PREPARATION OF MASTER PLAN OF RANCHI CITY IN GIS ENVIRONMENT

A DISSERTATION

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By

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(RAJEEV GUPTA)

ABSTRACT

Urban planning is basically resource generation, resource development and resource management exercise. The efficiency of urban settlements largely depends upon how well they are planned, how economically they are developed and how efficiently they are managed. Planning inputs largely govern the efficiency level of human settlements. Urban planning and development refers to a process that harnesses spatio-economic potential of an area for the benefit of the people. Its scope ranges from a cluster & houses to the entire settlement and beyond to a region and even the nation as a whole.

The cities liken the trees; both of them grow under the natural limits. These limits effect in the formulation of the city master plan. The Historical urban development of cities is usually used for defining the main direction of city's development. One of the objectives of any master plan is to guiding urban development by study the natural properties of the city borders and determines the suitable direction of city growth.

The need for GIS is driven by factors such as population growth and urbanization, which in turn create various types geo-referenced data. Information of this kind lends itself well to the analytical capabilities of GIS. GIS has ability to create, store, edit, visualize, analyze, and present the data which is needed for carrying out the historical urban growth of the city.

Urban planning and development is a continuous process and involves planners, administrators, developers, investors and of course, the residents. Their perceptions, expectations and actions, expectations and actions for complex analysis and rich envisioning capacity of GIS are found helpful to bring in transparency in planning desired by the above groups. It is therefore high time to consolidate on the reported gains of the GIS application in urban planning.

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CHAPTER 1

INTRODUCTION

1.1 About Ranchi City

Ranchi, the capital of Jharkhand, is situated in Chhotanagpur plateau at an attitude of 654.5 m above sea level. Ranchi is the district as well as divisional headquarter and now the capital of newly created state Jharkhand, located at 23°23' north latitude and 85°23' east longitude. The administrative and transportation hub of the mineral rich state, Ranchi also has a large number of business travelers. Waterfalls, hills and many temple complexes are the city's main points of interest.

The city is heterogeneous in terms of its population, composition and has complex land use structure. The physical form of cities has been shaped by economic, social, political and cultural forces of the society. The city comes to life with the spatial mobility of its people engaged in day to day activities to fulfill their economic social and cultural needs. Buildings, open land, roads, people all form part of the city structure.

Table 1. General Information about Ranchi City

Latitude	23.23 N
Longitude	85.23 E
Area (in sq. km)	7574.17
Height from sea level (in feet)	2140 ft
Temperature (in degree centigrade)	Winter(Min 10.3 Max 22.9) and Summer(Min 20.6 Max 37.2)
Rainfall (in mm)	1530 Annual
Climate	Summer, Winter and Rainy Seasons
Main Tribes	Oraon, Munda
Main minerals	Lime Stone, Coal, asbestos and ornamental stones etc.
Main crop	Rice, Millets, Pulses and oil seeds.
Languages spoken	Hindi, Nagpuri,Oraon,Mundari and Kurmali
Important Rivers	Subarnarekha, South Koel and Sankh
Nearest Railway Station	Ranchi
Nearest Airport	Ranchi
National Highway passing through Dist.	NH-33 and NH-23
Population density	362

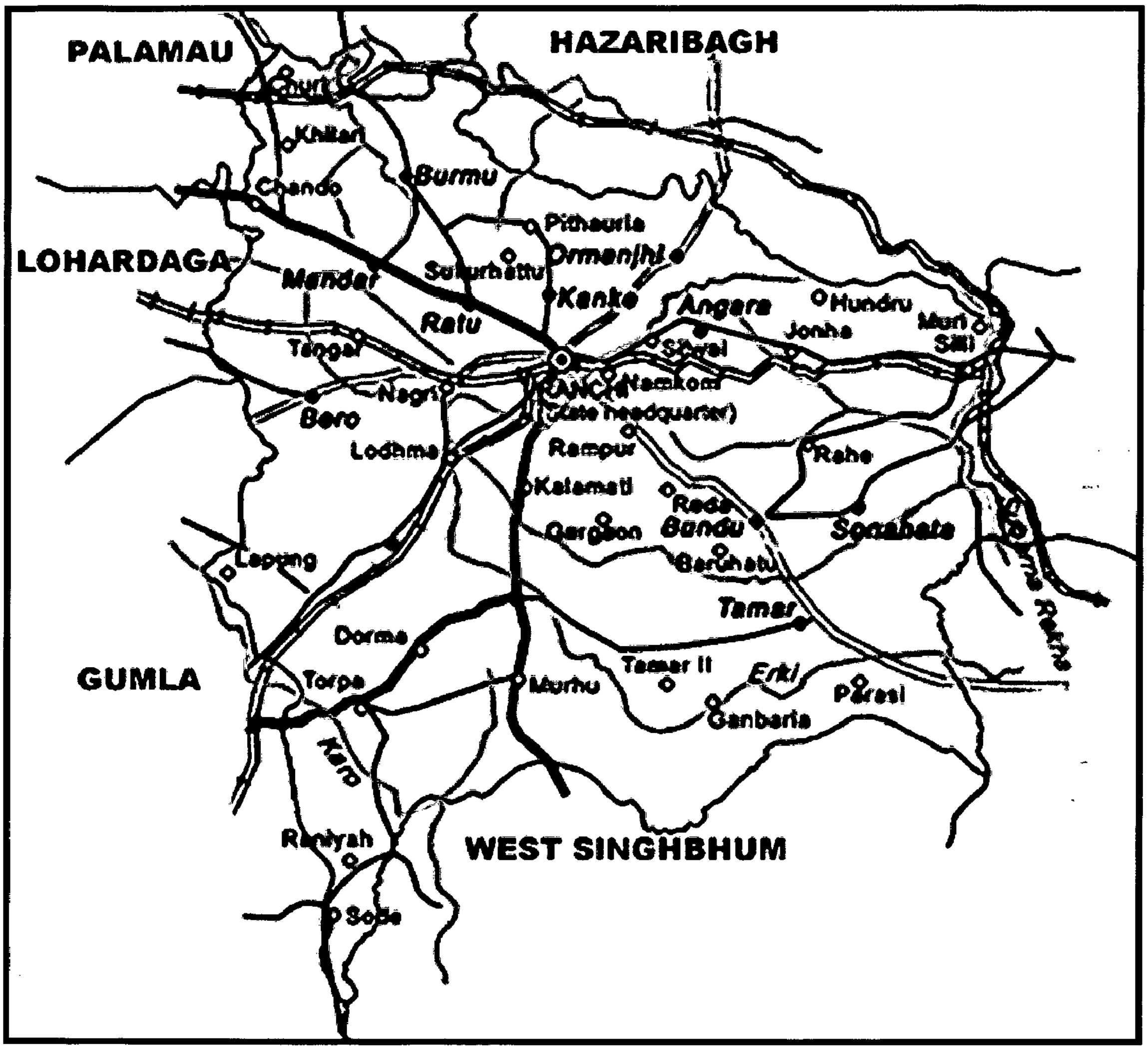


Fig. 1 Map of Ranchi District

Table 4. Administrative set up in Ranchi

Subdivision	Block	Panchayat	Village		
			Inhabited	Unhabitated	Total
Ranchi	Kanke	36	101	3	104
	Ratu	27	84	0	84
	Chanho	17	67	0	67
	Mandar	19	69	0	69
	Lapung	11	78	1	79
	Burmu	23	93	0	93
	Bero	26	114	0	114
	Namkum	23	93	6	99
	Ormanjhi	18	88	3	91
	Angara	23	91	1	92
	Silli	22	106	3	109
Khunti	Rania	7	66	1	67
	Murhu	16	141	0	141
	Torpa	16	95	0	95
	Karra	19	178	0	178
	Khunti	12	147	1	148
Bundu	Bundu	11	87	1	88
	Sonahatu	19	101	0	101
	Tamar	23	128	1	129
	Arki	16	127	1	128
		384	2054	22	2076

Over the years, a perceptible shift from rural paradigm to urban and from village to town to city has occurred. This reflected well in different land uses in a city. During the last decade, new urbanism and sustainable development have become persuasive concepts in planning rhetoric. The same is true for Ranchi City.

In general, development control regulations for residential area the growing needs of the societies are not reflected well so it leads to the violation and unsatisfied living conditions. The implementation of bye law does not lead to total effective residential environment for people. This can be avoided by giving more choice to people at initial stage of finalizing the layout and building plans, hence individual's future plans will also get a place. Therefore this makes imperative that various policies in Master Plan should be implemented with strictness.

1.2 Master Plan of Ranchi City

The urban areas in the developing world are under constant pressure of a growing population. Indian cities are experiencing an accelerated pace of growth since independence. Cities are now emerging as centers of domestic & international investments in an era of economic reforms, liberalisation and globalization. This has created opportunities for technologists and planning professionals to guide and develop the process of planned development and management. Same is the case with Ranchi City.

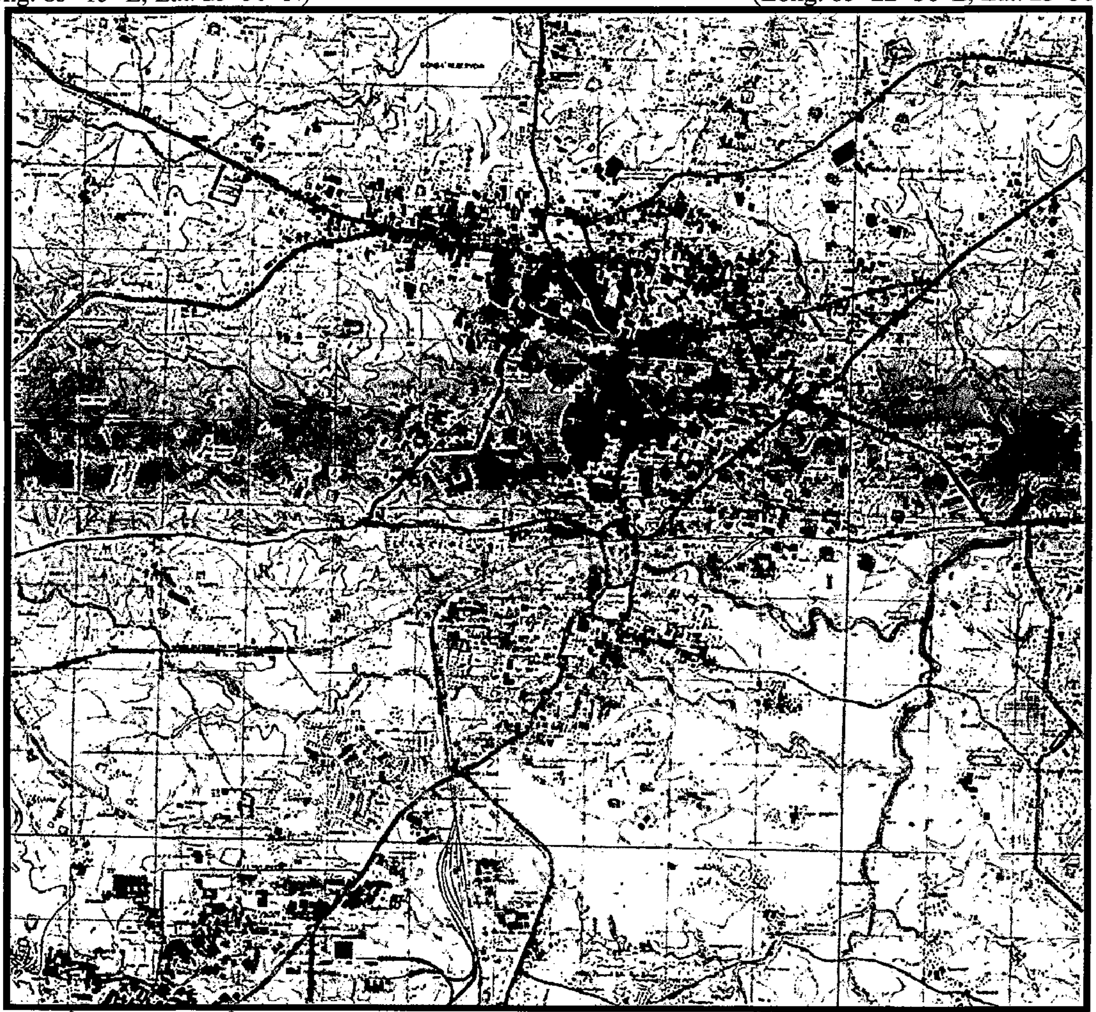
Rapid industrialization and massive increase in population witnessed in many parts of Ranchi City; which led to unbalanced settlement pattern and environment degradation which needs to be controlled through Master Plan. City planning through master plan portrays a future state of affairs; tries to link economic, social policy with physical design to solve urban problem and problems like housings, transportation, public spaces and green areas etc.

Geographically Ranchi is heterogeneous and due to its varied topological features, any developmental processes disturb the land, village forests, and natural resources etc. Activities like unplanned use of land and steep slopes for cultivation, and heavy engineering works in the Hatia (Part of Ranchi), can easily be taken into consideration to activate the ecological degradation. As natural resources act as an important base for subsistence purposes, so some means should be devised to let them use these resources.

Jharkhand region needs much more attention due to regular occurrences of deforestation and improper urbanization. The present thesis attempts to analyze these issues by looking into the feasibility of RS and GIS based integration systems in the Jharkhand State and specially for the Greater Ranchi Planning and a model has been proposed.

The Jharkhand Government is now in the process of chalking out a major city infrastructure development plan (referred to as a Master Plan), covering both civic areas such as water treatment, solid waste management and other public utility works and real

(Long. 85⁰ 15' E, Lat. 23⁰ 30' N) (Long. 85⁰ 22' 30"E, Lat. 23⁰ 30'N)



(Long. 85⁰ 15' E, Lat. 23⁰ 20' N) (Long. 85⁰ 22' 30"E, Lat. 23⁰ 20'N)

Fig. 2 Study Area In Ranchi City

estate development, including construction of cinema multiplexes, which would enjoy entertainment tax's relief. The plan also includes creation of a hi-tech city.

It is difficult to quantify the requirements of Ranchi City in future because it not possible to predict the parameters which will be governing the growth and Urban Planning of Ranchi City within next twenty years. However there has to be some guide lines which can act as substantial platform for making proposals of future infrastructure development in Ranchi City. Therefore there is a need to prepare Master Plan of Ranchi City in GIS Environment.

The existing Development plans are too backdated for these applications. Local Authorities will have to update the plans to find out the present situation in the ground. The availability of high resolution Satellite Images has made this up gradation faster, easier & accurate. The requirement of limited ground survey has made these projects cost effective.

1.3 Problem Identification

With passage of time, large population, growth of industries; pollution, lack of basic infrastructure became potential threat to the environment. This became burning issue and calls for an integrated sustainable development. Related to the urban planning issues of Ranchi City and regarding the proposals in Master Plan, following problems can be identified.

1. Population Growth which is taking place at uncontrolled rate. This needs to be quantified as basic amenities have to be in proportion of the total existing and future population.
2. Rate at which the agricultural land is diminishing changing the whole land use pattern.
3. Unplanned growth in the form of Urban Sprawl is taking place along highways and along the peripheries of the city deteriorating the whole urban structure.
4. For better transportation facilities there is lack of road length infrastructure.

The use of geographic information system for analysis, modeling and decision support in a wide range of application areas is growing rapidly. Applications such as mapping, monitoring, decision making and research benefit greatly from the GIS technology. GIS can be applied in a site selection and location analysis for residential developments.

GIS is a graphic based computerized database management system for storage, retrieval, manipulation, analysis and display of both spatial and non spatial data. GIS provides capabilities to obtain information for decision making. It plays significant role in spatial multi criteria analysis; it can be used in the development of land use plans, environmental impacts reviews and site selection for various land uses and public and private facilities.

The biggest advantage that we get by preparing the Master Plan in GIS Environment is preparation of database in the form of attributes, integration of data and information from various resources like satellite imageries, updation of data with the passage of time and spatial interpretation of various information and resources. Following advantages can be summarised as follows-

- GIS provides the planners an accurate spatial view of the city at different levels such as district, block, village level as well as road and rail network, drainage network etc.
- Planners also get the detailed demographic data and education & health related data on desktop in a GIS environment in the form of attributes.
- GIS assists the planners in finding out the possible locations for the schools and health centers depending on several parameters such as for health; population density, number of health centers required and its optimum location, number of disease infected persons etc. and similarly for education; percentage literates, number of primary schools and middle schools required and its optimum location, number of teachers posted, vacancy and required as per norms etc. in a village.
- GIS acts as Spatial Decision System so in GIS Environment it becomes easier to take decisions and make conclusions taking into consideration various criteria.

