Use of ITS in Development of Smart Bus Stations in Satna district (MP)

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Requirement for the Award of the Degree

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MASTER OF TECHNOLOGY

In

CIVIL ENGINEERING

(Specialization in Transportation Engineering)

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DECLARATION

I hereby declare that this thesis report entitled **"Use of ITS in Development of Smart Bus Stations in Satna district (MP)"** submitted in the partial fulfilment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara (Punjab) is my own work.

This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

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CERTIFICATE

Certified that this project report entitled "**Use of ITS in Development of Smart Bus Stations in Satna district (MP)"** submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara (Punjab) carried out the work under my supervision for the Award of Degree.

This report has not been submitted to any other university or institution for the award of any degree.

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ABSTRACT

Transport is very important for any city either it is small city or big city specially Public transport. Public transport is the root of the city. If Public Transport in the city is good then there will be no traffic problems like traffic congestion, accidents, delays which will side by side also reduce the pollution mainly air pollution as well as noise pollution in the cities.

For public transport, passengers and commuters go to bus stand/bus stops and catch the bus to their desired destination. If Public Transport will not provide good and effective management then people will use their own private vehicles for various trips which will increase pollution, congestion and other traffic problems. To make the Bus Stands smarter, better and hi-tech we have various technologies of Intelligent Transportation System (ITS) which can be used to make the Public Transport advanced.

In this study, Bus Stands of various metropolitan cities of Madhya Pradesh are surveyed and studied. Studies of various applications and technologies of Intelligent Transportation System required for the development of Smart Bus Station and to make Public Transportation more advanced are carried out. Road Side surveys are conducted to study the behaviour of commuters towards the current situation of Bus Stand. The study also includes the vehicular data details of Satna city, population details, current traffic scenario of Satna city and complete Bus Stand data.

At last, the conclusion is given from the analysis of data, through various graphs, calculations and tables that implementing ITS in the Bus Stand will help the commuters, reduce the traffic congestion on roads and will provide many more long term benefits. Cost for the improvement and development as well as the changes required to convert the Traditional Bus stand into Smart is calculated.

Keywords- Intelligent Transportation System, Commuters, Congestion, Metropolitan.

LIST OF ABBREVIATIONS

Symbol	Meaning
ANPR	Automatic Number Plate System
APTS	Advanced Public Transport System
ATMS	Advanced Traffic Management System
AVCSS	Advanced Vehicle Control and Safety system
CCTV	Closed Circuit Television
CVO	Commercial Vehicle Operation
ETC	Electric Toll Collection
GPS	Global Positioning System
GIS	Geographical Information System
ITS	Intelligent Transportation System
MAC	Media Access Control
MCS	Master Control Station
OCR	Optical Character Recognition
RFID	Radio Frequency Identification
SDCS	Speed Detection Camera System
SS	Space Segment
SV	Space Vehicles
UHF	Ultra High Frequency

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INTRODUCTION

CHAPTER -1

1.1 INTRODUCTION TO ITS

Transportation is now our basic need in the day to day life. In the past, few years because of the technological advancements in the automobile industry, there is enormous increase in the vehicles which now causing traffic congestion, safety concerns etc. But these advancement is highly appreciated because it is responsible for safe, reliable and smooth operation of the transportation system which is commonly called as Intelligent transport system (ITS). It is a comprehensive system for secure, safe and provide pleasant environment for traffic

So, Intelligent transport system (ITS), also called or named as Transport telematics is a transport system which uses the latest and modern technologies available for the improvement of traffic and transport network operations. The system gathered and collect all the traffic relevant data like speed, traffic volume, load carried, headway then after analysation it give results to reduce traffic congestion by providing real time information, guide traffic, reduce accidents and transport costs. For all the operations, applications of ITS needs TMC (Traffic management Centre) where collection, analysation and combination of data with other relevant data is carried out to solve the complex transportation problems.

1.1.1 OBJECTIVES OF ITS

- To improve traffic safety of road users.
- To reduce traffic congestion in the road.
- To improve transportation efficiency.
- To reduce air pollution.
- To increase the energy efficiency.
- To promote the development of automobile and its related industries.
- To save time.

1.1.2 APPLICATIONS OF ITS

ITS has a lot of applications. Some of them are given below-

- Provide information to the road users during traffic congestion.
- Providing alternative routes.
- ATIS (Advanced traveller information system) tells the highway road users about the traffic jams, weather condition, road closures etc.
- Electronic collection of taxes in toll.
- Monitoring accidents and incidents happening on the road through various CCTV cameras.
- Intelligent Vehicle Highway System (IVHS) through which highway road vehicles are guided by the electronic devices laterally and longitudinally for safe driving.
- Public transport management system, where the commuters in the Bus stations come to know about the real-time arrival and departure information of Buses. Use of GPS is extensively made.
- Control of traffic in the urban streets intersections and junctions by using actuated signals for harmonious flow of traffic and to reduce delays and congestions.
- Truck Transport Management System through which we can get the major information of truck like its location, accidents, breakdowns, detentions and further action can be taken for its improvement in the operations. GIS and GPS is extensively used.

1.2 AREA OF THE STUDY-

The area of the study is Bus stand of Satna city. Below is the image which shows the picture of Satna Bus stand.

Fig-1.1 Satna City Bus Stand

1.3 OBJECTIVES OF THE STUDY

Following are the major objectives of study-.

- To propose a new model of Smart Bus Stand which provide the commuters of Satna city a safe, good, effective and environmental friendly journey through ITS.
- To understand the condition of current Bus Station and suggest corrective measures and improvements wherever required.
- Locations to provide LCD panels in the Bus Stands to provide real time information to the commuters i.e. ETA (Expected time arrival) and ETD (Expected time departure) through GPS/GPRS technologies and information of Buses in the display panels.
- Locations to provide various CCTV cameras, Boom barriers, turnstile gates, Puffer Machine and Central Control Station.
- To give concept of starting GPS equipped Buses with panic buttons for woman safety, Digital Aadhar Cards, E-ticket facility for all Buses, E-purse facilities for payment of Buses for daily, weekly and monthly commuters.
- To suggest corrective measures and suggestions in the Bus Stands based on the ITS studies for reducing pollution and traffic congestion on the roads.

1.4 SCOPE OF THE STUDY

My study will figure out a new model of current Bus Station of Satna district which will be more effective among the current Bus station and conventional public transportation modes. As per according to 'Smart cities mission' Satna is in the list so main aim is to propose a model of smart Bus Station by use of Intelligent Transport System techniques and applications.

Thus, the study will help the MPSRTC (Madhya Pradesh State Road Transport Corporation) and the government during development of Smart Bus Stations in near-by future and my study will be used as a pilot project for various other development projects of Smart Bus Stations.

1.5 NEED OF THE STUDY

The current situation and condition of Bus Stands are very poor majorly in all metropolitan cities of Madhya Pradesh. Because of that, people prefer their own vehicles instead of using Public transportation mode which further increases the traffic congestion and pollution on the roads. Reason behind this is poor services provided by the Bus Stands and services.

So, this study will help the government to improve the condition of Bus Stand and MPSRTC for re-establishment of their Bus services.

1.6 EXPECTED OUTCOMES OF THE STUDY

- Increase in productivity- Using ITS technologies and techniques in Bus stands will help the commuters to know the real-time arrival and departure of Buses and finally it will save the quality time of all passengers instead of asking from someone and waiting for Buses.
- Reduction in travel time- With direct two-way communication between the driver and the central control station it will help Bus stand management during emergencies or help during journey.
- Patronage of Public Transport System- If we provide good transportation facilities, management and environment to the commuters then it will encourage them to use public transport instead of using own vehicles.

- Reduction in Congestion- Installing ITS in the Bus Stands will definitely reduce the traffic congestion after the significant modal shift of private transport to public transport.
- Reduction in accidents- When there will be less traffic congestion the rate of accidents will definitely decrease, with two-way direct communication, the help will immediately come during emergencies and sudden break downs and it will also decrease the fatalities when we get immediate help.
- Reduction in emission level- When people will use public transport instead of public, it will reduce the traffic on the roads thus will reduce the emission levels.
- Increase in number of tourist- If Bus services will be good, people prefer road transport instead of rail and private vehicles and it will definitely attract tourists to come and visit the city nearby places.

LITERATURE REVIEW

CHAPTER-2

2.1 REVIEW OF VARIOUS STUDIES- A brief review of various studies on Intelligent Transportation System is given below-

1. **Jun Liu, Peng Du and Baoshan Wang/2000**, Intelligent Management System of Passenger Station, ASCE

In the research paper, the researchers research on passenger stations in China. After various surveys and on-site observation in passenger stations they come to know that the passenger stations are only used for passengers waiting getting on and off trains and some information about the respective stations, the other services like safety ensuring system, public broadcast system and information related to Buses, trams are not available. Other services are also very poor, so after the surveys and research, they realised that the passenger station should be highly developed and it should have the facilities like Security, Convenience, Adaptability, Comfort and Practicality, total all in one service in one place. Later, they conclude that after adaptation of Intelligent Management System in stations in coming future, the following 5A features should be there i.e. Transportation Environment Management Automation (TA), Building management Automation (BA), Integrated Communication Automation (CA), Information Processing & Management Automation (IA) and Security Automation (SA).

2. **Nobuaki Ohmori, Takashi Omatsu, Shuichi Matsumoto, Kenji Okamura and Noboru Harata/2008**, Study on Passengers Waiting Behaviour at Bus and Tram Stops, ASCE

In this research paper, they investigated about the behaviour of the commuters and the passengers waiting for Buses and trams stations, what commuters usually do while waiting, there irritation levels during delays, their behaviour and the activities they perform at two Bus stops and tram stops in a local city - Kochi, Japan. Method of conducting research is On-site observations and questionnaire surveys. They also discussed the need and usefulness of Bus/tram departure time information which currently unavailable and is very much required for better public transport. Finally, at last they conclude from the analysis of data, through

various graphs and tables about the activities performed by separate ages of group and comparison in percentages are done.

3. **Yao Hongyun, Yu Juan/ 2008**, Intelligent dispatching system in the BRT, ASCE

In this research paper, the role and the importance of Intelligent dispatching system in the BRT (Bus rapid transit) is discussed. Basically, Intelligent dispatching system or service is the system in which we can locate the vehicles like taxis, fire bridge, ambulance through online nearest to the person who wants to book according to his/her need with the help of web, phone and mobile app. Here, researchers used the Intelligent dispatching system in the BRT. It works with the help of GPS integrated with GSM/GPRS and GIS to find the location of vehicles and RFID electronic label to collect Bus information for identification purpose. With this technique, the dispatching centre will get the exact location and running status of Buses. This information will further get transferred to the Bus stops/Stations so that commuters will get the real-time information of arrival of Buses. Finally, they conclude that IDS are the core key to operate the BRT fleetly and efficiently.

4. **Yuqi Wang, HUi Qi/2012**, Intelligent Transportation System Based on the Internet of Things Frame, SCIRP

In this research paper, researchers found that commuters face a lot of problem and inconvenience while waiting for Buses in Bus stops/stations due to lack of information regarding Buses arrival and departure time. By using ITS, will get the desired information of public transit vehicle through web. Commuters can also get the same information through station terminals. As per classification, four modules are explained i.e. Network server, Database module, Data transmission module and Moving Terminal. Researchers do various experiments using these techniques and results are positive. At last, they conclude that ITS have capability to improve the traffic resources utilisation ratio and make the trips much more comfortable and convenient.

5. **S.A. Mulay, C.S. Dhekne, T.U. Budukh, S.D.Gadgi**, Intelligent City Traffic Management and Public Transportation System, Case Study

In this paper, the researchers present the three modules of ITS which will be very much effective and beneficial for regulating of traffic flow, person's safety to avoid accidents and to reduce the traffic congestion in the city. The first module is Congestion detection and management which will provide the road users the real-time traffic situation and congestion

towards their destination. Second module is Intelligent Public Transport System which provide the real-time information of arrival/departure of local Buses. Third module is Signal synchronization which will help in controlling congestion at various intersections as well as signals. All the information of any of the three modules users can get through day to day device i.e. mobile (Android application/SMS) as well as through website also. For operations of these three modules one data centre is required which works fully autonomous/automatic without human intervention. At last, they conclude that by using these techniques will definitely improve the Bus Transport efficiency and will finally control the fuel consumption and pollution.

6. **Oreste Andrisano and Roberto/2000**, Intelligent Transportation Systems: The Role of Third-Generation Mobile Radio Networks, IEEE

In this research article, researchers presented the review of research developed in the field of short range communications of the last 10 years, how it is beneficial, the role of GPRS AND Third generation (3G) systems for the possible provision in services in ITS field is discussed. They also discussed some other research programs in the field of radio networks which are under development in Italy and Japan. The maim advantage of using these radio signals is during emergency situations. For example, in particular lane we can broadcast the information of warning message in the multicast group of all vehicles running in that particular lane if any accident or natural calamity occurs. With arrival of 3G, network become stronger. Finally, they conclude that communication with these radio networks and other network forms (GPRS, 3G) with road users help them driving safely and will increase the efficiency of road transport.

