

# ROAD SAFETY MANAGEMENT - APPLICATION OF ADVANCED TECHNIQUES AND EQUIPMENTS IN INDIA

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## ABSTRACT

*Road Traffic Accidents (RTAs) are the major cause of worry around the world as more than 1.2 million people die in road accidents each year. An additional of 20 to 50 millions is injured or permanently disabled [1]. Moreover, in low-and middle income countries, the rate of Road Traffic Incidents is twice as high as in developed nations. Road Traffic Accidents (RTAs) had consumed about 140000 invaluable lives in India in the year 2011. An average there is one road accident every minute and as per the statistics there is one death on the Indian road every four minutes and this is expected to escalate to one death every three minutes by 2020, an alarming figure that is really hard to digest. This paper analyse the application of latest technologies in Road Safety Management in India .*

**KEY WORDS:** Road Traffic Accidents, Road Management System (RMS), Road Measurement Data Acquisition System (ROMDAS), Advance Data Collection Equipment (ADCE), Road Accident Data Management System (RADMS), Geographic Information System (GIS), Global Positioning System(GPS), ePathai .

## 1. INTRODUCTION

Every day around the world, almost 16000 people die from all types of injuries. Injuries represent 12% of the global burden of disease, the third most important cause of overall mortality and the main cause of death among 20–40-year-olds [2]. The category of injuries worldwide is dominated by those incurred in road crashes. According to World Health Organization data, deaths from road traffic injuries account for around 25% of all deaths from injury [3].

Road Traffic Accidents (RTAs) are one of the leading causes of fatalities all over the world and the maximum number of fatalities occur in India every year i.e., around 140000 per year [4]. India contributes to eight percent fatalities with only one percent of vehicle population [5]. National crime records Bureau statistics show 15 people die in our country every hour due to RTAs. The average cost of RTAs in India is approximately 12.5 billion dollars (Rs.7 lakh crores). This does not include the economic burden of permanent disability of more than 10 lakh people who survive major accidents every year. 85 % of the victims of these fatalities are men in the age group 20-40 years. Majority of these men are the bread- winners for their families. At present the death on the roads account for twice more than the death in India by the combination of all serious diseases like HIV, Malaria, Cholera etc all put together. A developing country like India can scarcely afford the financial and social burden of road traffic accidents of this proportion.

The preventive/safety measures adopted to prevent Road Traffic Accidents (RTAs) are generally in combination of more than one concept or technology/device, as the situation of accident itself is complex in nature. In the computerised world, there are so many advancements in every field. So the latest technologies need to be applied, the latest equipments shall be used to prevent of road accidents. This should be interlinked with our day to day work and applications effectively. This paper throws some light on the latest application by different Organization in India, in this direction.

## 2. ROAD ACCIDENT IN INDIA – FACTS AND FIGURES

Road accident is an accident (collision ,overturning or slipping) which occur or originate on a road open to public traffic resulting in either injury or loss of life or damage to property in which at least one moving vehicle was involved. A total 3,90,884 accidental deaths were reported in the country during the year 2011 [6]. The major un-natural causes of accidental deaths were (i) 'Road Accidents' (37.3%), (ii) 'Railway Accidents and Rail-Road Accidents' (7.6%), (iii) 'Poisoning' (8.0%), (iv) 'Drowning' (8.1%), (v) 'Sudden Deaths' (7.3%) and (vi) 'Fire Accidents' (6.7%).

A total of 4,73,084 ‘Traffic Accidents’ were reported during the year comprising 4,40,123. ‘Road Accidents’, 2,385 ‘Rail-Road Accidents’ and 30,576 ‘Other Railway Accidents’. Deaths due to ‘Road Accidents’ in the country have increased by 2.2% during 2011 over 2010.

