CHAPTER - 1

INTRODUCTION
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1.0 BACK GROUND

Over the years, the road transport has come to occupy a dominant position in transport system due to its advantages in terms of easy availabilities, flexibility, speed and being open to public and private mode of transport alike. This has ability in accelerating the pace of modernization, putting the nation on the fast track of development and contributing to national integration. The complexities of building, managing and operating transport system efficiently and safely have outstripped the ability of past experience and professional judgment alone to provide solution. If a country is to satisfy the transport infrastructure demand in consonance to its development pace and operate the traffic with desired safety standards, decision must be based on more reliable, updated, relevant, easily accessible and affordable information. Better information guarantee better decision making capability but its absence surely precludes it (Vonderohe et al, 1993). Accurate and complete information is essential for today’s fast- paced decision-making processes (Martha et. al, 2005). This demand for information and underlying data requires new technology and approaches in which the transportation related spatio-temporal and other data should be identified, collected, stored, retrieved, managed, analyzed, shared and communicated among and within organization and presented. The data about transportation network-construction and preservation -transportation value and incidents, should be available at the click of mouse, to answer management inquiries on policy related question. The development in the field of information technology such as GIS, Expert System, Cellular Automata, Genetic Algorithm, Artificial Neural Network, World Wide Web, Internet, and Database Management System(such as Oracle, Microsoft SQL, and ESRI’s ArcSDE™ ) are especially relevant to the field of transportation engineering.

The rapid industrialization and liberalization in policy issues, the level of private auto ownership greatly increased in the areas of passenger transport and freight transport vehicles. Intercity and inter regional movements of people with low occupancy vehicles
and freight vehicles in rural region has endangered the safety and efficiency on road network. Though India has one percent of world motor vehicle population, it accounts for nearly 6 percent of world reported total road accidents as per Rajan (2005).

Due to rural area, there is the greater dispersal and lower density of households which has fostered growing private automobile dependency for mobility due to lower accessibility levels to public transportation.

It is likely that transportation related problems will be at forefront of private sector decision making and public sector debate as the world navigates through the twenty-first century. Our connected and crowded world requires efficient, responsive, and environmentally friendly transportation systems. The transportation decisions have enormous impacts on land, lives and life.

1.1 ROAD USERS MOVEMENT SCENARIO

Passengers are moved by various modes of transport world over. The passenger growth rates observed over years shows that passenger movement is shifting from railway to road transport (Vision 2021).

The road traffic generated due to road users in India has grown at a rate of 10 to 12 percent from year 1951 to 1990. The passenger and freight traffic during this period has grown from 26 to 80 percent and 11 to 60 percent respectively. In the third 20 years Road Development Plan, it is forecasted that the share of passenger movement and fright by road, in the year 2001 would be about 2000 billion passenger-km and 900 billion tonne-km respectively estimated based on the projected number of vehicle, their productivity and average occupancy/load carried is given in the Table 1.1.

During the last 200 years, world wide transport has grown much faster than population, economy and primary energy consumption. In 2000, people were traveling average of 40 km per person per day, which is 1000 times the mobility of people living in the year 1800. A trip rate of 1.2 is adopted to obtain trip production (Rao, 2003).
Over the last 25 years, the road vehicle stock grew by 130%, road vehicle-km grew by 160%, passenger aviation increased more than four fold and motor way infrastructure increased by 110% (OECD 1997). Activity growth in passenger-km and tonne-km has been the key constituent to the past energy demand growth in transportation.

**TABLE 1.1: ESTIMATED TRAFFIC MOVEMENT FOR THE YEAR 2000**

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>STUDY</th>
<th>PASSENGER MOVEMENT (BPK)</th>
<th>GOODS MOVEMENT (BTK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RITES study, 1998</td>
<td>1880</td>
<td>1136</td>
</tr>
<tr>
<td>2</td>
<td>Lucknow Plan, 1984</td>
<td>2152</td>
<td>1004</td>
</tr>
<tr>
<td>3</td>
<td>MORT&amp;H : Study on estimation of total road transport in the year 2000</td>
<td>3000-4000</td>
<td>600-1000</td>
</tr>
<tr>
<td>4</td>
<td>Vehicle fleet modernization study, 1998</td>
<td>2300-3800</td>
<td>800-1030</td>
</tr>
<tr>
<td>5</td>
<td>Steering committee on perspective planning for transport 1988</td>
<td>2400-4000</td>
<td>540-900</td>
</tr>
<tr>
<td>6</td>
<td>India infrastructure report 1996</td>
<td>3000</td>
<td>800</td>
</tr>
</tbody>
</table>

BPK: billion passenger km, BTK: billion tonne km.

