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Integrated Transportation and Land Use Planning Model: A Study on Traffic Congestion in Urban Areas

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Abstract: ***Transportation planning focuses on the most efficient movement for people and goods, access to new residents and businesses which contributes to the economic, industrial, social and cultural development of the country. Planning for transportation infrastructure takes significant role in the development of urban areas. ITLUP (Integrated transportation and land use planning) model deals with integrating proper alignment of transportation networks with land use to decrease travel length and need to travel thereby reducing traffic congestion. This study shows how ITLUP model can be applied in the urban areas. It also discusses about the improper planning of transportation in urban areas which leads to traffic congestion and ITLUP model as a solution to overcome this problem. Lawry model also plays a significant role in planning. It gives importance only for the population and employment in the planning process which is also considered in the study.***

Keywords: Transportation, land use, urban areas, traffic congestion, planning

1. Introduction

Improper planning will lead to problems like overcrowding, housing shortage, congestion etc. Integrating transportation and land use will be a solution for traffic problems facing in the urban areas by decreasing the travel demand. So there is a need of integrating transportation and land use. Integrating transportation with land use helps to decrease travel length and need to travel. Transportation planning and the land use planning have to be done together.

2. Aim & Objective

Aim is:
To maximise the efficiency of urban transport and minimise traffic congestion by utilising Integrated Transportation and Land Use Planning Model.

Objectives are:

- To study the significance of the relationship between land use and transportation planning in urban areas and the parameters relating.
- To study and prove ITLUP Model can be used as a solution for traffic congestion in urban areas.
- To identify the influence of Lawry Model on ITLUP Model.
- To show how to apply ITLUP Models in urban areas.

3. Introduction to ITLUP Model

ITLUP model aims to reduce the travel option by integrating land use and transportation, thus decreasing the traffic congestion. It focuses on high- speed mobility mainly in urban areas. The well- planned settlements avoid the need for unnecessary trips. Future development could be based on the principle of ITLUP Model to recreate livable cities. By coupling land use and transportation in the planning process, we essentially create urban spaces for people and not for automobiles, which is the core philosophy behind ITLUP Model.

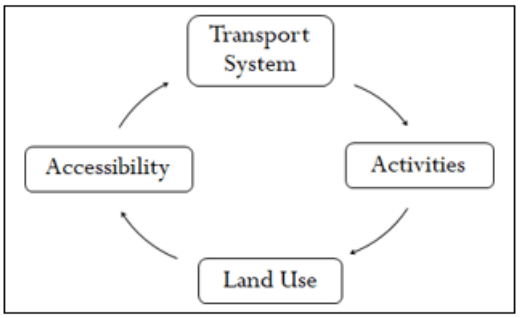

Figure 1: Principle of ITLUP Model
Source: www.urbantransportgroup.org

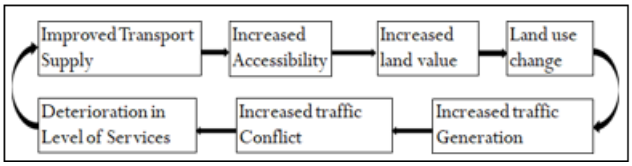

Figure 2: Land use and transport Linkage

3.1 Concept

ITLUP is based on the principle that the ultimate goal of transportation is to connect people with goods, services and people rather than improve mobility by supply enhancement. Integrated Transportation and Land Use Package is composed of a residential allocation model, employment

allocation model and a travel demand model.

Land is a convenient measure of space and land use provides a spatial framework for urban development and activities. The location of activities and their need for interaction creates the demand for transportation, while the provision of transport facilities influences the location itself.

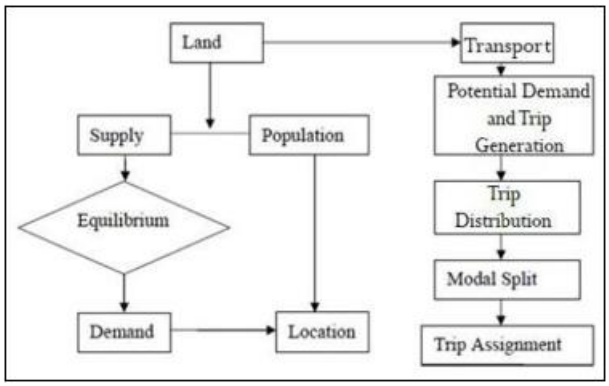

Figure 3: ITLUP Model process
Source: www.civil.iitb.ac.in

3.2 Procedure

1) Divide the area into different zones
Zones are divided in the basis of administrative boundary, physical barriers, road networks and public transport network, homogeneity in land use, special traffic generators.

2) Make a survey and collect the information under base year condition related to transportation and land use patters
Base year data include the spatial distribution of all employment and residential activities, estimate total number of people, total number of houses, characteristics of the households by zones, existing road networks and its characteristics, number of trips, travel demand, time taken for travel etc.

3) Identify the possible land use changes and predict the travel pattern of the horizon year i.e., 20 years beyond the base year or planning period
Land use changes consider some factors based on the type of zone, for example if it is a residential zone then certain number of households have its own characteristics with regard to average household size, average vehicle ownership, average household income etc.

4) Prepare a plan by integrating both land use and transportation
Relocate

5) Visualise the change by considering the parameters
Transportation network and the land use pattern will not be same after 20 years.

