Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 6, Issue 4; April-June, 2019, pp. 282-289

http://www.krishisanskriti.org/Publication.html

Intelligent Traffic Signal System

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Abstract—*The manoeuvre of increasing traffic these days is very challenging and needs to be catered with the help of state of art technology. To improve upon the existing system of the traffic signals in the city, adding pedestrian Signaling facility is very demanding and necessary. Orderly movement of traffic so as to decongest as well as to reduce accidents and also try to modernize the traffic management so that it can be integrated with Centralized Control room from where it can be operated and monitored remotely. This study intends to record data from different intersections in the city of Srinagar after installing Red Light Signal Violation Detection System. Intelligent Red Light Violation Identification System is a state of art solution to automatically identify red light runners and it captures and presents evidence of the red light violation that helps smooth functioning of law enforcement. Violations are captured with the help of vehicle sensors, cameras and the controller hardware installed at the road intersection. Images and video are captured at the intersection that will be stored in hardware and sent to the central server in frequent intervals through appropriate communication medium. The captured data will be used to generate Challan, Reports etc. By operating it we can get a check on Traffic Red Light Violations .All these will help us to get rid of heavy traffic jams and minimize the traffic violations and will also help to reduce the accidents. Installation of intelligent electronic traffic signal system including pedestrian signal lights with operations & monitoring of the traffic lights from a centralized control room remotely at junctions in Srinagar city. Intelligent traffic signal system with operations & monitoring of the traffic lights from a centralized control room remotely may reduce all the accidents and also try to modernize the traffic management with lowering of Traffic congestions. "Public spaces need to be spaces to play, where green is not an anecdote-where the neighborhood's history and local life have a presence."*

1. INTRODUCTION

The World population is increasing rapidly nearly crossing the digit of 9 billion simultaneously pacing the growth of world economy. When it comes to transportation, especially road transportation, which is easily available to use mobility, is of vital importance. Common public transportation systems provide a cost-effective way to move more or less freely in urban areas. Passively bundle their demand for transportation in terms of place and time.

Figure 1. Overview.

The problem of travel time prediction is an important part of the intelligent transportation systems domain. The demand of proper transportation system comes in picture as undoubtedly higher the people using the transportation system more will be the transportation conflicts.

Srinagar with annual population growth rate of 2.0 per cent has registered a phenomenal increase in vehicular population during the last decade. Its vehicular traffic is increasing rapidly at more than 7.0 per cent per annum. Due to this rapid growth of vehicles *vis-à-vis* marginal increase in road infrastructure, the problems related to transportation have grown manifold. Srinagar has geographical disadvantages with physical thresholds like mountains, wetlands, and water bodies which turn out to be the major constraints in the development of an organized road network. The city road network is cramped because of missing links, incomplete rings, inefficient radials, bottlenecks, etc. Some of the radials like Rangreth Road, Airport Road are virtually dead ends as they are not connected to any major arterials. Also the location of strategic installations across city has been another key impediment in the development of efficient transport network. Srinagar has historically developed with a radial road network spanning in north, south and west directions. All the radials are witnessing extreme traffic flows much beyond their capacities, hence poor level of service. The city road network needs a complete relook so that an efficient and sustainable transport network is developed to cater to the future demand.

Traffic congestion is already severe on many city roads and the gridlock plaguing Srinagar has reached a tipping point, with the region spending millions of man hours in traffic congestion each year. Vehicular pollution is assuming critical dimensions and parking problems are aggravating. These problems among others will grow in size and scale unless action is taken now. Two comprehensive Traffic and Transportation Plans have been prepared for Srinagar city which include the Srinagar Urban Transport Project 1992 and Comprehensive Mobility Plan (CMP), 2012 (by Rail India Technical and Economic Services) but not a single step has been taken so far. As per CMP, about 36% of urban road space is consumed by private modes (Cars/TWVs) which share about 30% of the total motorized passenger trips. On the other hand, public transport using 44% of road space caters to 71% of the total motorized passenger trips in main city areas; however, in the periphery at outer cordon stations, public transport consumes only 13% of the road space while sharing about 70% of the motorized passenger trips. Interestingly, buses and mini-buses occupying just 8% of the existing road space cater to 32% of the total motorized passenger trips.

1.1) As per the traffic Police Department, around 80,000 vehicles enter the Srinagar city on daily basis.