Source: MORT&H (2001), Road Development Plan Vision: 2021

At present, the share of road transport in passenger and freight movement is 80 and rail share is 20 percent respectively. The length of primary road network (NE, NH), secondary network (SH, MDR) and tertiary (ODR +VR +Others) is given in Table 1.2.
TABLE 1.2 LENGTH OF PRIMARY ROAD NETWORK

<table>
<thead>
<tr>
<th>TYPE OF ROAD WAY</th>
<th>LENGTH, km</th>
<th>% LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Expressway( NE)</td>
<td>200</td>
<td>0.003</td>
</tr>
<tr>
<td>NH</td>
<td>65570</td>
<td>1.978</td>
</tr>
<tr>
<td>SH</td>
<td>128000</td>
<td>3.8626</td>
</tr>
<tr>
<td>MDR</td>
<td>470000</td>
<td>14.1832</td>
</tr>
<tr>
<td>ODR +VR +Others</td>
<td>2650000</td>
<td>79.9693</td>
</tr>
<tr>
<td>Total</td>
<td>3313770</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: MORT&H (2001), Road Development Plan Vision: 2021

1.1.1 PROBLEMS IN ROAD TRANSPORTATION

The growth of road traffic, i.e. number of vehicles has grown by 242.4 times from 0.3 million in 1951 to 72.72 million in 2004. But, during this period the total road network has increased from 0.4 million km to 3.3 million km in 2003-04. Number of passenger buses was 34000 in 1950-51, has increased to 767000 in 2003-04 (MoSRTH, 2005). The increase in road length is not consistent with increase in road traffic on the primary and secondary road system in the country. The National Highway (NH) System, which is main arterial transport system for regional transportation in the country, constitutes (5.5% in 1950-51) about 2 percent and it carries about 40 percent of total road traffic. The existing road network in the country is therefore inadequate to carry road users and freight traffic. The road network problems are discussed below.

1.1.1.1 DEFICIENT ROAD NETWORK (QUANTITY AND QUALITY)

India's economy is in a better shape, to surge again, but the road network is not in good health to provide desired level of service and related benefits to road users. The deficiencies in the road network are inadequate length of primary road network, congested corridors, deficient geometric design, weak road section, poor riding quality,
distressed bridges and cross drainage structure and lack of bypasses around cities and towns, etc. In 1947 the National Highway constituted about 5.5 percent of total road length in country which has come down to about 2 percent at present. This established the fact that the National Highway Network, which is major mobility provider to road users at regional level, has been neglected. As per the third 20 year road development plan the total length of National Highway should be 66000km by the year 2001 and according to Road Development plan vision : 2021, the length should be at 71000km. The present National Highway length of primary road system is inadequate and is need to expand it in the country. Most of existing the primary road sections, (NH) in the country, is congested, leading increased travel time. About the width of existing road network, the present scenario is given in table below.

TABLE 1.3 CAPACITY OF PRIMARY ROAD NETWORK

<table>
<thead>
<tr>
<th>WIDTH OF CARRIAGE-WAY</th>
<th>NATIONAL HIGHWAY</th>
<th>STATE HIGHWAY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LENGTH, PERCENT</td>
<td>LENGTH, PERCENT</td>
<td>LENGTH, PERCENT</td>
</tr>
<tr>
<td></td>
<td>km</td>
<td>km</td>
<td>km</td>
</tr>
<tr>
<td>Four-lane</td>
<td>1000 02</td>
<td>1000 01</td>
<td>2000 1</td>
</tr>
<tr>
<td>Two-lane</td>
<td>24000 59</td>
<td>27000 22</td>
<td>61000 34</td>
</tr>
<tr>
<td>One-lane</td>
<td>22700 39</td>
<td>96300 77</td>
<td>119000 65</td>
</tr>
<tr>
<td></td>
<td>57700 100</td>
<td>124300 100</td>
<td>182000 100</td>
</tr>
</tbody>
</table>

Source: MORT&H (2001), Road Development Plan Vision: 2021

The data shows that 65% of road network is single lane. The two lane road network can carry traffic volume upto 15000 PCU/day. But traffic volume on such road exceeds 35000 PCU/day. This reflects the inadequacy of the primary road network.