7. **Yilin Zhao/2000**, Mobile Phone Location Determination and Its Impact on Intelligent Transportation Systems, IEEE

In the research paper, the researcher Yilin Zhao researched about locating the mobile (wireless) phone through various techniques and its benefits and advantages for ITS are discussed in detail. He further discussed about the technique - how much it will be beneficial if the mobile phone technology will become more mature. It will then significantly affect the modern public transit system, future Intelligent Transport System as well as automotive telematics. In the later part of paper, he discussed about the radio based technology and its benefits. How radio technology is used to determine the location from the mobile of the user and challenges are briefly explained and the techniques to determine the location i.e. Angle-of-arrival (AOA) positioning, time-of-arrival (TOA) positioning, and time-difference-of-arrival (TDOA) are

explained. Two specific applications of ITS i.e. Automotive Telematics and modern public transit system are also explained briefly. In the conclusion part, he concluded that if these techniques become more accurate, better and effective then this will definitely make our transportation system convenient and smooth.

8. **George Dimitrakopoulos/2011** Intelligent Transportation Systems based on Internet-Connected Vehicles: Fundamental Research Areas and Challenges, IEEE.

In this research paper, the new concept of Internet of vehicles (IOV), other basic research areas associated with it and the research challenges arising are described. Nowadays, due to increase in population, increase in growth of vehicles occurs on the road which causes problems like traffic congestion, emergencies and accidents. These problems can only be overcome by use of ICT (Information and Communication Technologies) findings which we are currently using at Traffic Emergency Management which is a part of ITS. Paper also presented a case study of Intelligent parking management in which vehicles connect with each other through internet exchange information through an IP - based level with the help of web communities and social networking applications. At last, in the conclusion he concluded that using IOV is very much effective and it will erase the problems of transportation and make it safer, smoother and green for everyone.

9. **Marie-Pier Pelletier, Martin Trépanier, Catherine Morency/2010**, Smart card data use in public transit: A literature review, Elsevier.

In the paper, the researchers give the literature review of the use of smart data cards in public transit. There they discussed about how the smart card are being used by the various public transit agencies for automated fare collection. Other important aspects of smart cards like information required to operate smart cards, privacy concerns, legal issues related to it, data storage, advantages and disadvantages of smart cards, use of cards at various levels are discussed. In conclusion, they conclude that it is beneficial to use smart cards irrespective of some potential challenges we are facing.

10. **Eiichi Taniguchi, Hiroshi Shimamoto/2004**, Intelligent transportation system based dynamic vehicle routing and scheduling with variable travel times, Elsevier.

In the paper, they proposed the model of dynamic vehicle routing and scheduling which calculates and analyse the information of traffic on the roads and provide the real travel time information of various routes through dynamic traffic simulation which results in reduction of

pollution, reduce traffic congestion and solve the other traffic relevant problems. Methodology they used is various tests on road network were conducted and according to the result they conclude that by implementing this model travel time will be decreased, fuel cost will decrease and freight carriers will provide delivery on time to their customers.

11. **Teodor Gabriel Crainic, Michel Gendreau, Jean-Yves Potvin/2007** Intelligent freight-transportation systems: Assessment and the contribution of operations research, Elsevier.

In this paper, all the three researchers highlight on the main issues, achievements, technological challenges of Intelligent freight-transportation system as well as they tried to illustrate the improvement in the performance of freight ITS through the introduction of advanced research-based and decision-support software. Various terms like Intelligent freight transportation, Commercial vehicle operation(CVO), Advanced Fleet Management Systems (AFMS), City Logistics and E-bussiness are briefly explained as well as research and conclusion based on various research papers are discussed.

12. **Nagendra R. Velaga, Mohammed A. Quddus, Abigail L. Bristow/2009**, Developing an enhanced weight-based topological map-matching algorithm for intelligent transport systems, Elsevier

In this paper, the researchers briefly explained about the Map-matching technique, algorithms, advantages and its disadvantages. Map-matching MM technique is a kind of algorithm which integrates the Global Positioning system data with the spatial road map data for the identification of road segment and the location in which user is travelling. The algorithm is tested on the road network and after the results they conclude that MM is more efficient than the previous algorithm we are using and it provide the more accurate, real time and reliable positioning information and will be beneficial for fleet management, root guidance, accident as well for emergency response in urban areas.

13. **Nour-Eddin El Faouzi, Henry Leung, Ajeesh Kurian/2010**, Data fusion in intelligent transportation systems: Progress and challenges – A survey, Elsevier

This paper briefly described the use of data fusion in various areas of ITS as well its uses, applications, problems, challenges and direction for research in the coming future. Basically, Data fusion (DF) is a technique which collects all the information of traffic through various multiple sources and after that provide better inference. In the paper, three approaches to analyse the data i.e. Statistical, Probabilistic and Artificial intelligence is explained. In the

conclusion, they said till now the results of using DF is quite impressive and will be more beneficial in the coming era.

14. **Kashif Naseer Qureshi and Abdul Hanan Abdullah/2013**, A Survey on Intelligent Transportation Systems, Research Gate

In this paper, Researchers do the brief survey of ITS. The development of ITS till now, its technologies are briefly explained with all prospectus. The challenges we are facing in every field of transportation, major areas of ITS in Metropolitan deployments, generation of ITS, its applications which we are using all are explained thoroughly. At the end in conclusion part, researchers said that ITS deployments in various transportation areas provide multiple benefits to the commuters on daily life and the paper will further help the other researchers to do research in this emerging field.

15. **Bhupendra Singh, Ankit Gupta/2015**, Recent trends in intelligent transportation systems: a review, Journal of transport literature.

In the research paper, ITS developments, technologies and applications are discussed in detail. The comparison is done between developed and the developing countries of using ITS in various aspects. This paper also highlights the conclusions which is extracted from various studies and gives the future scope in ITS field so that it became more accessible and user friendly. ITS classification terms i.e. Advanced Traveler Information System (ATIS), Advanced Traffic Management System (ATMS), Advanced Public Transportation Management System (APTMS), Emergency Management System (EMS) are explained in detail. In the conclusion, they highlight the challenges of using ITS in the developing countries because of its chaotic traffic and irregular road patterns.

16. **Fei-Yue Wang, Fellow/2010**, Parallel Control and Management for Intelligent Transportation Systems: Concepts, Architectures, and Applications, IEEE

This paper highlights an overview of the concepts, background, basic methods, current applications and major issues of Parallel Transportation Management System (PTMS). Basically, PTMS is a data-driven approach for analysis, modelling and decision-making which includes both the social complexity and engineering in its processes. The paper is organised in

two sections firstly the basic concepts of ACP approach (Artificial societies, Computational experiments and Parallel execution) and secondly Artificial transportation systems (ATS) and their applications in ITS. In conclusion, they conclude that PTMS is effective and useful in networked complex traffic and have good scope in the nearby future technology era.

17. **Rijurekha Sen, Bhaskaran Raman**, Intelligent Transport Systems for Indian Cities.

In this paper, the researchers highlight and discussed on the problems of Indian traffic, congestions on the roads and other traffic problems which make it very difficult to implement ITS in Indian cities because mainly in India the traffic is chaotic and is totally different from western countries. Further, they discussed about the ITS applications and architecture which can be feasible and adjustable according to Indian roads and traffic. In conclusion, they told that solution of ITS implementation on the Indian cities traffic is still a big challenge for everyone.

18**. Mark D. Hickman and Nigel H.M. Wilson/1995**, Passenger travel time and path choice implications of real time transit information, Pergamon

In the research paper, the problem of the commuters while waiting for the bus in the bus stops/stations are discussed thoroughly and the importance of real time arrival/departure information is briefly explained. Due to traffic congestion and other relevant problems buses got delayed in reaching next destination which affects the commuters the commuters and others to use another vehicle. Apart from this, various models for calculation and estimation of arrival time is discussed for the solution of the problem.

19. **B. Anil Kumar, Lelitha Vanajakshi and Shankar C. Subramanian/2017**, Pattern-Based Time-Discretized Method for Bus Travel Time Prediction, ASCE

In this paper, methodology and models of bus travel time prediction under heterogeneous traffic conditions are tested and results are discussed. The area of the study is Chennai. Two to three methods are used to choose the best method for travel time prediction. For testing on road networks, they choose two bus stops and data is collected through methods using Global Positioning System and then the analysis is done. In the conclusion part, they concluded that

proposed methodology of using GPS is useful and powerful and it will soon get more better with emerging new technologies.

20. **Yan Zhou, Glenn Hamilton Evans, Mashrur Chowdhary, Kuang Ching Wang and Ryan Fries/2009**, Wireless Communication Alternatives for Intelligent Transportation Systems: A Case Study, Journal of Intelligent Transportation Systems.

In this case study, the benefits of the use of wireless communications is briefly described over wired connections. Firstly, the authors conducted the interviews with traffic agencies to know about the experiences of using wireless communications then they also do the various other case studies to know about in which ITS applications and devices the wireless technology is feasible. So, various case studies are conducted to know about the better wireless service between Wifi and WiMAX. The study also proposed the range of the services of Wifi or WiMAX and cost analysis is done at the last.

2.2 HISTORY OF ITS

ITS was firstly used in the United States in the year nineteen sixties when the use of Electronic route guidance system (ERGS) was started to provide the real time information based on traffic analysis to the road users and drivers. A special hardware was used by the system to analyse current traffic condition. This hardware was further installed in various intersections as well as an on-board 2 way devices was installed inside vehicles which create a 2-way communication between the vehicle and the ERGS system from which road users get the route guidance information. During early seventies, country started using the Automatic Route Control System (ARCS) which is the advanced version of ERGS.

The Japanese Automobile traffic control system (ARCS) was developed further in the same era. In the year 1986, the Intelligent Vehicle Highway System (IVHS) was developed which bring spate of developments in Intelligent Transportation System.

2.3 CLASSIFICATION OF ITS

ITS is basically classified into four types which is given below-

1) Advanced traveller information system
2) Advanced traffic management system
3) Advanced public transport system
4) Advanced vehicle control and safety system

All the four types are briefly described below-

1) **Advanced traveller information system(ATIS)** - Advanced traveller information system is a new technology which provide real time information to the drivers, travellers, tourist for the selection of various routes, times of travel according to the traffic congestion and helps which travel mode is suitable for the journey according to the weather and traffic.

   So, with the help of ATIS, a person can decide its trip properly by taking pre-trip and en-route information through ATIS. It also helps to minimize the traffic jams and it saves the times of riders and drivers by telling them alternate route options and other relevant information.

Fig.-2.1 Advanced Traveller Information System

2) **Advanced Traffic Management System (ATMS)** - ATMS is a system which analyses the traffic flow in the intersection and the major roads by using real time information and then accordingly set and adjust the traffic signal controls for proper

and harmonious flow of traffic and to reduce traffic congestion. It is basically used as a tool to manage traffic smoothly by the traffic police department and regulation. So, it helps road users as it saves time and less fuel is consumed because of proper traffic flow.

Fig.-2.2 Advanced Traffic Management System

3) **Advanced Public Transport System (APTS)-** Advanced Public Transport System is the system which is concerned with increase in the efficiency and safety of public transport on the roads so that public transportation system become more efficient and reliable. This APTS system technology is changing the way of operation of public transportation by providing commuters more and accurate information regarding time , routes and trips. It is further divided into three categories given below-

1> Fleet Management System
2> Traveller Information System
3> Electronic Payment System

So, APTS encourages the road users and travellers to use more and more public transport instead of using own vehicles.

Fig.-2.3 Advanced Public Transport System

4) **Advanced vehicle control and safety system (AVCSS) -** It is a system which uses the latest advanced technologies in the field of ITS. This system is basically concerned with the safety of vehicles on the roads to improve traffic safety and reduce accidents by providing Anti-collision warning to the driver and control, automatic lateral/longitudinal control and automatic highway system.