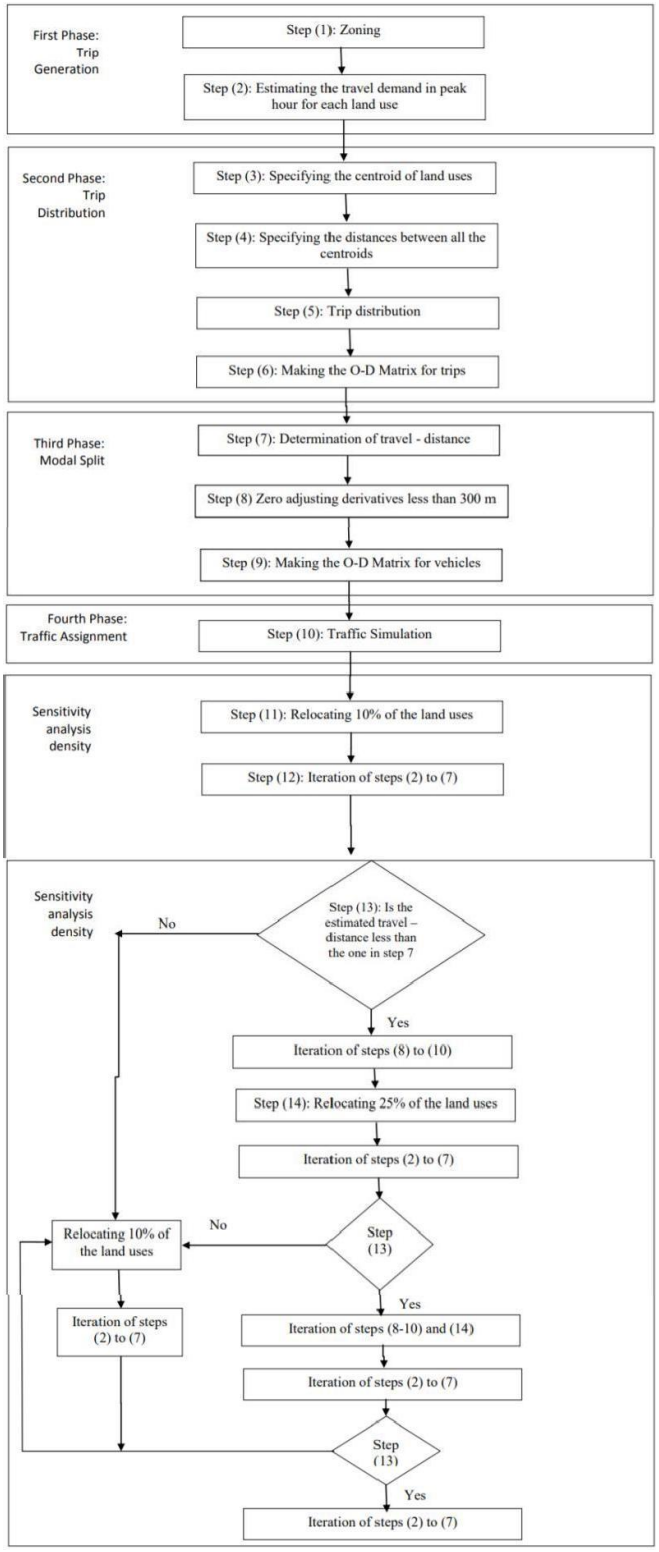

Figure 4: Procedure of ITLUP Model
Source: Tehran District 22

3.3 Relationship between land use and transportation

Land use and Transport are intricately linked to each other as a two- way relationship. Based on ITLUP Model:

i) Transportation depends on Land use (when land use changes it affects the whole road networks. ii) Land use

depends on transportation (when transportation network changes the pattern of land use changes).

If inefficiency happens in their relation, disorders will happen in different aspects in a city. For Example: socially (inconveniency for citizens), economically (delay, congestion) and environmentally (pollutions) and many more disturbances. Occurrences of these represent a city far from being sustainable.

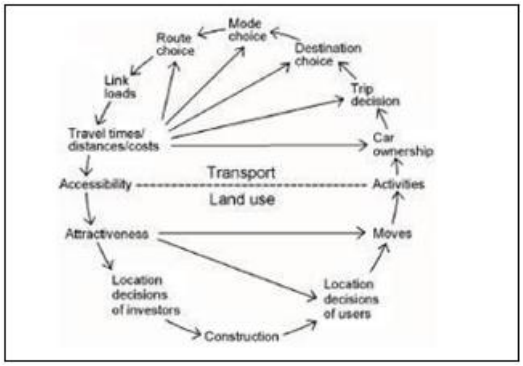

Figure 5: Land use/transport feedback cycle
Source: www.civil.iitb.ac.in

3.4 Factors relating land use and transportation planning

- Employment and population distribution
- Demographic transition (Migration, natural growth, family size, age, gender)
- Commercial, institutions, offices, residential buildings
- Travel behaviour (Choice of mode, route, destination)
- Networks and travel time
- Urban environment
- Rules, regulations, Laws etc.

3.5 Benefits

- Prevents urban sprawl and guides peri-urban development
- Helps decide on transportation and other urban infrastructure investment decisions
- Helps in travel demand management (reduces trip length, travel time, increases efficiency)
- Guides in transit oriented development
- Reduced demand on transportation system
- More interaction between community members
- Reduced travel cost
- Less energy consumption
- Improved air quality
- Expanded accessibility
- Large markets and choices
- Economics of scale
- Increases safety
- Availability and sharing of services

3.6 Scope and Limitations of ITLUP Model

Scope

- Integrating transportation network and land use helps to achieve convenient, comfortable, cost effective and sustainable mobility.
- Improvement access to employment, facilities & amenities increases the land value.
- Planning based on the future demand and future growth accounts for the planned development.
- Easy accessibility is a major contributor to the economy and a competitive force in business.
- By controlling land use transportation problems in cities can be fixed.
- It provides a viable and low cost solution of transport and saves time.
- This method can be used in most of the cities which faces problems related to traffic congestion.
- It helps in guiding the city form and land use pattern.