The structural strength and rigidity quality of existing roadway system is poor. Due to this vehicle operating cost (VOC) increases and premature failure of pavement
occurs. As per the statistics available, the vehicle operating cost comprising of consumption of fuel, tyres, spare parts and cost of wear and tear, crew cost and accidents comes to Rs.100000 million per annum (Singh,1999). About 15% of which can be easily saved by scientific planning, good construction practices and adequate maintenance of the pavement system.

There are several bridges /cross drainage structures on the existing road network in the country, having narrow width and limited load carrying capacity. About 7000 bridges are on NH network and many times more on lower categories (SH, MDR, ODR & VR) of roads in the country.

Large numbers of bridges showing signs of distress are in the age group of 25-30 years, requiring major rehabilitation works, and this number will increase in years to come. It is necessary to plan for systematic inspection of all CD works, diagnosis of ill-health and formulation of remedial strategies for execution on a defined time frame. The spatio-temporal data should be available to the concerned organizations for decision making.

The ribbon development along major roads reduces the capacity of the road and necessitates demand for bypass. Unregulated ribbon development growth creates alarming situation near towns and cities, affecting level of service of highways, leading to loss of comfort, increased congestion, reduced speed and a high accident rate.

1.1.1.2 HIGHWAY SAFETY

The transportation demand growth is at faster pace than the network capacity. Rapid increase in demand for transport especially road transportation is world wide scenario. Both in developed and developing countries increased vehicle population has put pressure on existing highway network.

In road transport, the number of fatalities has increased from 15000 in 1971 to 80000 in 2000, while our share in world vehicle population is around 1 percent, corresponding share in respect of fatalities is 9 percent. An international comparison of accident rates indicate that about 45 persons are killed in India per 1000 registered motor vehicles, whereas the rate is generally as low as 3 to 5 in most of the developed countries (Bhagat,2008).
In India there is an accident in every second minute and a fatality on road on every 9th minute. About 25 percent of deaths in hospitals in the productivity age group (18-65 years) are on account of road accident injuries (Mohan 1996). One of the main reasons behind this grim situation of road safety in the country can be attributed to inadequate road system in terms of quality and quantity. The other important factors are mixed traffic conditions on roads and lack of identification and removal of accident black spot from the road network. Roads with well designed features, proper maintenance, education, and enforcement are important factors for safe transport operations. Adoption of high occupancy vehicles will reduce low occupancy traffic and help to improve safety.

1.1.2 EXISTING PRACTICE OF REGIONAL PASSENGER TRANSPORT PLANNING AND MANAGEMENT

Mohenjo-Daro and Harappa have revealed the existence of roads in as early as 25 to 35 centuries B.C. These roads were planned for administrative and military purposes. The rules for thickness of pavement for different purposes have been mentioned in “Arthashastra by Kautilya”. Prior to the introduction of railways, numbers of trunk roads were metalled, and bridges were provided. In 1865, Lord Dalhousie, as Governor General, formed the public works department and constructed grant trunk road.

Chamber of Legislature in 1927 appointed M.R.Jaykar as chairman of Indian road development committee. The committed decided the roads as national interest, recommended formation of Central Road Fund (CRF) and technical body to collect and emit knowledge –Indian Roads Congress (IRC), and Central Road Research Institute – (CRRI).

Motor Vehicle Act 1939 was brought into effect by Government of India, which covered control of driver, vehicle ownership and vehicle operation on road and traffic stream. The M.V. Act has been revised in 1988, along with Motor Vehicle Rules 1989.

Planned road development programme was initiated during a conference of chief engineers of all states and the work carried out by IRC as the first twenty years road development plan 1942-1963 i.e. Nagpur Plan. The plan has given location and function based classification as National Highway (NH), State Highway (SH), Major
District Road (MDR), Other District Road (ODR), and Village Road (VR) and also fixed
the responsibility of construction and maintenance of various roads with different
agencies. The second twenty year road development plan 1961-1981, was initiated by
IRC and finalized at the meeting of Chief Engineers in 1959 at Bombay and is known as
Bombay Road Plan.

