Chapter 4. Issues at National and Regional Level

The issues at national and regional level are described as follows:

4-1 Issues at National Level

(1) Absence of Upper Level Plan of ITS

Any high level ITS plans/strategies such as national ITS master plan which shows a long-term ITS vision are not formulated in India yet. The related high-level policies such as the National Urban Transport Policy and the five-year plan of India highlight the importance of the use of ITS technologies. But the elaboration for ITS is not been sufficiently made yet. Under such circumstances, each city started introducing ITS systems independently. It is expected that the ITS implementations by non-standardised manner may incur inefficiency and eventually increase the cost.

(2) Absence of National Level ITS Architecture

The ITS Architecture is a framework which defines roles of the subsystems and data exchange amongst them to realise efficiently the required objectives of the systems. It includes ITS services which are to be offered to various system users. The national level ITS architecture were prepared in major developed countries including Japan, US, Canada and Europe.

It is now high time to prepare the national level ITS architectures in India under the condition where the ITS is expected to deploy at full scale in the near future.

(3) Weakness of Institutional Framework for Inter-Ministerial Collaboration for ITS Promotion

The inter-ministerial institutional framework is critical for promotion of ITS. The ITS Task Force was established in 2007. However it was found that any substantial activities were not carried out till now. Thus, it is important to reinforce the inter-ministerial organisational framework for promotion of ITS in India.

(4) Weakness of Institutional Framework for Industry, Government and Academia Collaboration and International Network

In addition to the inter-ministerial coordination, the collaboration amongst industry, government and academia, and international activities are also critical for promotion of ITS. However, such institutional framework still remains weak in India.

For example in Japan, ITS Japan, a representative of private sector, acts as a bridging role amongst ministry, industry and academia to promote information exchange and coordination for practical application of ITS. It also works to promote international activities cooperating with the ITS-related organizations overseas. The Association for Intelligent Transport System (AITS) is expected the similar roles as the ITS Japan. The reinforcement of inter-sectorial collaborations amongst government, industry and academia, and international network is required for India.

4-2 Issues at Regional Level

The issues commonly found across the cities are as follows. They are categorised by the issues of transportation and ITS.

4-2-1 Common Issues across Cities

(1) Transportation Issues

1) Road Infrastructure Conditions

It shall be stressed that the traffic issues can not be solved solely by ITS, or simply applying ITS. The ITS is one of the software measures, of which effect can be expected under certain maturity of infrastructures and traffic manners. In such sense, the road infrastructure is a basic required component and they are not sufficiently developed in the studied cities, except the limited areas in Delhi and Mumbai. The proper road alignment, lane-marking, appropriate intersection structure, footpath, pedestrian crossing, and etc. are not sufficient. In the absence of such basic preparations, the effect of ITS would be limited.

2) Saturation of Road Capacity

The road capacity in the cities is almost saturated especially during peak-hour due to the rapid increase of traffic in recent years. The existing inner ring road and outer ring road are not anymore able to adequately disperse the growing traffic in the cities such as Delhi, Chennai and Hyderabad. The alternative route doest not substantially exist in the saturated road network in the city. Thus, the effect by providing the alternative route guidance by ITS would be limited under this condition.

3) Increasing Number of 4 Wheelers due to Rise of Middle Class Population

The middle class population, which holds the economic power to purchase their own vehicles, is rapidly growing. The proportion of the middle class people is larger in the metropolitan areas. They are increasingly dependant on their own cars for daily commute due to absence of efficient public transport in the city, coupled with their economic capabilities.

4) Absence of Spaces for Pedestrians

It can be said that India is a ‘vehicle-prioritised society’, and the space for the pedestrians is not adequately in place in the cities except the limited areas in Delhi and Mumbai. The typical examples are extremely narrow sections and frequent missing sections of the footpaths along the road, a number of obstacles standing in the middle of the sidewalk areas, insufficient number of the pedestrian crossings, skywalks and pelican-crossings. The pedestrians are consequently forced to walk on the areas of the carriageway. Thus in India, the space for the vehicles and people are not clearly demarcated in the city, and the walking spaces are not practically functioning.

5) Traffic Manners

The traffic manner is also one of the major issues in India. The typical examples are opposite driving, lane hogging, traffic signal violation, lane mark violation, riding motorbikes without helmet and excess number of the passengers and etc. Road crossings by the pedestrians are frequent scene everywhere. The absence of the sufficient spaces for the pedestrian in the city, as explained above, is one of the major causes.

6) Religious Facilities Standing on the Road

The religious facilities such as temples, mosques, churches, religious statues, buildings, and etc., are left on the roadside in many cities. They are seriously affecting the traffic flow. Many of these structures are not removed at the time of widening of the road. There are various local conditions and reasons behind.

7) Increased Road Traffic Caused by Insufficient Connection amongst Different Transport Modes

The connections amongst different transport modes are not adequately prepared in the cities in India. For example, the metro or BRTS stations and the bus stops are not closely located. The commuters are thus required to walk or take auto-rickshaws for certain distance to take metro or BRTS after getting off the station. Consequently, people prefer to use their own private vehicles or taxi for commuting in the city.

8) Insufficient Last Mile Connection of Public Transportation Network

The urban mass transport such as metro and BRTS are increasingly developed/under planning in the major cities in India. However the last mile connections to supplement such major transport network are not sufficiently in place. For example, there are many cases that the public transport between the residential areas and stations is not available. The people are obliged to use the road transport such as their private vehicles. Hence, the road traffic demand has not been satisfactorily shifted to the public transport, still highly depending on the road transport.