1.2) Just 10% road length is having side-walks in Srinagar city though it has more than 22% walk trips.

2. HISTORY OF ITS

An intelligent transportation system (ITS) is an advanced application which, without embodying intelligence as such, aims to provide innovative services relating to different modes of transport and traffic management and enable users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks. Although ITS may refer to all modes of transport, the directive of the European Union 2010/40/EU, made on the 7 July 2010, defined ITS as systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes of transport. ITS may improve the efficiency of transport in a number of situations, i.e. road transport, traffic management, mobility, etc.

ITS has been around since the thirties and it has been slowly creeping into our lives. The major developments on ITS were made in Europe, U.S. and Japan and it has gone through three phases: preparation (1930-1980), feasibility study (1980-1995) and product development (1955-present). The origin of the formal ITS program dates back to the nineteen forties with the development of Electronic Route Guidance System, or ERGS in U.S to provide drivers without guidance information based on real-time traffic analysis. The same era saw the development of the Japanese Comprehensive Automobile Traffic Control System (CACS) program, presumably one of the earliest public-private partnership effort in the world to test an interactive route guidance system with an in-vehicle display unit. In Europe, the program for a European Traffic System with Higher Efficiency and Unprecedented Safety was designed by auto manufacturers and this was followed by 'Dedicated Road Infrastructure for Vehicle Safety in Europe' project set up by European Community.

3. PROBLEMS AND ISSUES

The population of Srinagar has been growing very fast. There has been a phenomenal growth in the population of vehicles as well due to rising household incomes. Besides nearby towns Anantnag, Baramulla, Pulwama, Budgam, Ganderbal and Bandipora are also growing fast and have large traffic interaction with the Srinagar.In the absence of the adequate and quality mass transport system, people are using the personalized modes which is not only leading to the congestion on road network but also increasing the environmental pollution. The present transportation system is grossly inadequate with the area under transportation is around 3 % as against 10 to 14 % in metro cities. The length of roads above 12 Meters wide is approximately 233Km in the city. The condition of the road is below the desired standards. The major problem associated with the transportation is the traffic congestion in the city and Concentration of the major commercial activities and in adequate parking along the city causes more traffic congestion on the roads.

Due to the inadequate parking space, on street parking has been found on major roads. Approximately half of the road space is being used for parking which is resulting in severe traffic congestion in the area. And as a result more fuel is burnt and there by excessive pollution is being added in the surrounding environment. Srinagar city like any other historical city has very complex road network. The present urban transportation situation of the cities is un organized and seriously lack of parking facilities. Usage of private transportation is predominantly observed in Srinagar city like other major cities in India. Present approaches for solving traffic problems in Srinagar city are cosmetic in nature as they are creating a niche for more traffic management and engineering problems. From the Jehangir Chowk flyover corridor to the Skewed bridge to the grade separator near the JK Bank Intersection, all the traffic proposals might prove to be suitable for the present situation, but in the long run, all those proposals are going to generate fresh problems along with aggravation in the existing problems.

4. CATEGORIES OF ITS

The most frequently used category of ITS is based on the position of the system are as specified below:

4.1. Advanced Traffic Management Systems (ATMS)

Integrates various sub-systems (such as CCTV, vehicle detection, communications, variable message systems, etc.)

into a articulate single interface that provides real time data on traffic grade and predicts traffic circumstances for more efficient planning and operations. Dynamic traffic control systems, freeway operations management systems, incident response systems etc. respond in real time to changing conditions**,**

4.2. Advanced Traveler Information Systems (ATIS)

ATIS provide the users of transportation systems, travel-related information to support decision making on route choices, estimate travel times, and keep away from congestion.

This can be enabled by providing different information using various technologies such as:

4.2.1.GPS enabled in-vehicle direction-finding systems,

4.2.2. Dynamic road significance signs for real time communication of information on traffic congestions, bottlenecks, accidents,

4.2.3.Alternate route information during road closures and,

Website to provide a color-coded network map showing congestion levels on highways.