The length of road has been fixed based on area or population and production
both. This is based on concept of saturation system based on U.S. system of highway
planning, which considers population and productivity units for the road network. Star
and grid pattern was assumed for finalizing formula to calculate length.

The third twenty year road development plan, 1981-2001 (also known as
Lucknow Road Plan), considered population, area, and numbers of towns for calculating
length of various types of roads at National, State, District and Tehsil levels. The new
system of road classification was adopted as primary road system (NE, NH), secondary
system (SH, MDR), and tertiary system or rural roads (ODR, VR).

The effort of planning of road network is based on population, production in
industry and agriculture. The mobility of persons/travelers/passenger and consumption
pattern are not considered. Vehicle occupancy and carrying capacity can optimize road
network. Intelligent Transportation System (ITS) can provide efficient and safe traffic
operation without increasing length or width of road network. The attempt has been made
to evaluate traveler's mobility in terms of trips/person and trips/HH. The passenger
vehicle occupancy of different modes are calculated from surveys at sites.

The evolution of transportation in general and public transportation in particular
belongs to adoption of internal combustion engine to motorized transportation. The motor
bus began to make inwards into the electric street car market around 1920 (Popacostas
and Prevedouros, 2002). The same technology marked the beginning of buses and public
transportation in general. The source of this demise was the private automobile, which
attracted patronage from public transportation systems. To add insult to injury, a few
entrepreneurs even began to use their automobiles to offer competing hire services by
seeking customers at transit stops.

Despite efforts, the ridership of central city buses and intercity and regional
buses has been declining due to increasing automobile ownership and operation of
intermediate para transit (IPTs), leading increased traffic volumes, reduced speeds, and higher accident rates on regional roads.

1.1.3 REQUIREMENT OF DATABASE

Transportation is data intensive activity. Data are generated exponentially. The problems in planning, execution, operation, maintenance, and management of transportation activities, the basic requirement are large volume of data. Presently the major hurdle in the above activity is the lack of availability of large volume of data required, if made available, the next problem will be how to manage and access that data. The valuable information is scattered all over the country with different authorities/organizations. The attribute data of Expressway, N.H., S.H., and M.D.R. network is available in pieces, in different parts of the state level system, and some O.D.R. and V.R. data are made available after execution of PMGSY project. These data are not utilized (or rarely utilized) effectively by the decision makers - planners, designers, or transporters. At present any exercise on sufficiency of existing road network required for movement of passengers and freight in regional context or producing national plans for introducing new expressways, upgrading N.H., S.H. can not use any of existing data. Thus, practically available data, at a large number of locations in all possible formats, are the highly underutilized, and therefore draining on the economy as a routine ritual without fulfilling the objective.

Database and database technology (Elmasari and Navathe, 2003) are having major impact on growing use of computers. The database coupled with GIS, ANN, GA and data mining tools helps to reduce cost and obtain better knowledge for decision makers.

1.2 INFORMATION TECHNOLOGY IN HIGHWAY TRANSPORTATION

The 20th century is characterized by the industrial revolution, and the 21st century of globalization is an era of information, communication and entertainment (ICE). The
today’s world is world of information due to advances in information technology (IT). According to Miller, et al. (2001) in many parts of the world, mobility has vastly improved over the past century. Increasing mobility combined with urbanization and rapid population growth is creating undesirable negative impacts on economies and individual quality of life. In 1995, commuters in the United States spent more than 2 billion hours in traffic jams, generating US $ 100 billion in lost productivity (USDOT 1998). In 1996, 41,907 people were killed and another 3.5 million were injured in United States due to automobile accident (USDOT 1999). In Japan, over 10,000 people die in traffic accidents each year, about 5.6 billion person hours were spent in traffic congestion. Economic losses due to traffic congestion in urban areas amounted to 12 trillion yen per year (Japanese Ministry of Construction, 1996).

Conventional approaches to tackling problems associated with transportation congestion attempt to increase transportation supply by building new highways and widening existing roads. This enhances land use, again falling in the same problem. Alternative approach is use of information technology in transportation, which is called intelligent transportation systems (ITS). ITS are integrated information technologies for monitoring and influencing a land use/transportation system through direct control (e.g. traffic signals) or indirect persuasion (Variable Message Signage, Web pages). Rather than increasing supply, ITS improves system efficiency through the use of advanced computing, real time data sensors and communication technologies. The objective is to make transportation systems efficient, safer and environment friendly. The ITS architecture subsystems and communication elements are presented in Fig.1.1 to have overview of the system.