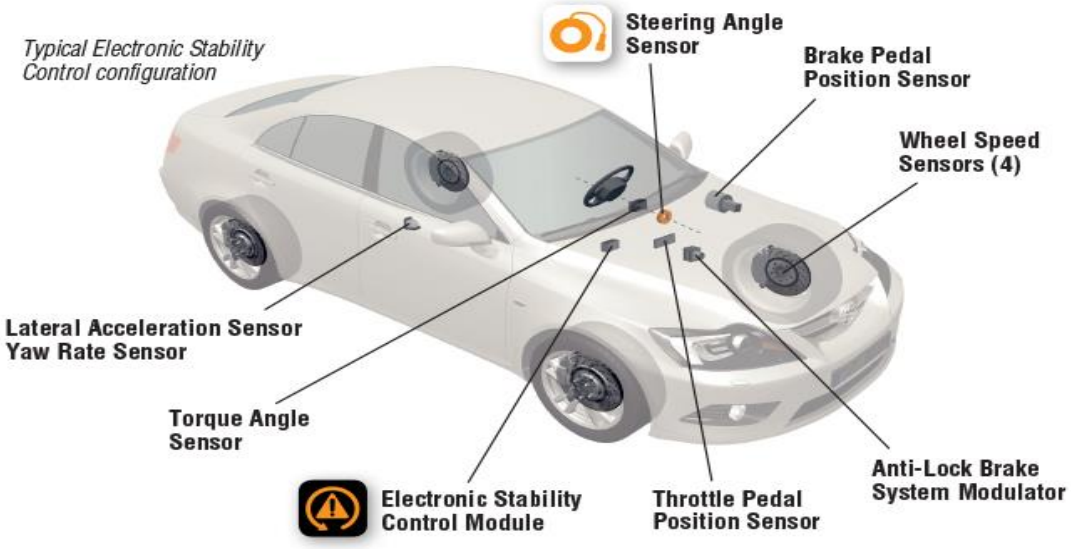


Fig-2.4 Advanced vehicle control and safety system

Besides above four major categories there is one more category called Emergency Management System (EMS) which is latest and newest research field in ITS which is basically concerned in using the combination of all ITS technologies in such a way so that it can provide help in emergency situations during accidents and improvement in reducing the fatality rates.

Commercial Vehicle Operation (CVO) - CVO uses the technology of all the above systems i.e. ATMS, ATIS and AVCSS in commercial vehicles like buses, ambulance, taxes, trucks to improve safety and efficiency during vehicle operations. System includes fleet management, computer scheduling, automatic vehicle monitoring and electronic payment.

2.4 ITS IN VARIOUS COUNTRIES

Many forms of ITS are extensively used in the various developed countries. Some are given below-

- 'Autoguide' was firstly introduced and used in the country U.K. in which Infra-red beacons are used. It was basically the dynamic route guidance system.
- Vehicle based driver information system named 'Carnivet' in France.
- Dynamic route guidance system named 'Advance' in Chicago.
- Highway 407 is the first electronic toll highway in Canada.
- 'Traffic master', in the country U.K. providing real time traffic information service in the highways.
- 'VICS' in Japan using ITS technology like radio beacons, infra-red beacons and FM radio broadcasts to give information to motorists on the roads.
- 'SCATS' in Australia which is basically a traffic responsive control system.
- Nowadays, almost all the developed countries are using Electronic Toll Collection System.
- China is now using Electronic Toll Collection in few major toll roads.

India is a developing country. There are many good expressways and highways in India. The Mumbai-Pune Expressway is a good example. Centralised traffic control system equipped with CCTV is used there.

Technology like 'SCOOT' is successfully used and tried so far in some of the major cities in India.

2.5 ITS IN INDIA

India is the developing country having second highest population in the world after China. With the increase in population, number of vehicles in the road increases causing traffic congestions, air pollution and other problems. With the increase in technology, automobile sector also lead to the significant growth. Till now, Government of India invested nearly about Rs. 234000 in Urban Infrastructure Sector. Metro rails, City Centres, BRT (Bus Rapid Transport), Mono rails, Expressways developed and started in many major cities so that people use and shift towards public transport. We have seen good growth in IT-Sector in major Metropolitan cities like Pune, Bengaluru, Hyderabad, Delhi-NCR with growth in population. But still after all these developments, India is far away in use of ITS technologies. Many reasons are responsible behind it. Many researchers try to find the reason behind it and they come to the conclusion that one of the reason is-since, almost all the cities of India do not follow any particular road pattern during development. Some cities like Chandigarh are exceptions. Disorderly chaotic traffic in non-lane based roads with large heterogeneity of vehicles is the major problem before adaptation of ITS techniques in the Indian scenario. So, significant Research & Developments efforts are required before use of ITS techniques in Indian context. 'SCOOT' software used in ITS which gives information to the drivers and travelers about weather condition and other traffic relevant data is till now successful in India.

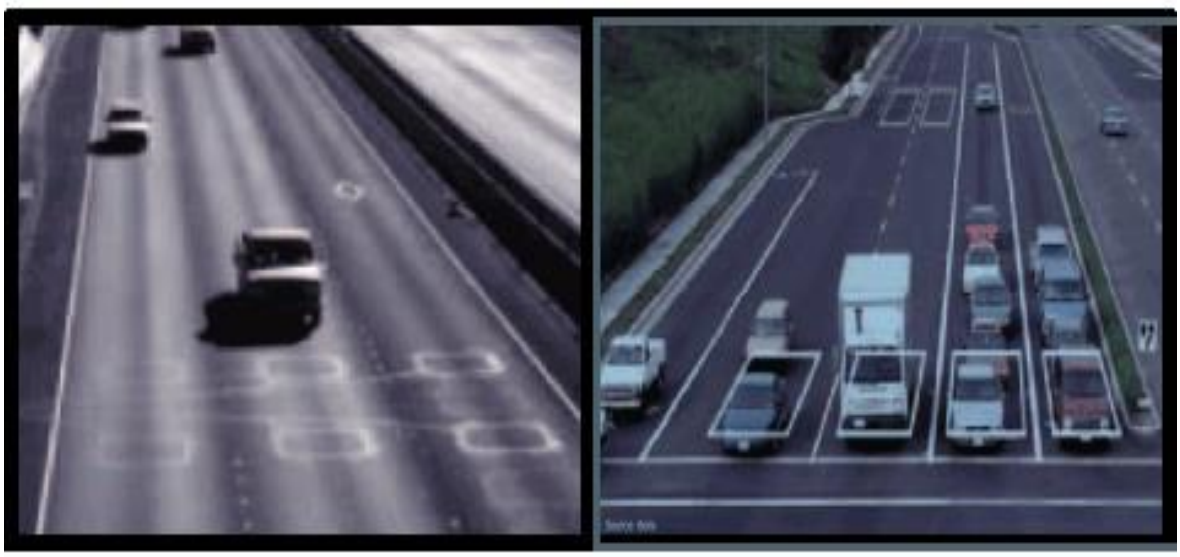


Fig-2.5 Traffic flow on the roads in other countries.

Fig-2.6 Traffic in Indian roads

2.6 SMART CITY MISSION

Smart City Mission is the new and bold initiative started by the Government of India. Universally, there is no any particular definition of Smart City. It varies from city to city and country to country depending upon according to their development level, resources, willingness to change etc. Smart City Mission is going to start in India for the development of cities under SPV (Special purpose vehicle). In January, 2016 Government of India announced the name of various cities for 'Smart City Mission'. In the approach, the main objective of 'Smart Cities Mission' in India is to convert traditional city into high-tech city with core infrastructure and various other facilities and provide its citizens a decent quality life with neat and clean living sustainable environment. Following is the list of changes which government planned for Smart Cities –

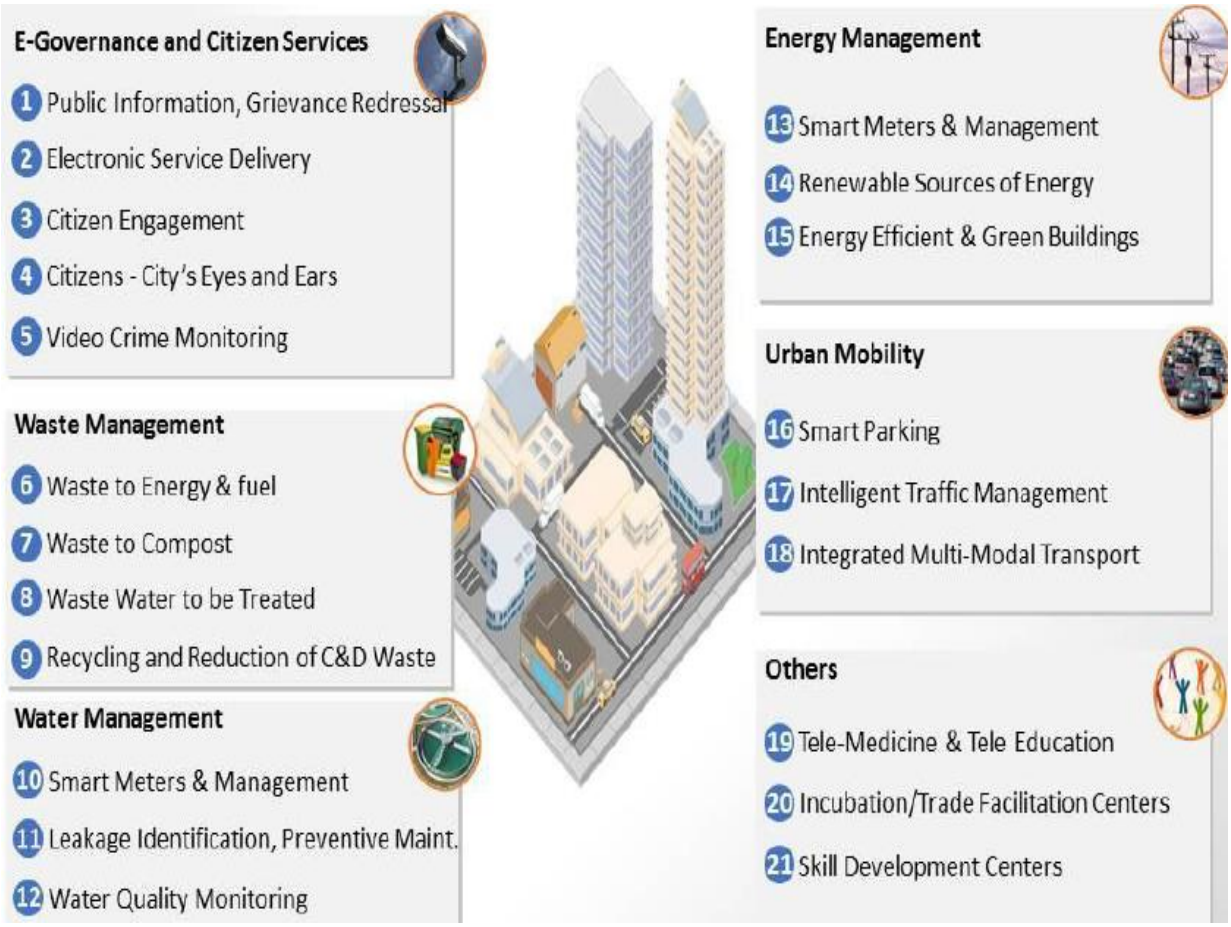


Fig-2.7 Classification of Smart City Mission

2.7 A BACKDROP OF MADHYA PRADESH

It is located in central India. It is the second largest state in terms of area. It play a major role in contributing growth to the national economy and growth of GDP. In this state, transport infrastructure is good having nearly 20 National Highways and about 4948 kilo meter rail lines. One of the major airport of this state is Devi Ahilyabai Holkar Airport which is located at Indore. Bhopal, Indore, Gwalior and Jabalpur are the major inter-state terminals from which nearly 2000 buses operates daily. The government started a project named 'Gramin Sadak Nirman Pariyojna' to merge the villages with roadway networks. The state roadway density is 22.15 km per 100 km Sq. In totality, the length of NH in state is nearly 5,027 km , SH is 10,529 and major district roads is 19,241 km approximately.

Fig- 2.8 Madhya Pradesh Map

2.8 ABOUT SATNA DISTRICT

Satna City which is also called ‘Cement City’ was formed in the year 1948. It is district in central India of Madhya Pradesh state. The city coordinates are 24®20’24” N 80®33’00” E. The city has an area of about 7502 sq. Km and having population more than 2,228,935 (2011 census), in which 21.28% is urban. Population density of this district is 297 persons per square km.

It is one of the district of Madhya Pradesh which has major sites of religious, archeological & tourist interest. Chitrakoot, Maihar, Birsinghpur, Girddhraj Parvat, Bharhut, White tiger safari, Ramvan and various other tourist places.

Fig-2.9 Map showing location of Satna City

2.9 BUS STAND IN INDIA

Bus stand which is also known as Bus terminal/Bus bay is defined as the place where all the buses (public and private) are parked/stopped for some particular time and commuters take the desired bus according to their destination.

Fig-2.10 Bus Stand in India

2.10 STUDY OF CURRENT TRAFFIC SCENARIO IN SATNA CITY

The character and nature of road traffic in Satna city is heterogeneous. It consists of fast motor as well as slow moving traffic like animal drawn vehicles. Cars, Vans, various commercial vehicles, Buses, auto rickshaws, cars etc comes under fast motor traffic. You can see considerable percentage of bicycles plying on roads because Satna is a cement city, Cement factories are there so workers working there use cycles for home to work and vice-versa. Pedestrian traffic is very heavy near Bus stand, Pannilal-Chowk, Circuit house. Thus, problems like delays and congestion occurs. As all types of vehicles move together the speed of moving vehicles get reduced which further effects the road capacity and problem of severe congestion occurs.