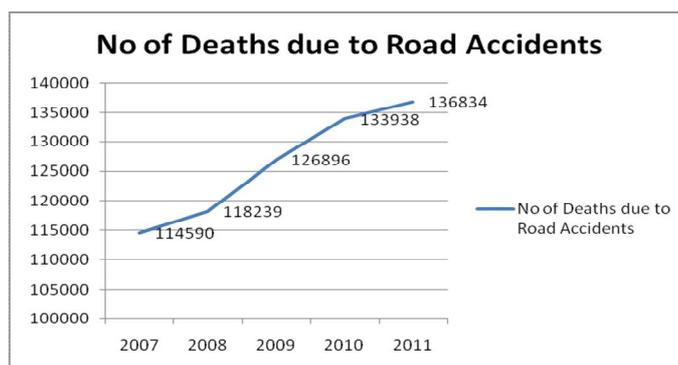
There are about 375 Deaths per day and 1284 injuries per day due to Road Accidents in India. The state of Tamil Nadu has reported the maximum number (65,873) of ‘Road Accidents’ accounting for 15.0% of such accidents in the country.

**2.1 FATAL ROAD ACCIDENTS**

Number of fatalities due to Road Accidents is on the raise every year. From 114590 deaths in the year 2007 had gone up to 136834 in the year 2011. This is shown Table 1 and Figure 1.

**Table 1: SHARE OF "ROAD ACCIDENT DEATHS" IN TOTAL "ACCIDENTAL DEATHS" BY UNNATURAL CAUSES IN INDIA DURING 2001-2011**

Sl. No	Year	No of Accidental deaths		Percentage of Road Accidental deaths in Unnatural Total Deaths
		Road Accidents	Total Unnatural	
1	2007	114590	315641	36.30
2	2008	118239	318316	37.10
3	2009	126896	334766	37.90
4	2010	133938	359583	37.20
5	2011	136834	367196	37.30



**Figure 1:**

Tamil Nadu, Maharashtra, Karnataka, Andhra Pradesh and Kerala have accounted for 15.0%, 10.7%, 10.2%, 9.3% and 8.0% respectively of total ‘Road Accident’ deaths in the country. And thus Tamil Nadu stands first, not an achievement we could be so proud of. In the same way Chennai tops in the number of fatalities per lakh in all the four metros. This is shown in Table 2.

**Table 2: RATE OF ACCIDENTAL DEATHS IN METROPOLITAN CITIES DURING 2011**

Sl.No	City	Population (in Lakhs)	Share of population in cities (Percent)	Share of Death in Cities(Percent)	Rate (No of Deaths per one Lakh population)
1	Chennai	87	4.4	6.8	49.1
2	Delhi	163.2	10.1	12.1	46.4
3	Kolkatta	141.1	8.8	1.4	6.1
4	Mumbai	184.1	11.4	12.5	42.4

**3. DECADE OF ACTION FOR ROAD SAFETY 2011-2020**

World Health Organization’s , first ever Global Status Report on Road Safety[7] reveals that 90% of deaths on the world’s roads occur in low and middle income countries (21.5 and 19.5 per lakh of population, respectively) though they have just 48% of all registered vehicles. India has the second largest road network in the world with over 3 million km of roads of which 60% are paved. These roads make a vital contribution to the India’s economy. According to a government report, road accidents in India killed 1,36,834 people in 2011 (an average of 375 a day).

The Year 2011 was marked by the Launch on 11 May 2011 of the UN Decade of Action(2011-2020) for Road Safety. For this occasion, the UN Secretary General, Mr. Ban Ki-moon, called on UN Member states, international agencies, civil society organisations, businesses and community leaders to ensure that the Decade leads to real improvement, and recommended governments to develop national action plans for 2011-2020. On this direction the Indian Government is taking so many actions to counter the ever increasing Road Accidental fatalities.

#### **4. ROAD SAFETY MEASURES**

To Device a suitable system/device, it is always suggestible to undertake a detailed study involving collection, compilation of data pertaining to accidents. The data so collected, at periodical intervals has to be analysed, so that the cause of the accident occurrence is known. The factors causing such an accident/(s) , shall be enumerated and weighed based on their level of contribution, to the accident occurrence. After an Integrated Comprehensive analysis, using computer aided software such as Geographical Information System (G.I.S.), which is capable of handling huge volume of spatial (map-like) and non-spatial (attribute) information, the application of exact technique/technology can be decided. Such a methodology always optimised the solutions and gives better results.