1.3 GIS TECHNOLOGY

GIS is relatively new branch of information technology, one of the fastest growing and rapidly changing technology of modern time (Lo and Yeung, 2006). It is emerged as a powerful and sophisticated means to manage vast amount of spatial and non-spatial data. GIS is multidisciplinary science, has grown out of number of
technologies, including cartographic information management, computer science, photogrammetry and remote sensing. The development of GIS was greatly accelerated by the phenomenal growth of computer technology in 1990s. With advances in operating systems, computer graphics, database management systems, computer human interaction and graphical user interface (GUI) design, GIS become multiplatform applications that run on different classes of computers as stand alone applications and as time sharing system and also on world wide web.

The GIS technology consists of computer software and hardware designed to organize spatial and non-spatial data for analysis, assessment and cartographic depiction. GIS can be divided into four components, namely, data, technology, application and people.

The **data component** of GIS is location and characteristics of natural features or human activities that occur on or near Earth’s surface. The digital geographic database data are represented by three basic forms: Vector, Raster and Surface. The data can be analyzed into two or three dimensions. The data component is more concerned with data sharing, quality and standards; rather than with data creation, structure and types. The information about geographic data set - i.e. metadata is available with data.

**GIS technology component** is software and hardware. The hardware of GIS is made up of a configuration of core and peripheral equipments that is used for the acquisition, storage, analysis and display of geographic information. Depending on the data processing power of CPU - personal computer, work stations, mini-computers and super computers - stand alone or in client/server architecture work as the dominant hardware platform for GIS.

On the software side, until late 1990s, the geo-relational data model was norm for GIS implementation. Following the thrust of the computer industry toward the use of object oriented technologies, GIS is based on object relational model which stores both graphical and descriptive data to be stored in a single database. The tool box approach in software design and construction helps to provide GIS with a set of core software tools for standard geographic data processing and analysis.
SAFE AND EFFICIENT REGIONAL ROAD USERS' MOVEMENT FOR GUJARAT STATE IN GIS ENVIRONMENT

FIG. 1.1 ITS ARCHITECTURE SUB SYSTEMS AND COMMUNICATION ELEMENTS
Source: LOCKHEED MARTIN FEDERAL SYSTEMS 1998
The **applications component** can be explained from three perspectives: area of applications, nature of applications and approaches of implementations. When GIS was first developed, it had a relatively narrow focus on land and resource management. Today, GIS are used in all sectors of the economy and for applications pertaining to both Earth's natural resources and human activities. The advent of the internet has fundamentally revolutionized the nature of GIS applications. The internet as a computer network of an internation computer network of networks logically consisting of millions of millions of academic, military, government, and commercial computers in cooperative collaboration by using different protocols of WWW and file transfer protocol (FTP), GIS have now become a virtual global system that offers all kinds of geographic information and knowledge as well (Harder 1998).

According to Monica Pratt (2006), the GeoWeb, the synergistic integration of GIS and Web comes at a time when the world is facing greater challenges than ever from disease, disaster, environmental degradation, and economic distress. Addressing these problem will require more resources in data and collective intelligence than can be mustered by individual organizations. The GeoWeb present a tremendous opportunity for helping build cooperation on a scale sufficient to help world evolve in a sustained way.

The spectacular growth of GIS that began in 1990s, has resulted in a GIS user community-initially in application and cartographic communications (Mark, 1993, Turk, 1993), presently user aspects of human factor in GIS development (Burrough and Frank,1995;Nyerges, 1993) classifying users into viewers, general users and GIS specialists as shown in Fig.1.2.
1.3.1 GIS FOR TRANSPORTATION (GIS-T)

Transport problems are getting more and more dynamic due to changes in our complex social, economical and physical world (Dueker, 2000). Transport researchers and managers around the world have been under increasing pressure to improve understanding about these changes and act efficiently to make decisions in transportation field considering the data and knowledge generated due to spatio-temporal and socio-economic changes. The range of models that need to be employed has expanded rapidly and the integration of transport models and technologies such as GIS has become major requirement in process of transport planning.

