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New city model to reduce demand for transportation

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Abstract

Managing demand for transportation can be a cost-effective alternative to increasing capacity. A demand management approach to transport services also has the potential to deliver better environmental outcomes, improved public health and stronger communities, and more prosperous and liveable cities. The increased distance between places will have a direct impact on the demand of transportation. Public transport system (MRTS) is an answer to the growing traffic congestion. However, the question is; Is MRTS the last resort? This paper will be an attempt to regularize the development scenario of the city and thus reducing the demand for transportation.

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1.0 Introduction

Transport is a service, which cannot be stored, it is consumed immediately. The demand for transport is derived from the demand for what travelling makes possible e.g. commuting. Transport is always measured in distance and time all trips are:

- made over a particular distance,
- between start and end destinations,
- and for a given duration of time
- at different times of the day (peak and off peak)
- at different seasons e.g. summer or winter[1]

1.1. Demands for Transport

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Demand for transportation is not an independent variable it depends on a number of factors like accessibility, distance, availability, affordability, etc. The demand for transport refers to the amount of journeys undertaken at various prices, in a given time period. The demand for transport can be by passengers or firms moving freight or it are a derived demand i.e. got from the demand for what travelling makes possible. The quantity of transport demanded is dependent on a range of factors:

- The price of a journey e.g. price of petrol, or rail fare
- Price of substitutes
- Price of complements e.g. price of new cars and petrol
- Income e.g. low-income households cannot afford a car and rely more on public transport.
- Consumer taste e.g. is public transport uncomfortable and unreliable?
- Time how long will a journey by a given transport mode take? [1]

1.2. Peak time, peaking and congestion

Peak time refers to hours immediately before the start and after the end of work hours when most workers commute i.e. rush hours and is when the demand for transport is at its highest. Peaking and congestion result [1]. Peaking is where the demand for transport is concentrated in a given time period causing congestion. E.g. peaking occurs:

- With workers commuting in rush hours
- At bank holiday on holiday routes

Congestion is when demand exceeds supply on a given network at a given period in time e.g. rush hour. Loading or load factor refers to the percentage of capacity utilized in a journey. E.g. a loading factor of 80% means 20% of seats or space is unused in a given journey. The term traffic demand is linked to the economic impacts of the sharp increase in oil prices in America during the 1973 oil crisis and the 1979 energy crisis. As long lines appeared at gas stations, it became self-evident that alternatives to single-occupancy commuter travel needed to be provided in order to save energy, improve air quality, and reduce peak period congestion. [2] Relatively low and stable oil prices during the 1980s and 1990's led to significant increases in vehicle travel in America, both directly because people chose to travel by car more often and for greater distances, and indirectly because cities developed tracts of suburban housing, distant from shops and from workplaces, now referred to as urban sprawl. Trends in freight logistics, including a movement from rail and coastal shipping to road freight and a requirement for just in time deliveries, meant that freight traffic grew faster than general vehicle traffic. Because vehicle travel was increasing rapidly from 1980-2000, it follows that (with exceptions) the techniques of demand
management were not widely or successfully applied during this period. Small-scale projects to provide alternatives to single occupant commuter travel were common, but generally were led from outside the mainstream of transport planning. However many of the techniques in the demand management toolbox were developed during this period. [2]

2. Hypothesis

The demand for transport will reduce if we shrink the size of city and allow vertical growth (majorly). By keeping the place of work and place of stay near, travel demand will be reduces to a larger extent. Integrated work, stay and utilities modules/sectors will divide the whole city into a number of small and self-sufficient nodes. A uniform and mixed land use pattern shall be adopted to curb the growing demand for transportation.

