing the land use and transportation characteristic of particular city and based on that predicting-forecasting the future need for land use and transport sector.

Forecasting the future demand of population is difficult task due the parallel changes in various actors in urbans system. For predicting the future demand there can be three method first is to ask the people second is to observe their current behaviour referencing past give the possible outcomes and third is to develop a mathematical model that use the data from above two methods as input and give the result. Only mathematical model can predict the unknown situations and also because of analysed data can identified the impact of every factor on system can be evaluated.

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