Limitations

- Takes a long time to analyse every possible solutions of integrating transportation and land use.
- Future demand can be changed.
- Continuous monitoring has to be made by professionals which is difficult.
- Huge investment is needed for relocation of transport network or land use pattern so the implementation will be difficult.

3.7 Parameters of ITLUP Model

Land Use Planning

- Changes occurred in Land Use pattern
- Existing Land Use in Land Use
- Further Expansion and changes
- Future land requirements

Transportation Planning

- Existing transportation system
- Urban Travel Pattern
- Travel Behaviour Survey
- Travel forecast (4 Stage Travel Demand Model)
- Traffic based on road types

3.7.1 Changes occurred in land use pattern

Spatial Changes that has occurred has to be analysed to study the past and existing conditions. Using the study of occurred land use changes, it is possible to know the future trends changes that may occur.

3.7.2 Existing land use in land use

Existing land use pattern has to be noticed. How much land is used for different purposes has to be identified and how much vacant land will be built up. Land Use distribution includes residential, commercial, industry, public and semi-public, transportation and communication, mixed use, recreational, primary activity, protective and undevelopable use zone, special areas, social infrastructure etc.

3.7.3 Further expansion and changes

Analysis has to be made to know the future expansion and the changes occurring. Peripheral expansion plays an important role in planning and also study of urban fringe has to be made. Analyse the changes in land use from one type to another.

3.7.4 Future land requirements

Future developments in each sector have to be considered. Forecast population density to understand the land use

changes in each areas and its cause. Changes in utilities and social infrastructure have to be identified.

3.7.5 Urban travel pattern

Land use characteristics that can affect urban travel pattern

- Location (with respect to existing towns, cities and infrastructure)
- Structure of development (size and shape)
- Land use type and overall mix
- Clustering/ concentration of development
- Land use mix (Level and scale of mix)
- Density of development (Population and employment density)
- Layout of development (movement networks, neighbourhood type)

Sustainable Urban transport Scenario

- Limiting private vehicle ownership and use
- Improving urban form, NMT infrastructure, Public transport improvement
- Regulatory and financial measures
- High density mixed use development
- Closure of city centres for car traffic
- Para transit as feeders to transit systems and intermodal facility provision
- Transit oriented development

3.7.6 Existing transportation system

The Nodes and networks in that area have to be identified. Connectivity to the nearby areas is important to check the flow of vehicles to that area and also travel demand survey has to be made. Public transportation System plays a significant role in the traffic analysis survey. Amount of vehicles on the road mainly depends on the transportation facilities. Dependence of private vehicles leads to traffic congestion so the cause of increasing private vehicle should be identified.

3.7.7 Travel behaviour survey

Travel behaviour survey is important in forecasting traffic, which depends on future changes to road networks, land use patterns, and policies. Household Travel Survey includes household characteristics, person characteristics, and a daily diary. Trip depends on an origin and a destination.

3.7.8 Four step travel demand model

Model is developed and calibrated using base year data for continuous trip producing and attracting zones. These steps are sequential with output from each step being taken as the input for the next step.

- Trip generation: To understand the reasons behind trip making behavior.
- Trip Distribution: It determines the number of trips. The direction of trips between zones has to be determined.
- Model Split: Process of separating person- trips by the mode of travel- expressed as a fraction or ratio. In general, it refers to the trips made by private car opposed to public transport.
- Trip Assignment: Trips are allocated to different part of the road network system. All assignment techniques are based on route selection.

3.7.9 Traffic Based on Road Types

1) Arterial roads

These roads connect the town to state highway or a national highway. They pass through the city limits and carry a large amount of traffic.

2) Secondary or Sub arterial roads

They are designed for slow moving traffic and cover a short distance.

3) Local roads

These roads are meant to provide approach to the buildings, offices, shops, schools, colleges etc. There should not be through traffic, therefore they form pockets or precinct roads mainly to serve the non-vehicular traffic.

4) Other roads

a) **Bypass roads:** Congestion free road, when the main or through road pass through the congested area of the towns there will be considerable reduction in speed of the vehicles and the smooth flow of thetraffic resulting in loss of time and fuel.
b) **Outer and Inner ring roads:** These ring roads help to reduce the traffic congestion. The outer ring is meant to divert the through traffic approaching the town. The inner ring road is meant to divert the local traffic from through traffic.
c) Express ways: These roads are meant to function as arterial road for the movement of fast moving traffic in the big metropolitan cities.
d) **Free ways:** These are special routes meant to carry fast moving traffic.

4. Lawry Model Planning

This model is introduced for the spatial organisation of human activities in a metropolitan area. The model relates three principle components of urban areas, they are

a) Population
b) Employment
c) Communication between these two.

According to Lawry Model, urban land use and transportation should be planned on the basis of:

a) Basic employment: Employment in industries whose outputs are sold in markets external to region under study. Independent of the population and service employment of that region
b) Service employment: Employment which serves the population in a region. Employment depends upon the population distribution of that region
c) Household employment- Consists of resident population
   - In the case of ITLUP, All the components have equal influence for planning but also give priority to the employment factor.