The Road Safety measures includes

- Devices,
- Techniques/Technologies,
- Engineering Design/Principles/Concepts,
- Imparting Education/Training on safety rules/codes/awareness,
- Strict Enforcement of safety measures and punishing the offenders/violators of safety codes/rules etc.,

The above measures most often may have to be employed in combination, as the situation may warrant. The advanced technologies and equipments such as Global Positioning System (G.P.S.), use of computer-assisted Geographical Information System (G.I.S.) network analysis, corridor analysis, Using advanced computer system including Hardware and Software to record, retrieve and analyse the accident data input into the computers etc., shall go in a long-way in reducing the rate of accidents

#### **5. APPLICATION OF ADVANCED TECHNIQUES - INITIATIVES BY DIFFERENT STATES IN INDIA - FOCUS ON TAMILNADU STATE**

With the advent of New Technology and increasing vehicular population, occurrence of Accidents have become almost inevitable and the number of accidents are increasing day by day, taking toll of more human lives equally or at times more than any natural catastrophe. The increasing rate of accidents is a real problem, that has to be tackled in real-time, by drawing up of a comprehensive action plan, involving various components of Traffic Engineering Measures, Enforcement Action plans, Educational tools/techniques, which needs co-ordination of more than one agencies/techniques/concepts.

The State of Tamil Nadu with had pioneered in application of advanced technology in various fields ,through the Highways department had made better utilization of the new technologies and equipments like Global Positioning System (GPS),Geographic Information System, advanced equipments like Road Measurement Data Acquisition System (ROMDAS) with its software ,Advanced Data Collection equipments (ADCE) and Road Accident Data Management Systems(RADMS), to collect, interpret ,analyse and manage the condition of road network .And through RADMS collect accident data continuously to spot the black spots where frequent road accidents occur and analyse and find suitable solutions.

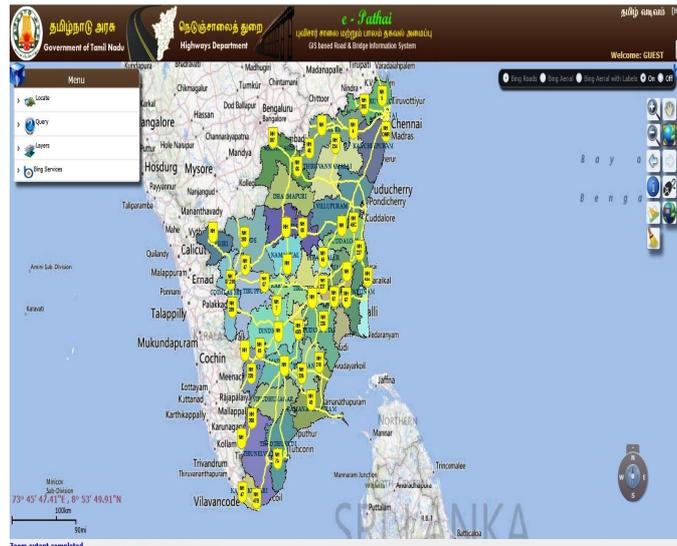
##### **5.1. e-PATHAI GIS BASED ROAD AND BRIDGE INFORMATION SYSTEM**

'e-pathai,' [8] is an electronic management system, for better maintenance of 62,017 km of roads in the State. e-pathai is an electronic project, administration, traffic, highway assets and information management system. The Web-enabled project will have three parts – Geographical Information System, Project Financial Management System and Road Management System.

##### **Data about roads:**

The road management system (RMS) will contain data about roads, and the history of works on each road to enable the Highways Department to scientifically prioritise infrastructural work to be taken up and to work out the funds required for execution.

The GIS application will give a pictorial representation of the entire road network and bridges with details of length, width and other details, which will be linked with the RMS history. The public can access the details online as well. The project financial management system, a work flow automation system, will revolutionise the way the Highways Department works. GIS will be integrated with the other two systems and the road accident data management system through the Highways Department using Tamil Nadu State Wide Area Network (TNSWAN).