3. Land use Transportation

Land use and transportation are two sides of the same coin. Transportation affects land use and land use affects transportation. Decisions that affect one also affect the other. As a result, it is important to coordinate transportation and land use planning decisions as they are complementary rather than contradictory. This assures that transport planning decisions support land use planning objectives and land use planning decisions support transport planning objectives. This requires an understanding of how specific land use patterns affect travel. [3] Urban land use comprises two elements; the nature of land use which relates to which activities are taking place where, and the level of spatial accumulation, which indicates their intensity and concentration. Central areas have a high level of spatial accumulation and corresponding land uses, such as retail, while peripheral areas have lower levels of accumulation. Most economic, social or cultural activities imply a multitude of functions, such as production, consumption and distribution. These functions take place at specific locations and are part of an activity system. Activities have a spatial imprint, therefore. Some are routine activities, because they occur regularly and are thus predictable, such as commuting and shopping. Others are institutional activities that tend to be irregular, and are shaped by lifestyle (e.g. sports and leisure), by special needs (e.g. healthcare). Still others are production activities that are related to manufacturing and distribution, whose linkages may be local, regional or global. The behavioral patterns of individuals, institutions and firms have an imprint on land use. The representation of this imprint requires a typology of land use, which can be formal or functional. Land use, both in formal and functional representations, implies a set of relationships with other land uses. For instance, commercial land use involves relationships with its supplier and customers. While relationships with suppliers will dominantly be related with movements of freight, relationships with customers would include movements of people. Thus, a level of accessibility to both systems of circulation must be present. Since each type of land use has its own specific mobility requirements, transportation is a factor of activity location, and is therefore associated intimately with land use. Within the urban system, each activity occupies a suitable, but not necessarily optimal location, from which it derives rent. Transportation and land use interactions mostly consider the retroactive relationships between activities, which are land use related, and accessibility, which is transportation related. These relationships often have been described as a "chicken-and-egg" problem since it is difficult to identify the triggering cause of change; do transportation changes precede land use changes or vice-versa? Urban transportation aims at supporting transport demands generated by the diversity of urban activities in a diversity of urban contexts. A key for understanding urban entities thus lies in the analysis of patterns and processes of the transport / land use system. This system is highly complex and involves several relationships between the transport system, spatial interactions and land use. Transport system considers
the set of transport infrastructures and modes that are supporting urban movements of passengers and freight. It generally expresses the level of accessibility. Spatial interactions consider the nature, extent, origins and destinations of the urban movements of passengers and freight. They take into consideration the attributes of the transport system as well as the land use factors that are generating and attracting movements. Land use considers the level of spatial accumulation of activities and their associated levels of mobility requirements. Land use is commonly linked with demographic and economic attributes.[4]

3.1. Urban Land Use Models

The relationships between transportation and land use are rich in theoretical representations that have contributed much too geographical sciences. Several descriptive and analytical models of urban land use have been developed over time, with increased levels of complexity. All involve some consideration of transport in the explanations of urban land use structures:

3.1.1 Von Thunen’s regional land use model:

It is the oldest. It was initially developed in the early 19th century (1826) for the analysis of agricultural land use patterns in Germany. It used the concept of economic rent to explain a spatial organization where different agricultural activities are competing for the usage of land. The underlying principles of this model have been the foundation of many others where economic considerations, namely land rent and distance-decay, are incorporated. The core assumption of the model is that agricultural land use is patterned in the form of concentric circles around a market [Krumme, 2002]. Many concordances of this model with reality have been found, notably in North America.

Fig: 2 Von Thunen’s Model
Source: http://people.hofstra.edu/geotrans/eng/ch6en/conc6en/vonthunen.html

3.1.2 The Burgess concentric model:

It was among the first attempts to investigate spatial patterns at the urban level (1925). Although the purpose of the model was to analyze social classes, it recognized that transportation and mobility were important factors behind the spatial organization of urban areas. The formal land use representation of this model is derived from commuting distance from the CBD, creating concentric circles. Each circle represents a specific socioeconomic urban landscape. This model is conceptually a direct adaptation of the Von Thunen’s model to urban land use since it deals with a concentric representation.
3.1.3 Sector and multiple nuclei land use models:

These were developed to take into account numerous factors overlooked by concentric models, namely the influence of transport axis (Hoyt, 1939) and multiple nuclei (Harris and Ullman, 1945) on land use and growth. Both representations consider the emerging impacts of motorization on the urban spatial structure.