Fig- 2.10 Traffic congestion at Circuit House in Satna City

2.11 SATNA CITY BUS STAND

The current condition and situation of Satna Bus stand is very poor. There is no proper parking pattern of Buses in the Bus stand, no information regarding Bus routes, no time table is there which results in lack of information for commuters to know about the ETA and ETD of Buses,

no enquiry office, even the capacity of waiting room is very small in which only few benches are there for sitting, lack of cleanliness. Because of this, commuters are facing various problems who travels daily, weekly and monthly as well as the tourists who come from outside to visit the near-by places.

Fig.-2.11 Commuters waiting for Bus in waiting room

Fig- 2.12 Bus ticket counter and Enquiry office

Fig-2.13 View of Satna Bus Stand

2.12 WHY ITS FOR PROJECT?

Because it provide benefits in terms of-

- Reduce uncertainty waiting time.
- Increase the system accessibility.
- Increase the safety of the commuters and users.
- Reduce the traffic congestion on roads.
- Improve economic productivity.
- Improve energy efficiency and environmental quality.
- Reduce operational costs.
- Reduce the consumption of fuel.

After implementation of Intelligent Transport System in Satna bus stand/station it will encourage the people to use public transport and others instead of using own vehicles.

The main ITS components we use for the transformation of current to Smart Bus stand is Vehicle tracking system mainly Global positioning system, Geographical information system, Information and Communication technologies, Electronic display systems i.e. LCD's, Boom Barriers, CCTV's, Turnstile gates with Puffer machines during Entry and Exit etc.

2.13 WHY SATNA CITY FOR PROJECT?

In India, it is just a beginning of converting cities into smart cities and 'Smart cities mission' project is right now in the initial stage. The main reason behind use of ITS for developing smart Bus stations/stands in the city Satna is because of its smaller size.

The cost for implementing ITS in Bus stands of big cities like Bhopal, Indore will be higher. Thus, it is always beneficial and wiser to implement the project in smaller size so that we can conclude the results and learn lessons from the outcomes.

2.14 International Literature survey of ITS studies and benefits

Various studies taken up internationally in various countries. These studies relate to 'before' and 'after' the project implementation list:

1. **98 B-Line Bus Rapid Transit Evaluation Study (Sep 2003)**

• Travel time savings (~by 20%) compared to previous services
• Modal Shift 23%
• Reduce travel time variability
• Reduction in 8 Million personal Vehicle Kilometres
• Reduction in Vehicle hours 25%
• Benefits estimated to be 30% higher than costs.

2. **Wisconsin community (1999)**

• Users perceived that waiting time is 2.62 more valuable than travel times
• Wait Times sensitive to Benefits

• Benefits of Modal over a period

• Weighted importance index of various features – rider's perceptions {The most important ranking is scored 1 and the least important ranking is scored 5}

Table- 2.1 Ratings given by commuters for ITS

Variable	**Score**
Real time information	1.55
Low fares	1.62
Replacement on breakdown	1.66
Emergency response	1.78
Exact Delay time	1.91
Latest Technology	2.01
Display Next stop	2.39
Availability of seat	1.91
Bus is on-time	1.48
Calling out stop	2.82

3. Passenger Wait Time Perceptions at Bus Stops (Chicago)

• Statistically significant between Perceptions and Actual Wait times

• Eliminate the Exaggerated perception of wait times

4. Regional Bus Study (Washington (Sept 2003)

• Scheduled Arrival 49%

• Signage of Arrival 9%

• Non-Riders - Better Information of Services

• Non-Riders - Allured by Premium Service Buses for Modal Shift

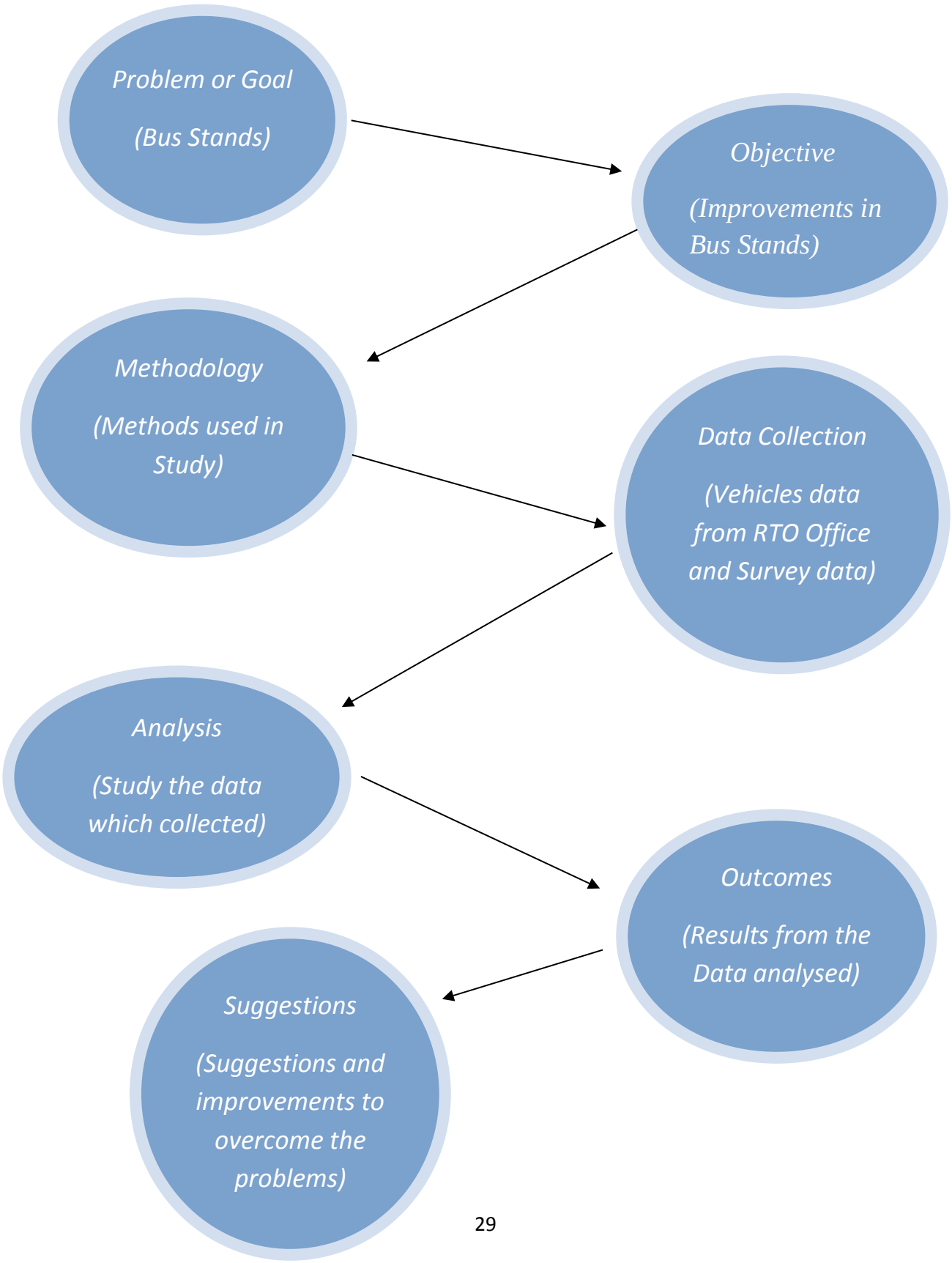
5. Transport Cooperative Research Program Washington 2003

• Passenger Valued Arrival Information at 31 Cents
• 90% passengers at least once looked at the Display
• 65% felt that they have waited for less time
• Real-time information at locations where key travel decisions are made (e.g., office buildings) would be used and considered useful by a majority of transit passengers.
• People travelling late at night now have the confidence that a bus is not far away
• Value of Display as very high 4.5 on 5-point scale
• Display by itself is not likely to increase Overall satisfaction
• Use of the bus services more often from modal shift toward public transportation
• Increase in ridership and revenue.

APPROACH AND METHODOLOGY

CHAPTER – 3

3.1 APPROACH FOR STUDY



3.2 METHODOLOGY USED FOR STUDY

- Survey Methodology- A questionnaire is prepared to conduct survey of 500 peoples of Satna City in various colleges, educational institutions and government offices.
- Observation Methodology – Observation of Bus Stand/Bus Stops is to be done to know the problems commuters are facing and average waiting time in Bus Stand/Stops.

3.3 METHOD OF ANAYSIS

Gap Analysis Approach

In this approach, the various data is collected and arranged year wise statistically, then the analysis is done for the various variables whether its performance is towards goal or not.

For example- 15 ug/meter cu. Matter per year should be present in the air as per according to the guidelines because it is threshold value by National Ambient Air Quality Standards (NAAQS). Like capacity measure depend on operating characteristics under various level of service.

The measures can be taken with Bus Stands-

- Alert- What is going on?
- Diagnose- How did we get here?
- Review-How are we doing?
- Learn-How can we do better?
- Decide-What should we do?
- Forecast-Where are we heading?

3.4 DATA TO BE COLLECTED

- Demographical data of city
- Road Map of Satna city.
- Population of Satna district as per the census
- Number of vehicles registered in the past three years.
- Number of Motor Vehicles ‘on-road’ in Satna city
- Generation of trips of Buses in various routes.

- Number of Buses currently running in the city.
- Number of commuters travel per day.
- Traffic Volume count
- Questionnaire survey data

3.4.1 DEMOGRAPHIC DATA OF SATNA CITY

Satna is a district of Madhya Pradesh. It is also called 'Cement City' formed in the year 1948. It is district in central India of Madhya Pradesh state. The city coordinates are 24®20'24"N 80®33'00"E. The city has an area of about 7502 sq. Km and having population more than 2,228,935 (2011 census), in which 21.28% is urban. Population density of this district is 297 persons per sq. Km. The major national highway which passes through Satna city is NH-7 and state highway NH-75 passes from the heart of the district connecting other cities Panna and Rewa.

3.4.2 MAP OF SATNA CITY

Fig-3.1 Map of Satna City

3.4.3 POPULATION OF SATNA CITY

Below is the details of the population of Satna City as per the census and the percentage increase is calculated between the consecutive years.

Table 3.1 Population of Satna City

Year	Population	Percentage increase
1991	156630	46.4%
2001	229307	
2011	282977	23.40%

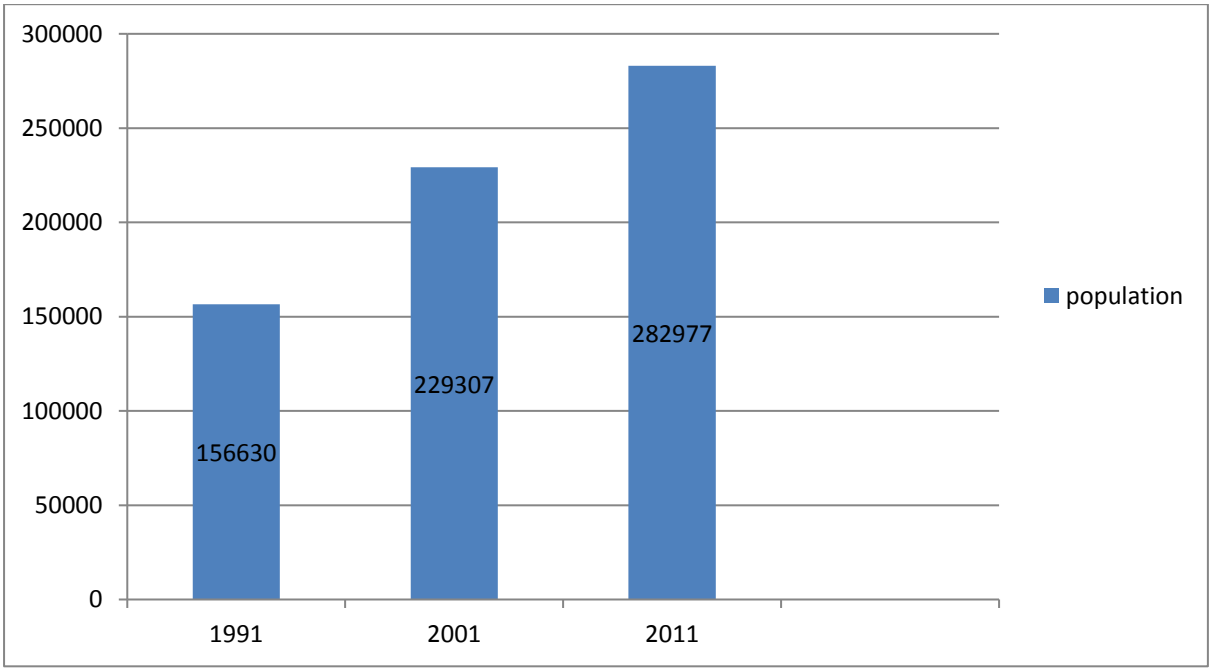


Fig 3.2 Graph showing the population of Satna city year wise

3.4.4 Motor Vehicles ‘on-road’ in Satna city

The given data is collected from the RTO (Regional Transport Office) of Satna district to know about the current vehicles running inside city till November 2016. The percentage share of the vehicle is calculated given in the table below-