4.3. Advanced Vehicle Control Systems (AVCS)

AVCS are tools and concepts that enhance the drivers‟ control of the vehicle to make travel safer and more efficient. For example, in vehicle collision admonition systems alert the driver to a potential about to happen collision. In more advanced AVCS applications, the vehicle could automatically break or steer away from a collision, based on input from sensors on the vehicle. Both systems are independent to the vehicle and can provide substantial reimbursement by improving safety and reducing accident induced congestion. The installation of high tech gadgets and processors in vehicles allow incorporation of software applications and artificial intelligence systems that control internal operations, ubiquitous computing, and other programs designed to be integrated into a greater transportation system,

4.4. Commercial Vehicle Operations (CVO)

CVO comprises an ensemble of satellite navigation system, a small processor and a digital radio, which can be used in commercial vehicles such as trucks, vans, and taxis. This system affords constant monitoring of truck operations by the central office and provides traceability and safety,

4.5. Advanced Public Transportation Systems (APTS)

APTS applies state-of-art transportation management and information technologies to public transit systems to boost efficiency of operation and improve safety. It includes real-time passenger information systems, automatic vehicle location systems, bus arrival announcement systems, and systems providing precedence of passage to buses at signalized intersections (transit signal priority),

4.6. Advanced Rural Transportation Systems (ARTS)

ARTS provide information about remote road and other transportation systems. Examples include automated road and climate conditions reporting and directional information. This type of information is helpful to motorists travelling to remote or rural areas.

5. OBJECTIVE OF ITS ARE AS FOLLOWS

5.1) Improve, enhance and provide high quality public transport having 80:20 modal shares in favor of public transport, which exclude the walk trips, by 2035,

5.2) Improve Air Quality and reduction in vehicular emissions to meet the National ambient air quality standard,

5.3) Promote accessibility, not just mobility and accessibility ensures that all users of the transportation system have equal access to safe and quality facilities, regardless of transportation mode. Motorists, pedestrians, bicyclists and transit riders should all be able to use the transportation system in a safe, efficient, and uniform way,

5.4) Equitable allocation of space:-Bringing about more equitable allocation of space with people, rather than vehicles, as its main focus,

5.5) Promoting Walkability and Inclusiveness nearly everyone walks and does so every day. Streets need to be more accessible and safer for pedestrians. Streets affect the way people live, work, and play. Streets should be viewed as part of a dynamic, integrated land use and transportation system. Street treatments (paving type, sidewalks, lighting, street trees, signs, and furniture such as benches and trash cans) should address the needs of regular users and the surrounding area,

5.6) Have good connections throughout Connected, continuous street systems make activities of daily living easier to accomplish. Upgradation of existing Skewed/Irregular Road Network to Ring Radial system will help in enhancement of Multi-Dispersal Trip distribution system.

5.7) Support all travel modes:-Promoting multi-modal system one that provides a range of travel choices. This will require planning and providing facilities for automobile, bus transit, high-capacity transit, pedestrian, and bicycle travel, etc,

5.8) Support transportation and land-use improvements:-Majority of the city supports Mixed Use development

especially the core city. Mixed-use areas are often favorite places with lots of activity easily accessible by different transportation modes. Streets with an attractive and interesting street atmosphere,.

Worldwide various societies and associations have been setup for the development of intelligent transportation system, first was setup in 1991 by US Department of Transportation. Vehicle to vehicle communication, vehicle to infrastructure communication, electronic fees collection are some of the very popular projects undergoing worldwide. In India, Intelligent Transportation System has a long way to go as it is in primary stage of its development.

6. STRATEGY FOLLOWED IN ORDER TO MEET THESE OBJECTIVES

6.1) Preparation and operationalization of an integrated and mutually complementary multi-modal transportation and traffic plan comprising the Road, Rail and Metro-rail network, so that work centres/residences are within a walkable distance,

6.2) Providing safe facilities for pedestrians, bicyclists, differently abled persons, children, women and the elderly and Intelligent Transport System (ITS) enabled public transport, taxis and three-wheeled scooter rickshaws (TSR) to arrive at truly integrated multimodal system,

Figure 2: Transport Planning.