3.1.4 Hybrid models:

These models tried to include the concentric, sector and nuclei behavior of different processes in explaining urban land use. They are an attempt to integrate the strengths of each approach since none of these appear to provide a completely satisfactory explanation. Thus, hybrid models, such as that developed by Isard (1955), consider the concentric effect of nodes (CBDs and sub-centers) and the radial effect of transport axis, all overlain to form a land use pattern. Also, hybrid representations are suitable to
explain the evolution of the urban spatial structure as they combine different spatial impacts of transportation on urban land use, let them be concentric or radial, and this at different points in time.

3.1.5 Land rent theory:

Rent theory was also developed to explain land use as a market where different urban activities are competing for land usage at a location. It is strongly based in the market principle of spatial competition. The more desirable the location, the higher its rent value. Transportation, through accessibility and distance-decay, is a strong explanatory factor on the land rent and its impacts on land use. However, conventional representations of land rent are being challenged by structural modifications of contemporary cities. Most of these models are essentially static as they explain land use patterns. They do not explicitly consider the processes that are creating or changing them.

![Land rent theory figure](http://people.hofstra.edu/geotrans/eng/ch6en/conc6en/landrent.html)

4. Transportation and Urban Dynamics:

Both land use and transportation are part of a dynamic system that is subject to external influences. Each component of the system is constantly evolving due to changes in technology, policy, economics, demographics and even culture/values, among others. As a result, the interactions between land use and transportation are played out as the outcome of the many decisions made by residents, businesses and governments. The field of urban dynamics has expended the scope of conventional land use models, which tended to be descriptive, by trying to consider relationships behind the evolution of the urban spatial structure. [4] This has led to a complex modeling framework including a wide variety of components. Among the concepts supporting urban dynamics representations are retroactions, where as one component influences others. The changes will influence the initial component back, either positively or negatively. The most significant components of urban dynamics are:

4.1. Land use:

This is the most stable component of urban dynamics, as changes are likely to modify the land use structure over a rather long period of time. This comes as little surprise since most real estate is built to last at least several decades. The main impact of land use on urban dynamics is its function of a generator and attractor of movements.
4.2 Transport network:

This is also considered to be a rather stable component of urban dynamics, as transport infrastructures are built for the long term. This is particularly the case for large transport terminals and subway systems that can operate for a very long period of time. For instance, many railway stations are more than one hundred years old. The main contribution of the transport network to urban dynamics is the provision of accessibility. Changes in the transport network will impact accessibility and movements.

4.3 Movements:

The most dynamic component of the system since movements of passengers or freight reflect almost immediately changes. Movements thus tend more to be an outcome of urban dynamics than a factor shaping them.

4.4 Employment and workplaces:

They account for significant inducement effects over urban dynamics since many models often consider employment as an exogenous factor. This is specifically the case for employment that is categorized as basic, or export oriented, which is linked with specific economic sectors such as manufacturing. Commuting is a direct outcome of the number of jobs and the location of workplaces.

4.5 Population and housing:

They act as the generators of movements, because residential areas are the sources of commuting. Since there are a wide array of incomes, standards of living, preferences and ethnicity, this diversity is reflected in the urban spatial structure. The issue about how to articulate these relations remains, particularly in the current context of interdependency between local, regional and global processes. Globalization has substantially blurred the relationships between transportation and land use as well as its dynamics. The main paradigm concerns that factors that used to be endogenous to a regional setting have become exogenous. Consequently, many economic activities that provide employment and multiplying effects, such as manufacturing, are driven by forces that are global in scope and may have little to do with regional dynamics. For instance, capital investment could come from external sources and the bulk of the output could be bound to international markets. [4] Transportation planners have traditionally focused on mobility rather than accessibility, and so have not considered the effects of land use accessibility on transport system performance [5] Different types of land use have different accessibility features. In general, more urbanized areas have features that increase accessibility and transport diversity, and therefore reduce automobile travel and increase use of alternative modes, while suburban and rural locations require more travel for a given level of accessibility and offer fewer travel options, as summarized in Table 2. Urbanized areas therefore tend to be multimodal, while suburban and rural areas tend to be automobile dependent (“Automobile Dependency,” VTPI 2008). [6]

5. Planning Objectives:

Changes in travel behavior caused by land use management strategies can help solve various problems and help achieve various planning objectives. Table 1 identifies some of these objectives and discusses the ability of land use management strategies to help achieve them. These impacts vary in a number of ways. For example, some result from reductions in vehicle ownership, while others result from reductions
in vehicle use. Some result from changes in total vehicle travel, others result primarily from reductions in peak-period vehicle travel and some result from increased non-motorized travel.