1.6 Objectives of Thesis

1. Main Objective of thesis is to study the present growth of Ranchi City and make predictions regarding the future need of City in the direction of growth.
2. Forecast the population growth, built up area and urban sprawl so that proposals for the basic amenities can be quantified.
3. Identify the main factors which govern the future growth of city and thus mapping the areas under high pressure of growth.
4. Study the Transportation Network of city and map the area of congestion in terms of traffic volume and make proposals related to road widening techniques.
5. Locate the major elements which contribute to traffic volume on path and thus determining the positions of control delay points by linear referencing.

1.7 Organization of Thesis

Chapter 1: Deals with the general introduction of the Ranchi City and it's planning. It also explains the need of preparing Master Plan in GIS Environment and objectives of thesis.

Chapter 2: It tells the conventional Approach in preparing the Master Plan and Review of work using GIS.

Chapter 3: It explains the role of GIS in preparing the Master Plan of Ranchi City.

Chapter 4: It deals with the various factors considered in Master Plan

Chapter 5: It shows the working plan and methodology implemented. It deals with the study area.

Chapter 6: covers the results derived from the study and their analysis for finding urban growth pattern.

2.1 Master Plan

A development plan or master plan can be defined as a general plan for the future layout of a city showing both the existing and proposed streets, open spaces, public buildings etc, thus, a development plan aims at controlling the future growth along preconceived and predetermined paths. A development plan is an ideal plan showing the full development of the town at some future date. Master plan serves two purposes; it provides solutions for the present and guides the future development along the desired lines.

2.2 Objectives of preparation of Master Plan

One of the most important objectives of master plan are to regulate the growth of city, to ensure the integrated development of different areas of the town, to evolve the plan pattern for future development of the city by providing basic needs of urban community. Other objectives include organizing and coordinating the complex relationships between urban lands uses; to improve the quality of life of the people, direct the physical development of the city in relation to its social and economic characteristics based on comprehensive surveys and studies on the present status and the future growth prospects.

2.3 Processes involved in preparation of Master Plan

1) Study of existing Development Plan

The city that is under going in preparation of master plan if already has any previous plan must be studied thoroughly so that a planner may get a wide idea regarding the previous development which was proposed

2) Data Collection and Survey

Data on the existing situation needed to accessing the requirements of the present and the future. It includes demographic data and physical data. Surveyed map of the city is an essential document to proceed with planning.

3) Identification of Problems

Existing problems should be identified through proper survey so that it can be considered during plan preparation.

4) Data Analysis

Analysis of collected data is important aspect to project the present and future needs of the society.

5) Projection of Need

Identifying the population that is going to be benefited and the facilities, which are in short supply, different land uses, their relationships with each other, transportation facilities, infrastructure services and financial position.

6) Formulation of Draft Plan

The long term Perspective Structure Plan include goals, policies, strategies for spatial economics development of the urban settlement, physical characteristics and natural resources, infrastructure network like water sewage, drainage, roads, bus, truck terminals, rail network, environmental conservation and preservation of areas of architectural heritage and ecological importance.

7) Legislative Approval

Within the framework of Development Plan, Annual Action plans for the urban areas should be prepared specifying the projects and schemes with costing and cash flow for both on going and new projects. The Annual Action plan should provide in built system for implementation of the Development Plan. In this plan various urban development schemes should be integrated spatially and financially.

2.4 Basic Elements of Master Plan

Master Plan consists of text and drawing which show the physical element of the community i.e. Land Use Maps, circulation pattern, transport systems and other infrastructure facilities etc. It should also support with regulation of land use standards for various factors like density, setbacks etc procedure and method employed in planning. The general feature of any master plan is the action in a sequence which is design to solve the future problems of the city or settlement.

Some basic elements of the master plan are:

1) Historical background and growth of town
2) Various study of city
3) Data Collection
4) Various Projection and growth trends
5) Existing Land Use Plan
6) Plan Concept
7) Proposed land use plan
8) Infrastructure Planning
9) Development Regulation
10) Plan implementation policies
11) Monitoring policies

2.5 Implementation

Implementation of development plans is generally through annual plans and projects. The various steps for effective implementation includes-

a) Formulation of annual plans and identification of projects for implementation within the frame work of approved development plan.

b) Identification of various agencies responsible for

c) Development, promotion and management the local authority will perform this function in case of infrastructures like post and telegraph, telephone, National and State Highways, Seaports, Airports, Power supply etc. The agency for this activity may be relevant departments of Central and State Governments.

d) Execution of action projects and schemes. Agencies for this function could be:

1) Private individuals, Groups, Promoters

2) Private Cooperative Societies

3) Non Governmental Organizations

e) Actions for implementation which include

1) Public Sector interventions

2) Private Sector Actions

3) Joint venture or public private partnership

f) Review of Plans-Review is defined as critical examination of the implementation of development plan during the government period. The basic objective of this exercise is to assess the progress of the work done so far and identify the areas of successes, failures, and conflicts to guide the future course of action. This is the important step in the dynamic planning process.

Master plan is a future land use plan and normally comprises a written statement and a land use map indicating the development scenarios of a city and a set of zoning regulations. Certain infirmities in the Master Plan have become subject of debate and deliberation. It is a necessary document but it is not flexible enough to absorb policy shifts affecting development programmes, which are inevitable in a developing country.

In absence of effective control and implementation, there have been large areas of unintended growth, development of unauthorized colonies, and development of areas with poor levels of physical and social infrastructure. Master Plan approach has come under criticism as being too complex, rigid, static, excessively bureaucratic, time consuming and elitist. Because of these shortcomings, this is argue d that urban planning which is largely based on techniques taken from the developed countries has been unable to adequately address the rapid urbanisation processes, which characterize the majority of developing countries.

CHAPTER 3

ROLE OF GIS IN PREPARATION OF MASTER PLAN

3.1 General

Planning is a primarily a way of thinking about social and economical problems, planning is oriented predominantly towards the future, is deeply concerned with relation of goals to collective decision and strives for comprehensiveness in policy and program. Planning is the process of evolving a sequence of actions which are designed to achieve certain goals, may be related to the development or to solve problems in the future. The planning period also varies according to the type and level of planning but all planning process which can be conceptualized into a number of stages.

Geographic Information Systems (GIS) applications are powerful graphic "tool-boxes" for the visualisation of spatial data integral to the work of urban planning and urban design. Conventionally GIS uses a two-dimensional cartographic interface to the data on a graphics workstation platform. However, recent developments in the field are greatly increasing the power of the graphic tools to visualise spatial data, as well as again easy access to it. These developments are Desktop GIS, Three-dimensional GIS, and Internet GIS.

The future success of economic growth policies depends a lot on the infrastructure development. It is universally established that remote sensing and GIS tools play a major role in various infrastructure development. Several decisions taken by different planning agencies require spatial analysis of maps involving many parameters. The GIS based maps provide the most important sources for spatial analysis. Remote sensing data provide latest and accurate maps, when used in the GIS environment, they become integrated. Also, the non-spatial data attached to it provide great help to the urban planners and decision makers.

Rapid and haphazard urban growth and increasing population pressure is resulting in deterioration of infrastructure facilities. To address these issues effectively it requires up to date and accurate data at regular interval of time on changing urban resources and urban environment. Remote sensing and GIS can provide reliable and accurate data, excellent possibilities to map, monitor and measure the various facets of urban development. The information thus generated, helps to formulate suitable plans and strategies for an effective urban planning and development. In order to extract and utilize information related to urban processes and forms, one can evaluate remote sensing along with GIS in a variety of ways.

Urban planning is one of the main applications of GIS. Urban planners use GIS, both as spatial database and as an analysis and modeling tool. GIS is just one of the formalized computer-based information systems capable of integrating data from various sources to provide the information necessary for effective decision making in urban planning. GIS serves both as a database and as a toolbox for urban planning. In a database oriented GIS, spatial and non-spatial data can be stored and linked using geo relational models.

3.2 Advantages of using GIS in Urban Planning and Preparation of Master Plan

i) Improved mapping, better access to maps, improved map accuracy, more effective thematic mapping and reduced storage cost.

ii) Greater efficiency in retrieval of information.

iii) Importance in planning and the ability to explore a wider range of 'what if' scenarios.

iv) Better communication to the public.

v) Improved quality of service e.g. speedier access to information for planning application.

vi) Management of land records, thematic mapping planning application processing and land use management

3.3 Role of GIS in Transportation Planning for Master Plan

The demand for transportation is well understood to be derived from the demand in urban activity. Urban activity, on the other hand, is a function of land-use. Interestingly, the provision of transportation system (i.e. services and infrastructure) may also influence the development of land use. Thus, there is a clear interaction or cause-and-effect relationship between transportation and land-use.

A land use-transportation interaction model, then, is a simulation model that combines theories, data and algorithms to represent the functioning of the land use and transportation systems. Once calibrated against a known scenario, this simulation model can be used to make predictions about the future. In urban and transportation planning, this ability of knowing the likely future is important as urban and transportation policies affect people's lives. But, more importantly, the interaction model helps create sustainable cities as land use and transportation developments have their share of adverse impacts, e.g. social ills and environmental pollution.

The application of GIS has relevance to transportation due to essentially spatially distributed nature of transportation related data, and the need for various types of network level analysis, statistical analysis and spatial analysis and manipulation. Most transportation impacts are spatial, at GIS platform, the transport network database is generally extended by integrating many sets of its attribute and spatial data through its linear referencing system.

Transportation Planning generally consist of a number of individual modules, often operated independently of one another. These modules include construction quality control, pavement management, maintenance management, traffic management and accident data.

Thus, potential applications for GIS in transportation planning include the following.

1. Executive Information System
2. Pavement Management System
3. Bridge Management System

4. Maintenance Management
5. Safety Management
6. Travel Demand Forecasting
7. Accident Analysis
8. Transportation System Management
9. Overweight/oversize vehicle permit routing
10. Construction Management

3.3.1 GIS Functionality in Transportation

For the purpose of identifying and classifying GIS-T applications, seven GIS functions and groups of functions are used:

1. Basic Functions
2. Overlay
3. Dynamic Segmentation
4. Surface Modelling
5. Raster Display and analysis
6. Routing

3.4 Determining Level of Service of Traffic Signals using Network Analysis in GIS Environment

The GIS Network Analyst extension allows building a network dataset and performing analysis on a network dataset. This extension is composed of a number of parts: a wizard to create a network dataset (in ArcCatalog), a dockable Network Analyst window (in ArcMap), a Network Analyst toolbar (in ArcMap), and a number of geoprocessing tools contained within ArcToolbox.

The Network Analyst Window helps to manage inputs to analysis and results. It displays objects, such as barriers, stops, and routes. The Network Analyst toolbar is a combination of menus and buttons for adding and modifying network locations, generating directions, identifying network features, building networks, and performing analysis on network datasets.

The Network Analyst extension also supports the use and creation of layers in ArcMap, including the network dataset layer and the network analysis layer. The network dataset layer allows displaying and querying the underlying network dataset. The network analysis layer is the layer created through one of the Network Analysis operations. This layer can be used in further analysis, both within the ArcMap user interface and within the geoprocessing framework. It can also be saved as a permanent layer.

3.4.1 Transportation network

Transportation networks are undirected networks. This means that although an edge on a network may have a direction assigned to it, the agent (the person or resource being transported) is free to decide the direction, speed, and destination of traversal.

3.4.2 Utility network

A utility network is directed. This means the agent (for example, water, sewage, or electricity) flows along the network based upon certain rules built into the network. The path that the water will take is predetermined. It can be changed, but not by the agent. The engineer controlling the network can change the rules of the network by opening some valves and closing others to change the direction of the network. In ArcGIS, utility networks are modeled using geometric networks.

Network datasets are made of network elements. Network elements are generated from the sources used to create the network dataset. The geometry of the source features is used to establish connectivity. In addition, network elements have attributes that control navigation over the network.

There are three kinds of network elements: edges, junctions, and turns. Edges are elements that connect to other elements (junctions) and are the links over which resources flow. Junctions connect edges and facilitate navigation from one edge to another. Turn elements record information about movement between two or more edges. Edges and junctions form the basic structure of any network. Connectivity in a network deals with connecting edges and junctions to each other.

There are three types of network sources that participate in the creation of a network dataset: edge feature sources, junction feature sources, and turn feature sources. Line feature classes participate as edge feature sources. Point feature classes participate as junction feature sources. Each feature class that participates in a network as a source generates elements based on its assigned role. Geometric network feature classes cannot participate as network dataset sources because they are actively linked to a geometric network. Feature classes that participate as a source in a network dataset can participate in a topology.

Connectivity in a network dataset is based on geometric coincidences of line endpoints, line vertices, and points and applying connectivity rules that you set as properties of the network dataset. Connectivity in ArcGIS Network Analyst begins with the definition of connectivity groups. Each edge source is assigned to exactly one connectivity group and each junction source can be assigned to one or more connectivity groups. Junctions that are assigned to two or more connectivity groups are the only way that edges in different connectivity groups can connect. Connectivity groups are used to model multimodal transportation systems.

Network attributes are properties of the network elements that control traversability over the network. Examples of attributes include the time to travel a given length of road, which streets are restricted for which vehicles, the speeds along a given road, and which streets are one-way. Network attributes have four basic properties: name, usage type, units, and data type. Additionally, they have a set of assignments defining the values for the elements.

- The usage type specifies how the attribute will be used during analysis, which is identified as a cost, descriptor, restriction, or hierarchy.
- Units of a cost attribute are either distance or time units (for example, centimeters, meters, miles, minutes, and seconds). Descriptors, hierarchies, and restrictions have unknown units.
- Data types can be either Boolean, integer, float, or double. Cost attributes cannot be a Boolean data type. Restrictions are always Boolean, whereas a hierarchy is always an integer.

Network attributes are created either in the New Network Dataset wizard (when defining a new network) or on the Network Dataset Properties dialog box on the Attributes tab. Network analysis layers are composite layers in ArcMap used to store inputs, parameters, and results of network analysis. A network analysis layer acts as an in-memory workspace for each type of input as well as the result, all of which are stored as in-memory feature classes. The analysis parameters are stored as properties of the analysis layer.

There are four kinds of network analysis layers:

- Route analysis layer— This layer contains the input network locations (stops and barriers), parameters, and the resultant route or routes of route analysis.

- Closest facility analysis layer — This layer contains the input network locations (facilities, incidents, and barriers), parameters, and the resultant route or routes of closest facility analysis.

- Service area analysis layer— This layer contains the input facilities and barriers, parameters, and the resultant service area polygons and service area lines.

- OD cost matrix analysis layer— This layer contains the input origins and destinations, parameters, and results of OD cost matrix analysis.

Network locations are used as input during network analysis. These include stops, barriers, facilities, incidents, origins, and destinations. There are six kinds of network locations that function as inputs in ArcGIS Network Analysis: stops, barriers, facilities, incidents, origins, and destinations.

Stops are locations between which a route is calculated in a route analysis. One can have more than two stops for which a route can be created that starts at the first stop and ends at the last stop. The intermediary stops are visited en route from the first to the last stop. Barriers are locations where the analysis should not traverse. Barriers are used in route, closest facility, and service area analyses. Barriers can be used to represent locations where the analysis cannot pass through, for instance, a blocked intersection. One can model road closures or accident sites as barriers if one wants the route to avoid that point. Facilities are locations used in closest facility and service area analyses.

In closest facility analysis, one searches for the closest set of locations (facilities) from other locations (incidents). In service area analysis, the location for which the service area is being calculated is called the facility. Incidents are used in closest facility analysis and represent the locations for which the nearest facility is sought.

Origins are locations used in an OD cost matrix as starting stops from where the route costs to destinations are calculated. Destinations are network locations that are used in an OD cost matrix analysis to generate lines. An OD cost matrix is a table of route costs from origins to destinations

3.5 Determining Location of Route Events contributing the traffic Volume by using Linear Referencing.

In GIS, geographic data is modeled in one of three ways: as a collection of features in vector format, as a grid of cells with spectral or attribute data in raster format, or as a set of triangulated points modeling a surface in TIN format. Data that has a discrete location with a defined shape and boundary is modeled in a vector format. In this format, data is represented by features. Features are stored in feature classes. Feature classes can be stored in feature datasets. Every feature has a geometry or shape associated with it. This geometry is stored in a special field that is typically called "shape". A feature can have one of these types of geometries: point, multipoint, polylines, or polygon. Each geometry is stored as a two-dimensional pair of geographic coordinates for example, latitude/longitude and x, y or as a set of coordinate pairs.