6.3) Optimal use and utilization of the existing road network and full development of ROW by removing all impediments and equitable distribution of road space as per National Urban Transport Policy. All arterial roads will be restructured to allow for smooth and safe flow of buses non-motorized transport and pedestrians to minimize pollution and congestion,

6.4) Restructuring of the finer street networks and creating alternate access ways and reducing congestion on the existing roads to the extent possible. New Urban Link Roads should also be identified as additional or alternative links, wherever possible, to reduce congestion,

6.5) Making all roads usable and safe at all times for women, children, elderly and the differentially abled,

6.6) Planning for High capacity bus system, BRTS for city travel and Metro for high-speed inter-city travel,

6.7) Developing an integrated relationship between the bus, rail and metro-system to provide for seamless multi-modal transport, through provision of additional stations, park and ride facilities, introduction of single multi-modal ticketing, etc. The choice of technology for the multimodal public transport system (Bus Rapid Transit System, Metro, Mono-Rail, Light Rail etc.) be based on comparative cost-effectiveness analysis studies to ensure rapid development of public transport and to ensure judicious use of public funds. Public transport modes be made more reliable and affordable to the end-user to induce shift from private modes,

6.8) Development of a comprehensive parking policy by the concerned local bodies in line with the broad aims of the Plan for transportation mentioned earlier, including measures for linking new vehicle registration with owner parking facilities,

6.9) Establishment of a quick and efficient transport network between Srinagar city and Srinagar Metropolitan Region,

6.10) Provision of directional Goods and Passenger Terminals with adequate infrastructure,

6.11) Review of the licensing policy and systems, and effective arrangements for training of drivers / transport operators, and

6.12) Planning of new road network in such a manner as to prevent possibilities of future congestion by modifying road sections to promote use of public transport, non-motorized transport and walking, which would reduce use of private transport modes.

7. TRANSPORTATION NETWORK PLAN

The road network and its hierarchy given below are provided taking into consideration the following factors:

7.1) Existing transit systems (road, rail, airport etc),and

7.2) Relief and Topography of the area.

Location of important activity nodes like terminals, hospitals, educational institutions, administrative offices and business centres.

The Srinagar Metropolitan Region (SMR) is planned on a Ring-Radial pattern with a well-defined functional hierarchy. The road network is designed to address regional, intra-city and local traffic demands.

8. SYNERGY BETWEEN TRANSPORT AND LAND USE

A major fall-out of this is the distortion between infrastructure, transport and land use. To achieve spatial balance, development should take place according to new corridors of mass movement. This has implications in terms of land use planning along the Transit System. This would not only help to solve, to some extent, the enormous problems of mass transportation, but would also generate a dynamic potential for growth and employment. In this context, the High capacity Bus corridors up to 200m depth on either side from center line of Road would require selective re-development and re-densification / intensification of existing land uses based on site conditions. The concept of Transit Oriented Zone (TOZ) needs to be adopted such that maximum number of people can live, work or find means of recreation within walking/ cycling distance of the High capacity bus corridors/ stations.

9. HIERARCHY OF ROAD NETWORK

9.1) Arterial Streets

The arterial roads are the regional corridors or outer bypass meant for access controlled high speed traffic. These roads are recommended to have a RoW of more than 60 meters.

9.2) Sub-Arterial Streets

All major city roads and other district roads creating important communication lines for inter-city and intra-city traffic are classified as Sub-Arterials Roads. These roads will have the RoW of 30 - 60 meters.

9.3) Collector Streets

All urban streets providing transition to sub-arterials road the limits are defined as the Collector Streets. These roads include the roads with recommended RoW of 20 meters but less than 30 meters. These roads will have comparatively lesser speeds and will have the maximum intensity of city traffic.

9.4) Local Streets

These are the non-high capacity bus corridors generally meant for paratransit traffic. These roads include the streets with recommended RoW of 10 meters but less than 20 meters are designated as Sub-Arterials.

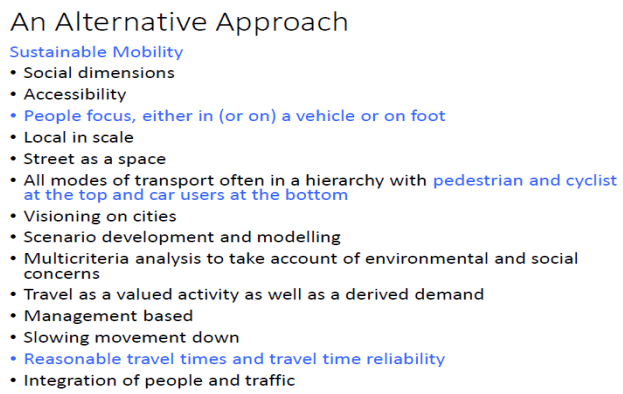

Figure 3.Different Alternative Approach.