**FIGURE 2**

### **5. 2. NEED FOR REPORTING ROAD SAFETY CASUALTIES**

A complete picture of casualty totals from road crashes is needed to fully assess the consequences of road crashes and monitor progress. Injury information should complement information on fatal crashes to give a fuller picture of road crashes. Information on injuries should become more important for international comparisons. Police data should remain the main source for road crash statistics. However, because of under-reporting problems and possible bias (for example, with differing rates of reporting by vehicle type), police data should be complemented by hospital data, which are the next most useful source.

### **5.3. GEOGRAPHIC INFORMATION SYSTEM**

Geographic information system (GIS)[9] is a system designed to capture, store, analyze, manage, and present all types of geographical data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology.

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared. GIS technology [10] can be integrated into any enterprise information system framework.

#### **What Can You Do with GIS?**

GIS gives us a new way to look at the world around us. With GIS you can:

- Map Where Things Are
- Map Quantities
- Map Densities
- Find What's Inside
- Find What's Nearby
- Map Change

### **5.4. GLOBAL POSITIONING SYSTEM (GPS)**

The Global Positioning System (GPS) is a space-based satellite navigation system [11] that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users around the world. It is freely accessible to anyone with a GPS receiver.

The GPS or Global Positioning System has become a very advanced technology. The main idea behind using this system is to find the location of the person, vehicle or an item. There are various benefits of using vehicle tracking GPS system. But in the view point of Road Safety Management, this can be effectively used to trace the vehicle involved in accidents accurately and take immediate recovery measures, like rushing the injured persons to the nearest trauma care centre within the Golden Hour which can save many lives. This will also be useful to trace the vehicle which caused the accidents and offending vehicles would be easily traced. For enabling all this possible, fixing a GPS enabled chip in every vehicle may be made mandatory.

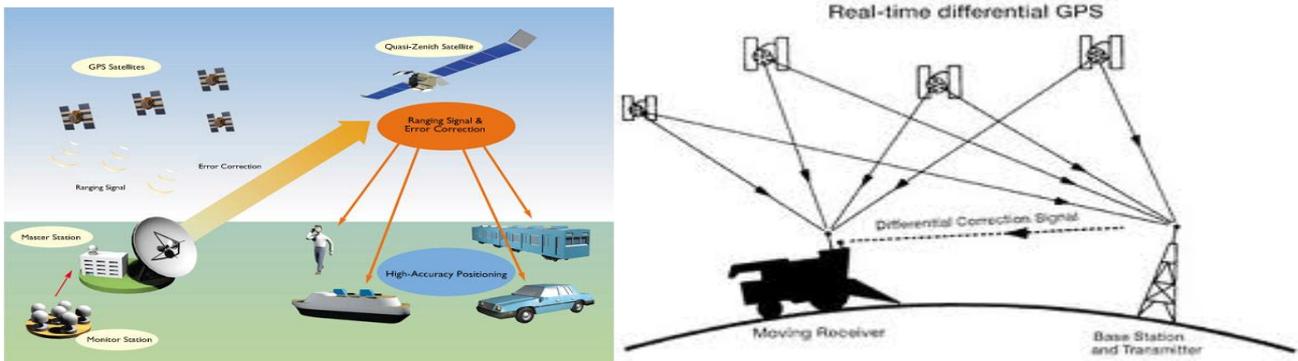


**FIGURE 3: GPS VEHICLE TRACKING SYSTEM**

#### **5.4.1. DIFFERENTIAL GLOBAL POSITIONING SYSTEM (DGPS)**

Differential Global Positioning System (DGPS) [12] is an enhancement to Global Positioning System that provides improved location accuracy, from the 15-meter nominal GPS accuracy to about 10 cm in case of the best implementations. DGPS uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. These stations broadcast the difference between the measured satellite pseudo ranges and actual (internally computed) pseudo ranges, and receiver stations may correct their pseudo ranges by the same amount. The digital correction signal is typically broadcast locally over ground-based transmitters of shorter range.