Using the vector format works well for modeling features with static characteristics, such as parcel boundaries, water bodies, and soil characteristics. Some applications, however, require the ability to model the relative location along various types of linear features, such as highways, city streets, railroads, rivers, pipelines, and water and sewer networks.

Because of this need, one-dimensional measuring systems, such as river mile and route milepost, have been devised. Instead of using two-dimensional geographic coordinates, these systems simplify the recording of data by using a relative position along an already existing linear feature. That is, location is given in terms of a known linear feature and a position, or measure, along it. The need to visually represent features on a map whose coordinates are not geographic but are recorded as a relative distance along another linear feature led to the development of dynamic segmentation.

Dynamic segmentation is the process of displaying linearly referenced features on a map. Locating a spatial feature along another linear feature is typically done using a planar (two-dimensional) referencing system of x, y coordinates. This may work well in some applications. In others, however, locations along linear features are referred to in terms of their route measure, or distance from a known point. To determine a location along a linear feature, a system of measurement is required. When a measurement system is stored along with a linear feature, any location along that linear feature can be expressed in terms of the measure values.

The vector model of data storage dictates that a linear feature must be split wherever its attribute values change. Certain linear features, however, have attributes that change frequently. The pavement condition of a road, for example, changes as pavement deteriorates and is subsequently repaired. To accurately reflect the changes in pavement condition, some features will have to be split and others merged.

Segmenting linear features on a frequent basis becomes even more problematic when one considers that one may need to store other attributes. Using the roads example, one may also want to record attributes, such as traffic volumes, lane information, surface material, speed limits, and accident locations. Every time these attributes change, the road will need to be further subdivided. With all the required segmenting, it is evident that the linear features will be so subdivided that the data will be difficult, if not impossible, to maintain. About aggregating event data describes the process of working with route event tables and changing data.

GIS uses route event tables to store linearly referenced attributes. Event rows are composed of a route identifier, measure values indicating a location, and one or more attributes describing the location. Because events simply reference measure locations along linear features, they are edited and maintained independently of the linear features.

The terms routes and route events are used to refer to linearly referenced features in GIS. A route is any linear feature, such as a city street, highway, river, or pipe that has a unique identifier and a measurement system. This measurement system defines discrete locations along the linear feature. A collection of routes with a common system of measurement can be stored in a single feature class—for example, a set of all highway routes in a county. In a geo database, many feature classes containing routes can be stored in a single feature dataset.

CHAPTER 4

OVERVIEW OF VARIOUS FACTORS INVOLVED IN MASTER PLAN

4.1 Urban Sprawl

In India, unprecedented population growth coupled with unplanned developmental activities has led to urbanization, which lacks infrastructure facilities. In many areas of the study region the urbanization has taken place either in radial direction around the main city or linearly along the highways.

This dispersed development along highways, or surrounding the city and in rural countryside is often referred as sprawl. Some of the causes of the sprawl include – population growth, economy and proximity to resources and basic amenities. Patterns of infrastructure initiatives like the construction of roads and service facilities (such as hotels, etc.) also often encourage the regional development, which eventually lead to urbanization.

Sprawl is considered to be an unplanned outgrowth of urban centers along the periphery of the cities, along highways, along the road connecting a city, etc. Due to lack of prior planning these outgrowths are devoid of basic amenities like water, electricity, sanitation, etc. Provision of certain infrastructure facilities like new roads and highways; fuel such sprawls that ultimately result in inefficient and drastic change in land use affecting the ecosystem.

Since the sprawl is characterised by an increase in the built-up area along the urban and rural fringe, this attribute gives considerable information for understanding the behaviour of such sprawls. This is also influenced by parameters such as, population density, population growth rate, etc.

Rapid industralisation causes haphazard and unplanned growth of urban centers which becomes more complicated but the fact that it must take place within the built up area. This pressure of continuously growing population results in over crowding and become burden to limited civic cycle amenities which forces the middle class as well as builders to move to outlying suburbs, a phenomenon called Urban Sprawl or Growth.

The spatial patterns of urban sprawl over different time periods, can be systematically mapped, monitored and accurately assessed from satellite data (remotely sensed data) along with conventional ground data. Mapping urban sprawl provides a "picture" of where this type of growth is occurring, helps to identify the environmental and natural resources threatened by such sprawls, and to suggest the likely future directions and patterns of sprawling growth. The patterns of sprawl are being described using a variety of metrics and through visual interpretation techniques.

The complexity of a dynamic phenomenon such as urban sprawl could be understood with the analyses of land use changes, sprawl pattern and computation of sprawl indicator index. The percentage of an area covered by impervious surfaces such as asphalt and concrete is a straightforward measure of development. It can be safely considered that developed areas have greater proportions of impervious surfaces, i.e. the built-up areas as compared to the lesser-developed areas. Further, the population in the region also influences sprawl. The proportion of the total population in a region to the total built-up of the region is a measure of quantifying sprawl.

Various analysts have made considerable progress in quantifying the urban sprawl pattern. The common approach is to consider the behaviour of built-up area and population density over the spatial and temporal changes taking place and in most cases the pattern of such sprawls is identified by visual interpretation methods.

Urban sprawl dynamics was analysed considering some of the causal factors. The rational behind this is to identify such factors that play a significant role in the process of urbanisation. The causal factors that were considered responsible for sprawl were:

1. Population
2. Population Density(A) and Population Density(B)
3. Annual Population Growth Rate

Population has been for long accepted as a key factor of urban sprawl. The percentage built-up is the proportion of the built-up area to the total area of the village. The population density (A) is the proportion of the population in village to the built-up area of that village. The Population density (B) is the proportion of population in village to the total area of that village.

The (B) population density is often referred as population density. Since the built-up area plays an important role in the current study for the purpose of analyses, the percentage built-up, (A) and (B) population densities are computed and analysed. The annual population growth rate (AGR) is computed from the population data. This growth rate is used in predicting the population for subsequent years.

4.2 Analysing factors governing Future Growth

Historical land use patterns, together with current trends in a region, are used to model future land use. Results from modeling urban growth and land use change can be used by the public, land use planners, and policy makers to anticipate and plan for the future. Land use change models can also generate alternative landscape predictions on the basis of different land use policies and environmental constraints. Prediction from models is based on a set of assumptions about the nature and functional form of the drivers of land use and land cover change into the future. The simplest approach is to assume that the drivers and their functional relationships are similar to those of the recent past. These land use change models use simple parameters including present urban extent, major transportation routes, topography, land values and protected lands.

While planning urban area of the city in right direction, an urban planner should know the direction and trend of the existing urban area. Creating different thematic layers in GIS database for different time periods can do this. The layers of a theme for different time information can be overlaid in order to find out the change of that theme in that time duration. In this way, after knowing the rate of urbanization, urban planners can now assess the scenario of urban development of the city and then can approximately predict the growth of urbanization in future. This will help them in decision making process in planning the urbanization.

In Ranchi city there are many factors which can be taken into consideration while predicting the direction in which the growth will take place and how the land conversion will take place. These factors are proximity to central business district, nearness to road connectivity, zoning regulations, vicinity to other amenities like hospitals, schools and work place. Taking these parameters into mind the direction of growth can be anticipated and it can also be anticipated that where the proposals of development are to be made.

The factors which have been considered are as follows:

1. Zoning Regulations
2. Proximity to Highways and Roads.
3. Proximity to Central Business District
4. Land Conversion Elasticity
5. Holding Capacity of an Area

4.2.1 Zoning Regulations

Development Authority of Ranchi city has declared certain areas as "Prohibited Areas" where the urban settlement cannot take place. This includes areas near airports, areas around lakes and rivers, conserved forests, sites of historical importance and hilly regions where the bye laws do not permit any kind of unnecessary construction. Some area could also be reserved for floriculture and horticulture. In city planning space is also left for parks, playgrounds and recreation spots.

Restrictions mostly indicate areas where land use changes are restricted through policies or tenure status. Some spatial policies restrict all land use change in a certain area, e.g., a log-ban within a forest reserve. Other land use policies restrict a set of specific land use conversions, e.g., residential construction in designated agricultural areas or permanent agriculture in the buffer zone of a nature reserve

4.2.2 Proximity to Highways and Roads

There has been a tendency to change land use along road side especially national highways and state highways. Houses and shops are constructed or such land is put to even other non-agricultural uses. As a result of this contiguous effect leads to further expansion of settlements near highways and such places become accident prone. Therefore, there is need to regulate land use along roadside. A green strip should be developed on both sides of road. Such green strip on each side should not be less than 10 meter wide. Those who construct houses or buildings on agricultural lands along side road should be fined heavily (say ten times the cost of the land).

4.2.3 Proximity to Central Business district

As the distance increases from central business district/Market Place area becomes less susceptible for future growth. Also, it is essential for economic, social and educational development for the region or city, it should be close to Market Place. Areas with reasonably good accessibility to CBD are given priority in development of city in order to save additional infrastructure cost also.

4.2.4 Land Conversion Elasticity.

Land use changes are caused by many factors, including social, political, environmental, and economical factors, in addition to increased accessibility due to transportation improvements. Designation of land uses and activity centers on the Future Land Use Map should not be interpreted to propose nor preclude development without full consideration of all policies, principles, standards or intentions. Land use conversion patterns are the result of two types of influences: (1) spatially heterogeneous features of the landscape, including spatially varying policy variables, and (2) interactions among neighbouring land characteristics due to land use externalities.

Policies have both direct and indirect effects, either of which may create unintended consequences in terms of resulting land use patterns. Direct policy effects are those that influence a landowner's decision by directly influencing either the costs or returns to development in some way, e.g. by constraining land use choices, limiting the allowable density of development, or improving the level of public services associated with a parcel. Indirect effects, on the other hand, arise via neighbourhood-level interactions among landowners making land use decisions.

If a policy influences neighbouring land use decisions and if these changes in land use influence a parcel's development potential due to neighbouring land use externalities, then the policy will have an indirect effect on the landowner's land use decision that operates through the land use externality. For example, a policy that increases the costs of development may have the direct effect of slowing growth within an area, but open space amenities that result from this slowed growth could offset this by increasing the returns to developing a parcel within the area.

Depending on the nature of the interactions, indirect effects can either offset or augment the direct effect and may generate unexpected consequences in terms of land use conversion patterns. Such effects certainly complicate the task of predicting the likely impacts of a policy on land use patterns and, in some cases, may contribute to the evolution of a sprawl pattern of development.

In this study particularly the magnitudes of the interaction effects relative to policy effects and other exogenous features have been taken into consideration, the potential for interactions to moderate the effectiveness of policies aimed at managing growth, and the possibility that these effects may lead to unintended consequences that can exacerbate sprawl. According to government policies agricultural land cannot be directly converted into land for development purposes.

The conversion elasticities are related to the reversibility of land use change. Land use types with high capital investment will not easily be converted in other uses as long as there is sufficient demand. Examples are residential locations but also plantations with permanent crops (e.g., fruit trees). Other land use types easily shift location when the location becomes more suitable for other land use types. Arable land often makes place for urban development while expansion of agricultural land occurs at the forest frontier.

An extreme example is shifting cultivation: for this land use system the same location is mostly not used for periods exceeding two seasons as a consequence of nutrient depletion of the soil. These differences in behaviour towards conversion can be approximated by conversion costs. However, costs cannot represent all factors that influence the decisions towards conversion such as nutrient depletion, esthetical values etc. Therefore, for each land use type a value needs to be specified that represents the relative elasticity to change, ranging from 1 (easy conversion) to 0 (irreversible change). The user should decide on this factor based on expert knowledge or observed behaviour in the recent past.

4.2.5 Holding Capacity of an Area

Each town has a particular population carrying capacity. When the population of a town increases beyond its carrying capacity, the quality of life in that town declines. There is unsustainable pressure on basic infrastructure. Because of this, the residents of the town face shortage of water, housing, transport and other basic goods and services. After a town has reached a certain size, some form of new growth centers is desirable to break its continuous sprawl beyond that size. As with the periphery getting further from its heart, the city becomes less convenient and less comfortable due to the fact that the town services become less effective and less economical. When the holding capacity of an area reaches to its saturation level, it expands. This happens sequentially as first low density area will be converted into medium density and then into highly dense area. Holding capacity depends upon present population and vacant land. The relation is as follows-

Holding Capacity (HC) = P + VD

P = Existing Residential Population

V = Vacant, suitable land available

D = average density at which future residential development will take place

4.3 Road Length Requirement of study area.

Ranchi city has not been able to meet the total road length requirement as formulated by Third Twenty Year Road Development Plan. According to this plan long term master plan for road development has been prepared at different levels like National Highways, State Highways, Major District Roads, Other District Roads, and Village Roads.

Main concentration of this plan is to improve the existing roads by rectifying the defects in the road geometries, widening of the pavements, to connect villages with population over 500, to build roads in less industrialized areas to attract the growth of industries.

4.4 Traffic Volume

Traffic volumes determine both the number of travelers who will benefit from a highway improvement project and, in the case of capacity enhancement projects, the future congestion relief provided by the project. Accordingly, accurate forecasts of traffic volumes are critical to obtaining valid results. An assumption that the historic growth rate of traffic on a road will continue unchanged after it is improved can lead to significant miscalculations of its actual future traffic. In fact, traffic levels on an improved road may increase faster than anticipated as drivers seek to take advantage of its better driving conditions.

The traffic forecasting process begins with the collection of data on current traffic on the facility and throughout the region, followed by the calculation of expected growth in traffic for the region in general. This base case regional traffic projection should reflect expected economic, demographic, and land use trends, based on historic and projected relationships between these factors and regional traffic growth.

There are two types traffic forecasting-

1. Current Traffic-existing and attracted (or diverted)

This represents the volume of traffic that would use an improved highway if it were open to traffic. It consists of the existing traffic plus or minus the existing traffic attracted to it /or diverted traffic that is lost to it from/to other facilities when the improvements are completed.

2. Traffic increase

a) Normal growth of traffic- It represents the increase in traffic on the existing facility if no improvement is made. This is due to general increase in the number and usage motor vehicles. Generally the traffic volume growth is taken to be 7.5% annually if no improvement is made and present conditions appear to exist in future.

b) Diverted Traffic- It represents the traffic diverted on to or away from the route or mode being studied.

c) Induced Traffic- It represents the new traffic because of new travelers making use of the improved or new facility.

d) Development Traffic- It represents the increase in traffic due to improvements on adjacent land over and above the development which would have taken place had not the new or improved highway been constructed.

The simplest method of forecasting is to analyse the past data for a number of years and to extrapolate the past trends assuming that the conditions will continue to change in the future at the same rates as in the past. If the future economic development is expected to continue as in the past then the normal traffic growth may be estimated by extrapolation of time series data on traffic volumes on the existing and/or the parallel highways. The following growth curves are commonly used.

Linear growth: $y = a + bt$;

Exponential growth: $y = c.e^{dt}$

Logistic growth: $y = Y_s / (1+f.e^{-gt})$

y = traffic volume

t = time variable

Y_s = saturation level

a, b, c, d, f, g = parameters which may be developed from time series data

4.4.1 Volume Capacity Ratio of Different Roads

Before making any proposals in relation to Transportation for future in Master Plan, it is imperative that one should have look on existing traffic conditions and existing road characteristics so that judicious decisions can be taken. The growth of vehicular traffic on roads has been far greater than the growth of the highways; as a result the main arteries face capacity saturation.

The Volume/Capacity Ratio indicates the congestion levels on a particular road. The IRC specifies a design service volume (DSV) for each road type therefore indicating a level of service. For example, urban roads are assigned a 'C' level of service (LOS) for road design purposes, which implies that the DSV at LOS-C is about 70% of the maximum capacity the road type can accommodate.

Design Service Volumes for each road type, based on the carriageway width, is detailed in table below. It indicates that number of PCUs the particular road type can accommodate in a time-span of one hour. The utilization of a particular road is then derived using the V/C Ratio where 'V' indicates the observed traffic volume on the identified road type and 'C' indicating the DSV or the Maximum Volume on the identified road type.

For calculation of capacity, both 'design service volume' and 'maximum volume' is adopted. The following are indications of the congestion levels on roads.