9) Insufficient Parking Spaces

There are not adequate spaces for parking lots in the cities, and the illegal parking vehicles are common issues in India. However in addition to the physical factors of the parking spaces, the parking development is not thoroughly and strategically considered as a part of the comprehensive urban development. For example, there are many cases that the parkings are not available near the railway stations, offices, large commercial complexes and etc. The national parking policy was set out by the National Urban Transport Policy, thereby mandating the states to formulate rules/regulations on the parking development. Such regulations/rules include, for example, obliging the developers to assure the spaces for parking for construction of commercial complexes, and office building. But the actual implementation of the mandate of the parking policy has not been adequately put into practices yet at the state level.

10) Obsolete City Bus

Most of the vehicles of the city bus are quite obsolete and not equipped with the air condition. They are not as comfortable as BRTS, and their service quality is not satisfactory. The replacement of the old city buses to the new vehicles is underway in some cities under the scheme of Jawaharlal Nehru National Urban Renewal Mission. But the number of the renewed vehicles is still limited. The people, especially the middle-class population who has the economic capability to purchase their own vehicles, tend to choose their own cars for commute. This background is also adversely contributing to increasing traffic congestion in the cities.

11) Road Information Management

The basic road information is not sufficiently prepared and properly managed in the cities. In general, the city government is responsible for construction and maintenance of the general roads in the city, the National Highway Authority of India is for construction of the national road in the city, the state government is for maintenance of the national road in the city and construction and maintenance of the state road and the planning agency for road network planning. It was found that the road inventory and drawings of the roads in the city are not sufficiently available and managed by any of these agencies. Consequently, the proper road management is not adequately carried out.

12) Traffic Accident Information Management

The traffic police are responsible for management of the traffic accident information in India. It was observed that a standard for maintaining such traffic accident information has not been established. Thus, the management level such as accuracy, contents and duration of storage of the accident information and management methods significantly varies by city. The information of the traffic accident is not sufficiently shared amongst the related authorities such as the road administrators and planning agencies, and the accident information is not satisfactorily utilised for improvement of the traffic and road management measures.

13) Obsolete Traffic Signal Facilities

A number of issues in regard of the traffic signal facilities in the cities were observed. They are;

- The number of the traffic signal is not sufficient to handle the traffic in the cities.
- There are many cases that the traffic signals are not in place in spite of the traffic volume.
- Many of them are not well maintained and functioning.
- The electricity supply is not stable for proper functioning.
- In spite of such above issues, there is a great necessity of traffic signals.

For example, The green-light provision of traffic signal for VIP is frequently required for security reason in India. There are many festival events throughout year, and the traffic needs to be regulated because the crowd of people advance onto the roads during the festivals. Coupled with the above mentioned many number of the broken traffic signals, much of human resources is spent on controlling the traffic signals at site and this is adversely affecting the activities of the traffic police.

14) Necessity of Intersection Improvement

As mentioned above, there is a great necessity of improvement of the traffic signals in India. However, more fundamental problem is that the intersections are generally not properly developed at many places in the cities. Furthermore, it was observed that many officials tend to adhere an idea that the improvement of the traffic signals is replacement of the stand-alone type with the signals which are connected to the centre. It is important that the structure of intersection shall be improved before replacing the traffic signals.

(2) ITS Issues

1) Upper Level Planning at Regional Level

Likewise at the national level, a high level ITS plans/strategies such as ITS master plan with a long-term vision are not prepared yet. It is concerned that the system will become increasingly inefficient and inconsistent, and it may eventually lead to higher cost because of double investment. This issue is applicable to the studied eight cities except Hyderabad where formulation of ITS Master Plan is underway with JICA assistance.

2) Regional Level ITS Architecture

The regional ITS architectures are not prepared in most of the studied cities yet. As the ITS system components/services are derived from the local requirement such as traffic characteristics, road network and public transport, the urban structure. And such characteristics vary by city and region. This issue is applicable to the studied eight cities except Hyderabad where the preparation of regional ITS architecture is underway together with formulation of ITS master plan with JICA assistance.

3) ITS Deployment Plan

The regional level plan for ITS deployment is not existed in the cities. The CMP is an urban transport plan in the city and they were formulated in some cities. Some of the prepared CMP touch on the ITS. But the consideration of ITS is not satisfactorily sufficient yet. The ITS deployment plan shall be thoroughly prepared as part of urban transport plan under the framework of the regional ITS master plan.

4) Institutional Framework for ITS Promotion

A number of different agencies are involved for planning, introducing and operating ITS. Particularly in the case of India, the jurisdiction is complicated. For example, the city government is responsible for installation and maintenance of the facilities. The traffic police is responsible for operation. And actual maintenance and operation are outsourced to the private agencies by these different governmental bodies. Thus, the cross-sectorial institutional framework is important for effective planning, introduction and operation of ITS in India.

5) Quantitative Measurement and Utilisation of Traffic Data

The facilities for quantitative measurement of the traffic are not in place in the cities in India. There are various technological challenges to apply the quantitative traffic data collection. For example they include the mixed traffic with two-wheelers and three wheelers, non-lane keeping behaviour, frequent reverse driving, etc. The quantitative measurement of the traffic is technologically difficult under such conditions. Thus, the traffic management is almost solely dependant on the CCTV monitoring. Moreover, it is generally observed that many of the involved personnel in the traffic management are fixated with the idea that the traffic management is CCTV monitoring.

6) Road Traffic Information Provision

The variable message sign boards were installed in major cities in India. However the provided messages are limited to such static information as warning for speed-over, helmet wearing and stoppage at stop lane at the intersection. The dynamic information such as the expected travel time to the destination, appropriate alternative route guidance and congestion level information is not provided. This condition is closely related to the issue mentioned above in regard of measurement and utilisation of the quantitative data.

7) Equipment Management

In general in India, the road side facilities are not sufficiently and properly maintained. Many of the existing signals are not working due to the lack of the proper maintenance in many cities. The major reason is a scarce financial resource for the maintenance. But also, the jurisdictional aspect is one of the major causes for this, as well.