In the Advanced Data Collection Equipments the DGPS is used to collect the data of Road Network of Tamil Nadu Highways Department which is more advanced and naturally more accurate. This is being used at the e-Pathai a GIS enabled front end tool to map the road alignment with all roads furnishing including bridges, culverts, junctions etc., with details of various levels like District, Circle, M.L.A and M.P constituency. In this application the State of Karnataka had gone a step ahead where any road used can make complains about the pot holes or any other such defects by taking photographs which shall also have specific reference and send message or email to the concern authority and the authority should acknowledge the complaint and after rectification shall inform the same to the person who made the complaint.



**FIGURE 4: REAL TIME DIFFERENTIAL GPS**

#### **5.5. ROAD MEASUREMENT DATA ACQUISITION SYSTEM (ROMDAS) AND ADVANCED DATA COLLECTION EQUIPMENTS (ADCE)**

A better Engineering design, construction and proper maintenance of the road with a right blend of strict Enforcement and proper Education (awareness) of road safety rules, would certainly result in the reduction of accident rate. Over the last several decades ROMDAS has been a leader of integrating new data collection technologies and with over 200 units in use in over 60 countries, ROMDAS has a level of refinement rarely found in competing systems. For Construction and maintenance of the roads possessing a complete data about the total road network, frequent updates is inevitable. ROMDAS and ADCE [15] takes a long way ahead in obtaining good quality and almost all possible data about all the roads maintained by Highways Department in Tamil Nadu. The data is collected throughout the state continuously and are being updated in the RMS which will in future enable to maintain better quality standards. With such quality and comprehensive data, the construction and maintenance of road network will become very effective.

##### **5.5.1. DATA COLLECTION THROUGH ROMDAS (Road Measurement Data Acquisition System)**

In the earlier ROMDAS equipment, Surface Roughness (in IRI), Distance, Speed, Latitude, Longitudinal co-ordinates, Video information are collected simultaneously and input into the ROMDAS software through the Interface device. The Advanced Data Collection Equipment had gone steps ahead in terms of quality and quantity of data collected.

Vehicle mounted with the Advanced Data Collecting Equipment (ADCE), do possess Speed Sensors, Vehicle Odometer, Vehicle Mounted Bump Integrator, Differential Global Positioning System, Video cameras, Laser Profilers ,

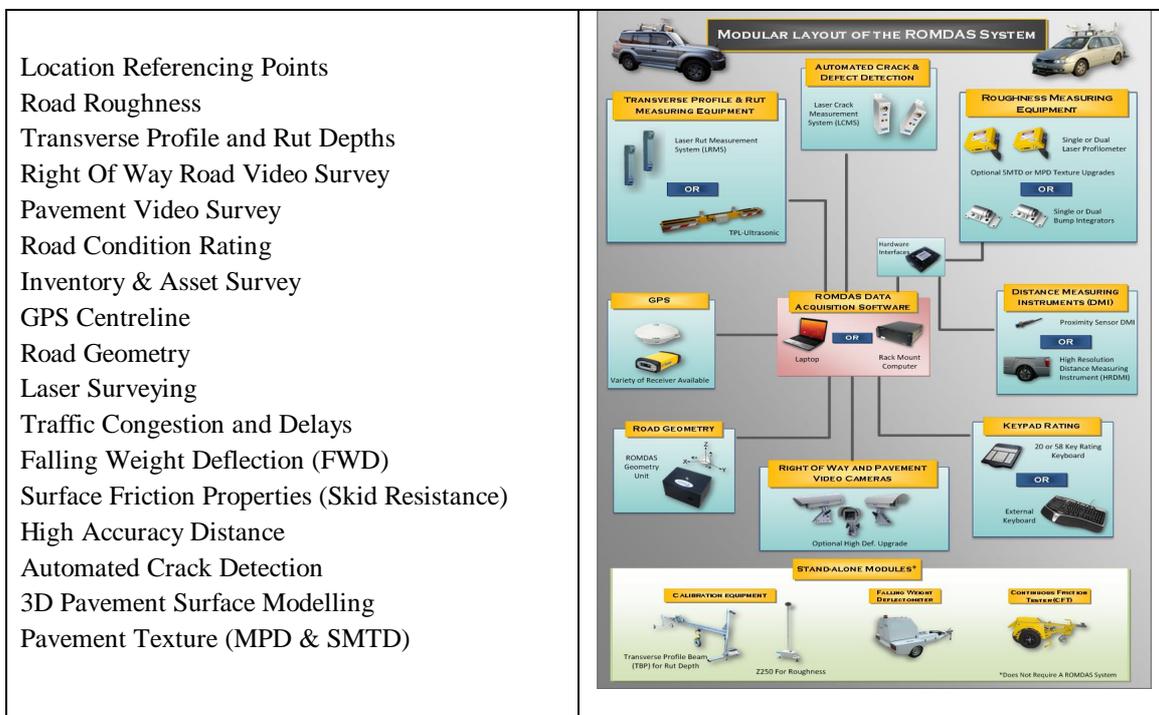
Laser Crack Measurement System, ROMDAS Interface Unit ,Gyro meter coupled with GPS, Lap-top computing system.