5. Case Studies

The case studies show the methods and techniques used for integrating and how to plan urban area with congestion free mobility.

5.1 International Level- Singapore

General

Singapore is a small island city state located in South East Asia. It has an area of 714 Km^2 and has a population of 5.3M. Density of Singapore is 7300 persons/km^2. Singapore has very high Human Development Index of 0.912. Singapore is more known for its integrated approach to urban development.

Figure 6: Location of Singapore
Source: www.googleimage.com

Evolution of ITLUP Model in Singapore

1) Planning was mainly confines to the control of private development which resulted in considerable haphazard growth, severe housing shortage and overcrowding in the central city.
2) Authorities were forced to set up a master plan committee to study the problem
3) 1959 First Master Plan: Marked the beginning of an era of continuous official involvement on a comprehensive scale.
4) 1967 Government commissioned the State and City Planning project to examine urban planning and transportation development.
5) Formulation of new planning strategy to guide long- term growth of the island
6) 1971 First Concept plan, incorporation with five year Master plan i.e., from 1975onwards.

Singapore's Transformation

In 1960's Singapore faces urban sprawl, poor housing and overcrowding which leads to the degradation of the country. Today, Singapore is a most preferable country for sustainable living which shows the effective planning.

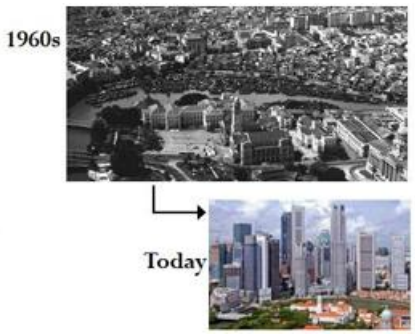

Figure 7: Singapore during 1960's and now
Source: www.ura.gov.sg

Long- Term Planning for Infrastructure Development

The strategic land use and transportation plan was formulated aiming Singapore's development over the next 40-50 years. Planning is based on the concept plan and master plan and a feasibility study will be conducted at particular intervals.

1) Concept Plan was developed for 40 to 50 years and updated every 10 years. It ensures that adequate land is available for future land use development to meet needs of growing population and economy.

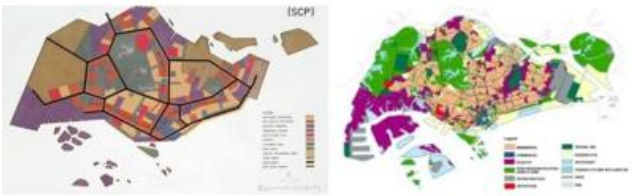

Figure 8: Concept plan 1971 and 2011
Source: www.ura.gov.sg

2) Master Plan, for 10 to 15 years and it is reviewed every 5 years. It is more specific in nature, delineating the permissible land use and density and time frame for developments in the city.

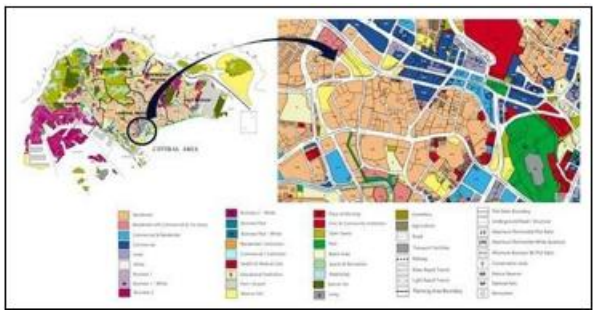

Figure 9: Master Plan showing zoning based on land use
Source: www.ura.gov.sg

3) Planning Feasibility studies 5- year road development programme & Rail line and bus network.

Figure 10: Expressway and MRT based on concept
Source: Land Use Planning: The Singapore Experience

Measure Adopted to Integrate Land Use and Transportation

To ease congestion due to traffic to and from the Central Area (where CBD is located) during peak hours several regional, sub-regional and fringe centres are developed around major MRT stations. A part of the commercial and economic activities are thus decentralised to these locations. MRT originates from the Central area and spread outwards. Centres are basedon largest economic hubs.

In Singapore, planning for land use and transport networks are done together. The land transport network constitutes almost 12% of the total land area and has High density urban residential building.

Zoning Interpretation- Zoning based on the land use (Legends represents zones). The full area is divided into different regions based on the importance of that area.

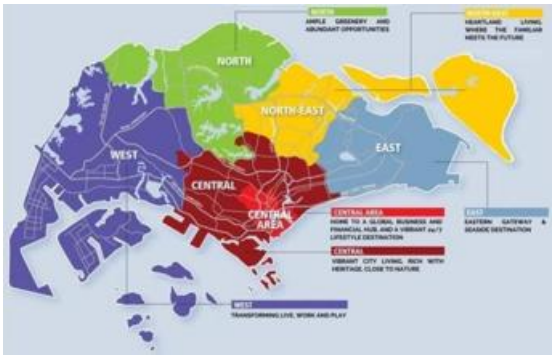

Figure 11: Regional division and highlights
Source: www.ura.gov.sg

- Central Region- Vibrant city living, rich with heritage, close to nature
- Central area- Home to a global business and financial hub
- North Region- Ample greenery and abundant opportunities
- North East- Heartland living where the familiar meets the future
- West Region- Transforming Live, work and play
- East Region- Eastern gateway & seaside destination

Measures to reduce the need for travel

Main housing towns and commercial centres are focused on the MRT line so the need for travel availing basic amenities is reduced by greater extent. Locations of business centres are chosen near the residential areas, to further reduce the need to travel. Restaurants, Super markets, pharmacies etc are built at walkable distances.