Table-3.2 Motor vehicles running on road

Type of vehicle	**Number**	**Percentage**
Bus	2058	0.86%
Car/Jeep	16321	6.85%
Auto/Cab	7826	3.28%
2-wheelers	172473	72.45%
Other vehicles	39371	16.53%
TOTAL	238049	100%

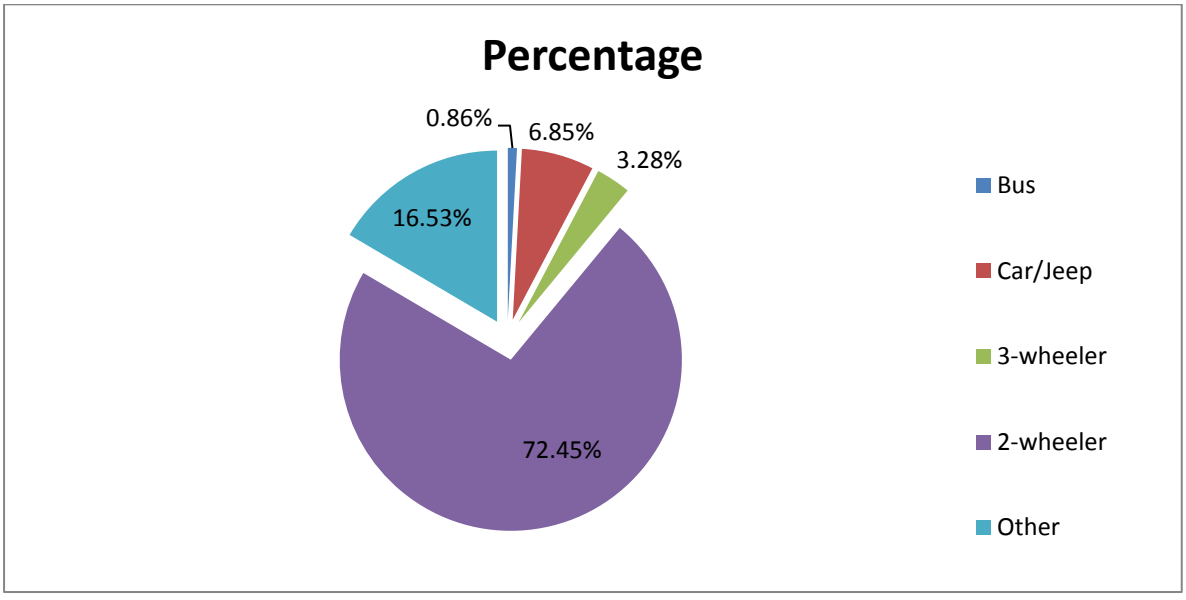


Fig-3.3 Pie-chart showing the Percentage Share of vehicles ‘on-road’

3.4.5 VEHICULAR GROWTH IN SATNA CITY

The increase and growth in number of vehicles from the last ten years is given below-

Table- 3.3 Year wise vehicular growth in Satna

Vehicle Type	2005	2010	2015	2016
2-Wheeler	59,681	1,00,123	1,59,221	1,67,482
3-Wheeler	1260	2043	4534	4849
4-Wheeler	6070	10,741	17,765	18,816
Bus	1475	1750	1998	2027
TOTAL	68486	114657	183518	193174

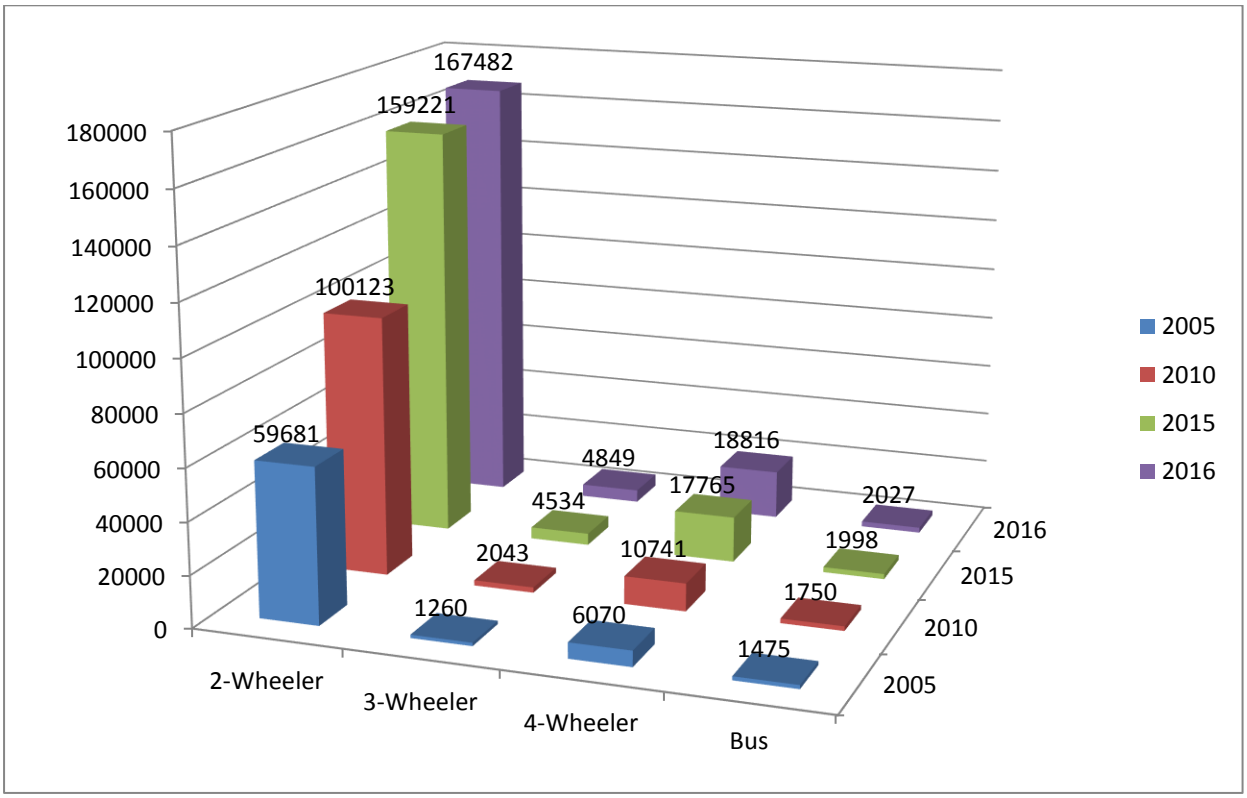


Fig-3.4 Vehicular growth in Satna city

3.5 BUS NETWORK DENSITY

Satna Bus Stand operates about 429 trips through 194 schedules from 1 depot on 77 various routes making around 26,850 passenger trips per day. The total number of bus stops in the city is about nine. The average waiting at the bus stops is found to be around 10-15 minutes through Observation Survey.

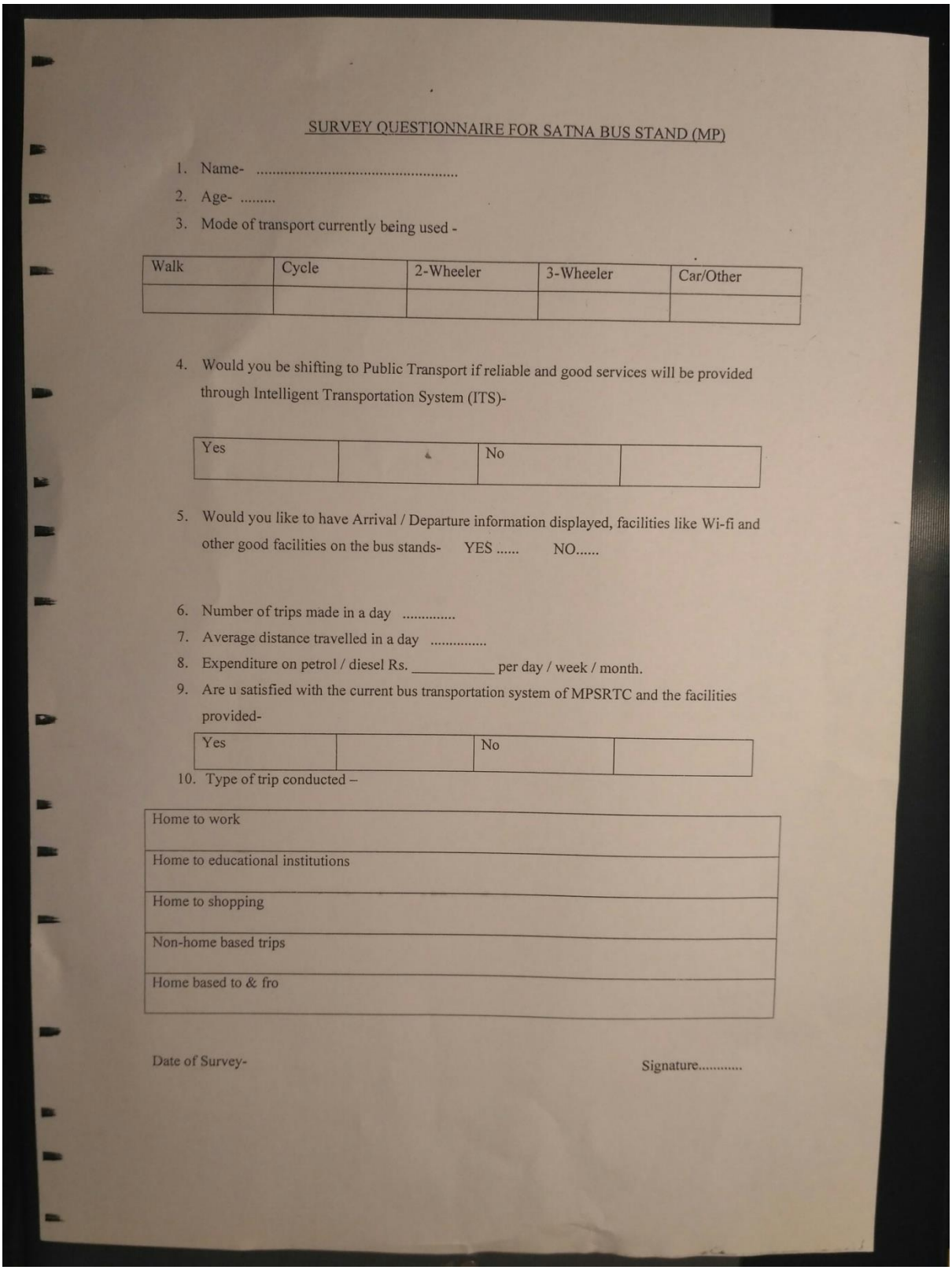
Table- 3.4 Bus Network density of Satna district

Total trips conducted per day	429
Total no of Bus depots	1
Schedules	194
Routes	77
Passengers travelled in a day	26,850 (approx.)

3.6 DATA COLLECTED FROM QUESTIONNAIRE SURVEY

Survey of 500 people is conducted in various government offices, Educational institutions, Homes and Buildings. Survey is conducted to understand the behaviour of commuters towards Public Transportation Mode. Ten different questions were asked from the people and answer is filled in each paper.

Below is the format of Questionnaire Survey Conducted-



SURVEY QUESTIONNAIRE FOR SATNA BUS STAND (MP)

1. Name- .....
2. Age- .....
3. Mode of transport currently being used -

Walk	Cycle	2-Wheeler	3-Wheeler	Car/Other

4. Would you be shifting to Public Transport if reliable and good services will be provided through Intelligent Transportation System (ITS)-

Yes		No	

5. Would you like to have Arrival / Departure information displayed, facilities like Wi-fi and other good facilities on the bus stands- YES ..... NO.....

6. Number of trips made in a day .....
7. Average distance travelled in a day .....
8. Expenditure on petrol / diesel Rs. _____ per day / week / month.
9. Are u satisfied with the current bus transportation system of MPSRTC and the facilities provided-

Yes		No	

10. Type of trip conducted –

Home to work
Home to educational institutions
Home to shopping
Non-home based trips
Home based to & fro

Date of Survey- Signature.....

Fig- 3.5 Questionnaire survey format

3.6.1 MODE OF TRANSPORT USED

The below data is collected from the questionnaire survey conducted after the analysis.