**UNITS OF ADCE**

- **Laser Profilometer** : To measure the profile of the road surface, while the test vehicle is in motion, also measures the surface roughness and capable of measuring both Longitudinal and Cross sectional Profile.
- **Laser Crack Measurement System (LCMS)** : To measure cracks, pot-holes, ruts, texture of the road surface
- **Vehicle Mounted Bump Integrator:** To measure the roughness of the road surface.
- **Differential Global Positioning System:** To track the path of the vehicle with *latlon* coordinates.
- **Video Camera:** Used to Capture the Video Data.
- **Speed Sensor** : Used to record the speed of the vehicle
- **Computing System** : Used to store the Data simultaneously

**ROMDAS SOFTWARE**

- ROMDAS Software links computer and ROMDAS hardware interface to collect Data
- ROMDAS Software integrates field data as well as the data back at office
- ROMDAS Software contains a number of standard features , like location referencing, condition rating and travel time, greatly enhancing the value of data collected
- Modules have a proven reputation for success on the most challenging road Networks



**FIGURE 5: MODULAR LAY OUT OF ROMADAS SYSTEM**



**FIGURE 6: ROMDAS WORKING PROCEDURE**

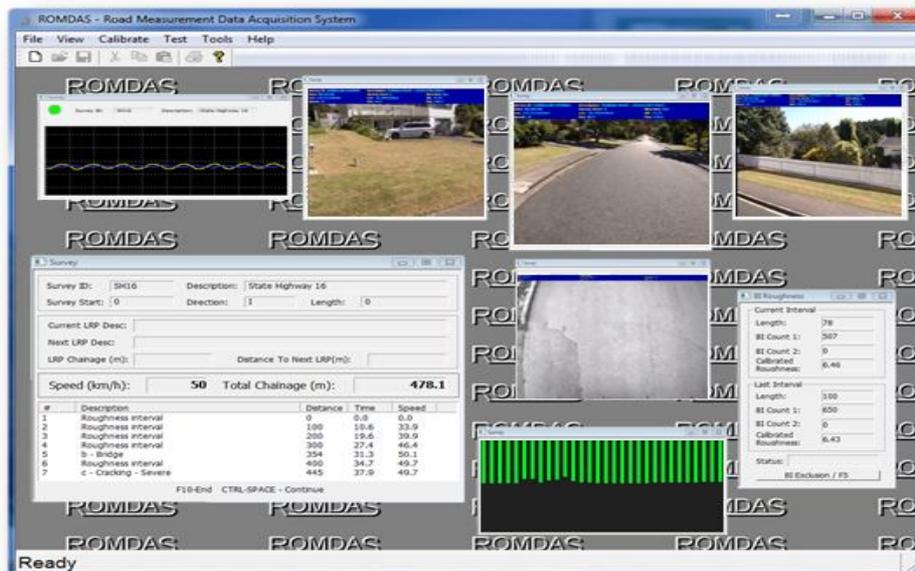


FIGURE 7: ROMDAS SOFTWARE

### 5.6. ROAD MANAGEMENT SYSTEMS

Constructions of new roads and up gradation of the existing roads in many ways play a major role in the development of almost all sectors of the economy. But scarcity of resources and competing demands from various sectors are the dominating features of a developing economy. It, therefore, becomes extremely necessary to allocate the scarce resources in the most beneficial manner amongst various sectors and within a sector, amongst various schemes. A good management system is required to look after all this. A management system is the frame work of processes and procedures to ensure an organization fulfill all tasks required to achieve its objectives.