9.5) Access Streets

All such roads directly abutting properties with recommended RoW less than 10 meters are designated as Access Streets. As per this classification, the city will have at least 50% of its road length under two-lane dual carriageway configuration with footpaths mandated for the pedestrians. As a matter of general policy, it is enunciated that for all categories of roads, the full cross section should be developed in future and no encroachments shall be permitted on the existing road network. Further, the development of roads should start from the extremes ends of the designated ROW.

9.5.1) In order to reduce congestion on the existing roads, there is dire need to identify additional/alternative links and access corridors to augment the current network, with the following measures

9.5.1.1) Augmentation of road network to distribute high traffic volume over multiple roads, instead of stand-alone corridor/ junction capacity improvement strategies,

9.5.1.2) Road networks to be planned with a vehicular route network of approximately 250m c/c, as also specified in the NMSH parameters, 2011. Additional pedestrian/ NMT thorough fares should be provided as required,

9.5.1.3) Road networks/ alignments need to be planned with minimum disruption of existing settlements/ structures and environmentally significant areas sensitive to such development,

9.5.1.4) Area level parking management should be taken up as part of network improvement for effective utilization of the capacity of roads to augment the network.

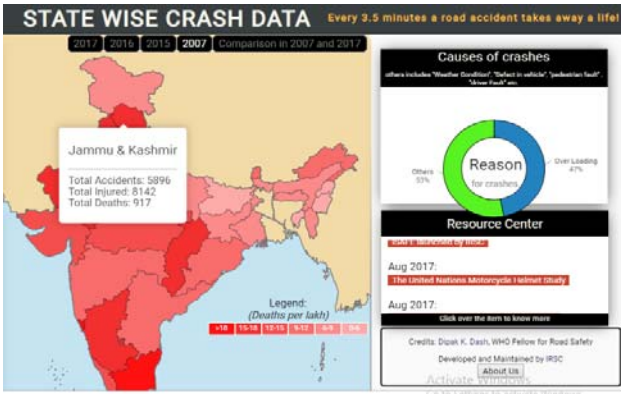

Figure 4 Data Analysis of J & K.

Table 1.1 Hierarchy of Road Network.

Roads	Arterial Roads	Sub Arterial Roads	Collector Roads	Local Streets	Access Streets
Right of Way	> 60 M	30 – 60 M	>20 M	30-20 M	5.5 - 10 M
Suggested speed limit	40-50 km/hr.	30-40 km/hr.	20-30 km/hr.	10-20 km/hr.	>10-20 km/hr.
Busways	Segregated busways (3.5M) per direction	Segregated busways (3.5M) per direction	Demarcated bus-lanes (3.3M) per direction	No segregated-ted bus lanes required. No segregated bus lanes required.	No segregated-ted bus lanes required.

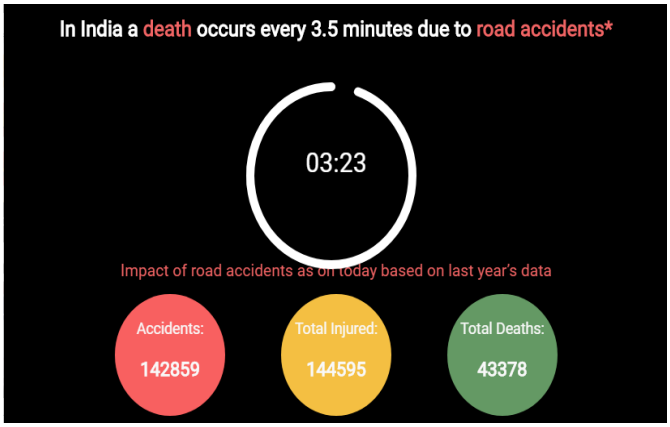

Figure: 5 Data Analysis of accidents every seconds.