If the Design Service Volume is considered as the road's 'capacity':

a) If V/C is less than 1, the road has better service levels and within the designed capacity (No congestion).

b) If V/C is between 1.0 and 1.5, traffic level has crossed the designed capacity but less than the maximum capacity and there is a presence of traffic congestion (less congestion).

c) If V/C is beyond 1.5, traffic level has crossed the maximum capacity and there is a presence of heavy traffic congestion (severe congestion).

If the Maximum Volume is considered as the road's 'capacity':

a) If V/C is less than 0.7, the road has better service levels and within the designed capacity (no congestion).

b) If V/C is between 0.7 and 1.0, traffic level has crossed the designed capacity but is within the maximum capacity, and there is a presence of traffic congestion (less congestion).

c) If V/C is beyond 1.0, traffic level has crossed the maximum capacity and there is a presence of heavy traffic congestion (severe congestion).

Above discussion has been used as important parameter in customised interface in Visual Basic which deals with determining the road characteristics based on volume capacity.

WORK PLAN AND METHODOLOGY

5.1 Study Area

Study Area lies between Latitudes $23^0 25' 0''$ N to $23^0 15' 0''$N and between Longitudes $85^0 15' 0''$ E to $85^0 25' 0''$ E. It occupies almost 144 sqkm. Study area mainly covers residential, commercial, industrial, water falls, forest area and agricultural areas. Following is the demographic data of study area in years 1971, 1981, 1991, 2001. (Source: Ranchi Guide Map-Published by Survey of India in year 2001).

Table 5. Demographic Data of Study Area

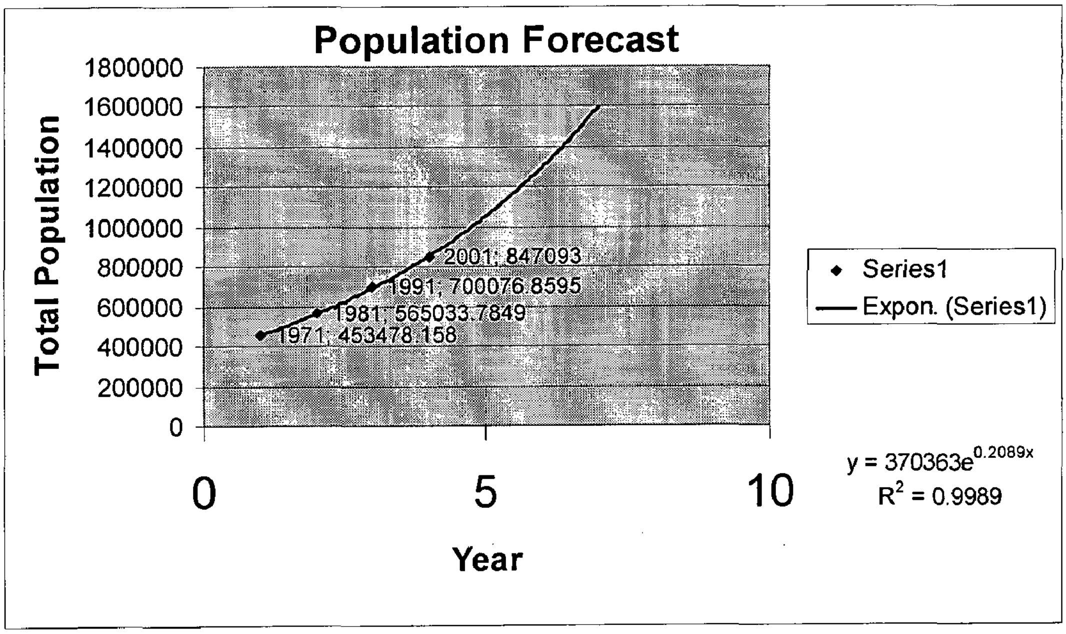
Year	Total Population	Total Urban Population	Total Rural Population	Total male population	Total female population
1971	453478	294113	159364	241289	212188
1981	565033	366465	198568	300647	264386
1991	700076	454050	246026	372501	327575
2001	847093	549401	297692	450727	396366

In mathematics, exponential growth (or geometric growth) occurs when the growth rate of a function is always proportional to the function's current size. Such growth is said to follow an exponential law. This implies for any exponentially growing quantity like population, the larger the quantity gets, and the faster it grows. But it also implies that the relationship between the size of the dependent variable and its rate of growth is governed by a strict law, of the simplest kind: direct proportion.

In Ranch City study area this mathematical model based on the idea that the population size for one generation depends on the size of the previous generation has been implemented for projecting the population of years 2011, 2021, 2031.

Regression Analysis which is a form of statistical analysis used for forecasting and estimating the relationship between variables so that a given variable can be predicted from one or more relationships, this analysis has been used which uses growth function for extrapolating the y-values (Population) that extend exponential curve that best describes the existing data.

Growth functions are used to graphically display trends in data and to analyze problems of prediction. Such analysis is also called regression analysis. By using regression analysis, one can extend a growth function in a chart beyond the actual data to predict future values.



Graph 1 Population Forecast Using Exponential growth

Table 6. Forecast Population of Study Area

Year	Total Population
2011	10,30,450
2021	12,22,345
2031	13,90,685

From the above forecast it can be stated that in next 30 years population of study area will be around 14lakhs so whatever proposals are to be made regarding physical development ; it must be able to cater this much population.

5.2 Quantifying Change in Land Use Pattern in last 20 years

Information about changes in land use and land cover provides valuable insights while devising future natural resource management strategies. Remotely sensed data, serve as an effective tool for deriving this kind of information. In recent years, the significance of spatial data technologies, especially the application of remotely sensed data and geographic information systems (GIS) has greatly increased.

An analysis of natural resources and rates of urban change over time is essential for a proper understanding of why present urban planning problems have arisen. Information on the existing land use/land cover patterns regarding the spatial distribution and changes in the land use pattern is a prerequisite for Urban Planning. Incorporating these data in models will help in the utilization and formulation of policies and programs for making any developmental decisions in study area. Following data has been used for quantifying the land use pattern.

The most crucial information for preparing a Plan is an accurate and updated Base Map and land use land cover of the planning area, road networks, spatial extent of development and the information on the use of each parcel of land. Land use land cover is the basis for making rational planning decisions. With the advent of Geographic Information System (GIS) technology and Remote Sensing technology, the process of urban planning in India received a new impetus. Capturing the spatial details by remote sensing, either by satellite imageries or aerial photographs and organising those details together with corresponding attribute data under GIS environment, offers tremendous ease in undertaking some of the urban planning activities.

Table 7. Data Used

Segment	Material	Source
Primary Data	Toposheets No-73E/3, 73E/11, 73E/7, 73E/8 Ranchi Road Guide and Political Map	Survey of India, Scale-1:50,000 Designed, Cartographed, Edited and Published by N.C Kansil and Sons(Permission by Surveyor General of India)
	Satellite Imagery-IRS 1D LISS III imagery, Resolution: 23.5 M Dated:29 th March 2004	National Remote Sensing Agency (NRSA), Hyderabad
Secondary Data	Demographic details from Primary Census abstracts for 1971, 1981, 1991 and 2001 Published in Ranchi Guide Map	Directorate of census operations, Census of India
	Blue Print showing village, ward and RMCA boundary lines	Scale: 1:25,000 Source: Ranchi Muncipality

Table 8. Percent of Land Use/Land Cover

Land Use/Land Cover	Percent	Area(sqkm)
Water	4.2%	6.04
Vegetation	18.4%	26.50
Dense Settlement	22.1%	31.82
Others	8.4%	12.09
Agricultural Land	49.5%	71.28

5.2.1 Classification of Satellite imagery

Classification of IRS-1 D LISS-III satellite imagery has been done by using software ERDAS Imagine 8.3 by Maximum Likelihood classification algorithm. First the signature file is prepared consisting of training pixels and then using the signature file imagery is classified into Land Use Land Cover. After Maximumhood classification of satellite imagery we get the following percent of Land Use and Land cover. (Refer Fig. 3)

5.2.2 Preparation of Land Use Zonation Map

First the toposheet 73E/7 (Surveyed in 1982) is georeferenced in Erdas Imagine and then the Guide Map (Scale 1:20000) is registered over this toposheet. This registered guide map is then opened in ArcGIS and reprojected in UTM projection system (Ranchi City falls in 44N zone) so that areas of different land use pattern can be calculated in GIS environment. (Refer Fig. 4)

Table 9. Percent of Land Use/Land Cover

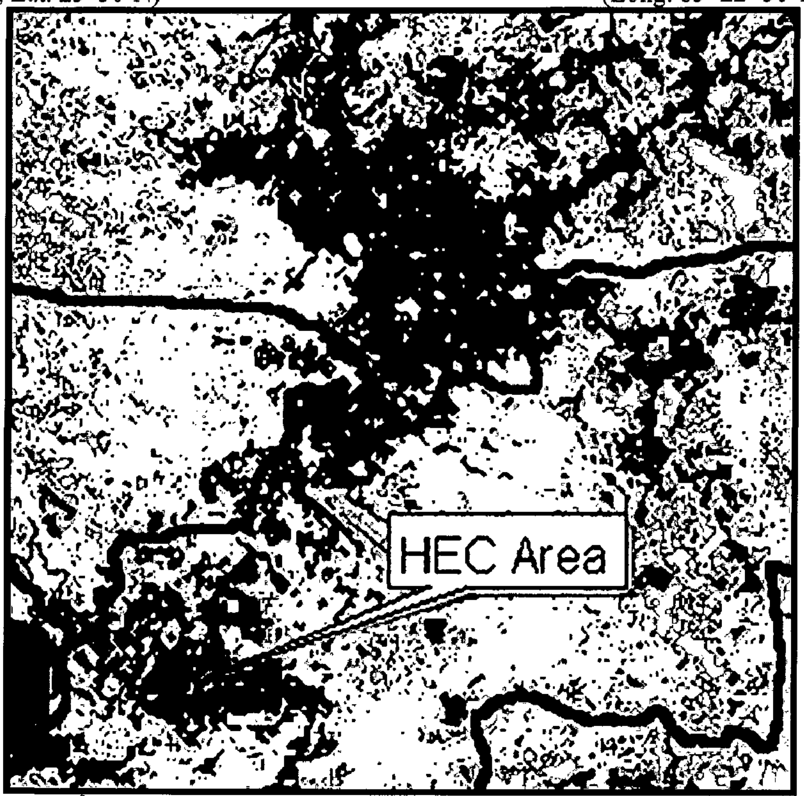
Land Use/Land Cover	Percent	Area(sqkm)
Water	3.8%	5.47
Vegetation	14.6%	21.02
Dense Settlement	28.76%	41.41
Others	10.14%	14.60
Agricultural Land	42.7%	61.48

From the above figures it can be concluded that there has been growth in built up area (Dense Settlement) by 30% and there has been considerable decline in vegetation cover and agricultural area.

5.2.3 Analysis and Conclusions from change in Land Use Pattern

Overall growth of urban area was estimated as 30 % in a span of 25 years. Scattered unplanned development all over the city has taken place. Planned development has taken place only in industrial colonies, housing complex. Urban area growth has been observed

(Long. 85^0 15' E, Lat. 23^0 30'N) (Long. 85^0 22' 30"E, Lat. 23^0 30' N)



(Long. 85^0 15' E, Lat. 23^0 20' N) (Long. 85^0 22' 30"E, Lat. 23^0 20' N)

	Water
	Vegetation
	Dense Settlement
	Others
	Agricultural Land
	RMC boundary

Fig. 3 Classified IRS-1D LISS –III satellite imagery

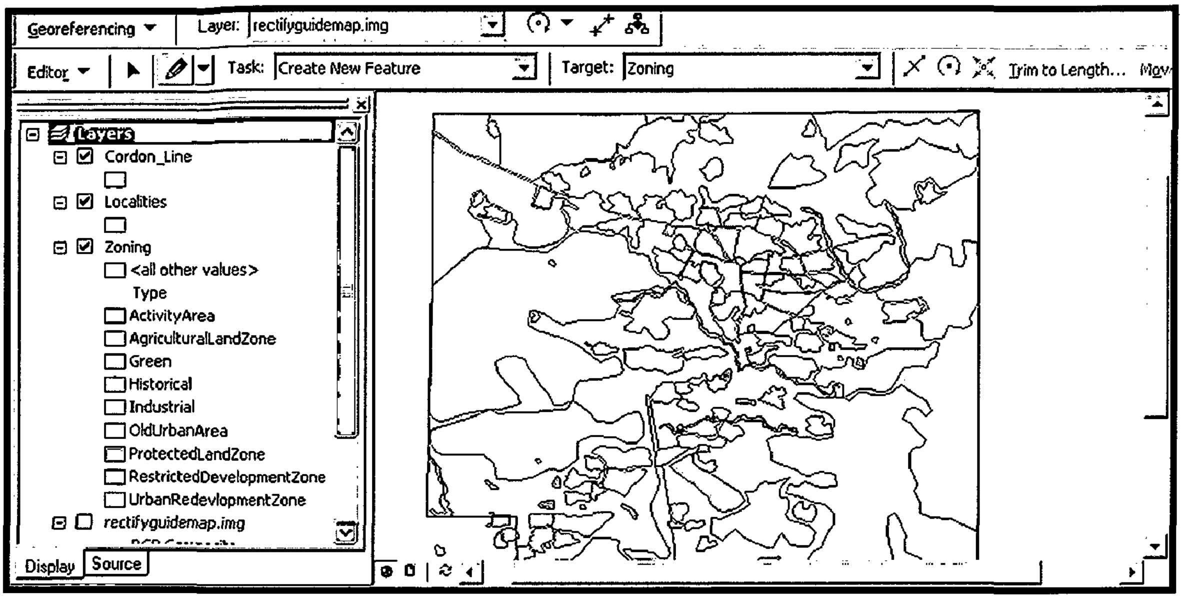


Fig. 4 Land Use Zonation Map of study area in software ArcGIS

Attributes of Zoning

FID	Shape*	Id	Type	Name
0	Polygon	0	Industrial	ModernFoodIndustries
1	Polygon	0	Industrial	OilMill
2	Polygon	0	Industrial	HEC
3	Polygon	0	Industrial	IOL
4	Polygon	0	Industrial	RegionalWorkshop
5	Polygon	0	Green	ZakirPark
6	Polygon	0	Historical	RanchiHills
7	Polygon	0	OldUrbanArea	Hindpiri
8	Polygon	0	OldUrbanArea	Kacheri
9	Polygon	0	ActivityArea	LowerBazar
10	Polygon	0	ActivityArea	UpperBazar
11	Polygon	0	ActivityArea	AgricultureMarketingYard
12	Polygon	0	ActivityArea	JPMarket
13	Polygon	0	ActivityArea	BahuBazar
14	Polygon	0	ActivityArea	ShastriMarket
15	Polygon	0	ActivityArea	RRMarket
16	Polygon	0	Green	Sal
17	Polygon	0	OldUrbanArea	Tharpakhna
18	Polygon	0	UrbanRedevlopmentZone	GondaReservoir
19	Polygon	0	OldUrbanArea	Kumhartoli
20	Polygon	0	UrbanRedevlopmentZone	RanchiLake
21	Polygon	0	UrbanRedevlopmentZone	HarmuZone
22	Polygon	0	UrbanRedevlopmentZone	HarmuZone
23	Polygon	0	UrbanRedevlopmentZone	SubarnarekhaZone
24	Polygon	0	UrbanRedevlopmentZone	Lake
25	Polygon	0	ActivityArea	StateBusStand
26	Polygon	0	ActivityArea	ArgoraRailwayStation
27	Polygon	0	ActivityArea	PrivateBusStand

Record: 1 Show: All Selected Records (0 out of 73 Selected) Options

Fig. 5 Attribute Table Attached to shapefile consisting different land use patterns along highways and the areas where electricity and communication facilities are fairly well developed In near future, fast growth can be observed in south along the highway following the trend of the city.