For example in Japan, a single responsible department of road administrator or traffic administrators basically takes care of the roadside facilities throughout the entire cycle. The department is responsible for procurement, owning, operation, maintenance and upgrade. Although some proportion of maintenance works are outsourced to the outside agencies. But the particular department takes a responsibility. However the situation is different in India. For example in the case of traffic signal or CCTV, a city government installs, owns and maintains the facilities. But the actual maintenance is outsourced to the private contractor. The cost for the maintenance comes from budget of the city government.

The traffic police do not own these facilities and they are only users. But the actual operation is also outsourced to the private contractor.

The budget allocated for the maintenance is not generally sufficient. The traffic police carry out the enforcement, but the collected fine is generally treated as the general account. Moreover, the contractors for the maintenance are out of the traffic police authority. Such administrative divisions hinder the smooth process to reflect the requirement of the traffic police for fixing of non-operational traffic signals. As a result, many of the facilities are left without proper maintenance.

8) Vehicle Number Plates Vary in Region

In India, the current number plate system is not unified and there is no standardization such as material, character, setting position, etc. Thus, it is technically difficult to automatically detect and recognise such number plates by the sensors.

9) Difficulty in Tracing Violated Vehicles in Relation to Current Vehicle Registration

The enforcement systems such as traffic signal violation, speed violation, etc., are in place in almost all cities in India. The number plate of the violated vehicle is captured by the CCTV installed at roadside and separately sent penalties to their registered addresses. However, the vehicle tracking is an issue as the RTA database is not integrated at national level and it is difficult to trace the vehicle owners whenever they change the residences.

4-2-2 Issues in Cities

This section describes the current condition and issues particularly faced by the cities.

(1) Delhi

1) Current Condition of Road and Transport Network

(a) Overview of Urban Development

Delhi is a capital city of India with an area of 33,578 km^2 and a population of about 12.6 million. It is constituted of Old Delhi and New Delhi areas.

The Draft Master Plan Delhi 2021 was prepared by Delhi Development Authority. The Master Plan includes 1) the development of public transport network by interlinking various modes of transportation such as metro rail, BRTS, monorail, light rail, etc., 2) the road network development of approximately 55,000 km, and 3) development of 5 new cities.

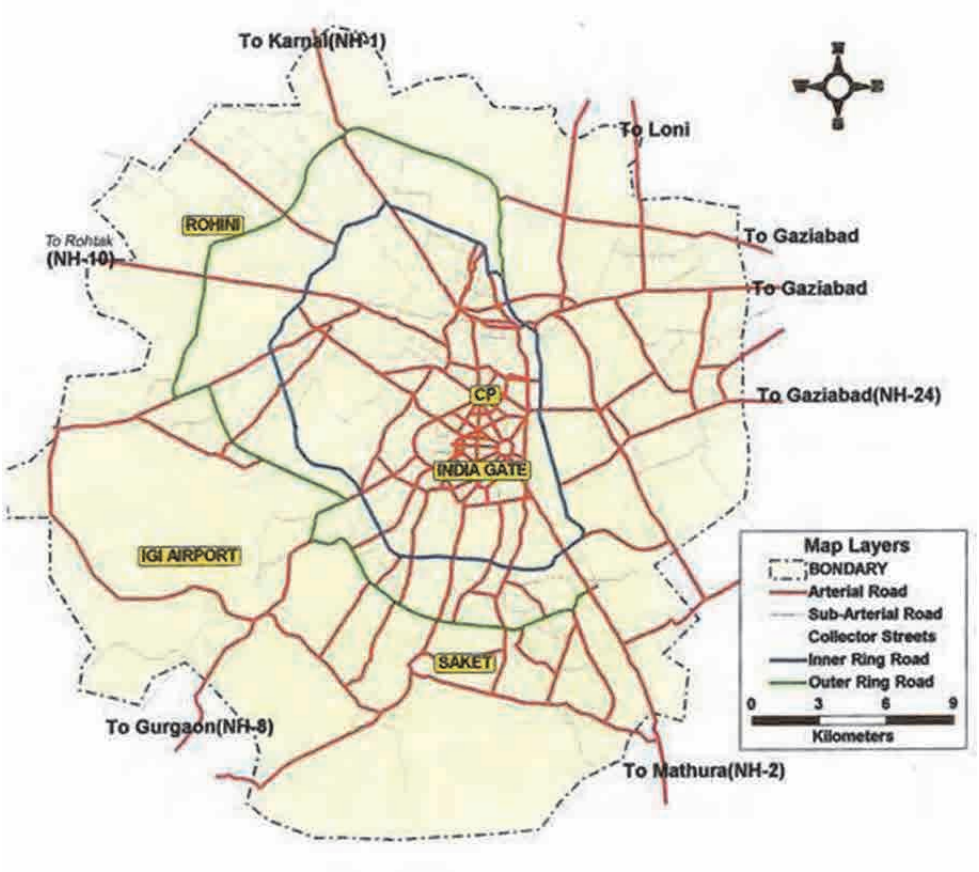
(b) Road Network

The total road network in Delhi is approximately 28,508 km. It includes 388 km of national highways, 51 km of inner ring road and outer ring road.

National Highways, such as NH-1, NH-2, NH-8, NH-10 and NH-24 pass through Delhi. Delhi-Gurgaon Expressway connects Delhi & Gurgaon and Delhi-Noida-Direct (DND) Flyway connects Delhi & Noida.

Ghaziabad-Faridabad-Gurgaon Expressway Bypass Corridor from southwest to east is under construction. Delhi Western Peripheral Expressway known as the Kundli-Manesar-Palway (KMP) on the outskirts of major cities of length 135.6 km is also under construction. The Eastern Peripheral Expressway (EPE) of length 135 km is proposed.