Road Management System is helpful in

- Unbiased selection of road networks for improvement, purely based on the scientific data, collected annually on core state road networks, through Advanced Data Collection Equipments,
- Is a Holistic approach to scientific prioritization of road stretches for Improvements,
- Data is stored for the entire state which is useful in analysing all the relevant road data.

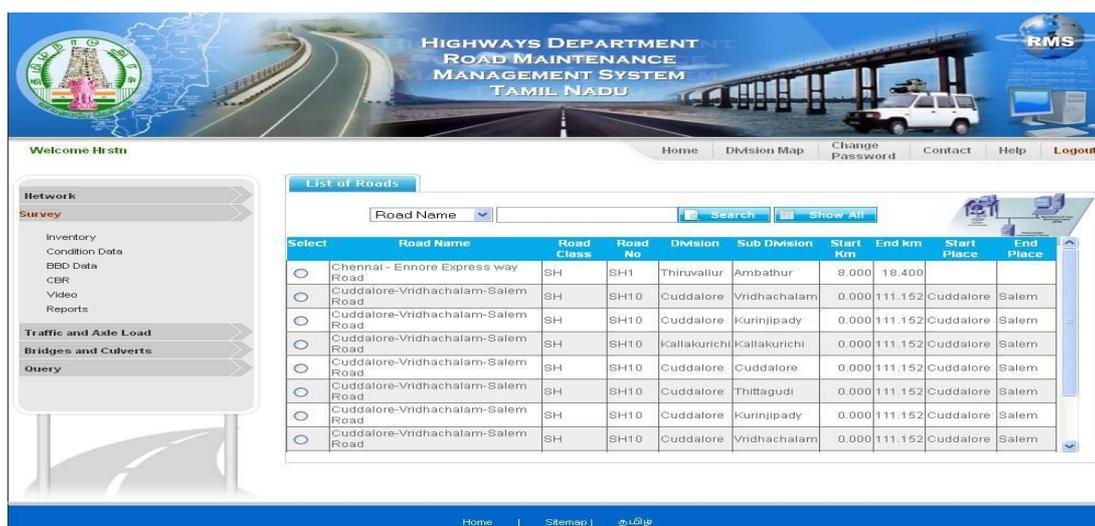


FIGURE 8: ROAD MAINTENANCE MANAGEMENT SYSTEM

### 5.7. ROAD ACCIDENT DATA MANAGEMENT SYSTEM (RADMS)

Progress in the area of prevention is formulated in an environment of beliefs, called paradigms [14] as can be seen in the next table. Some of them can be referred as professional folklore, i.e. a widely supported set of beliefs with no real basis. For example, the “accident-prone driver” was a belief that was supported by the data in the sense that a small number of drivers do participate in a disproportionate number of accidents, it follows that the identification and

removal of this drivers will reduce crashes. A more scientific analysis of the data indicate that this phenomenon can be explained simply by the random nature of the accidents, and not for a specific error-prone attitude of such drivers.

ASPECTS	PARADIGM I	PARADIGM II	PARADIGM III	PARADIGM IV
Decennia of dominating position	1900 - 1925/35	1925/35 - 1965/70	1965/70 - 1980/85	1980/85 - present
Description	Control of motorised carriage	Mastering traffic situations	Managing traffic system	Managing transport system
Main disciplines involved	Law enforcement	Car and road engineering, psychology	Traffic engineering, traffic medicine, advanced statistics	Advanced technology, systems analysis, sociology, communications
Terms used about unwanted events	Collision	Accident	Crash, casualty	Suffering, costs
Premise concerning unsafety	Transitional problem, passing stage of maladjustment	Individual problem, inadequate moral and skills	Defective traffic system	Risk exposure
Data ideals in research	Basic statistics, answers on "What"	Causes of accidents; "Why"	Cost/benefit ratio of means "How"	Multidimensional
Organisational form of safety work	Separate efforts on trial and error basis	Co-ordinated efforts on voluntary basis	Programmed efforts, authorised politically	Decentralisation, local management
Typical countermeasures	Vehicle codes and inspection, school patrols	The three E's doctrine, screening of accident prone drivers	Combined samples of measures for diminishing risks	Networking and pricing
Effects	Gradual increase in traffic risks and health risks	Rapid increase of health risk with decreasing traffic risk	Successive cycles of decrease of health risks and traffic risks	Continuous reduction of serious road accidents