There has been great loss of agricultural land as maximum agricultural land has been converted to settlement. City is expected to grow in the NE and SW direction. In near future, fast growth can be observed in the southern part of the city following the trend of urban development along highways. (Refer Fig. 6, 7, 8)

5.3 Measuring Urban Sprawl of Hasel Village of Study Region

In order to explore the probable relationship of percentage built-up (dependent variable) with causal factors of sprawl (population, A and B population densities, etc.), regression analyses considering linear, quadratic (order=2), and logarithmic (power law) have been calculated for Hasel Area. Following data has been collected by Xavier Institute of Social Service, Ranchi for assessment of impact of poverty alleviation programmes for Hasel Village. (Refer Fig. 9)

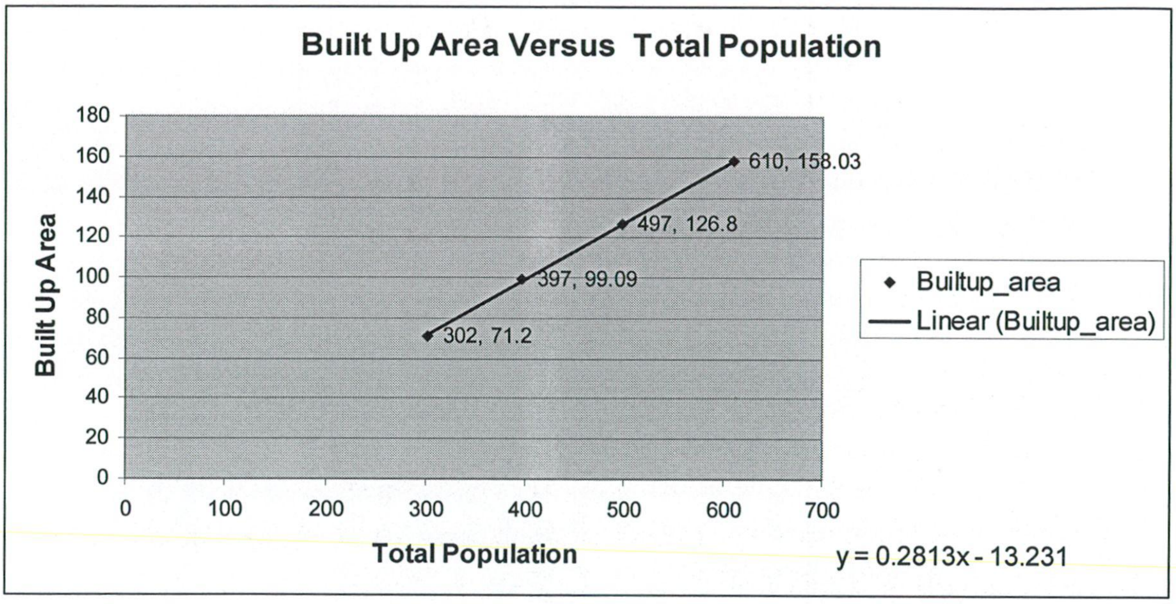
Table 10. Data for Hasel Village

Year	Tot_Pop	Builtuparea	M_pop	F_pop	T_geo	W_area	C_area	Others
1971	302	71.2	166	36	169.51	17.25	71.2	5.4
1981	397	99.09	221	176	187.74	19.69	58.07	7.63
1991	497	126.8	249	248	201.45	21.05	51.2	12.45
2005	610	158.03	310	300	263.54	42.52	43.1	20.03

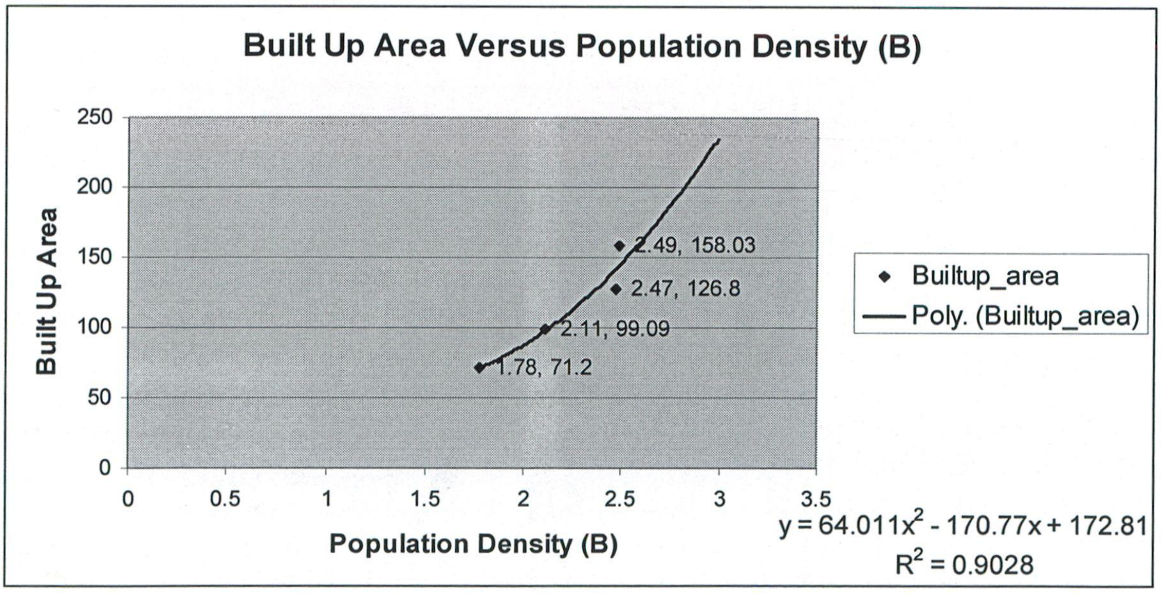
(Area in Hectares)

Table 11. Data for Hasel Village

Year	Tot_Pop	Builtuparea	No_of_Households	Pop/Totalgeo P_Density(B)	Pop/BuiltupArea P_Density(A)
1971	302	71.2	59	1.78	4.241
1981	397	99.09	71	2.11	4.04
1991	497	126.8	96	2.47	3.98
2005	610	158.03	123	2.49	3.76



Graph 2 Graph showing Built up area versus Total Population



Graph 3 Graph showing Built up area versus Population Density (B)

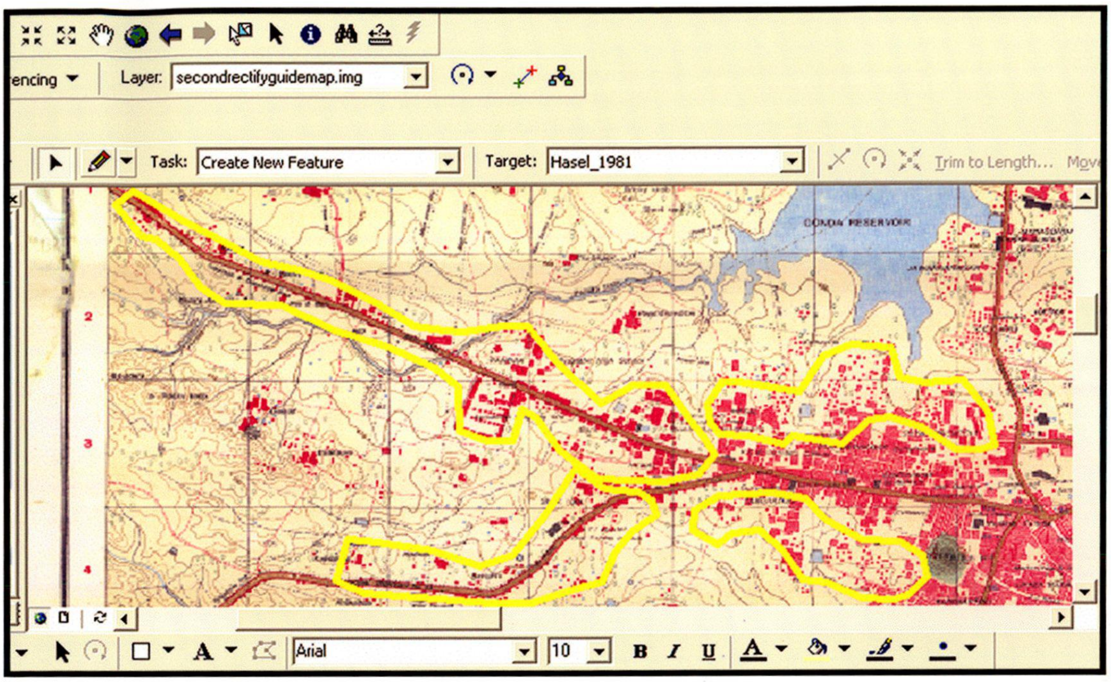


Fig. 8 Urban Sprawl along Highways and peripheries of City

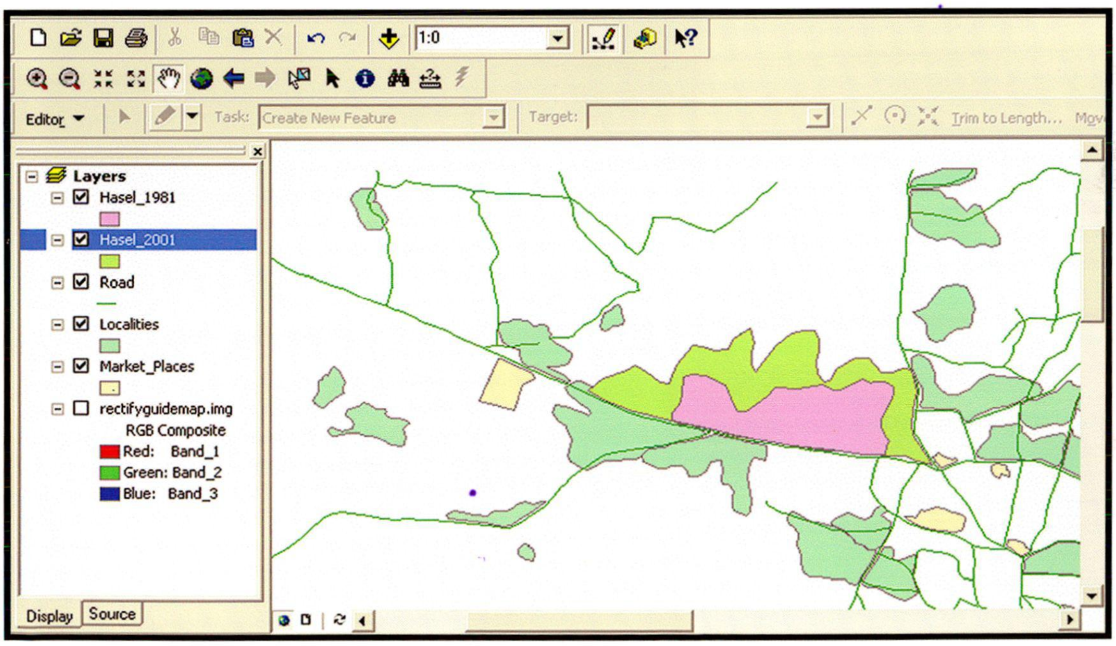


Fig. 9 Hasel Area in year 2001

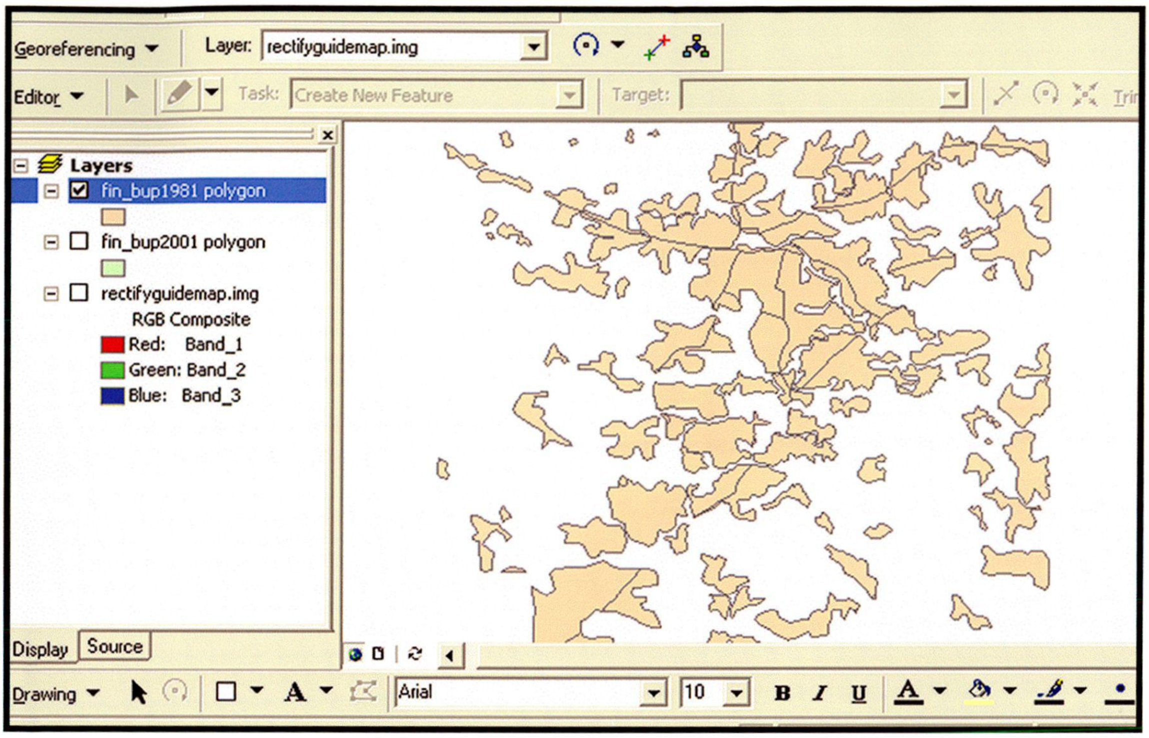


Fig. 6 Built Up Area in year 1982

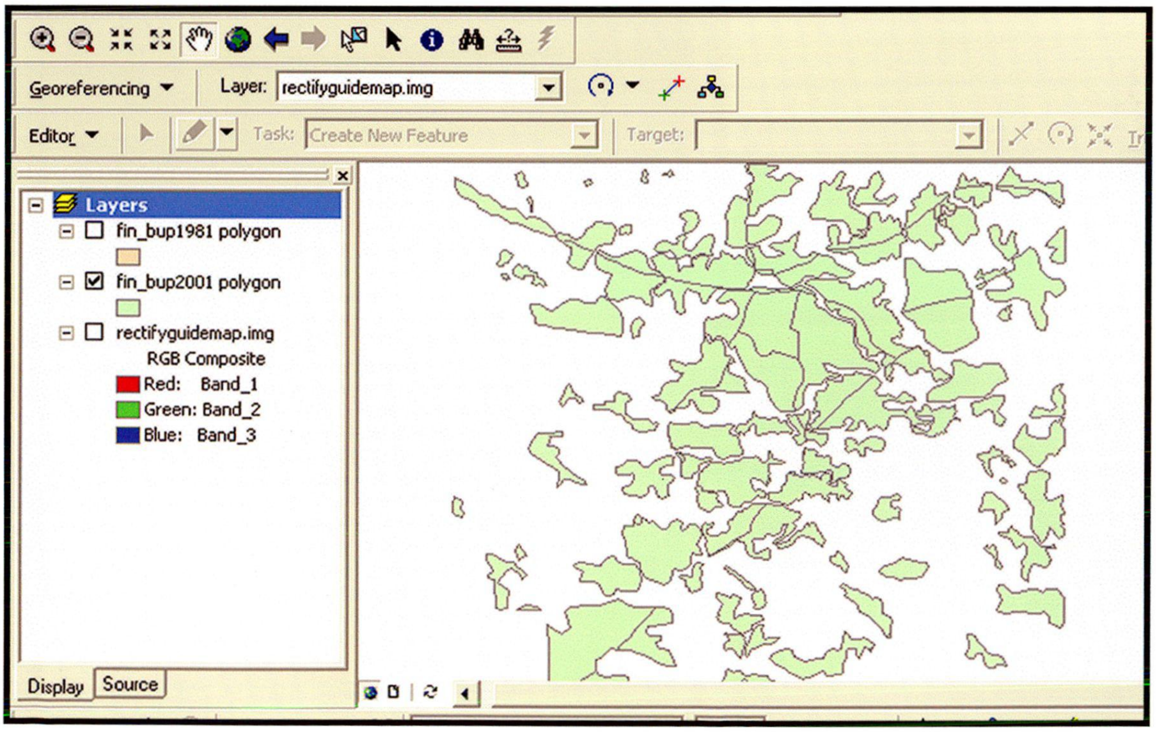
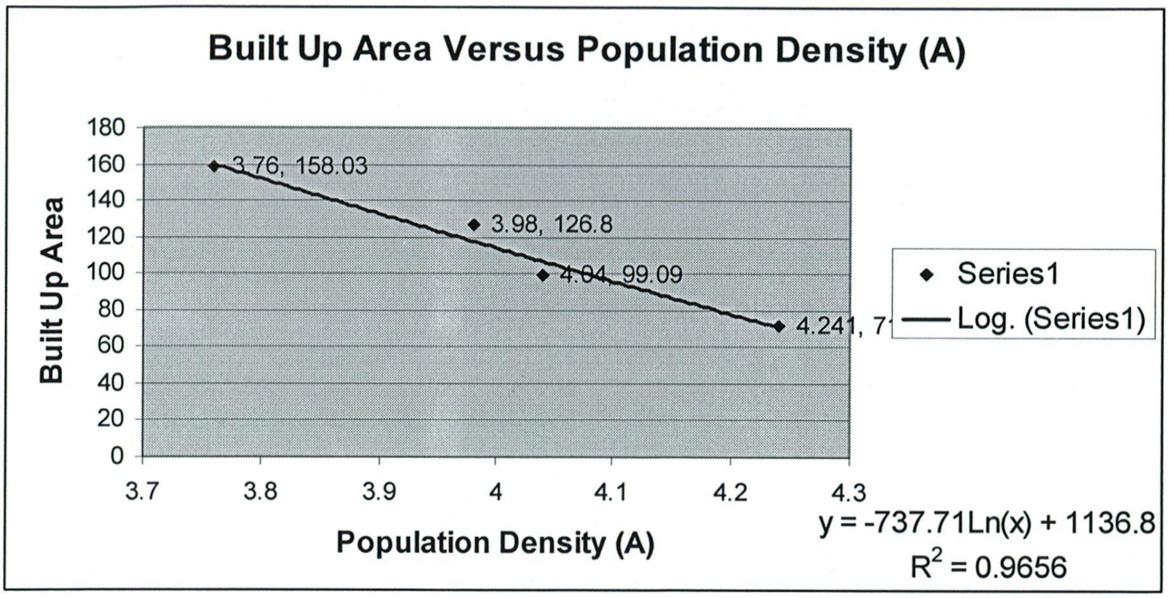