The current road network of Delhi is shown below.



(Source: City Development Plan, Delhi Development Authority, 2006)

Figure 4-1 Road Network in Delhi

(c) Public Transport Network

The major public transport services in Delhi are the city bus (private and public fleet carriers) and metro rail. Approximately 5,667 city buses are operated by the Delhi Transport Corporation (DTC).

The 190 km metro rail network is in operation and an additional 140 km of the network is planned by 2016. The 14 km BRTS corridor is also in operation. There is a proposal to construct monorail on three corridors covering a length of 47.8 km and a light rail on three corridors covering a length of 45 km.

The draft Master Plan of Delhi 2021 is planned by the Delhi Development Authority for the development of public transport network by interlinking various modes of transportation such as metro rail, BRTS, monorail, light rail, etc., by 2021.

2) Transportation Issues

(a) Increased Traffic in accordance with Satellite Cities in the Suburb

The satellite cities are rapidly growing in accordance with the economic growth in the Delhi Metropolitan Area. For example, Gurgaon in Haryana State is located 35 km southwest. A number of private companies are extending their businesses in this city. The office buildings and high-rise condominium are under construction. Under such situation, the expressway connecting Gurgaon and Delhi is facing serious congestion especially during peak hours due to the increasing number of commuter vehicles that are daily travelling to these satellite towns.

(b) Increasing Road Traffic Caused by Insufficient Connection amongst Different Transport Mode

The connections amongst different transport modes are not adequately prepared in Delhi. For example, the metro stations and bus stops are not closely located. Therefore, the commuters are required to walk or take auto rickshaws for a certain distance to take the metro after getting off the city bus. This makes it difficult to shift the road traffic demand to public transport.

(c) Affect on Travel Time of BRTS due to Difficulty of Land acquisition

The BRTS lane is prepared in the middle of the road in Delhi. However, the road width was not sufficiently expanded due to the difficulty of land acquisition. Thus, it resulted in a situation that the BRTS lane got in the way of road space for the general traffic, seriously obstructing the traffic flow.

Because of this problem, the BRTS lanes opened to general traffic to relieve the traffic flow, and consequently reduced the travel time of the BRTS. This resulted in the limited usage of the BRTS.

(d) Limited Number of Passengers of BRTS due to Other Major Factors

It has been pointed out that the selected route of the BRTS is also one of the reasons that the number of passengers are limited. It was originally intended to shift the road traffic demand, largely from the auto rickshaws to the BRTS by targeting the lower class, which constitute majority of the population. However, the large portion of the route is laid in middle class areas.

Additionally, combined factors such as difficulties to transfer to other traffic modes and reduced travel time of BRTS as mentioned above are adversely making it difficult to attract the middle class. As a result, the road traffic demand has not been successful in shifting to public transport.

3) ITS Related Issues

(a) Roles and Functions of DIMTS Centre

The control centre is operated by Delhi Integrated Multimodal Transit System Ltd (DIMTS). The basic concept of the DIMTS is to function as a single agency for planning, introducing, operating, and expanding the ITS. It is also aimed to utilise the collected and accumulated traffic data for traffic, road and urban planning.

However, the function of the DIMTS Centre is currently limited to the operation of BRTS because of the difficulty in assuring sufficient coordination amongst the related agencies. It is important to reinforce and extend the functions of the DIMTS as originally planned specifically in view of integration of ITS in Delhi, by more extensively coordinating amongst the involved agencies.

(b) Insufficient Facility of Traffic Police for Proper Traffic Control in Delhi

The ITS facilities that are currently available to the traffic police in Delhi are insufficient considering the size of the city and traffic volume. The traffic police operate a limited number of CCTVs from a small control room. Thus, the police are facing difficulty in carrying out proper traffic management. They plan to establish their own control centre together with traffic signals, CCTVs and other associated facilities. It is important that such plan shall be surely implemented.

(a) Demarcation between DIMTS and Traffic Police

As described above, the traffic police plan to establish their own control centre and road side facilities such as the traffic signal, CCTVs and others. However at the same time, the DIMTS was formulated on the concept to be a single entity for ITS in Delhi, and their functions are intended to expand the quantitative traffic data utilisation for better planning of traffic, road and urban improvement. The utilisation of the quantitative traffic data involves the traffic data collection from the road side. Considering such factors, two similar traffic control centres will exist in the near future in Delhi. As observed by the study, the demarcation between the traffic police and DIMTS, from both system and administrative view point, may not have sufficiently been considered/discussed/highlighted by the involved parties yet.

It is critical to elaborate such aspect and reflect on the design of the system in order to avoid the double investment and to assure effective integration of ITS in Delhi.

(b) Quantitative Measurement of Traffic and Utilisation of Traffic Data

The DIMTS Control Centre is one of the best prepared centres amongst the studied cities. However, the traffic information method is limited to CCTV monitoring, and quantitative traffic data is not collected. The BRTS vehicle location information is collected from the GPS devices equipped in the vehicles. But this is for the purpose of BRTS operation monitoring and it is not intended for utilisation of the collected data for traffic analysis and congestion information generation.

It is important that the DIMTS centre is equipped with the functions which enable utilising the quantitative traffic data.

(c) Static Message Provided by Variable Message Sign Board

The variable message sign boards are installed at limited locations on the city roads in Delhi. However, the provided messages are limited to static information such as warning for over speeding, helmet wearing, and stoppage at stop lanes on intersections. The dynamic road traffic information such as expected travel time to destination, appropriate alternative route guidance, and congestion level information is not available. This condition is closely related to the issue mentioned above with regards to equipping the functions for measuring, analysing, and utilising the quantitatively collected traffic data.