GIS are proving to be effective in integrating the data needed to support transport modeling and data management. The term GIS-T, which stands for GIS for transportation, emerged in the 1990s. GIS and transportation have been developed as two independent systems originated from the two disciplines: geography and transportation. The transportation systems are extended with capabilities to cover GIS-type functions;
and GIS is extended for use in transportation area. GIS-T supports a broad range of applications levels (planning and operations) and areas of management (facility management and fleet management).

Planning applications are characterized by a low level of accuracy that needs to be updated or forecasted infrequently, whereas operational systems are characterized by real-time data needs and high level of spatial accuracy so that vehicle operation can be related to the correct road ramp or lane represented in the database. The Table 1.4 illustrates the kinds of planning and operations in GIS-T functional framework.

**TABLE 1.4 GIS-T FUNCTIONAL FRAMEWORK**

<table>
<thead>
<tr>
<th>Planning systems</th>
<th>Transportation planning</th>
<th>Logistic planning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geocode and allocate activities</td>
<td>Analysis of demand and resources</td>
</tr>
<tr>
<td></td>
<td>Inter zonal travel flows</td>
<td>Design of route systems and location analysis of depots or warehouses</td>
</tr>
<tr>
<td></td>
<td>Visualization of traffic flows on network</td>
<td>Visualization of system plans</td>
</tr>
<tr>
<td>Project</td>
<td>Environmental impact analysis</td>
<td>Service planning</td>
</tr>
<tr>
<td></td>
<td>Digital mapping</td>
<td>Analysis of individual routes and depots</td>
</tr>
<tr>
<td></td>
<td>Engineering design at workstation</td>
<td>Visualization of service plans</td>
</tr>
<tr>
<td></td>
<td>Environmental impact estimates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visualization of design impacts</td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>Traffic and safety analysis</td>
<td>Scheduling</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Aggregate data by location and time periods</td>
<td>Analysis of on-time performance for revised schedules and work rules</td>
</tr>
<tr>
<td></td>
<td>Statistical analysis</td>
<td>Visualization of revised schedules</td>
</tr>
<tr>
<td></td>
<td>Display and animation</td>
<td></td>
</tr>
<tr>
<td>Real-time</td>
<td>Intelligent transportation systems</td>
<td>Vehicle navigation and commercial-vehicle dispatch</td>
</tr>
<tr>
<td>Operations and control</td>
<td>Display traffic flows in real-time</td>
<td>Minimum path routing</td>
</tr>
<tr>
<td></td>
<td>Incident response</td>
<td>Routing with dynamic travel-time data</td>
</tr>
<tr>
<td></td>
<td>Manage ramps and signals</td>
<td>Visualization of routings</td>
</tr>
</tbody>
</table>

Source: Hensher and Button, 2002
1.3.2 TransCAD

TransCAD software is a revolutionary system for transportation data management and analysis. TransCAD fully integrates Geographical Information System (GIS) with planning, modeling and logistic operations (TransCAD 2000). It can be used for digital mapping, geographic database management and presentation graphics and operation research and statistical models in transportation. Advanced geoprocessing capabilities support spatial queries, polygon overlay and multi-band buffering. It is ideal for highway network, transit routing and planning operations, inventory and facility management, accident reporting and analysis, pavement management, maintenance planning, demand modeling and forecasting, environmental impact assessment, regulatory and policy analysis, distribution planning and emergency management. TransCAD has been selected as the GIS-T software package in present study due to availability for developing and testing new analytical procedures with complete development of decision support systems.

1.3.3 Arc GIS AND Arc NETWORK ANALYST

Arc GIS is ESRI’s premier GIS software. This software is used for any GIS job at any scale of complexity, from conducting a single analysis to implementing vast, multi-user, enterprise wide project work. Arc GIS has different application modules - the basic among them are Arc Catalog, Arc Map and Arc Toolbox. Arc Catalog is the application for managing spatial data housing, database designs and recording, and viewing metadata. Arc Map is used for all mapping and editing tasks as well as for map based analysis. Toolbox is used for data conversion and geoprocessing. Using these three applications together simple to advanced, including mapping, data management, geographic analysis, data editing, any GIS task can be performed.

Arc View provides comprehensive mapping and analysis tools, along with simple editing and geoprocessing tools. Arc Toolbox for Arc View, Arc Editor contains more than 20 commonly used tools for data conversion and management.