Fig. 7 Built Up Area in year 2001



Graph 4 Graph showing Built up area versus Population Density (A)

From the above graphs it can be seen how the various factors contribute to total growth of built up area. If same conditions prevail then these equations can be used to predict the total built up area in various areas of study region and various facilities can be proposed in accordance to future growth of built up area. If further analysis of urban sprawl is done in study region then it can be stated that there are 3 forms of sprawl. First sprawl is Low Density Sprawl which exists along the margins of main city centre, second is of Ribbon type that is following major transportation corridors outward from urban cores and third one is Leapfrog sprawl which is a continuous pattern of Urbanisation with patches of developed land that are widely separated from each other and from the other boundaries.

Urban sprawl is also referred as irresponsible, and often poorly planned development that destroys green space, increases traffic, contributes to air pollution, leads to congestion with crowding and does not contribute significantly to revenue, a major concern. Defining this dynamic phenomenon with relative precision and accuracy for predicting the future sprawl is indeed a great challenge to all working in this arena. One of the basic and major challenges is quantification of such sprawl.

5.4 Future Growth of Study Area and Forecasting Direction of Future Growth

5.4.1 Zoning Regulations

Buffers have been drawn around various areas which have been declared as prohibited zones like conserved forests, lakes and surrounding areas, river banks, highway's adjoining areas etc. These areas have been filtered from the study area under consideration. Remaining areas have been considered for future growth. Various bye laws like 10m on both sides of highways, 50m spaces around features like rivers and lakes have been considered for defining buffers. (Refer Fig.10)

5.4.2 Proximity to Highways and Roads

As the distance increases from the highways and roadways, value of land decreases linearly. Generally the following relation exists between the land value and its distance from the roads. (Refer Fig.11)

LV = a-bD

LV-Land Value

a, b are constants (generally a =100 and b=1 is taken)

D-Distance in meters

Table 12. Land Values at different distances

S.No.	Distance	Land Value	Ranking in terms of susceptibility for Future growth
1.	10 m	90	Highly susceptible
2.	20m	80	Moderate susceptible
3.	30m	70	Low susceptible
4.	40m	60	Very Low susceptible

Fig. 10 Prohibited Area in accordance to Zoning Regulations

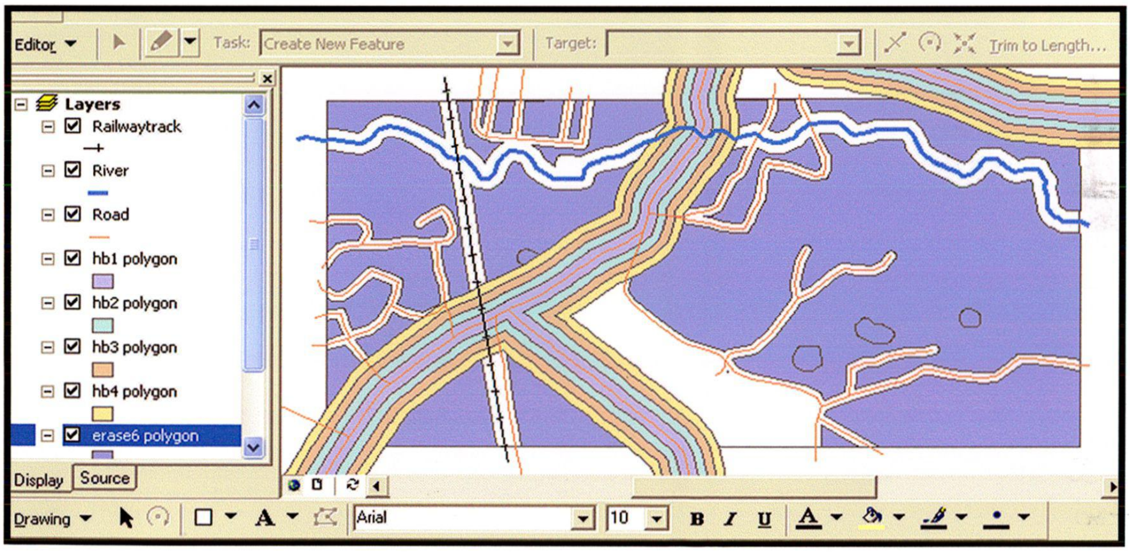


Fig. 11 Buffers around highways indicating Land Values

5.4.3 Proximity to Central Business District

Population density index varies exponentially as the distance from Central Business District increases. Higher the population density index higher is the susceptibility of future growth. (Refer Fig.12)

$D_x=D_0e^{-bx}$

D_0 = Population Density Index at CBD (Generally it is taken as D_0 =1)

x=Distance from CBD

b=constant (b=2)

Table 13. Population Density Index at different distances

S.No.	Distance	Population Density Index	Ranking in terms of susceptibility for Future growth
1.	1Km	0.135	Highly susceptible
2.	2Km	0.018	Moderate susceptible
3.	3Km	0.002	Low susceptible
4.	4Km	0.0003	Very Low susceptible

5.4.3 Land Conversion Elasticity.

The conversion elasticities are related to the reversibility of land use change. Land use types with high capital investment will not easily be converted in other uses as long as there is sufficient demand. Examples are residential locations but also plantations with permanent crops (e.g., fruit trees). Other land use types easily shift location when the location becomes more suitable for other land use types. Arable land often makes place for urban development while expansion of agricultural land occurs at the forest frontier.

The second set of land use type characteristics that needs to be specified are the land use type specific conversion settings and their temporal characteristics. These settings are specified in a conversion matrix. (Refer Fig. 13)

Table 14. Land Conversion Matrix

Future Land Use / Present Land Use	Agricultural Area	Residential Area	Barren Land	Reserved Forest
Agricultural Area	_	P(conditions)	P	NP
Residential Area	NP	_	NP	NP
Barren Land	P	P	_	NP
Reserved Forest	NP	NP	NP	_

P= Conversion Possible

NP=Conversion Not Possible

As the distance from the high, medium and low dense residential areas increase the possibility of conversion of agricultural land into different land use patterns like urban settlement become less.

Table 15. Conversion Elasticity of Agricultural Land as distance increases.

S.No.	Distance	Conversion Elasticity	Ranking in terms of susceptibility for Future growth
1.	50 m	1	Highly susceptible
2.	100m	0.8	Moderate susceptible
3.	150m	0.6	Low susceptible
4.	200m	0.5	Very Low susceptible

5.4.4 Holding Capacity of an Area

When the holding capacity of an area reaches to its saturation level, it expands. This happens sequentially as first low density area will be converted into medium density and then into highly dense area. Holding capacity depends upon present population and vacant land. The relation is as follows-

Holding Capacity (HC) = P + VD

P = Existing Residential Population

V = Vacant, suitable land available

D = average density at which future residential development will take place

5.5 Volume Capacity Ratio of Different Roads in Study Area

Design Service Volumes for each road type, based on the carriageway width, is detailed in table below. It indicates that number of PCUs the particular road type can accommodate in a time-span of one hour. The utilization of a particular road is then derived using the V/C Ratio where 'V' indicates the observed traffic volume on the identified road type and 'C' indicating the DSV or the Maximum Volume on the identified road type. (Refer Fig. 14, 15)

Table 16. Design Service Volume for different types of Roads

S.No	Type of Carriageway	Arterial Roads (PCU/Hr)	Sub Arterial Roads (PCU/Hr)	Collector Roads (PCU/Hr)
1.	2-Lane (One Way)	2400	1900	1400
2.	2-Lane (Two Way)	1500	1200	900
3.	3-Lane (One Way)	3600	2900	2200
4.	4-Lane Undivided (Two way)	3000	2400	1800
5.	4-Lane Divided (Two way)	3600	2900	
6.	6-Lane Undivided (Two Way)	4800	3800	
7.	6-Lane Divided (Two Way)	5400	4300	
8.	8-Lane (Two Way)	7200		

Table 17. Carriage width requirement for different traffic volume

Required Carriage Way Width For LOS 'C' for volume up to	1500 PCU	2 Lane 2 Way
	2000 PCU	3 Lane 2 Way
	3600 PCU	4 Lane 2 Way
	5400 PCU	6 Lane 2 Way
	7200 PCU	8 Lane 2 Way

Visual Basic Interface has been generated where the user is asked to enter the type of road, volume of road, capacity of road, number of lanes , maximum speed of vehicles, minimum speed of vehicles, operational speed of vehicles and the result like volume/capacity of road along with degree of congestion is displayed. (Refer Fig. 16, 17, 18, 19, 20, 21)

5.6 Traffic Census

The growth of motor vehicles in Ranchi City has been phenomenal. There were about 2.1 lakh registered motor vehicles in Ranchi Sub-Region by the year 2003-04. Motorised two-wheelers and cars constitute 81% and 12% of the registered vehicles respectively. About 13,000 cars and 68,800 and two wheelers have been added since 1999. The registered vehicles have grown at a rate of about 17.6% p.a. during last 10 years.

Table 18. Registered Vehicles in different years in Ranchi (Source-RTO)

Year	Car/Jeep/ Van	Scooter/ M.Cycle / Moped	Taxi /Maxi	Auto /Tempo	Bus /Minibus /Omnibus	Goods Vehicle	Others	Total
2000	12972	109498	1678	905	1405	3502	1207	131167
2001	15262	121678	2135	1567	1461	3835	1427	147365
2002	17479	135202	2620	1956	1546	4155	1612	164570
2003	20214	150296	3041	2187	1621	4658	1754	183771
2004	23859	166399	3370	2484	1991	5479	1987	205569
Growth Rate (p.a.)								17.6%

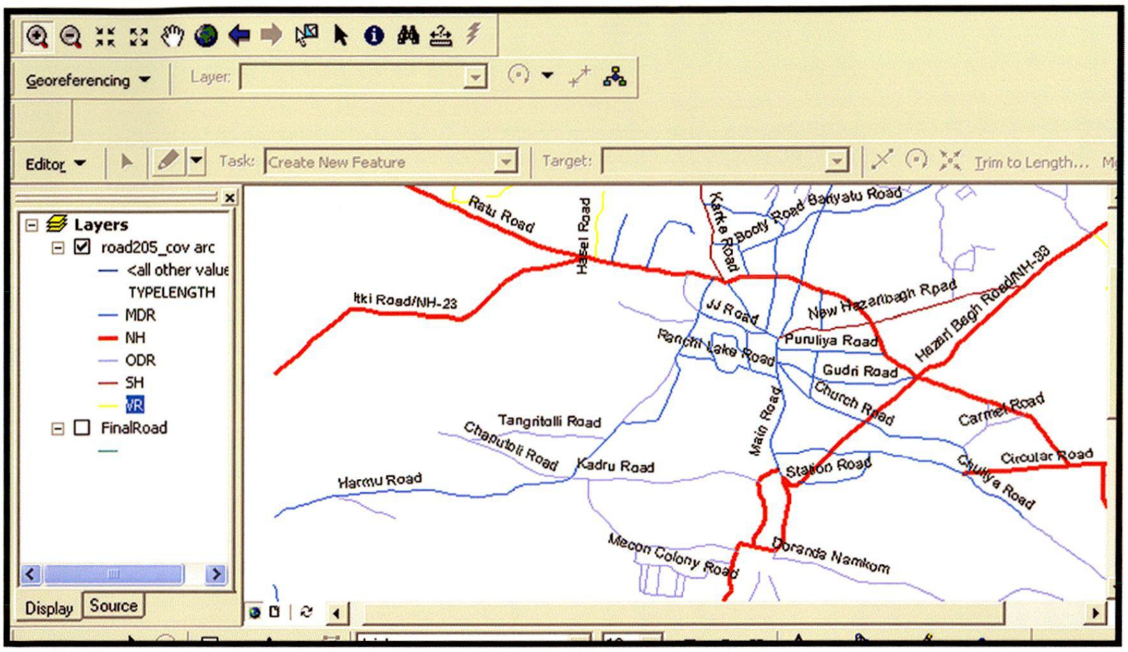


Fig. 14 Different Types of Roads in Study Area

FID	Shape*	Id	Name	Type	Width	TypeLe
0	Polyline	0	Ratu Road	Metalled	0	NH
1	Polyline	0	Kanke Road	Metalled	0	SH
2	Polyline	0	Circular Road	Metalled	0	NH
3	Polyline	0	Tata Road	Metalled	0	NH
4	Polyline	0	Governor's House Road	Metalled	0	MDR
5	Polyline	0	New Hazaribagh Rpad	Metalled	0	SH
6	Polyline	0	Hinoo Main	Metalled	0	NH
7	Polyline	0	Doranda Namkom	Metalled	0	ODR
8	Polyline	0	Khunti Road	Metalled	0	SH
9	Polyline	0	Sadabahar Road	Metalled	0	NH
10	Polyline	0	Namkom Road	Metalled	0	ODR
11	Polyline	0	Tonko Road	Metalled	0	SH
12	Polyline	0	Harmu Road	Metalled	0	MDR
13	Polyline	0	Jhiri Road	Metalled	0	ODR
14	Polyline	0	Gonda Reservoir Road	Cart Track	0	VR
15	Polyline	0	Chatekpur Road	Pack Track	0	VR
16	Polyline	0	Pandra Road	Pack Track	0	VR
17	Polyline	0	Chatakpur Road	Pack Track	0	VR
18	Polyline	0	Hasel Road	Cart Track	0	VR
19	Polyline	0	Gandhinagar Road	Unmetalled	0	ODR
20	Polyline	0	Vidyapathi Nagar Road	Metalled	0	ODR
21	Polyline	0	Hilly Area Road	Unmetalled	0	ODR
22	Polyline	0	Ranchi University Road	Metalled	0	MDR
23	Polyline	0	Tagore Subroad	Unmetalled	0	ODR
24	Polyline	0	Gurudwara Road	Metalled	0	MDR