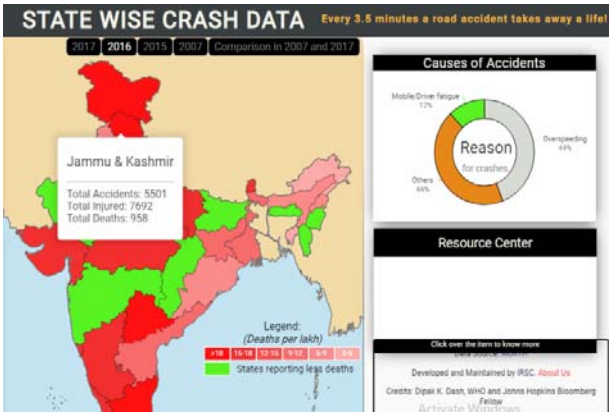

Figure: 6 Data Analysis of J & K.

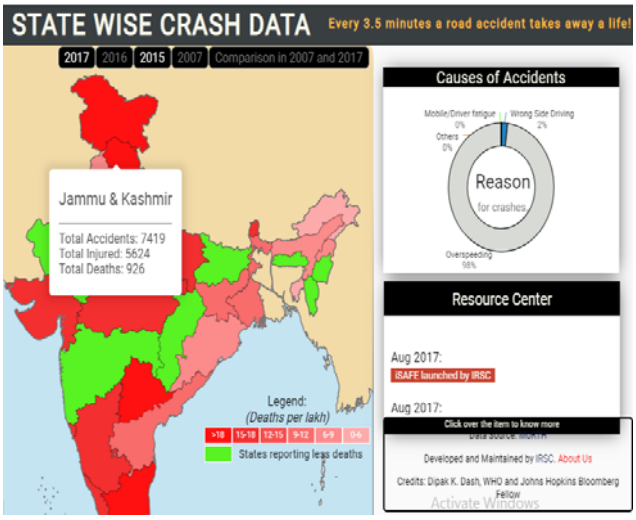

Figure: 7 Data Analysis of J & K.

10. Red Light Violation Detection System

Red Light Violation Detection System (RLVD) is a state of the art solution to automatically identify Red Light Runners. It captures and presents evidence of the Red Light Violation that helps smooth functioning of law enforcement. Violations are captured with the help of vehicle sensors, cameras and the controller hardware installed at the road intersection, images and video captured at the intersection will be stored in hardware and sent to the central server in frequent intervals through an appropriate communication medium. The captured data is processed at the Control Centre to generate challan, reports etc.

10.1) RLVD (Red Light Violation Detection System) should have the following features:

10.1.1) Automatic capturing of Red running with evidence (Video and snapshot),

10.1.2) Simultaneous monitoring of multiple lanes,

10.1.3) Detection of multiple Red light violations,

10.1.4) Automatic recognition of standard number plates,

10.1.5) Automatic ticket generation on violated vehicles,

10.1.6) Three second videos and progressive snapshots as evidence,

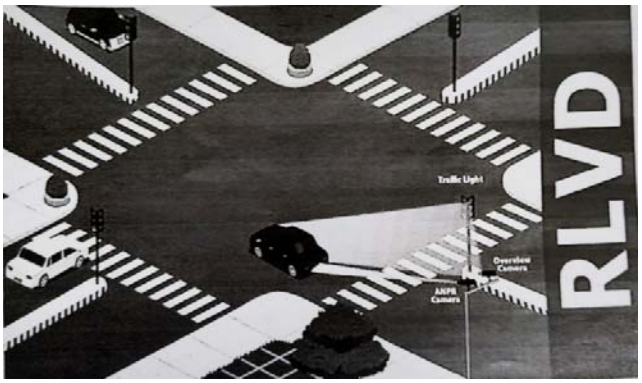

Figure: 8 RLV Captured by Camera.

10.1.7) Remote RTO database connectivity,

10.1.8) Custom and third party ALPR(Automatic License Plate Recognition),

10.1.9) Manual verification before ticket dispatch,

10.1.10) Local storage on network failure,

10.1.11) Compatible with traffic signal controller of any make,

10.1.12) Universal interface to Red light signal (230VAC/24VDC/12VDC),

10.1.13) Optically isolated vehicle detector interface,

10.1.14) IR operation during low light condition,

10.1.15) Custom and third party ANPR(Automatic Number Plate Recognition),

10.1.16) User friendly GUI (Graphical User Interface), and

10.1.17) Web enabled.