(2) Ahmedabad

1) Current Condition of Road and Transport Network

(a) Overview of Urban Development

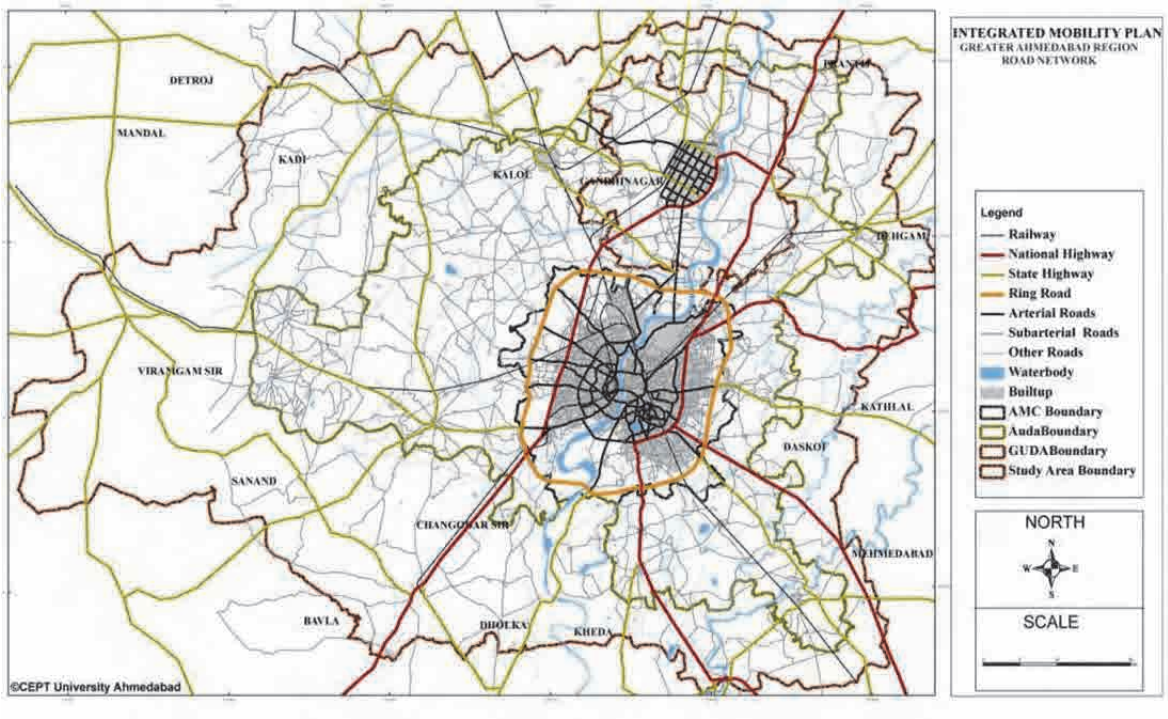
Ahmedabad is the largest city in the state of Gujarat with an area of 4,708km^2 and a population of about 4 million. It is the seventh largest metropolis in India and the second largest industrial centre in western India after Mumbai. The Gandhinagar is the capital city of Gujarat state and situated about 20 km north of Ahmedabad. The Gujarat state is actively attracting foreign investment by developing special economic zones and investment regions. The Government of Gujarat set up 'Gujarat International Finance Tec-City Company Limited' (GIFT) aiming to develop as central finance and business district in the region. Delhi Mumbai Industrial Corridor (DMIC) passes through the Gujarat state and it accounts for 38% of total length of DMIC.

Ahmedabad city is spread out in a radial pattern with relatively scattered economic activity. Except the congested areas of old city, the other part of the city still has enough capacity to handle the population growth.

(b) Road Network

The total road network in Ahmedabad is approximately 2,436 km. It comprises 5 ring roads, 20 radial roads, seven major roadways and one expressway (Ahmedabad-Vadodara expressway). National Highways, such as NH-8, NH-8C and NH-59 pass through the city. Sardar Patel ring road is the outermost ring road of length 76 km surrounds the Ahmedabad urban area.

The current road network of Ahmedabad is shown below.



(Source: City Development Plan, Ahmedabad Urban Development Authority, 2011)