For use of spatial data, drawings created in Auto CAD are imported in to Arc View and converted to shape files using conversion tool. The shape files can be exported to TransCAD for further analysis.
1.4 NEED OF PRESENT STUDY

The road network is the responsibility of the State and Central Public Works Department (PWD), as the custodian of India's 3.3 million kilometers of road network, has an enormous responsibility to maintain, develop and improve them. This is absolute necessity, because the roads as the most basic transportation network, is major force to activate the nation's economy. To become developed nation and have world class economy it must be supported by comparable world class network in India. Geographical Information System (GIS) stores the road network with the attributes like length of road segments, number of lanes, traffic volume, capacity, cost of construction and maintenance, riding quality and pavement data. This helps to identify congested segments in road network and poor riding quality stretches to decision makers. The SRTUs can view route network and load factors on various segments. The data mapping tools help to map location of accidents and decide site of promise/black-spots. This helps to improve road users' safety. For PWD and SRTUs and all road users to be effective in any of their activities, the activities have to be integrated with spatial information technology i.e. GIS. Road traffic safety and efficiency are interconnected issues. The GIS helps both operators and decision makers with database integrated with maps which needs developments of methodology and database.

1.5 RESEARCH OBJECTIVES

Considering the problem of safe and efficient regional road users' movement for Gujarat State in GIS Environment there are following broad research objectives.

1. Creation of GIS database for the regional transportation analysis Zone (TAZs) and road network.
2. To develop methodology for estimation of trip rates (trips/HH and trips/person) and total trips for the study region based on socio-economic parameters.
3. Development of GIS based procedures for preparing, planning and monitoring strategy for regional road users' movement.
5. Accident Analysis in the study region using the GIS database developed.
1.6 SCOPE OF WORK

The scope of work includes:
1. Literature review of related concepts, methodology, case studies and methodologies adopted for similar studies.
2. Creation of database for District of Anand which includes Transportation Analysis Zones (TAZs), Road Network, Bus Depots and GIS database for Gujarat State including Districts, Ports and Airports. This includes map registration, digitization and populating the database.
3. Design of questionnaires, training of interviewers and implementation of surveys.
4. Coding of survey data into SPSS software and computing the socio-economic parameters and trip rates.
5. Deriving Trip Generation equations for purpose based trips for District of Anand using TransCAD tools.
6. Extraction of O-D Matrix from sampled data and expanding the same for population size.
7. Creating desirelines for decision making process.
8. Developing methodology for person trips to passenger car units (PTPCUs) and calculating PTPCUs for various modes.
9. Collecting accident data and coding for GIS based analysis.
10. Analyzing the accident data for black-spot identification and presenting into maps.

1.7 RESEARCH METHODOLOGY

The research methodology can be divided into three main phases:
1. Problem identification.
2. Framework formulation.
3. Completed framework phase.

Each phase includes several steps to achieve the objectives of this particular phase.
FIG. 1.3 FLOW DIAGRAM OF RESEARCH METHODOLOGY
1.8 DISSERTATION STRUCTURE

This dissertation is organized into nine chapters. Chapter one introduces the background, states the problems and formulates the research problem, specifies the research objectives and significance, and introduces the research methodology. The Chapter two lays necessary background about GIS database modeling, and database modeling and database created for study area. Chapter three describes the study area characteristics and zoning development. Chapter four develops data collection methodology for primary data collection, sampling, questionnaire design and analysis using SPSS software. Chapter five presents development of O-D matrices after reviewing the related case studies and estimates base year and horizon year O-D demands. The Person Trips to Passenger Car Unit conversion factors are developed. Chapter six develops trip generation equations modal trip conversion methodology and presents future trip scenarios. Traffic assignment is carried out on SH and NH network. Alternatively traffic projections are done on network based on national growth rates and IRC:108 method based growth rates and links are identified for capacity augmentation and improvement based on ranking on volume capacity ratios. Chapter seven describes inventory management and pavement improvement study. Chapter eight describes linear referencing methodology in crash recording and identification of black-spots on NH8 stretch. Chapter nine presents summary, conclusions of the research contributions, and suggests recommendations. Lastly relevant references are recorded. There is no separate chapter on literature review but important studies reported in textbooks, journals, conferences, etc. in the context of present study are presented at appropriate locations in different chapters.