Figure 12: MRT and Expressways connecting housing towns and commercial centres

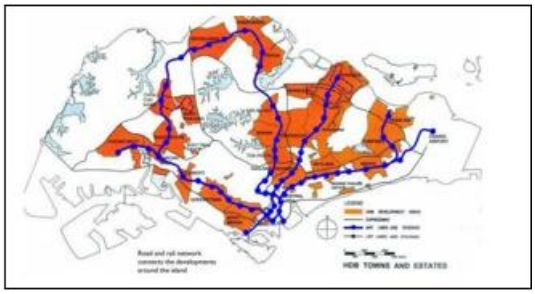

Figure 13: Residential area and Expressways
Source: www.ura.gov.sg

High- rise residential complexes are constructed in mixed land uses, so that the distance between work and home can be reduced considerably. Residential area concentrates on the expressway which shows the well planning of land use and transportation network.

Measures to improve public transit and active transport conditions

Singapore has a very efficient public transportation system consisting of Mass Rapid Transit (MRT) and Light Rapid

Transit (LRT) which connects major commercial areas, residential areas etc. Bus stops are placed at walkabe distances from the residential complexes, so that accessibility to bus transit is ensured. The number of bus stops was 4638 i,e., more than 6 bus stops per square Kms.

Planning For Future

1) Proposal for rail network in 2030
- New rail network for 2030 has been introduced based on the ITLUP Model concept.

2) Work force proposal for Dover Knowledge District, Central Region
- Introducing new public transportation facilities in Dover Knowledge District in Central Region for making it as an employment hub.

3) Mobility corridors in the West Region
- Proposal for sky corridors and Jurong canal drive extension.

4) Recreation & Community Hub in North Region
- Proposal for rail corridor connecting parks

5) Extending rail network in the East Region
- Proposal of rail network in the East Region focusing on the commercial and industrial development. The proposed rail network connects parks also.

6) Growth of Public Transport Network and Distribution of Employment Nodes in the North East Region
- Introducing public transport network focusing on job centres and also the distributing employment nodes along the transportation networks.

Inference

- Before implementing ITLUP Model, Singapore faces overcrowding of people in the city centre, poor housing and urban slums.
- After making use of ITLUP Model in planning, Singapore became the most sustainable place to live with high efficiency of transportation.
- Other than the city centre, the regional and sub-regional centres are also placed andgiven importance to decrease the flow of people towards the city centre.
- Singapore plans transportation network focusing on the residential area, major commercial centres etc which increases the accessibility.
- Planning of land use was based on mixed use development so that the need for travel can be decreased.
- Transportation network connects the centres which increases the accessibly.
- Special importance given to public transportation to decrease traffic congestion.
- Space is allotted for daily needed amenities near residential area at walkable distance so that use of vehicles can be decreased.
- Promote high density and compact public transport-

centric urban fabric with more transportation choices.

5.2 International Level - Adelaide, Australia

General

Adelaide is the capital city of the state of South Australia. It has an area of 3,258 km² and has a population of 13.1 Lakhs. The density of Singapore is 400 persons/km².

Figure 14: Location of Adelaide
Source: www.googleimage.com

Division of Area

Adelaide has three concentric areas that spread out from the CBD and extend along an elongated north-south corridor which is based on the land use patterns and the relative proximity to employment and services.

CBD and Inner Adelaide

- Travel Pattern- within 5Kms
- Shorter journeys and more frequent
- Large numbers of commuters needing to travel into and around the CBD for work each day
- More people walk and cycle

Middle Adelaide

- Travel Pattern- between 5Kms and 15Kms of the central city
- Gained the largest amount of population growth over the past decade
- Housing, services and jobs are located apart
- Longer public transport trips and more dispersed, with major role in bus network

Outer Adelaide

- Slower population growth
- Lower transport options and Employment is more widely distributed
- The bus network is important in reaching more dispersed residential and employment areas, and the train network is well-used for trips into the central city.
- Depends on cars to travel to work

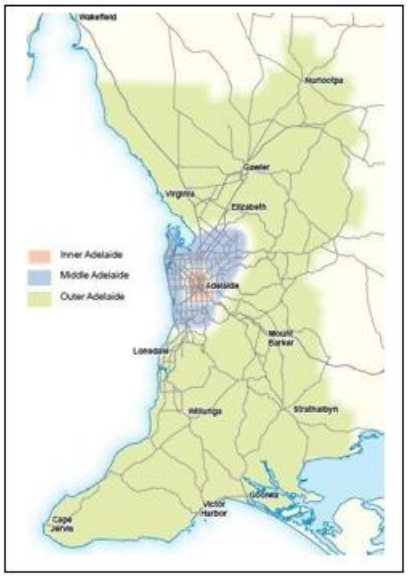

Figure 15: Division of area
Source: Building a stronger South Australia

Adoption of ITLUP Model

Adelaide has implemented the ITLUP Model in 2015. Alignment of road network connects the residential areas and work centres to decrease travel length and need for travel. Corridors are fixed based on the land use and then transportation facilities. They focus on improving public transport for a safe and efficient transportation.

The planning focuses more on providing public transportation for improving accessibility between residential areas and job centres. High density Public housing in the Inner Adelaide has been proposed aiming high density development.