Figure 4-2 Road Network in Ahmedabad

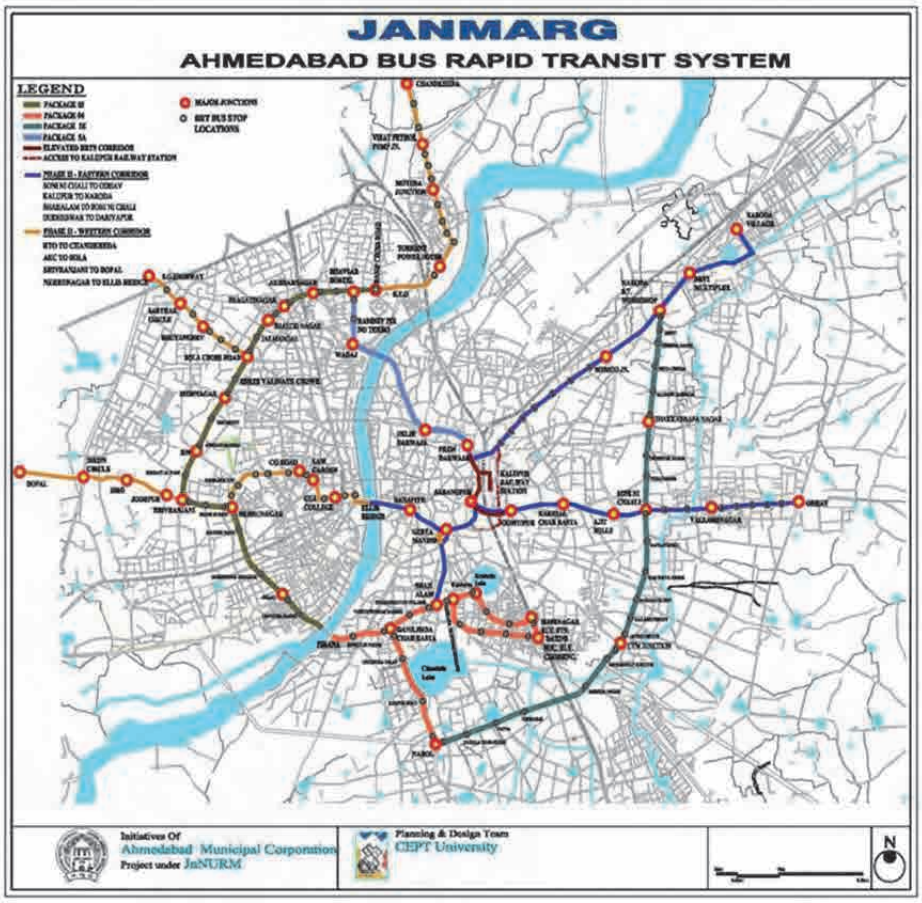
(c) Public Transport Network

The major public transport services in Ahmedabad are the city bus and BRTS. Approximately 1,100 city buses and BRTS operations for a length of 45 km (Phase 1, 5 corridors) operated by the Ahmedabad Municipal Corporation (AMC).

It is planned to extend the BRTS lane to 80 km by 2015 and to introduce metro rail of 76 km by 2015.

The City Development Plan is under preparation with a focus on integrated mobility and it aims to develop a transportation system that would accommodate future growth and enhance the quality of life of the residents.

The current and planned BRTS route of Ahmedabad is shown below.



(Source: City Development Plan, Ahmedabad Urban Development Authority, 2011)

Figure 4-3 Ahmedabad BRTS Route Network (Including Planned Route)

2) Transportation Issues

(a) Deteriorating Traffic Condition Due to Urbanization

The road conditions are relatively better in Ahmedabad compared to other studied cities. However, Ahmedabad is also experiencing rapid urbanization, and the city is expanding toward the suburban areas. The old city is located in the centre surrounded by the new city. The road capacity in the old city has already been saturated and it is facing serious congestion, particularly during peak hours.

(b) Necessity of Reinforcement of Logistic Yards

Ahmedabad is the largest commercial and industrial city in Gujarat State. Gujarat State has long been active in attracting foreign investments by preparing the special zone for export products. There exist a number of industrial areas around Ahmedabad, and large number of commercial vehicles is generally circulating in these areas. These commercial vehicles are required to go through the city of Ahmedabad since a number of the small-sized yards are located specifically in the old town where it is chronically congested. It is therefore important to prepare the logistic centres in the suburbs to avoid the traffic.

(c) Necessity of Improvement of Procedure for Approval of Commercial Vehicle Passage

The commercial vehicles require the approval by the city authorities for passing through the city area. However, different organisations are involved for issuance of the approvals, including Ahmedabad city, traffic police, etc. Such administrative procedures take long time in general, and the commercial vehicles are thus parked in those areas creating major traffic congestion. It is important to improve the procedures for the approval of the commercial vehicle passage by establishing a single authority to oversee such issues.

(d) Facilities for Pedestrians to Cross the Road for BRTS

It is widely known that the BRTS in Ahmedabad is the most successful practice in India. The BRTS buses run on the dedicated lane in the centre of the road, which is physically divided from the carriageway for the general traffic. The bus stops are located on the median of the road. Therefore, the passengers need to cross the road to take the BRTS. However, the pedestrian facilities for crossing the road are not sufficiently in place. The facilities such as pedestrian signals, zebra, and underpasses are required.

(e) Land Acquisition for Planned Route of BRTS

The extension of the BRTS route is currently planned. The current route in operation passes through the new city. The road width of the current BRTS corridor is sufficiently assured because there is a space in the new town. This made it possible to assure the adequate space for the carriageway of the general traffic on the BRTS corridor.

However, the planned route will pass through the old town. As mentioned above, it is crowded with high population density and chronic congestion in the old town area, and the land acquisition is difficult. Thus, the route is not designed to widen the road width. Under such situation, it holds a possibility to face similar problems in Delhi unless sufficient road facility development is considered along with the BRT route extension.

3) ITS Related Issues

(a) Insufficient Facilities of Traffic Police for Proper Traffic Management

In almost all studied cities, the traffic police use some facilities such as CCTV for traffic management in the centre. However, in the case of Ahmedabad, the traffic police do not have any such kinds of facilities. Thus, they are facing difficulties in carrying out proper traffic management.

The size of the city of Ahmedabad is small. The roads are not generally saturated, except in the core area. Furthermore, the road network is idealistically prepared by five ring roads and several radial roads. Therefore, it holds high possibility that the traffic can be controlled and diverted by carrying out the proper traffic management centre and providing the route guidance information to the users by ITS.

(b) Facility Maintenance

In general, in India, the roadside facilities are not sufficiently and properly maintained. Particularly in the case of Ahmedabad, nearly 70% of the existing signals are not working due to the lack of proper maintenance. The reasons and background for this is as described in the previous corresponding sections.