Table- 3.5 Mode of transport used

Type of vehicle	**Total number**	**Out of 500**	**Percentage share**	**Approximately percentage**
2-wheeler	500	146	29.2%	29%
3-wheeler	500	106	21.2%	21%
Car	500	69	13.8%	14%
Bus	500	54	10.8%	11%
Cycle	500	86	17.2%	17%
Walk	500	39	7.8%	08%
Total		500		100%

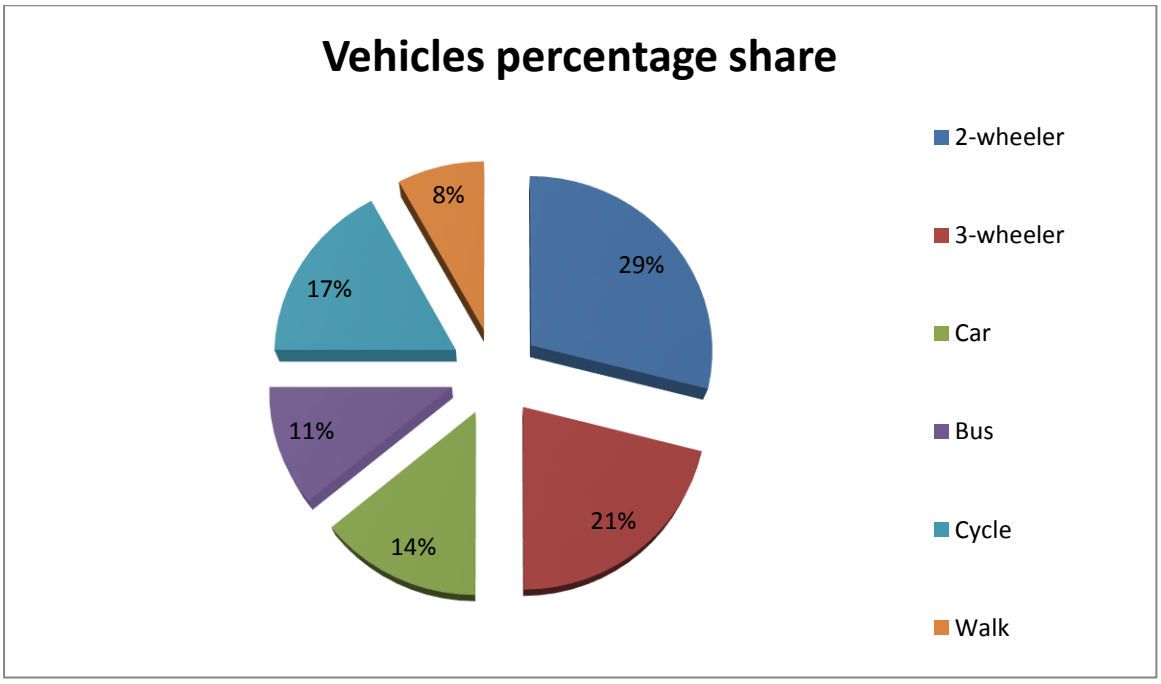


Fig-3.6 Pie-chart showing percentage share of vehicles

3.6.2 AVERAGE TRIP LENGTH

From the survey conducted, the average trip length of people per day is calculated-

Table-3.6 Average Trip Length per day

Type of vehicle	**Avg. trip length per day (km)**
2-wheeler	5.5
3-wheeler	3.3
Car	6.1
Cycle	1.8
Walk	0.7
Bus	4.6

3.6.3 PER CAPITA TRIP PER DAY-

Per capita trip is defined as number of trips conducted by each person in each day. The calculation is done from the survey by calculating the per capita trip age wise.

Table-3.7 Per capita trip per day

Age group	**Till 15**	**15-25**	**26-58**	**Above 58**
Male	46	109	113	35
PCT per day	03	09	06	02
Female	21	86	79	11
PCT per day	02	07	05	01

3.6.4 NATURE OF TRIPS

The type of trip conducted by the commuters and the percentage share is calculated and given in the table below-

Table-3.8 Type of trip conducted

TYPE OF TRIP	NUMBER	PERCENTAGE SHARE
Home to work	206	41.20%
Home to educational institutions	108	21.6%
Home to shopping	15	3%
Non-home based trips	09	1.8%
Home based too & fro	162	32.4%
TOTAL	500	100%

3.6.5 WILLINGNESS TO SHIFT TO PUBLIC TRANSPORT

The given data is analysed from the survey conducted and percentage share of people who will shift to the public transport after the improvement of Bus Stand of Satna from private to public is given below-

Table-3.9 Willingness to shift to Public Transport

Mode of transport	Sample size	Willingness to shift	% Share
2-wheeler	146	87	59.58%
3-wheeler	106	101	95.28%
Car	69	56	81.15%

Cycle	85	79	92.94%
Walk	39	30	76.92%
TOTAL	**500**	**353**	**70.60%**

Given below is the graph which shows the percentage share of each vehicle who will shift towards the Public Transportation-

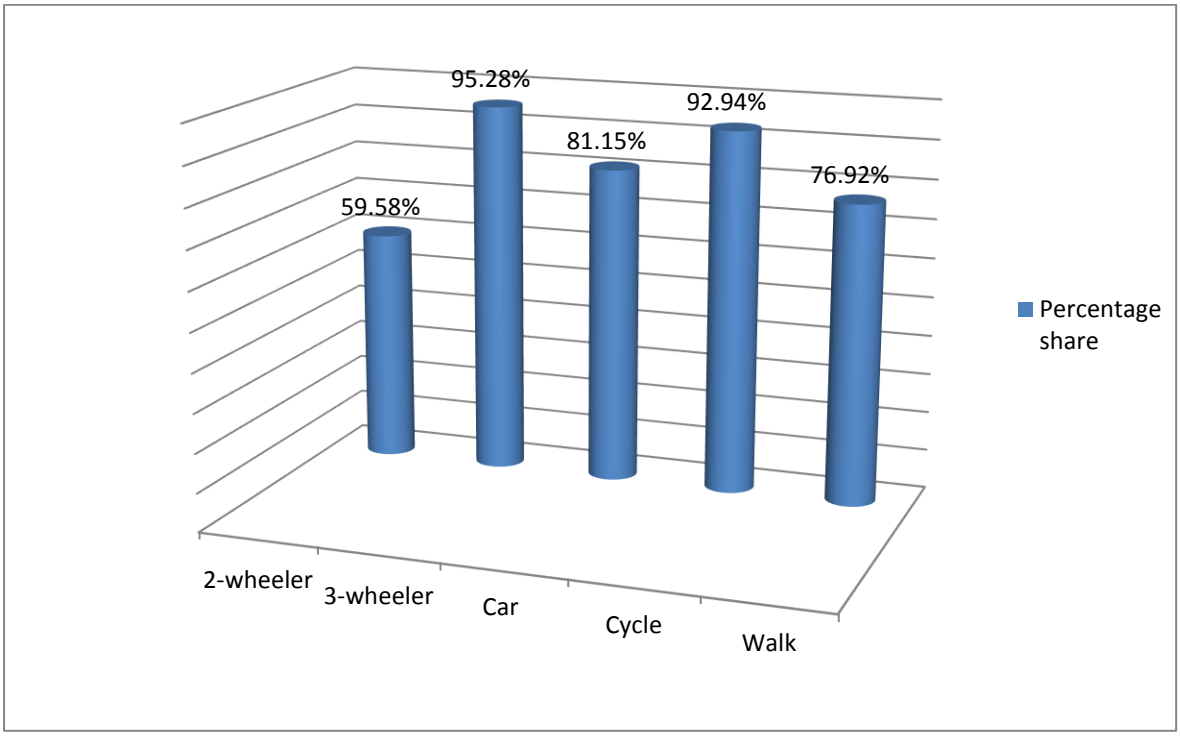


Fig-3.7 Graph showing percentage of vehicles willingness to shift

3.6.6 OTHER SURVEY DATA

Tables and Pie-charts showing no. of commuters who wants better services, good environment in the Bus Stand and who are satisfied with the current Bus Transportation System provided by MPSRTC-

Table-3.10 Commuters who want better services in Bus Stand

YES	497	99.4%
NO	03	0.6%
TOTAL	500	100%

Table-3.11 Commuters satisfied with the current facilities provided

YES	39	7.8%
NO	461	92.2%
TOTAL	500	100%

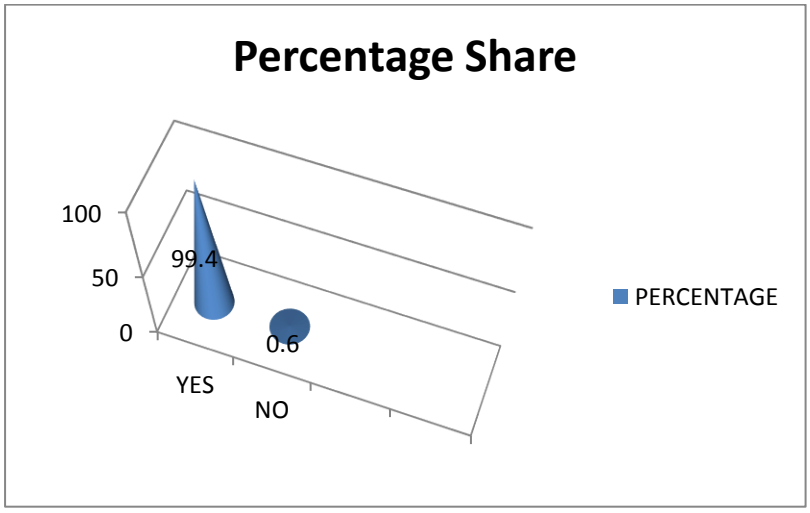


Fig-3.8 Graph of Percentage of commuters who want better services

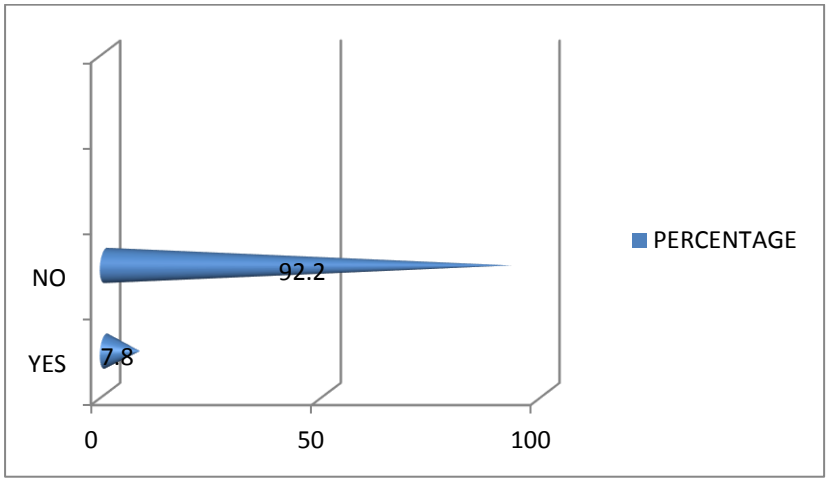


Fig-3.9 Graph of commuters satisfied with the current facilities provided

3.7 AVERAGE DAILY TRAFFIC

The Average daily traffic of 12 hours i.e. from 9 am to 9 pm duration of the road in-front of Bus Stand is taken manually. Given below are the details in the table-

Table-3.11 Average Daily Traffic

TIME	CAR	2-W	TRACTOR	BUS	3-W
9-10 AM	26	354	1	44	12
10-11 AM	34	399	3	34	22
11-12 AM	55	472	4	46	31
12-01 PM	52	480	6	38	45
01-02 PM	41	484	3	31	36
02-03 PM	46	365	2	34	35
03-04 PM	37	324	4	21	29
04-05 PM	33	320	3	14	22
05-06 PM	45	494	4	12	37
06-07 PM	44	452	3	3	33
07-08 PM	39	339	2	8	24
08-09 PM	27	321	2	6	21

Table-3.12 PCU values of different vehicles on urban roads in India

Vehicle	PCU
Car	1
2-Wheeler	0.5
3-Wheeler	1.2
Bus/Truck	2.2
Tractor-Trailer	4

3.8 TRAFFIC VOLUME COUNT (TVC)

Traffic Volume Count in terms of PCU is calculated from the ADT table to find the Flow Rate and Peak hour factor.