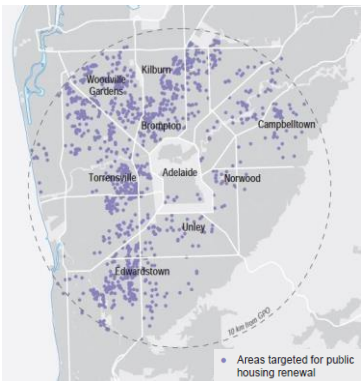

Figure 16: Areas proposed for public house renewal
Source: Integrated transport & land use planning- Australia

Transportation networks are provided based on the future employment growth trends. Networks mainly connects capital city, regional centres, major districts, specialist centres with manufacturing hubs, defence hubs, universities and science, technology and innovation centres. The city provides tram, bus, rail for decreasing traffic congestion.

North-South Corridor connects inner, middle and outer Adelaide which accounts for easy accessibility and economic development.

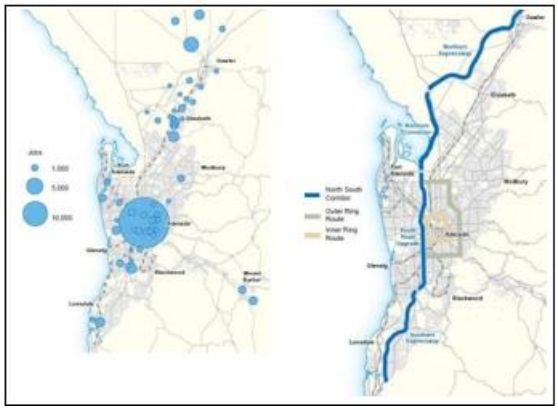

Figure 17: North- South economic corridor connecting employment growth in Greater Adelaide(2011– 2036)
Source: Building a stronger South Australia

Transportation facility aiming:

a) Increasing the efficiency of traffic flow
b) Improving safety for all road users including motorists, pedestrians, cyclists and businesses moving freight and delivering goods and services
c) Providing alternative, efficient connections for traffic travelling around the central city, which forms the basis for creating attractive main streets, streetscapes and pedestrian amenity in the CBD

Solution Plans

Central and inner Adelaide solution plans

Efficient public transport has been provided to connect the central city with the people. Parallel roads will be upgraded which is required to provide efficient traffic flow for those people choosing to travel by car.

Middle Adelaide solution plans

Middle Adelaide improves the road networks and transportation facility for increasing accessibility towards the Inner Adelaide. Public transport facility in the residential areas has to be increased for a safe and convenient transportation which accounts more to the population growth.

Outer Adelaide solution plans

New strategic employment lands are provided to decrease the travel length. Examination of future growth area was done and provision of transportation facilities has given. New road networks to the central Adelaide to increase connectivity and to decrease the traffic congestion.

Forecast- 2045

Transit corridor connecting proposed residential area to decrease traffic and to increase accessibility to the job centres. Expanding accessibility to the outer Adelaide thus expanding urban growth area and also aiming to increase the land value. The new proposal aims to decrease the travel length to the central city.

Inference

- Lack of planning leads to congestion in the central city.
- Planning mainly focused on connecting residential areas and job centres with transportation based on ITLUP Model.
- High density and compact residential area is proposed in the central Adelaide for reducing the need for travel.
- Extending existing road for increasing accessibility.
- Creating new road networks in the residential area to decrease length of journeys.
- Provides public transport facilities based on land use, so that all the trips will assign toa particular bus stop or railway station. Thus, traffic congestion can be decreased.
- Connectivity provided between central, middle and outer Adelaide helps in efficient distribution of goods and services to business and community.
- Encourage the use of public transport system by providing more convenient, safe and comfortable facilities.
- Provision of more employment and job centres in the outer Adelaide for decreasing traffic flow towards the inner city, thus decreasing traffic congestion.
- Parallel roads aiming private vehicle users for congestion free mobility.

5.3 National Level - Ahmedabad, India

General

Ahmedabad is the largest city and former capital of the Indian state of Gujarat, one of the Most Urbanized States in the Country. It has an area of 464 Km^2 and has a population of 5.5M. The density of Ahmedabad is11,800 persons/km^2. Ahmedabad is the 5th largest city and 7th largest metropolitan area of India.

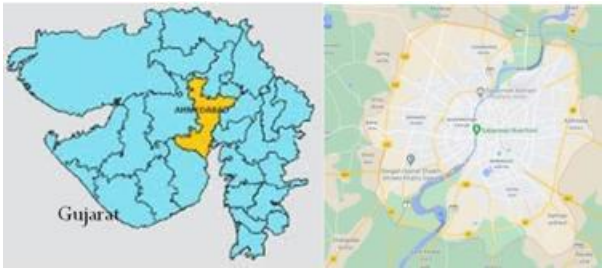

Figure 18: Location of Ahmedabad
Source: www.googleimage.com

Urban Structure

- City is growing at a decadal growth rate of 22.31% (provisional Census 2011)
- Relatively compact structure with mixed use development owing to effective town planning practices.
- Gradual tendencies of dispersal especially in the peripheral areas of the city (CoE, CEPT University, 2008)
- The growth of the city has been in a ring-radial structure, owing to a planned road network of ring roads and well-defined radials in the Development Plan of the city.
- The development of the road network has preceded urban development and has been instrumental to the growth of the city.