(3) Hyderabad

1) Current Condition of Road and Transport Network

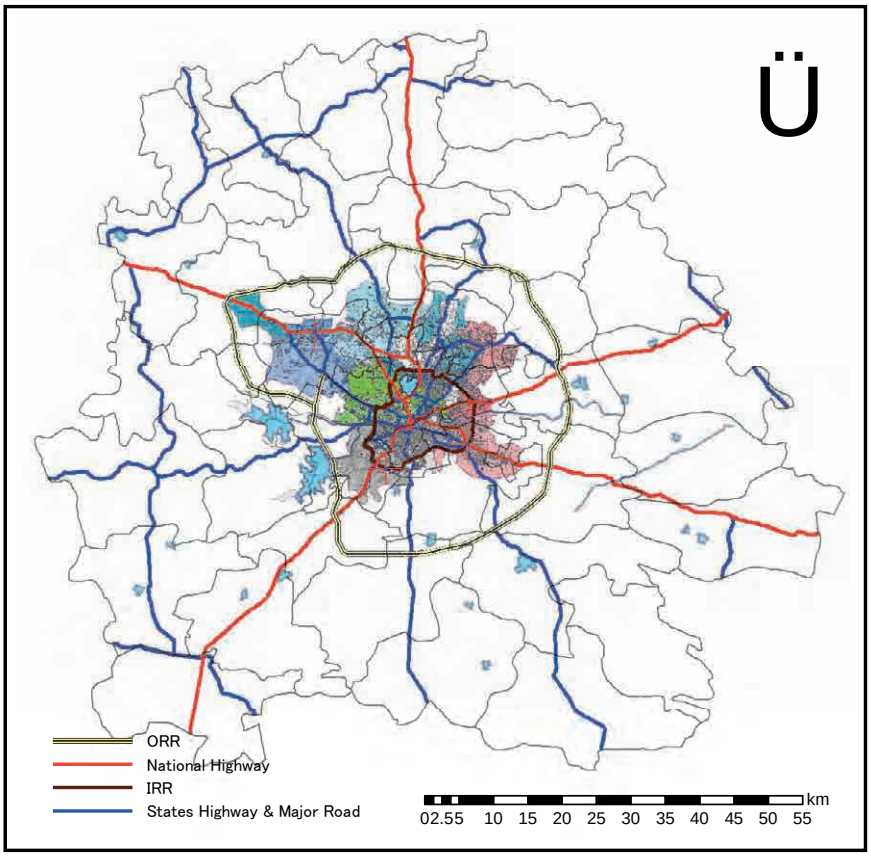
(a) Overview of Urban Development

Hyderabad city is the capital of Andhra Pradesh state. The city has an area of 7,100 km^2 with a population of about 8 million. Population growth in the city is remarkable in the recent years. Hyderabad Metropolitan Development Authority was established in 2008 integrating the surrounding areas under the purview of city development planning authority. The technology township (HITEC city) was developed in suburban area in the city and multi national software companies such as Microsoft, Google, Oracle, and Infosys established their development centres here. It is proposed to develop hardware parks and industrial zones around Hyderabad Metropolitan Area. The preparation of "Hyderabad Master Plan" targeting 2031 is underway. The Master Plan emphasises on the 1) Transit Oriented Development (TOD) along the major corridors to encourage public transport usage, 2) development of multi-nuclei centres to disperse the economic activities which are currently concentrated on the centre area in the city. These centres are proposed to be self-contained zones and include an employment hub to avoid excessive influx of people into the core area of the city.

(b) Road Network

The total road network in Hyderabad is approximately 4,900 km. It includes approximately 50 km of inner ring road connecting core areas of the city and 159 km of outer ring road which is under construction. The city comprises 33 radial roads emerging, which are under planning, from the core city towards the outer ring road and 11.6 km long flyover expressway (PVNR Expressway) that connects the city to the international airport. National Highways, such as NH-7, NH-9 and NH-202 pass through the city.

The current road network of Hyderabad is shown below.



(Source: Prepared by JICA Study Team based on HMDA Map, 2012)