Table-3.13 Traffic Volume Count

TIME	CAR	2-W	TRACTOR	BUS	3-W	TV
9-10 AM	26	177	4	96.8	14.4	318.2
10-11 AM	34	199.5	12	74.8	26.4	346.7
11-12 AM	55	236	16	101.2	37.2	445.4
12-01 PM	52	240	24	83.6	54	453.6
01-02 PM	41	242	12	68.2	43.2	406.4
02-03 PM	46	182.5	8	74.8	42	353.3
03-04 PM	37	162	16	46.2	34.8	296
04-05 PM	33	160	12	30.8	26.4	262.2
05-06 PM	45	247	16	26.4	44.4	378.8
06-07 PM	44	226	12	6.6	39.6	328.2
07-08 PM	39	169.5	8	17.6	28.8	262.9
08-09 PM	27	160.5	8	13.2	25.2	233.9
TOTAL TRAFFIC VOLUME PER DAY						4085.6

Flow Rate (q) = Maximum Traffic Volume*(duration/time interval taken)

q = 453.6*(12/1) = 5443.2

Peak Hour Factor (PHF) = Traffic Volume /Flow rate (q)

= 4085.6/5443.2 = **0.75**

If PHF of any road in given time is greater than 1 then traffic is considered more than the capacity of road but value is less than 1 i.e. 0.75 thus traffic is below capacity.

RESULTS, ANALYSIS AND DISCUSSION

CHAPTER – 4

4.1 GENERAL

This chapter mainly deals with the results and discussion from the data provided in the Chapter no. 4. From the various data collected from the RTO of Satna district, through Observations and Questionnaire survey conducted in various places of Satna district, calculations as per the requirements is done and the analysis and discussion of results came out is discussed in this chapter briefly and Recommendations as well as Improvements required is explained.

4.2 ANALYSIS OF PRIMARY DATA

4.2.1 Analysis of Population and Vehicles of Satna District- The population of Satna in the year 1991 counted is 156630 in number. After 10 years, i.e. in 2011 the population increases to 282977 in number. The percentage increase is 80.66%. Thus, it is clear that population is increasing rapidly with faster rate Similarly, the vehicles which is just 68486 in number in the year 2005 increases to 183518 in number after 10 years i.e. in 2015. The percentage increase is 167% which is huge.

So, with the increase in population the vehicular growth is also there which is huge as compare to the population growth rate.

Table-4.1 Percentage increase in growth of vehicles

Vehicle Type	**2005**	**2015**	**% increase**
2-Wheeler	59,681	1,59,221	**166.78%**
3-Wheeler	1260	4534	**259%**
4-Wheeler	6070	17,765	**192%**
Bus	1475	1998	**35.45%**

We can see from the table that the percentage increase in the ten years of 2W, 3W and 4W is 166.78%, 259% and 192% while percentage increase in Bus is just 35.45% which is surprising.

4.2.2 Analysis of Motor Vehicles 'on-road' in Satna city- The percentage of vehicles currently registered in the Satna district in totality is 238049 in number. From the table 3.2 it is clear that the percentage share of 4-W and 3W in totality is 10.13%, 2-W is 72.45% and other vehicles share 16.53% while buses is 0.86%. which is not even 1% .

This clearly says that the use of other vehicles is higher in number as compare to the buses. As the use of public transportation is less it results in traffic congestion and pollution problems inside the city.

4.2.3 Analysis of Questionnaire Survey data- Survey of 500 people is conducted in various government offices, Educational institutions, Homes and Buildings. The format of Survey is given in the Fig-3.5. From the data and after calculations we come to know that only 11% of people prefer Buses for trips while other 89% people prefer other modes of transport. The percentage of trips conducted by commuters via Bus will be increased if MPSRTC will provide good and better services.

The average trip length per day of commuters is 4.6 km by bus and per capita trip of male and female between age 26-58 is 06 and 05 respectively. In daily basis inside city, people travelled around 5 km on an average via Bus and majorly for Home to Work which shares around 41.20% out of 100 given briefly in the table-3.8 but the main issue is people are not using Public Transportation mode.

From the survey conducted, we come to know that 92.2% (given in Table-3.10) of people are not satisfied with the facilities provided in the Bus Stands of Satna district. This clearly says that we need to improve the current traditional Bus Stand to a Smart High-tech Bus Stand to increase the use of Bus by the people.

The percentage of Willingness to shift of the commuters who use 3-W/Cab, Cycle and Car after the survey comes is 95.28%, 92.24% and 81.15% respectively (Table-3.9) and commuters who want better services in Bus Stand is 99.4%. So, it is clear that if we provide better services by making Bus Stand Hi-tech and Smart more and more people will prefer bus instead of using their own vehicles which will finally reduce the air pollution and traffic congestion on the roads.

4.3 OVERVIEW OF BUS STAND

Satna Bus Stand operates about 429 trips through 194 schedules from 1 depot on 77 various routes making around 26,850 passenger trips per day. The Bus Stand is situated in the heart of the city i.e. in the centre of the city. Because of that one can easily reach in the Bus Stand.

Below are some of the images of Satna Bus Stand-

Fig-4.1 Bus Stand, Satna (view from the top of the building)

Fig-4.2 Bus Stand, Satna (view from the entry side)

Fig-4.3 Bus Stand, Satna (Front view of waiting room)

4.3.1 Present Condition of Bus Stand

- There is neither any Bus bay marking made nor any particular pattern followed for parking of buses.
- No parking facility available for 2-Wheelers near the bus stands for the persons who came from their homes to go far places through bus. As a result, they parked their vehicles on the side of the road which consumes road space
- No enquiry office to get information of Bus.
- No ticket-counter available for purchasing of Bus tickets.
- No time table is available anywhere to know the Bus information.
- Lack of cleanliness everywhere inside bus stand and open drains.
- The condition of waiting room is worst. Fans not working even during summer season, walls are dirty, no dustbins to throw garbage, no points for mobile charging. Because of that some people spit on the walls.
- of that passengers sit on the floor.
- No Washrooms/Bathrooms available in the Bus Stand.
- No drinking water facility is available. People are helpless to buy water bottles specially during summers. Seating capacity of waiting room is less as around 26,850 passengers travelled in a day. Because
- No police station or security office is present for security purposes of woman and tourists.
- No government authorised food zone is there. Because of that, people buy food from local shops which is unhygienic and costly
- No cloak room available.

4.4 SUGGESTIONS FOR IMPROVEMENT

4.4.1 FOR PARKING-

Fig-4.4 Parking Bays

Fig-4.5 Open drains

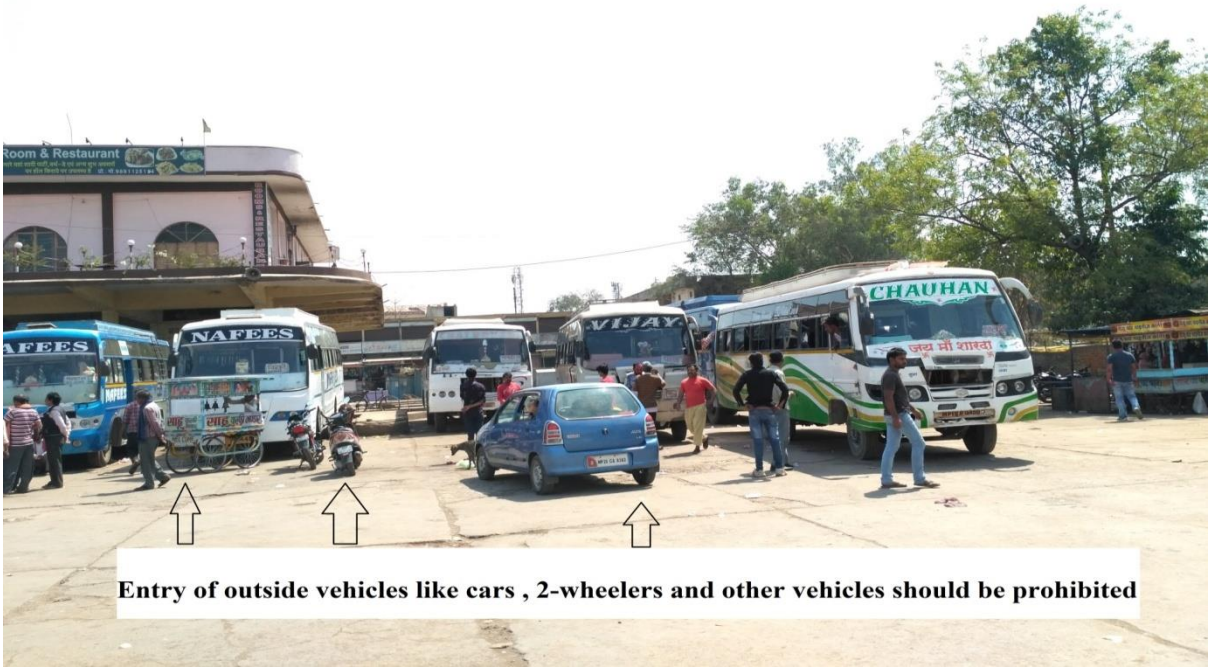


Fig-4.6 Outside vehicles inside Bus Stand

Fig-4.7 Location for construction wall/railing

- Marking of parking bays of length 12.5m and width 3m should be made everywhere.
- Drains should be closed.
- Walls should be constructed and railings should be installed at the locations given in the images.
- Entry of outside vehicles should be prohibited.
- Dustbins should be provided at some particular interval of distances for neat and cleanliness.

4.4.2 FOR WAITING ROOM

Fig-4.8 Condition of waiting room (image-1)

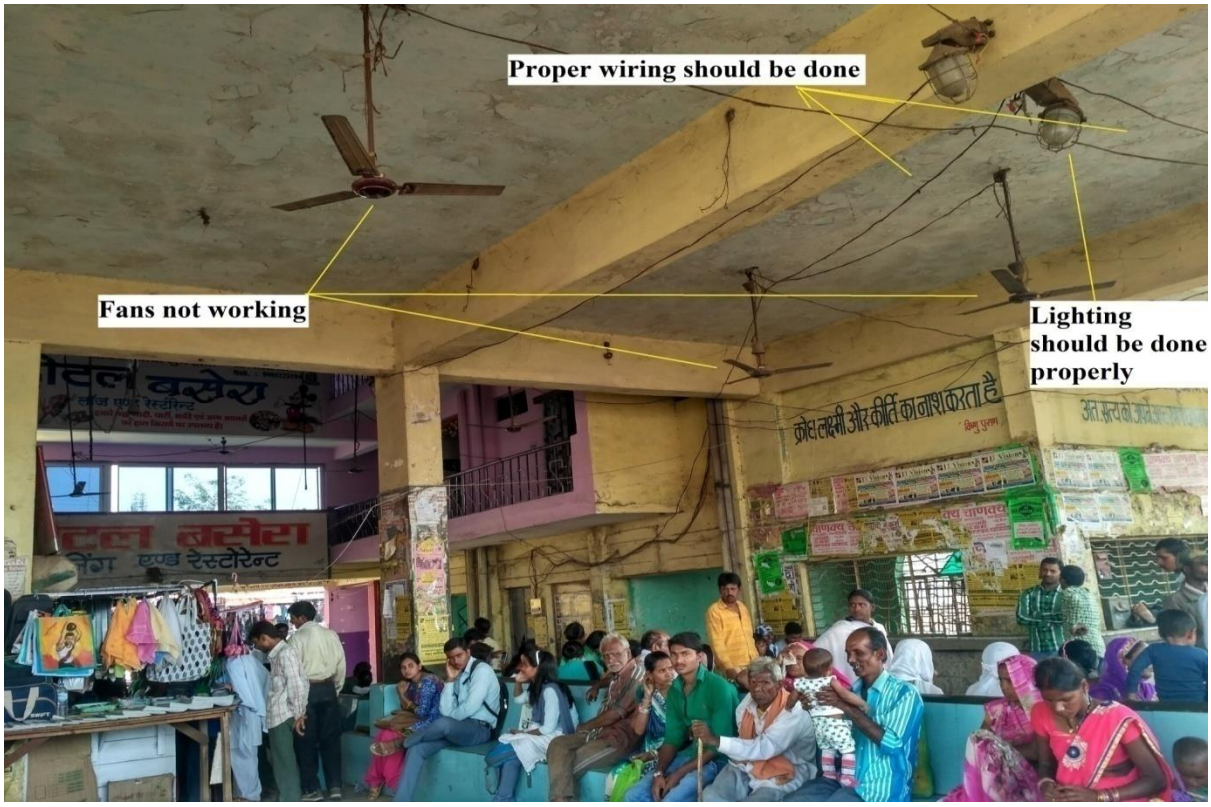


Fig-4.9 Condition of waiting room (image-2)

Fig-4.10 Condition of waiting room (image-3)

- Seating capacity of waiting room should be increase. Due to less number of seats available, passengers are helpless to sit on the floor.
- Proper cleaning of waiting room should be done in daily basis twice a day.
- White washing and paint of walls is required.
- Pasting of papers, stickers and pamphlets on the walls should be strictly prohibited.
- Proper wiring inside the waiting area should be done and fans should be workable and tube lights/ LCDs or LEDs should be installed at every corner of the room.