11. Lack of required road infrastructure acting as impediment: Survey

11,1) Signifying rapid growth of transport sector, the number of vehicles registered with government rose up-to 15, 89,895 in 2017 from 8, 19,093 vehicles in 2011, thus witnessing a growth of astounding 94 percent in last six years. An official document reads “as against 818093 vehicles (both public and private) registered in 2011, the number of vehicles has reached to 1589895 ending October 2017”,

11.2) It states that number of vehicles registered during the year 2016-17 was 1, 22, 638 while in 2017-18 ending October, 2017, department has registered 101705 vehicles including 10028 commercial vehicles. While the transport has increased manifolds over the years, the failure of authorities to increase road length is acting as impediment in the development of the state. As per economic survey 2017, road length maintained by PW(R&B) Department is 35,289 km. With Jammu region having highest road length of 15,920 kms followed by Kashmir where road length recorded is 14,803 km. Leh and Kargil have 3202, 1364 Kms of road length respectively. “Road Transport plays a vital role in the economic development of J&K State. Transport, whether passenger carrier or goods carrier, is important rather fundamental requirement for economic development of state. Accessibility of essential commodities in far flung areas depends on connectivity through road transport. Transport has and is playing significant role in this regard,’ the survey report points out. Experts believe that ‘lackadaisical’ development of road length in J&K is not keeping pace with the bulging transport on roads, thus resulting in traffic congestions wasting precious time of the citizens. Owing to poor transport connectivity, Jammu and Kashmir has been placed at the bottom of logistics index, an indicator of the efficiency of logistical services, in the first set of rankings released by Union Commerce and Industry Ministry recently. The Logistics Ease across Different States (LEADS) Index has given only 1 index point to J&K, placing it at the bottom of the list of states having “worst logistic” connectivity in India.

12. Conclusion

It is the most important to have the activities that improve the use and development of ITS in Srinagar City since traffic congestions, car parking and many road problems are there on roads. The characteristics of roads and traffic in Srinagar city makes the problem more complicated but also helps to solve them after a vigorously planned activities. Traffic Engineering and management measures should be taken, with proper intersection improvements, provisions of channelisers, ban on certain turning movements and closing of median gaps. Providing footpaths and subways for the pedestrains. The new scope for innovative ideas and the existing challenges in different traffic scenarios and ideas of evaluating traffic solutions with in collaboration with private and public sectors. The new initiatives includes the up-gradation of old traffic signal system and installing the new signals with RLVD (Red

Light Violation Detection) System and with the cameras at all important heavy congested junctions. In array to complete the full potential of ITS in Srinagar, a careful systematic approach is required in the propose and scheduling, development and implementation, which tackle the problems of user needs and benefits, system architecture and integration issues while at the same time giving due intelligence to other national and international medium and long-term objectives related to such issues as land use and regional planning, infrastructure design, carrying system management, and many other important areas that are directly or indirectly inclined as a result of ITS accomplishment. Intelligent Transport Systems (ITS) have been developed to solve probable problems caused by the modern transportation environment through the adaption of innovative technologies recently. ITS are the advanced integration systems which plan, manage and control all the relations of passengers, drivers, vehicles, road operators, managers and the environment. Furthermore, the aims of these systems are to deal with traffic congestion, traffic and road status, pedestrians, vehicles, roads, traffic jam, pollution and accidents for efficient and safety transportation management by using computer, electronics and communication technologies in many countries. With the increased problems of the traffic congestion in the Srinagar, the road transportation management has become a vital research topic to overcome its major problems immediately. By this reason, Intelligent Transport Systems are considered as new promising applications to solve these problems in Srinagar. In line with this aim, the purpose of this paper is to shed light on the usage, benefits and importance of these systems with available applications in Srinagar especially Srinagar road transportation industry. Once implemented, it will bring Srinagar on the global map as one of the smartest cities of the world with best transport management. The great potential offered by technologically and economically viable ITS was rapidly recognized as an efficient way to resolve many simple and complex transportation problems. Recent expectations in relation to this potential have suggested, for example, that ITS will lead to a 50 per center deduction in road fatalities; a 25 per cent reduction in travel time; a 50 per cent reduction in traffic delays; and a 50 per cent reduction in city pollution. Also encourage and follow the International Standards Development, with proper work force, co-ordination with all the departments of traffic and provide the suitable training for all the common people of the state. In this paper I tried to put an effort for the for the new ideas and giving a new hope to the ITS which is growing Transport sector in India. And also provide an overview of the problems with the new different solutions which can at least help to resolve the growing problems in traffic in a different way.

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