**FIGURE 9: EVALUATION OF ROAD SAFETY PARADIGMS**

							
ACCIDENT INFORMATION REPORT							
Report	: Number of accidents marked according to Road Category Vs ,Accident Severity						
District	: All						
Date Range	: 25/08/2011 To 25/08/2012						
Accident Severity	Road Category						
	Express highway	Major district road	National highway	Other district road	Other roads	State highway	Village roads
Fatal	122	703	2506	494	346	3823	157
Grievous injury	2	49	608	81	208	4144	209
Simple injury (hospitalised)	35	182	3677	307	1135	15536	776
Simple injury (non hospitalised)	0	4	77	4	24	191	22
Vehicle damage only (non - injury)	1	3	247	9	51	883	21

**FIGURE 10: ROAD ACCIDENT MANAGEMENT SYSTEM**

A good reliable and extensive Database is always necessary to keep track of accidents. This is because accident database is the building block for accident reduction and prevention. The operation of accident investigation procedures hinges on the existence of a reliable database and clearly defined technical procedures.

The key elements of an accident database are an accurate location reference, basic Information describing the accident, its victims, the events leading up to the accidents, a collision sketch showing the paths of the vehicles and road users involved and information about the accident site and circumstances (road condition, weather etc). The accident database needs to be set up in order to meet policy objectives. Targets need to be set and quantified.

RADMS [16] is an advanced comprehensive traffic accident analysis system to investigate the real causes behind accidents, so that similar incidents can be prevented in future. The essential data necessary for evaluating accident prone zones were collected. In Road Accident Data Management System (RADMS,) Information Technology is best applied for tackling Road Accident Menace. This Software is helpful in identifying Accident 'Black-spots, which in turn Aids improving geometry and thus Enhances Road Safety.

Data regarding accidents Hour-wise, Day-wise, month-wise, for the entire state are collected, stored and preserved by the Additional Director General of Police, State Traffic Planning Cell, and Government of Tamil Nadu. Data of fatal, non-fatal accidents within Chennai City Limits are being collected and stored by the Additional Commissioner of Police, Greater Chennai-Traffic, Chennai

The RADMS enable a systematic and scientific approach to accident reduction and prevention with:

- An overall assessment of the accident problem in various defined areas

- The clear definition of the location of each accident
- Prioritizing of accident locations, accident types, and accidents to defined categories of road user some of the key elements of an accident database are given below.
- Basic description of the accident
- Road Types
- Road Features
- Environmental Features
- Driver features
- Casualty details
- Vehicle features

Traffic characteristics - related to time and location.

## 6. CONCLUSION:

With the Advancement of latest technologies and availability of innovative software the Accident Data shall be collected in an efficient and exhaustive manner which will enable in analyzing the cause of accidents and taking remedial measures. A better Engineering design, construction and proper maintenance of the road with a right blend of strict Enforcement and proper Education (awareness) of road safety rules, would certainly result in the reduction of accident rate.

A detailed study of crash causation, crash severity and injury outcomes will help in policy decision making very much. Targeting a status of 'Zero Accident' for any road network, every step should be taken in reducing the rate of accidents. This could be achieved by adopting a safety concept not alone by providing/installing any safety feature, but by inculcating the safety aspect right from the planning stage of a road construction, if it is a new formation. By applying all the latest technologies India will go ahead in achieving this target.

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**Dr.R.Krishnaraj** is presently working as Assistant Professor in the school of management for the past five years. He has around twenty years of industrial experience, including three years of experience as Management Consultant. He has published fourteen international journals and presented around twenty five papers in various international and national conferences. He was awarded Ph.D in the functional area of marketing.