Fig. 15 Attributes of Different Types of Roads

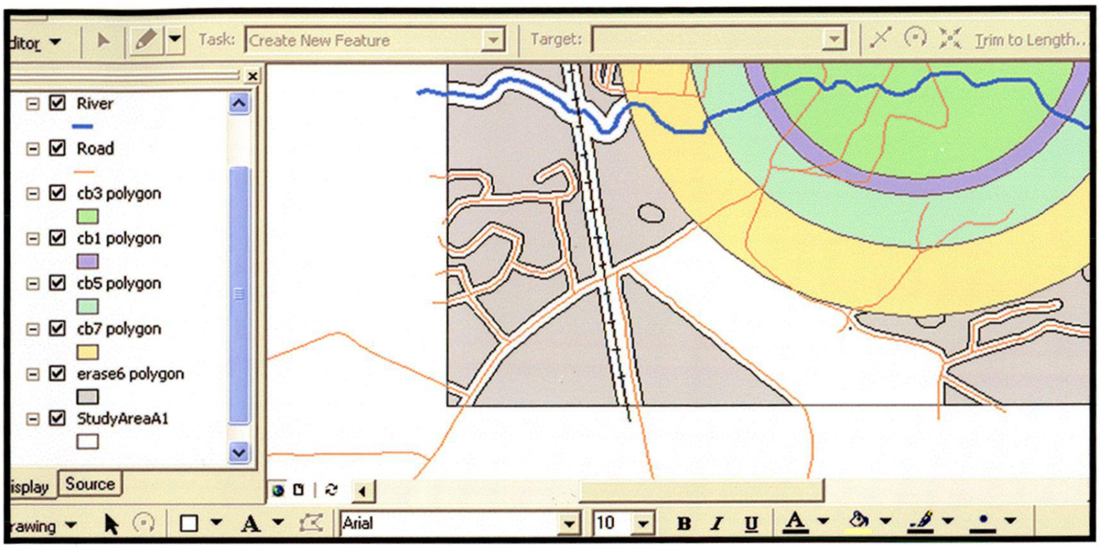


Fig. 12 Buffers indicating Population Density Index around CBD

Fig. 13 Buffers indicating Land Conversion Elasticity

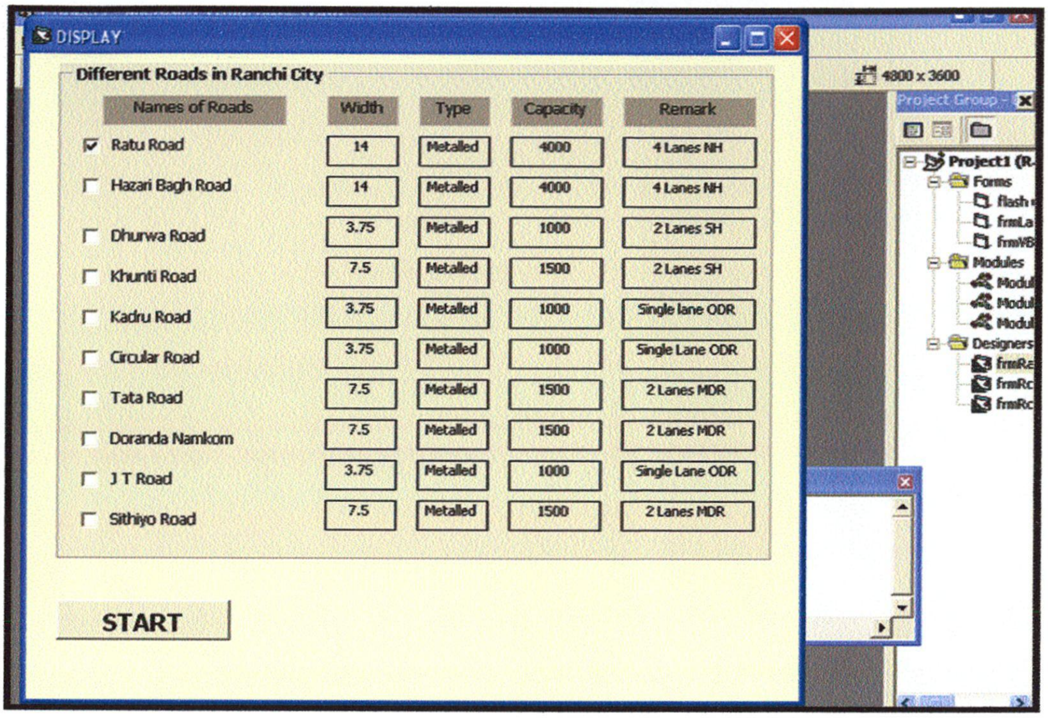


Fig. 16 Visual Basic Interface for Display for different types of Roads for Ranchi City

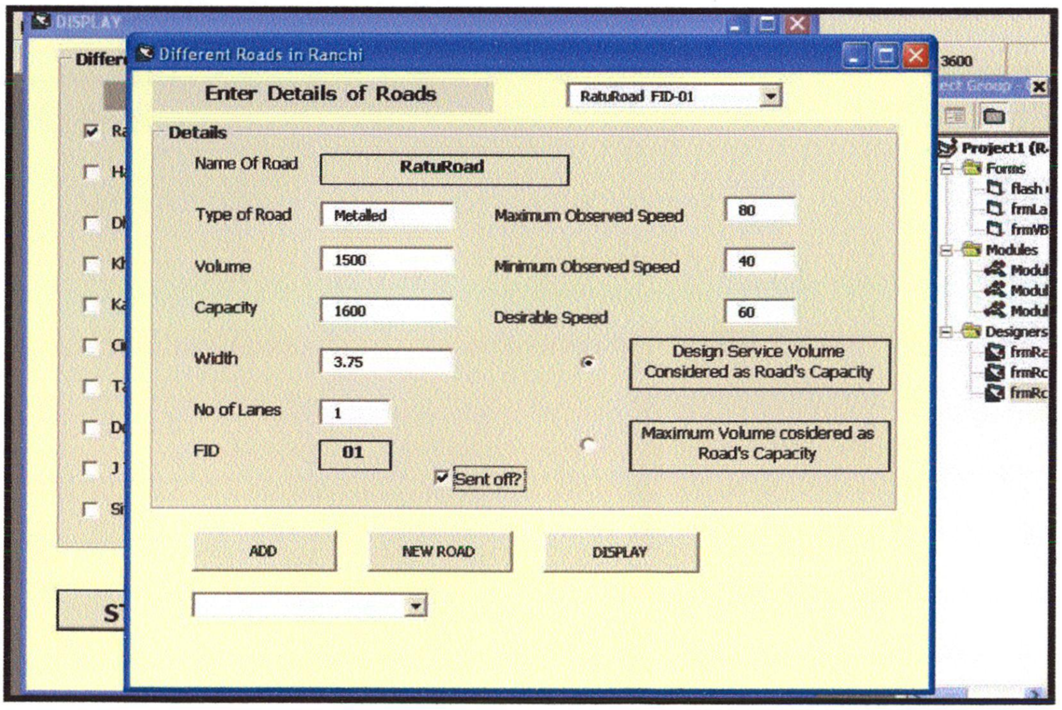


Fig. 17 Visual Basic Interface for taking information from User

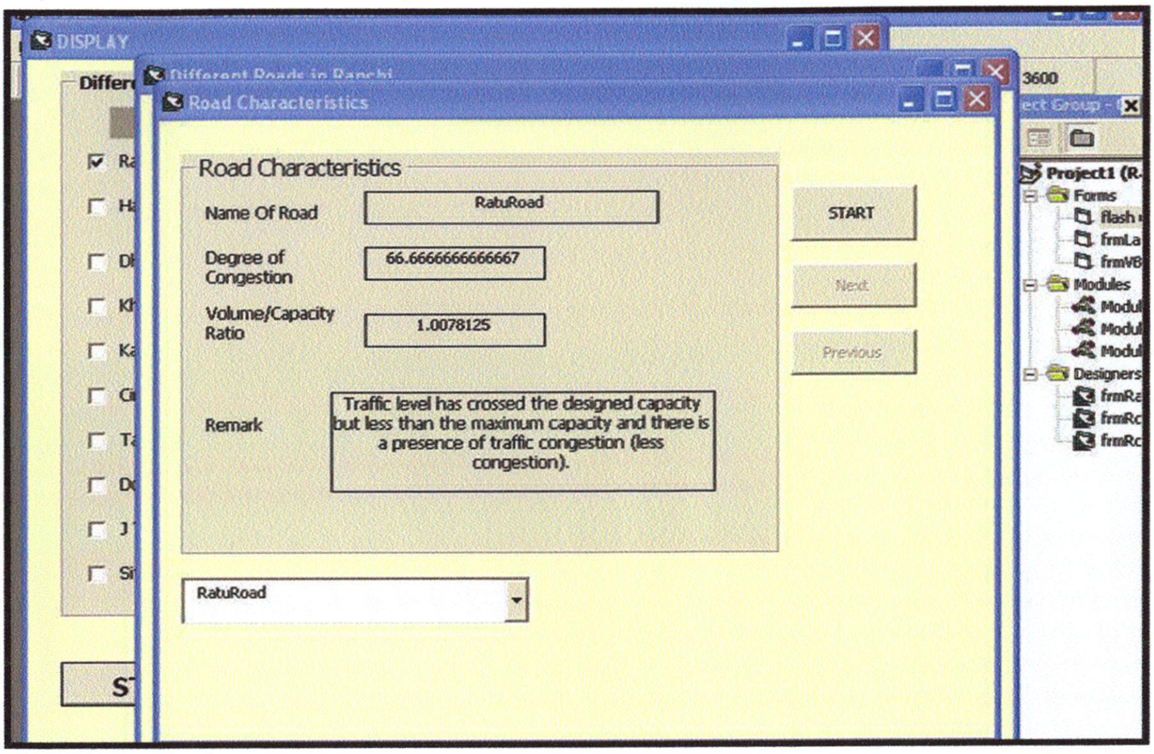


Fig. 18 Visual Basic Interface for Display of Information related to Road's Characteristics

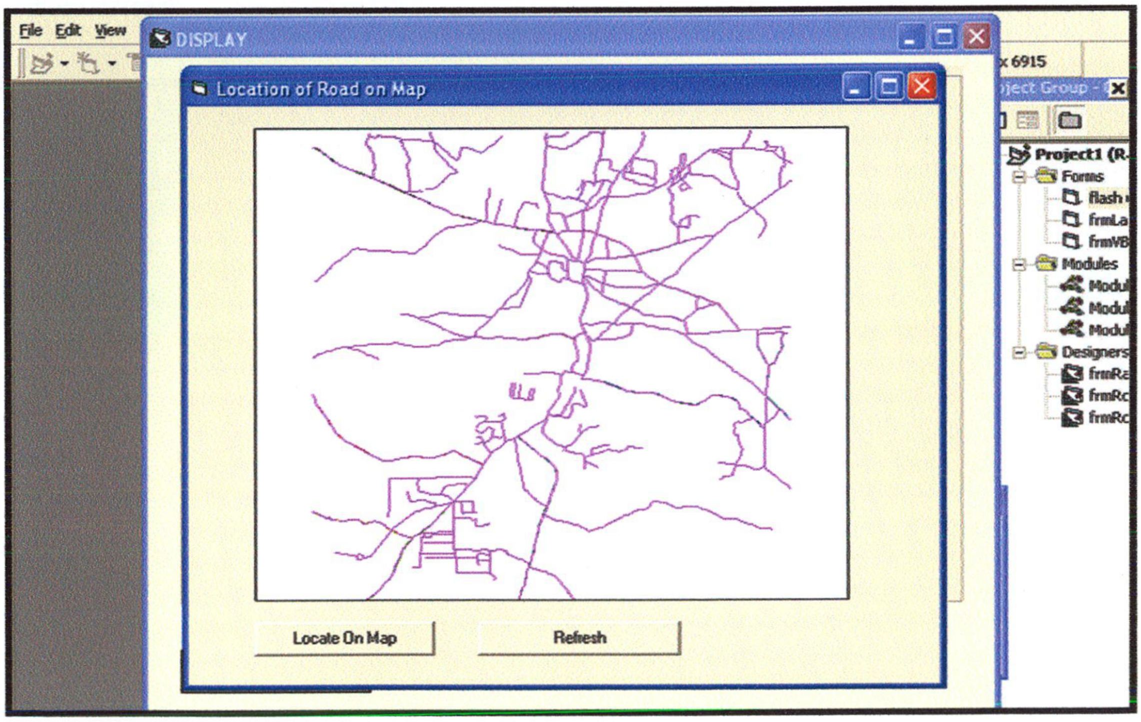
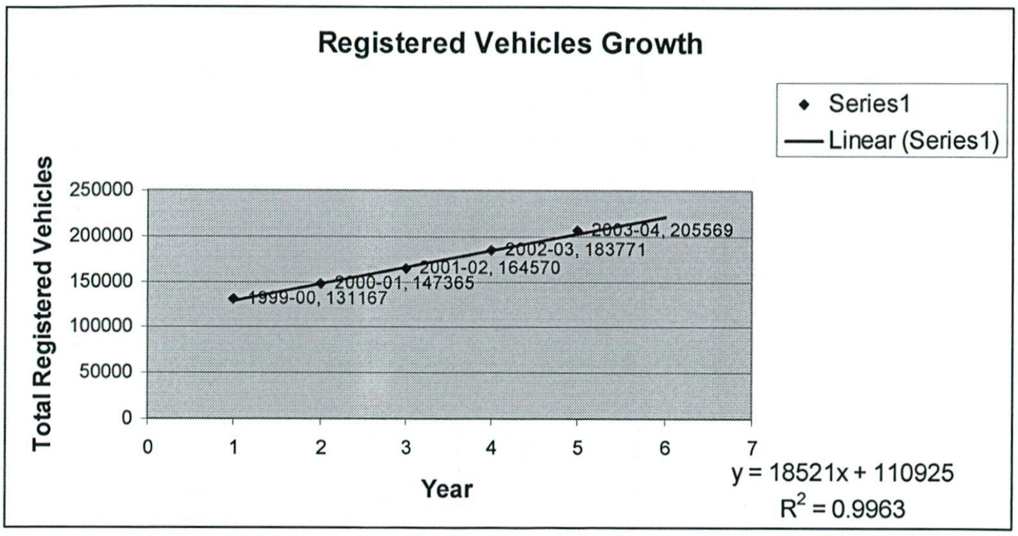