4.4.3 SUGGESTIONS FOR MAKING SMART BUS STAND

Before moving to Smart Bus Stand, condition of current traditional Bus Stand should be improved. Suggestions and improvements required are already mentioned in 4.5.1 and 4.5.2. Following are the suggestions for making Bus Stand better, Smart and Hi-tech –

1. **Wifi-** The Bus Stand should be fully equipped with free Wi-fi . At least two Wi-fi routers with good bandwidth capacity should be installed either on the side of the wall or at the top of the wall in the waiting room.

Fig.-4.11 Wi-fi router attached on the wall

2. **Solar light-** Solar light should be installed inside the Bus Stand at every corner, edge and centre which will save electricity and money for longer time and provide light during night time.

Fig.-4.12 Solar light

3. **Turnstile Gates -** Turnstile gates should be installed at the entry/exit points of Bus Stands to avoid unnecessary rush inside the Bus Stand. Currently, we have Aadhar Cards with us, if we convert Aadhar Card into Digital Aadhar Card and connect it with Turnstile gates then entry/exit will be possible only through the digital Aadhar Card which will improve safety of Bus Stand and government will get complete data of commuters.

Fig-4.13 Turnstile gates

4. **CCTV cameras-** CCTV cameras should be installed inside the Bus Stand at every corner, edge and centre for video surveillance which will increase safety specially during night time for commuters.

Fig-4.14 Different types of CCTV cameras

5. **Puffer Machine-** Puffer machine also called trace portal machine is a security device which detects the explosives and illegal drugs. It should be installed at the entry point of Bus Stand to make Bus Stand secure.

Fig-4.15 Puffer Machine

6. **RFID readers and Boom barriers-** The Boom barriers in collaboration with RFID readers should be installed at the entry point of Bus. For that, a RFID chip should be attached at the front side of Bus. When bus will come, the RFID reader will detect the signal and boom barrier will open automatically. This ITS technique will stop the entry of other vehicles and increase the safety

Fig-4.16 RFID reader and Boom Barrier

7. **GPS devices and Panic Buttons-** GPS devices with Panic Buttons should be attached in each single bus for tracking and monitoring of Bus. In case of any emergency or untoward event, the woman passenger would be able to push the button which will transfer the information to the Central Control Room of Bus Stand via GPS.

   Apart from this, if Bus will deviate from its prescribed route Central control room will come to know through GPS and immediate action will be taken. This will increase the safety of passengers.

Fig-4.17 GPS device

Fig-4.18 Panic Button

8. **Master Control Room**- Master Control Room also called Central Control Room is required for video surveillance, tracking of buses and for storage of data. This room consists of computer terminals, UPS LCD screens which display the movement of Buses and updating of PIDS data is done from this room.

   In Satna Bus Stand, the room is available beside the ticket counter to make it CCR. And after study, there is requirement of only 4 computers with internet connection, 2 led display panels and storage devices. The GPS mounted in the buses will send the information to the CCR which will be displayed on the LCD screens.

Fig-4.19 Working of GPS

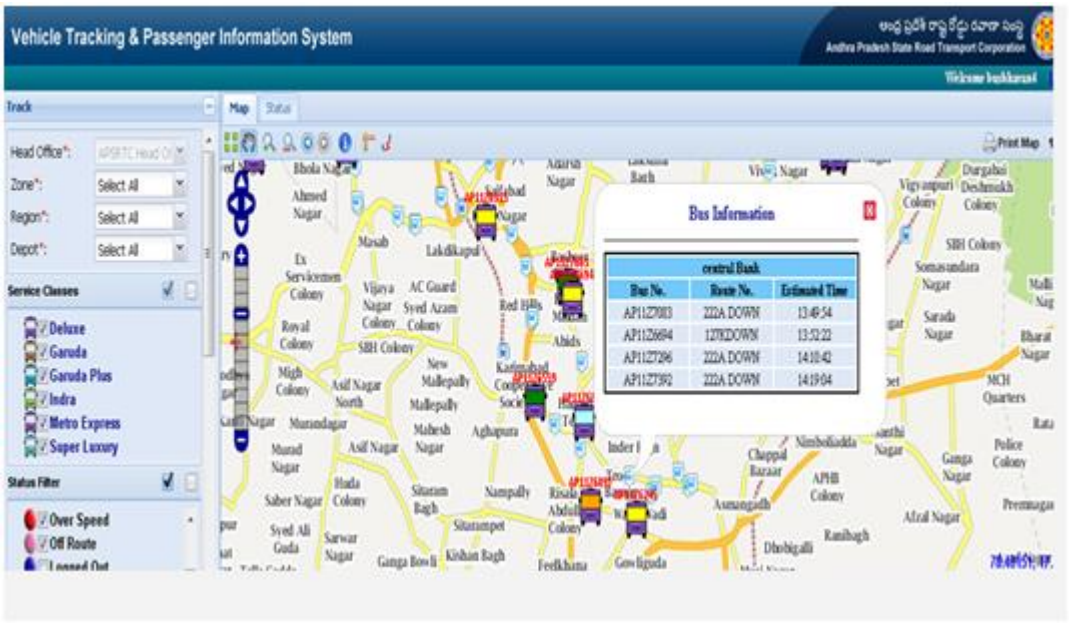


Fig-4.20 Commuter Portal: Internet

9. **Passengers Information Display System (PIDS)** - PIDS is required for showing the time table of buses as well as ETA (Expected Arrival Time) and ETD (Expected Departure time) of buses.

Fig-4.20 PDIS inside waiting room

Fig-4.21 PDIS outside waiting room

10. **E-ticket counters-** Computerised E-ticket counter should be started having facility of giving payment via money as well as through POS machines. As everyone have mobile nowadays ticket will be send directly to the mobile which will help saving paper.

    Besides, number with SMS facility and helpline number should be started so that commuters waiting in the Bus Stops will come to know about the ETA of Bus through CCR or directly through call through helpline number.

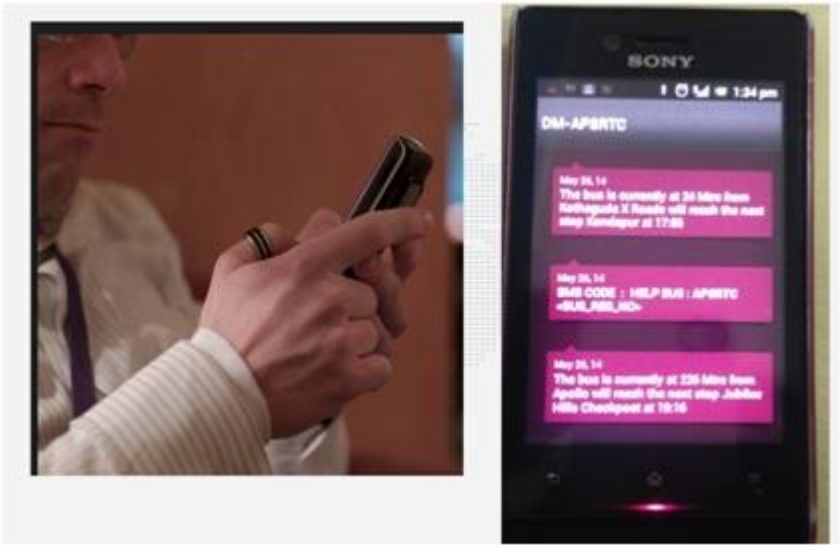


Fig-4.22 Commuter: ETA with SMS

11. **In-bus display -** Display Panels should be installed in each single Bus outside as well as inside the Bus so that commuters will come to know about the destination without asking to the conductor again and again.

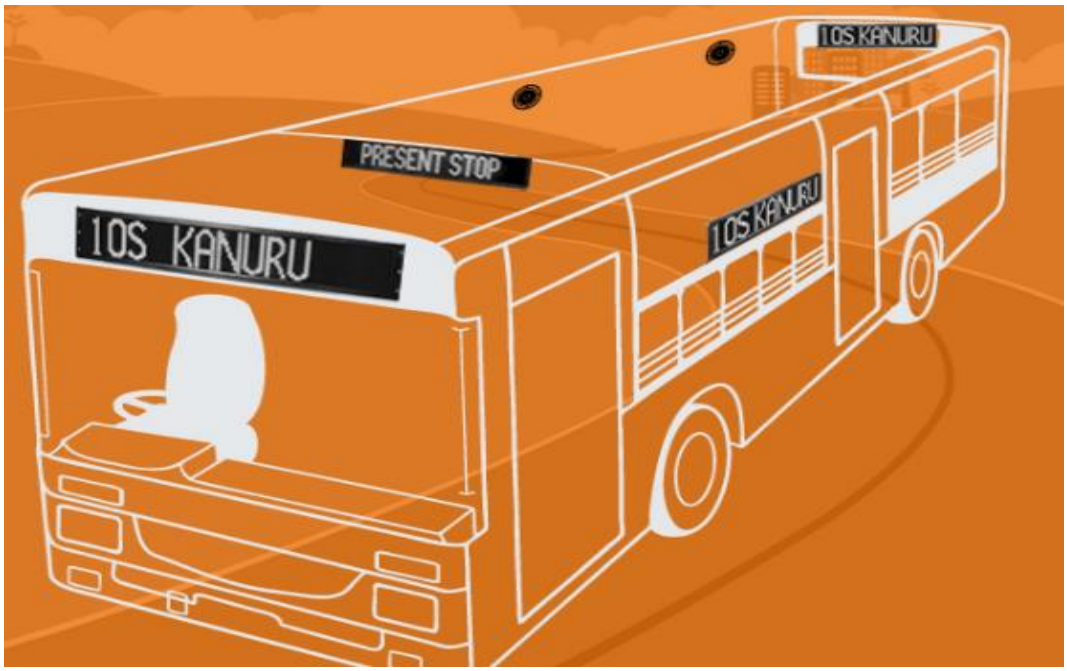


Fig-4.23 Bus equipped with display panel

4.4.4 OTHER GENERAL SUGGETIONS FOR IMPROVEMENTS

- Drinking water facilities and toilets for men, women and disabled persons should be made separately.
- Government authorised Eateries and Food joints should be started.
- Cloak room should be made.
- Rest rooms and Dormitory should be constructed.
- Reserved parking bays for breakdown vehicles, space for mini workshop should be made.
- Separate Enquiry counters for Tourists and Security 24x7 should be started.
- Space for parking for 2-wheelers should be constructed.

- Unauthorised local vendors and shops who create nuisance inside Bus Stand should be removed.

4.5 COST ESTIMATION

Table-4.2 Cost analysis

NO.	DESCRIPTION	UNIT COST
1	Computer for MCR	35000
2	Dot-matrix printer	10000
3	Ink-jet printer/Scanner	30000
4	UPS (min.10 min backup)	10000
5	Window A/C (4 tons capacity)	75000
6	Generator	900000
7	GPS tracker for buses	5000
8	Bus Mounted Display Panel	50000
9	Bus Terminal Display Unit	350000
10	LCD TV	130000
11	Panic Button	3500
12	RFID reader	12000
13	Boom Barrier	70000
14	RFID chips for tag	1200
15	Puffer Machine	2000000
16	Turnstile gate	120000
17	CCTV camera	15000
18	Wi-fi routers	2500
19	Solar lights	5000
20	GIS server	385000
21	Application software of ITS	5000000
22	GSM/GPRS server	385000
	TOTAL	9594200

This is the unit cost given of each equipment/machines required. The actual cost will be different depending upon the number of quantities required.

CONCLUSION

CHAPTER -5

We have studied the advantages of Intelligent Transportation System in formation of better performance of Public Transportation status in city. The existing transportation mode character of people of Satna city is more towards using private vehicles and cabs/3 wheelers instead of Bus which can be improved if better services and good facilities will be provided to the commuters and timely management of Buses be done in Bus Stations which is possible by use Intelligent Transportation System techniques and technologies. As vehicular growth on the road is increasing, it is affecting the capacity of roads as public transport share is less.

A detailed brief study of Current traffic scenario of city through Traffic Volume Count, vehicular growth data collected from Regional Transport Office (RTO), Population details, data collected from Observational survey and Questionnaire survey conducted is analysed and various calculations are done to understand the problem briefly and to find the appropriate solution. At last, we come to the conclusion that a huge percentage of people are not satisfied with the current facilities provided in the Bus Stand and percentage of willingness to shift towards Public Transport is also high if we provide better service which is only possible by the use ITS technologies.

As the current condition of Bus Stand is very poor of Satna city because of lack of facilities available, various suggestions for improvement is given. After that, to convert the traditional Bus Stand to a Smart Bus Stand other suggestions and recommendations are provided. By making the Bus Stand Smart and Hi-Tech, it will increase the performance of city making the city environment better and friendly.

At last, estimation of cost is done. Though the initial cost of implementation of Intelligent Transportation System is high but it has benefits which will be visible after the successful implementation.

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