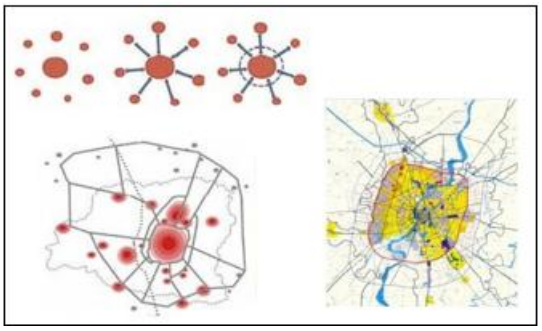

Figure 19: Connecting the small centers with the core area
Source: Integrated Land Use and Transport Planning Ahmedabad City

Development Plan (Master Plan), 1967

Development Plan provides the overall development framework. It is revised every 10 years. The aim of the development plan is:

- Overall direction of urban develop
- Land use planning & Zoning
- Urban mobility & Road network
- City Level Infrastructure (Public Utilities & Amenities)
- Demarcation for public purposes including housing for urban poor
- Urban Transport Planning
- Development Control Regulations for Building Plans

Planning for ITLUP Model

The ring roads connect the people with the centre. Ring - radial network of streets, with 5 ring roads and 20 radials with a road length of 2400 km. 20 well defined radials include 12 in the west and 8 in the east, acts as important axes of development. To connect these radials arose, 5 ring or orbital roads were planned.

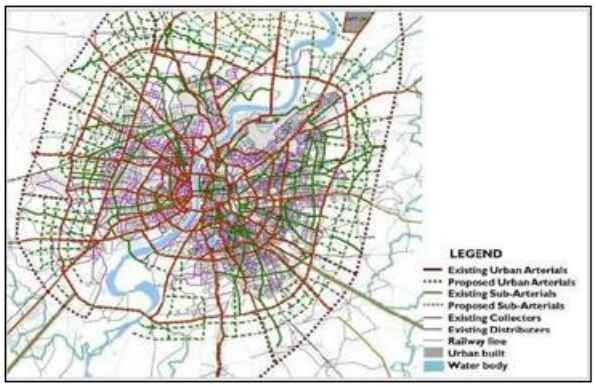

Figure 20: Road networks
Source: Integrated Land Use and Transport Planning Ahmedabad City

Proper land use and transportation planning has done to decrease congestion. Industrial areas in the eastern parts, trade is concentrated mostly in the central parts and institutions in the western parts. Low rise high density character with almost 20 % of its population staying within 1 km of its operational transit network (BRT), focusing on an increase of 80% once transit network completes. Potential areas to be developed as activity nodes and connected by transit system for easy accessibility.

BRT alignment mainly focused on residential, industrial and educational areas. The city has high density development with proper transit system. It connects major urban employment areas, major employment centres and urban area centres to decrease travel length.

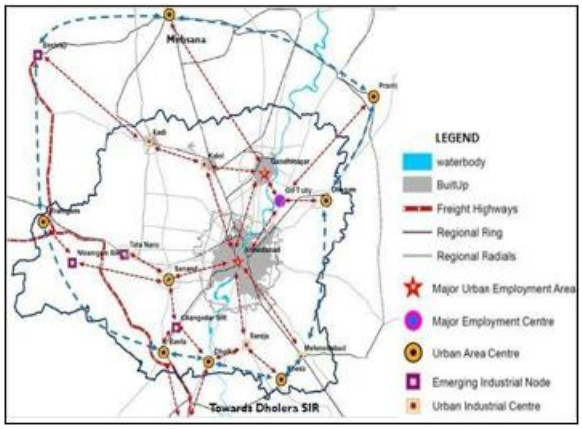

Figure 21: Connectivity between urban area centres, industrial areas and employment areas
Source: Integrated Land Use and Transport Planning Ahmedabad City

Inference

- Ring model road alignment to increase accessibility and to decrease the travel length.
- Connects the developed centres to the central city.
- Road network of the city has contributed in the high-density development and compactness of the city.
- Special places for residential, industrial and educational institutions as a part of planning.
- Improved connectivity between employment centers, residential areas and urban area centres to decrease length of travel.
- Gives importance to the public transport system to decrease traffic and to increase safe and convenient transportation.

5.4 Comparison of Case Studies

The cities can be planned in any manner but the planning should fulfill the needs. The comparison of case studies shows what they have done to rectify the problems.

Table 1: Comparison of case studies

Case Studies	General Comparison	Based On Analysis
Singapore	Already implemented and still updating	To eliminate Urban Sprawl. Total relocation of land use and transportation networks.
	Long term planning aiming	Transportation planning is done on the basis of land use and also land use is located on the basis of transportation facilities. Considers sector wise land use for zoning
Adelaide	Ongoing project	To increase easy accessibility to central city and to increase the use of outer cities.

	Fixing the current problems	Extending the existing transportation networks and also proposing new land use areas and transportation facilities to satisfy ITLUP Model. Gives more importance to the Lawry model of planning for ITLUP Model i.e., gives importance to employment, residential area and transportation. Considers Build up area as a whole, no importance given to different sectors
Ahmedabad	Ongoing project	Ongoing project Trying to solve the existing problems by implementing ITLUP Model
	Trying to solve the existing problems by implementing ITLUP Model	To decrease travel length and to increase accessibility. Modifying the existing alignment or road networks and also increasing public transport system. Changing transportation facilities based on land use pattern to satisfy ITLUP Model Block wise zoning

6. Analysis

- Make two or more city centres other than central city based on economic hubs or the places with importance to reduce traffic congestion and to reduce the flow of vehicles to the central city. Proper connection with the city centres can decrease traffic congestion to an extent.
- High density and mixed use development is more preferable to decrease travel length and to increase accessibility.