Fig. 19 Visual Basic Interface for Locating Road on Map

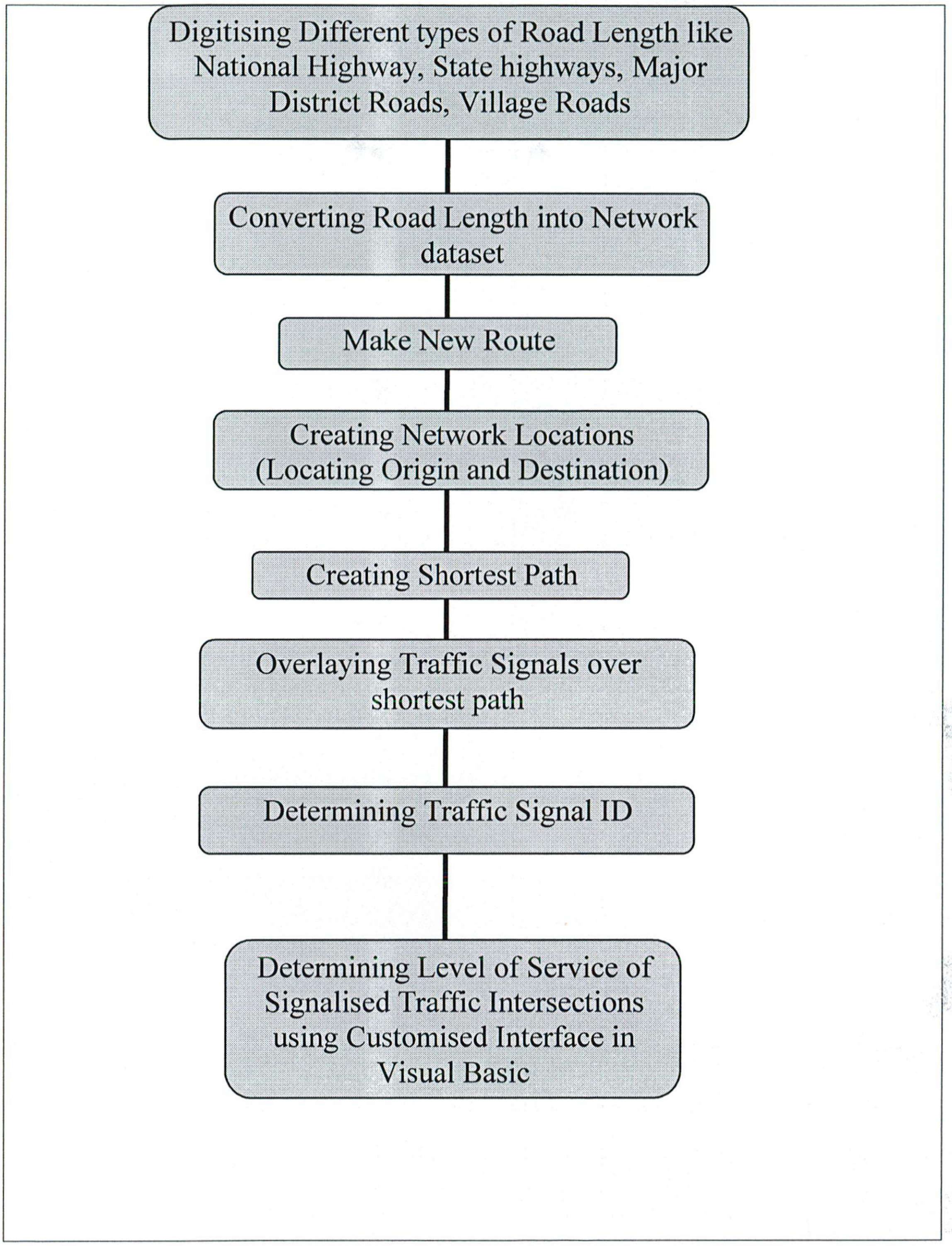


Graph 5 Graph showing Registered Vehicles Growth in Ranchi City

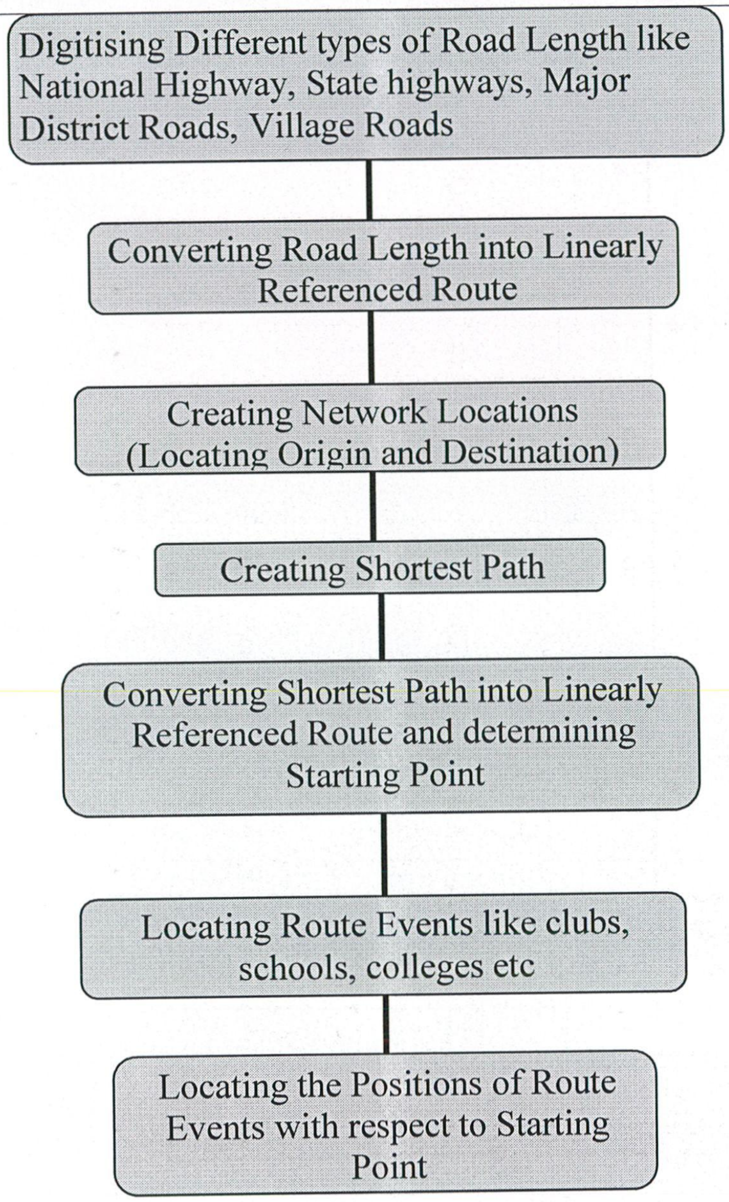
5.7 Traffic Signals on shortest route between two stops

Creating a route can mean finding the quickest, shortest, or most scenic route, depending on the impedance chosen. If the impedance is time, then the best route is the quickest route. Hence, the best route can be defined as the route that has the lowest impedance, or least cost, where the impedance is chosen by the user. Any cost attribute can be used as the impedance when determining the best route.

After finding the shortest route, all the traffic intersections lying on the shortest route are determined. These traffic intersections are then labeled according to their intersection IDs. Once their intersection IDs are determined, customised module developed in Visual Basic, which calculates the Level of Service is opened. Traffic Signals are then selected and control delay per Vehicle is entered for the signalized traffic signal. Level of Service (LOS) for signalized intersections is defined in terms of control delay. The average control delay is estimated for each lane group and aggregated for each approach and for the intersection as a whole. LOS is directly related to the control delay value as per the following value.



Flowchart 1 Methodology implemented in determining Level of Service



Flowchart 2 Methodology implemented in Locating Route Events

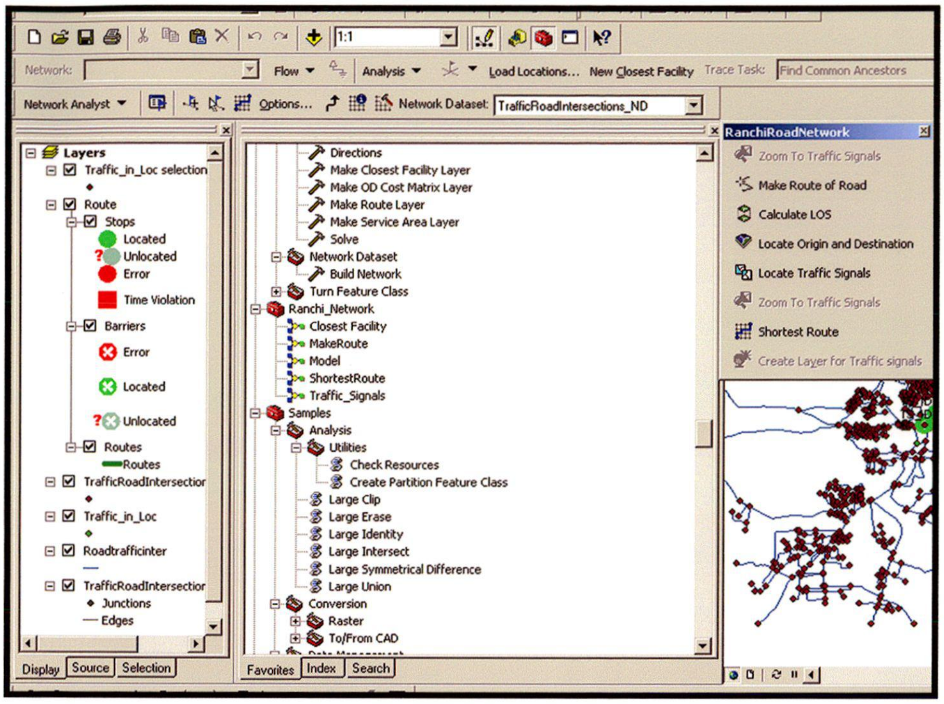


Fig. 24 Module developed for calculating the Level of Service at Traffic Signals

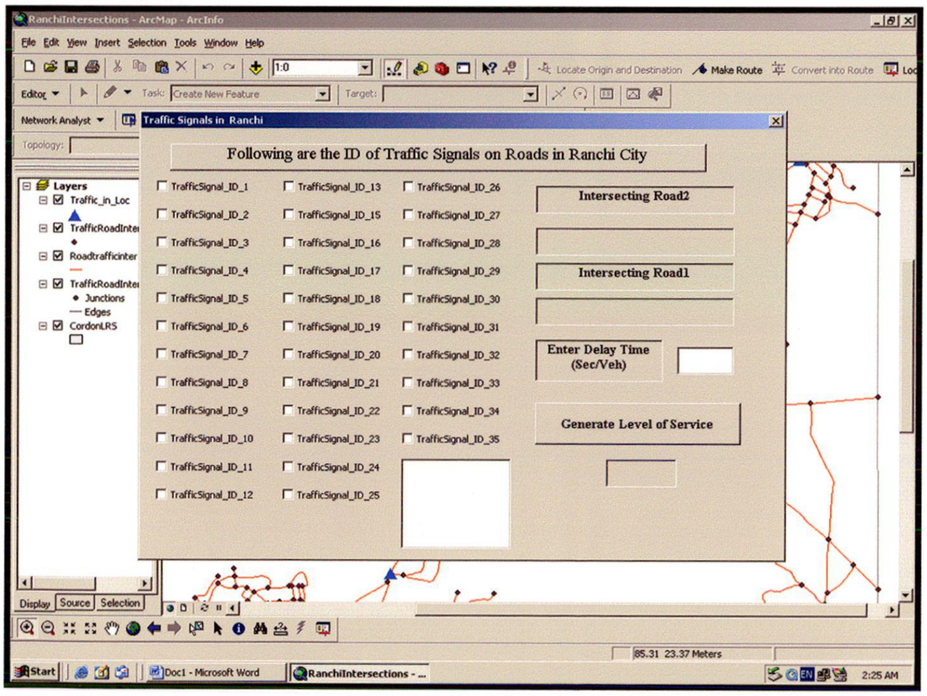


Fig. 25 Visual Basic Interface for calculating Level of Service

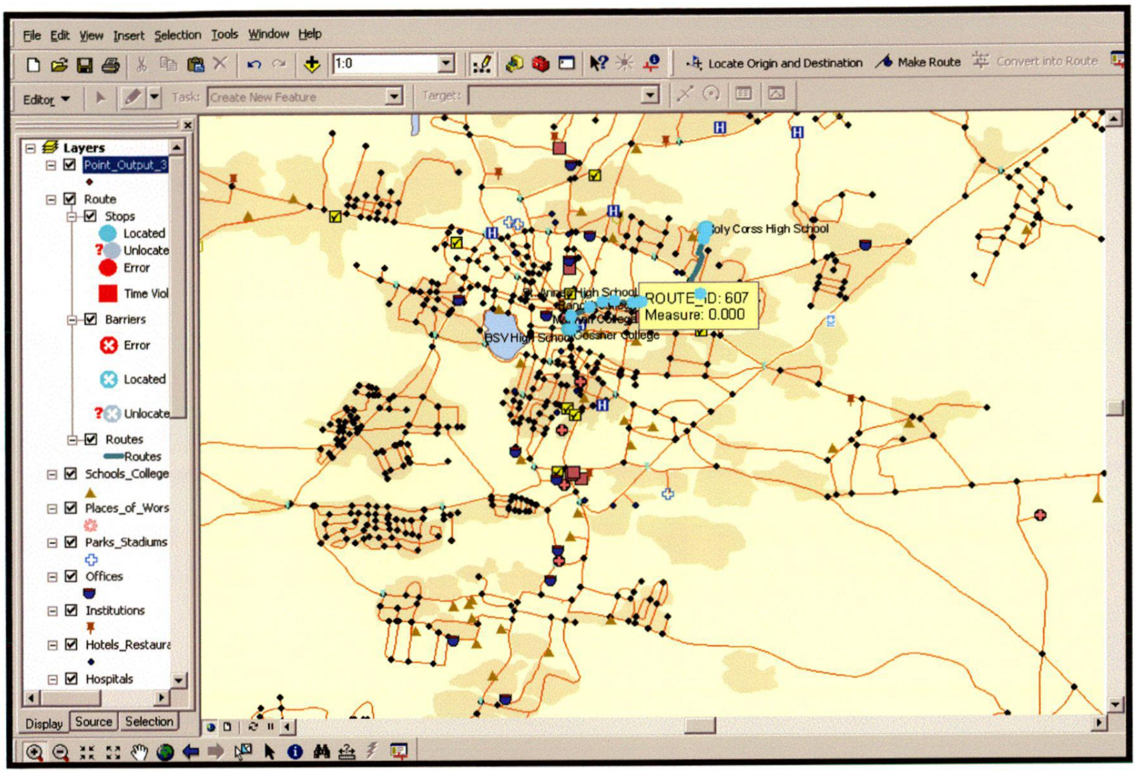


Fig. 26 Linear Referencing for Locating Route Events

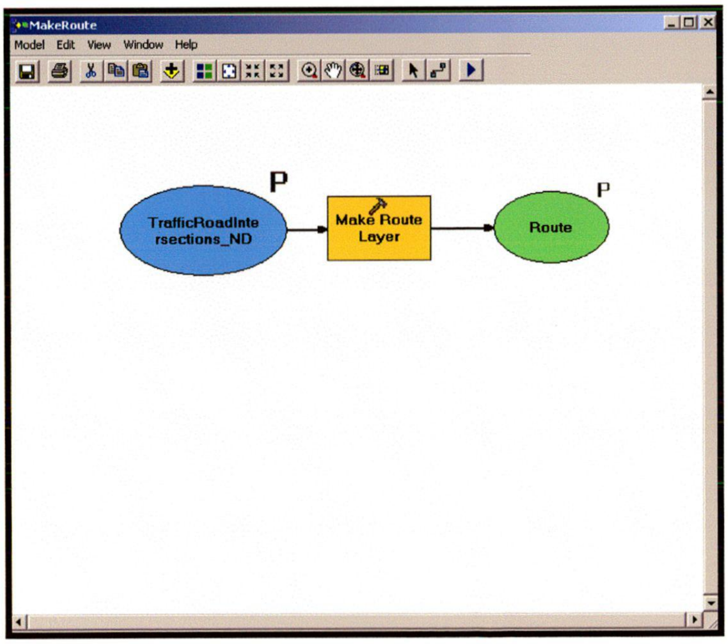


Fig. 27 Model Builder for Linear Referencing

of city has all educational facilities, major offices are located in this direction, and moreover most of the recreational facilities are also located in this area while other compact settlement has industrial area close to it as a result of which the connecting links between these two areas suffer high congestion. So road improvement techniques need to be implemented in this area.

4. There exists dispersed settlement in areas like Hinoo, Gosaintola, A G Colony, Kalyan Pur which indicates uneconomical use of land pattern and more consumption of Agricultural land which need to be prevented. This would also prevent the misuse and inefficient use of urban land along with abnormal growth of one urban centre on the cost of other two settlements.
5. As Ranchi City is rich in rivers and lakes, there has been no effort from the government side in relation with the environment improvement of river Harmu, such areas near rivers and lakes can be developed into recreational parks from which the government can generate income and revenue.
6. Areas rich in heritage should be conserved and they should be promoted as tourist development centres especially Rnachi Hills area.
7. There should be relocation of market areas like whole sale markets, vegetable mandi from highly congested areas.
8. As compared to population growth rate, rate at which development of infrastructure facilities and public utilities are taking place, is relatively slow.
9. There should be proposals regarding adequate management in areas like Urban Land Management, Institutional Coordination, Adequate finance, real estate development.
10. Growth Programmes like "Smart Growth" and "Special Economic Zones" need to be encouraged for efficient use of land especially in areas where there is scattered settlement exists.
11. Coordination between different agencies and different priorities by different departments should be felicitated for proper implementation of plan proposals efficiently.

6.3 Future Scope

Internet has become a competent technology for data communication due to distributing technology of the web servers. The data and maps reach to the people with the minimum system requirements at user end. Geographers and planners, who use map and related information traditionally to plan and manage, have found Internet technology of much use since it reduces the cost of data management and information distribution to mass usages. With the advent of GIS and Internet technologies, the conventional intricacies to get solutions in time and position have been improved.

If this system is further extended to Web GIS level it can be used for E-Governance by Government Authorities and secondly at web level even people can forward their opinions regarding the implementation of policies formulated in Master Plan which are generally prepared for the benefit of the people.

With the advent of information technology and modern day pressures on land, the fundamentals of public service delivery, demand, a new system more in sync with the problems of this age. Electronic Governance (EG), which started off with the computerisation of back office operations, has now gone beyond this basic feature. It has redefined the fundamentals of work and speed and intends to bring about a major change in how the Government operates not only in urban India but globally as well.

GIS has the potential to link data visually on a common denominator, analyse it and make predictions for the future. Maps for Master Plan are essential in Urban Planning and EG and through WEB-GIS they have the potential to revolutionize city governance.

Appendix (A)

Photographs of Ranchi City

APPENDIX (A)-PHOTOGRAPHS OF RANCHI CITY

Akka Chowk

Lalpur Chowk

Internet Resources

1. http://www.sierraclub.org/sprawl

2. http://www.vtsprawl.org/casestudies.htm

3. http://www.osc.edu/education/webed/Projects/urban_sprawl

4. http://www.sprawlcity.org/