Table: 1 Land Use Management Strategies Effectiveness (Litman 2004)

| Planning Objective          | Impact of Land Use management Strategies                                                                 |
|-----------------------------|----------------------------------------------------------------------------------------------------------|
| Congestion Reduction        | Strategies that increases density, increases local congestion intensity, but by reducing per capita vehicle travel they reduce total regional congestion cost. Land use management can reduce the amount of congestion experienced for a given density. |
| Road & parking savings      | Some strategies increase facility and construction costs, but reduce the amount of road and parking facility required and so reduces the total cost |
| Consumer Saving             | May increase some development cost and reduces other, and can reduce total household transportation cost. |
| Transport choice            | Significantly improve walking, cycling and public transit services                                        |
| Road Safety                 | Traffic density increases crash frequency but reduces severity. Tends to reduce per capita traffic fatalities. |
| Environmental Protection    | Reduces per capita energy consumption, pollution emission and land consumption                           |
| Physical Fitness            | Tends to significantly increase walking and cycling activity                                             |
| Community Liveability       | Tends to increase community aesthetics, social interigation and community cohesion                      |

6. Proposed Model:

The complete city needs to be planned keeping in view the demand for transportation. There will be two major areas of action; first, planning a new city, and secondly redeveloping the existing city. The first one has many options and huge flexibility where are the latter has more complexity and challenges and this is where major problems of traffic are arising. Therefore the second part needs to be addressed carefully. Before we move to second part there is a need to understand the model first which is explained here as:

- The city shall comprise of integrated, self-sustained units/neighborhoods. Therefore mixed land use pattern is adopted.
- Each neighborhood units will have a work place and residences in equal proportions i.e. each person working in the office will have a residence in the neighborhood.
- To accommodate the growing population, the neighborhood units comprises of high-rise buildings, which will hold residences.
- Movable accommodation. The residences will not be fixed in one sector only. The location of work place will govern the location of accommodation. For example a person shifting his work place from a neighborhood unit to B neighborhood will be provided with an accommodation in the unit B.
- There will be categories of accommodation which will be as per income group.
- To serve daily needs of people living in the area, single roof shopping stores will be provided in the ground floor of apartment tower, which are along the periphery of the neighborhood unit. Maximum distance travelled by any use will be 800 mts.
- School building along with residences will form the core of neighborhood unit so that children walk for a lesser distance.
- There shall be network roads of varying width to accommodate different volume of traffic.
• Each unit will be surrounded by another neighborhood unit of similar facilities and buildings such that both look alike.
• 4-6 neighborhood units will form a district and each district will be dedicated to one type of industry. Say IT district. Manufacturing District and so on.
• Each of these districts will be connected to each other through a network of roads.
• All the districts are connected to national highway like the leaves of a tree are connected to its branches. That means all the development shall be away from highway. The concerned government can regulate this by modifying development rights.

The above mentioned guidelines are good for any new town to be developed, but the present scenario shows that all new development is taking place around the existing cities because of the property market and various facilities of city life. Proposal of a new town is always number two on the priority list. Therefore following are the guidelines for the existing towns:

The development shall be to respect the spatial pattern and spatial interaction of the existing city. The natural growth of the town shall be studied before the new development is proposed.

The new development shall be the extension of the spatial interaction

The similar neighborhood units (as discussed above) shall be proposed on the outer periphery of the town but their arrangement shall be according to the natural/existing form of the city.

In existing towns the new development shall have more office buildings and less residential spaces as the city already has a number of residences.

All these office buildings are connected to each other through ring road and one class of industries will be clubbed together rather than just spreading them around the city.

Land prices play a vital role in the development scenario concerned government shall improve the land prices around the periphery of the city by making more development projects and better infrastructure facilities.

Fig: 6. a) Neighbourhood  b) District  c) Tree layout of different district.

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