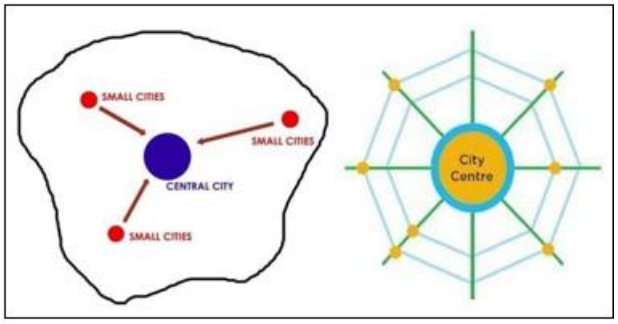

Figure 22: Linking cities
Source: Self-generated

- Residential allocation should be based on transportation infrastructure i.e., along the expressways, arterial roads etc.
- Redevelopment has to be made by relocating to make a linkage between land use and transportation.

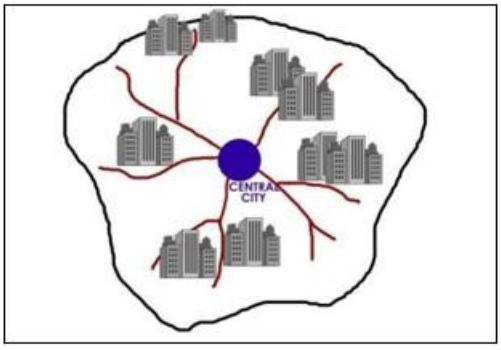

Figure 23: High density residential building along road networks
Source: Self-generated

- Eliminate unwanted roads

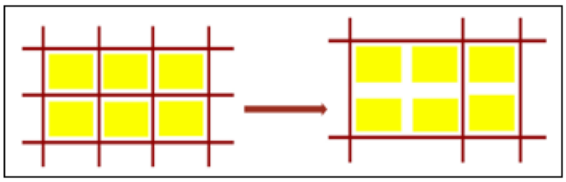

Figure 24: Designing Road Network in Residential Areas
Source: Self-generated

- Provide recreational and open spaces and give proper accessibility to those places to make more sustainable.

Figure 25: Recreational Area designed in the Land Use Map
Source: Self-generated

- Transport facilities should focus more on job centres and employment allocation which increases easy accessibility and decreases travel length, thus decreases traffic congestion.
- Proper connectivity should be given between residential area and job centre, which helps to increase employment opportunities.

Figure 26: Linkage between residential area and other infrastructures
Source: Self-generated

- Encourage walkability by providing footpaths for safer pedestrian walking and by providing basic amenities at walkable distance.

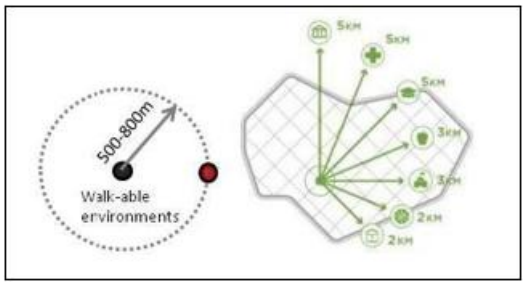

Figure 27: Walkable Distance and regional facilities at walkable distance
Source: Mohinder Sing,Transport- Singapore

- Proper public transport facility helps to decrease the number of vehicles.

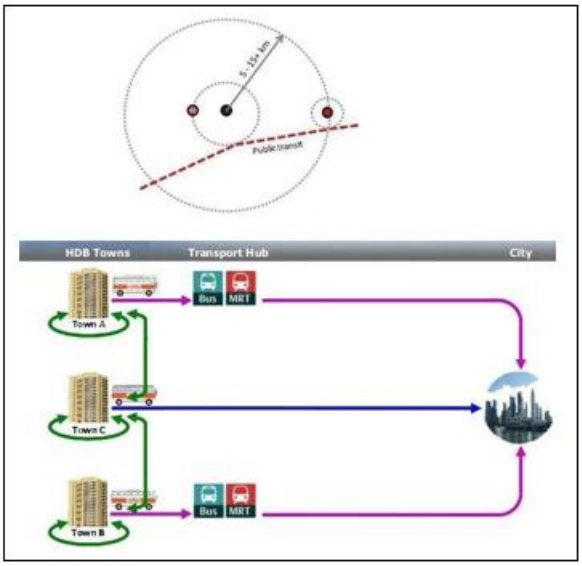

Figure 28: Public Transport Facilities
Source: Self-generated using Mohinder Sing,Transport-Singapore

7. Conclusion

Integrated Transportation and Land Use Planning Model can be used for eliminating traffic congestion problems in urban areas. Integrated Planning can be done in two ways. Either we have to change the city as a whole or improve the existing transportation facility by decentralising the existing infrastructural facilities. Integrated planning should be done by considering the past, present and future changes to get an efficient solution. Population, Occupation, Infrastructural facilities etc has to be considered while planning. Controlling traffic congestion is very essential in most of the urban areas, or else it will decay the city. Transportation planning has to be made based on the land use and the land use planning has to focus on the transportation networks. Both the factors play a significant role in sustainable environment. Improper planning will decrease the land value and make the city slum. So, the planning must be done by focusing on good accessibility and proper land use distribution.

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