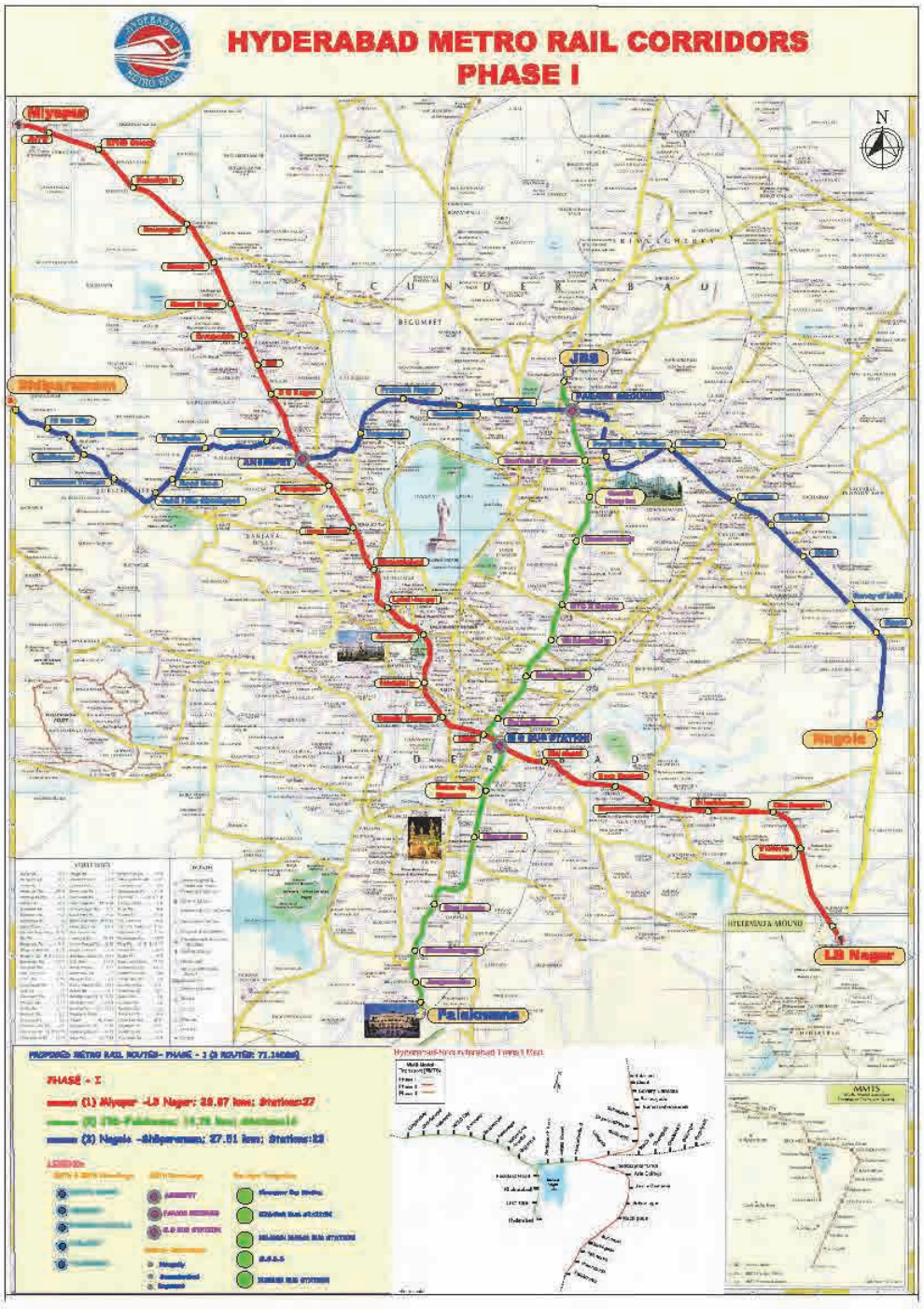
Figure 4-4 Road Network in Hyderabad

(c) Public Transport Network

The major public transport services in Hyderabad are the city buses and city trains. Approximately 3,872 buses are operated by the Andhra Pradesh State Transport Corporation (APSRTC). The Multi-Modal Transport System (MMTS) city rail covers 27 stations carrying approximately 65,000 to 70,000 passengers per day operated by Indian railways.

The 72 km long metro rail route is currently under construction under a Build-Operate-Transfer (BOT) model and is scheduled to be in operation by 2017.

The metro rail network plan of Hyderabad is shown below.



(Source: Hyderabad Metro Rail Limited Website)
http://www.hyderabadmetrorail.in/html/routemap.htm

Figure 4-5 Hyderabad Metro Rail Network Plan

2) Transportation Issues

(a) Insufficiently Prepared Road Infrastructure

Generally, the road infrastructure conditions are not satisfactorily developed in India. The situation in Hyderabad is more serious. The road alignment in the city changes continuously. The structures on the intersection are not properly designed, and the traffic signals are installed on wrong intersections structure. The lane markings are not visible. The road width of the flyover section is strangely narrow, causing serious congestions during peak hours. The width of the underpass section at the crossing point with the railway is dangerously narrow. The drainage systems were laid 50 years ago, usually causing serious flooding during the rainy season. Under such situation, the Hyderabad city is facing serious traffic condition.

(b) Under Developed Pedestrian Facilities

The road infrastructures are not generally designed for pedestrian. The case in Hyderabad is particularly serious. The footpaths intended for pedestrians are nearly absent. Even in the sections where some footpaths are in place, there are a number of obstacles. These are not functioning as a space for the pedestrian. Consequently, a crowd of people spill over into the carriageway and hinder the traffic flow.

The number of crossing point of the railway is quite limited as well. For example, there are some locations where the bazaar is located in front of the railway while the residential community is situated on the other side. However, the crossing point of the railway does not exist there. The people are forcibly required to cross the railway to go home or to the bazaar in this case. It is assumed that the residential community and commercial areas such as bazaar were developed after the railway had been deployed.

This case typically exemplifies that infrastructure development/improvement is not able to catch up with changes of social conditions in the surrounding areas due to financial and other reasons.

(c) Road and Traffic Planning in line with Urban Development

The special economic zone, ‘Hi-Tech city’, was developed in the northwest of Hyderabad, where business units of the world famous IT companies are established. It is planned to develop the industrial area in the southeast of Hyderabad. The international airport was recently renovated. The construction of outer ring road is underway.

One of the problems is that the road network and transportation network are not thoroughly planned in accordance with such urban development. The traffic pattern will significantly change by these socioeconomic activities. The road network and transportation network need to be accordingly planned to accommodate these altered traffic pattern. Under the situation where such major development as outer ring road and industrial area development are taken up, it is significantly important to prepare the plans in accordance with urban development.

(d) Basic Road Information

The basic road information in the city is not properly managed. The Greater Hyderabad Municipal Corporation is responsible for construction and maintenance of general roads in the city. The National Highway Authority of India is responsible for construction of national highway in the city and the Roads and Buildings Department of the state government is responsible for maintenance of the national highway in the city, and construction and maintenance of the state highway.

The road inventory information and drawings by section of the road, for example, are not sufficiently prepared and managed by any of these agencies. The planning agency, Hyderabad Metropolitan Development Authority, does not have such information, either.

Thus, proper road management is not being carried out. This issue can be more or less applied to other cities in general, and is not only limited to the case of Hyderabad.

3) ITS Related Issues

(a) Facility Maintenance

Like the case in Ahmedabad, the roadside facilities such as traffic signals and CCTV are not properly and sufficiently maintained in Hyderabad. The reasons and details for such situation are as mentioned in the section of Ahmedabad.

(b) Operation Monitoring System for City Bus

The operation monitoring systems for the city buses are in place in almost all studied cities. The system is composed of GPS location, data collection, monitoring centre, and information provision such as arrival time by variable message sign board at the bus stops or SMS. However, such system is not present in Hyderabad. Some GPS devices were procured and installed during previous occasions, but the centre system was not prepared due to financial difficulties.

(4) Bangalore

1) Current Condition of Road and Transport Network

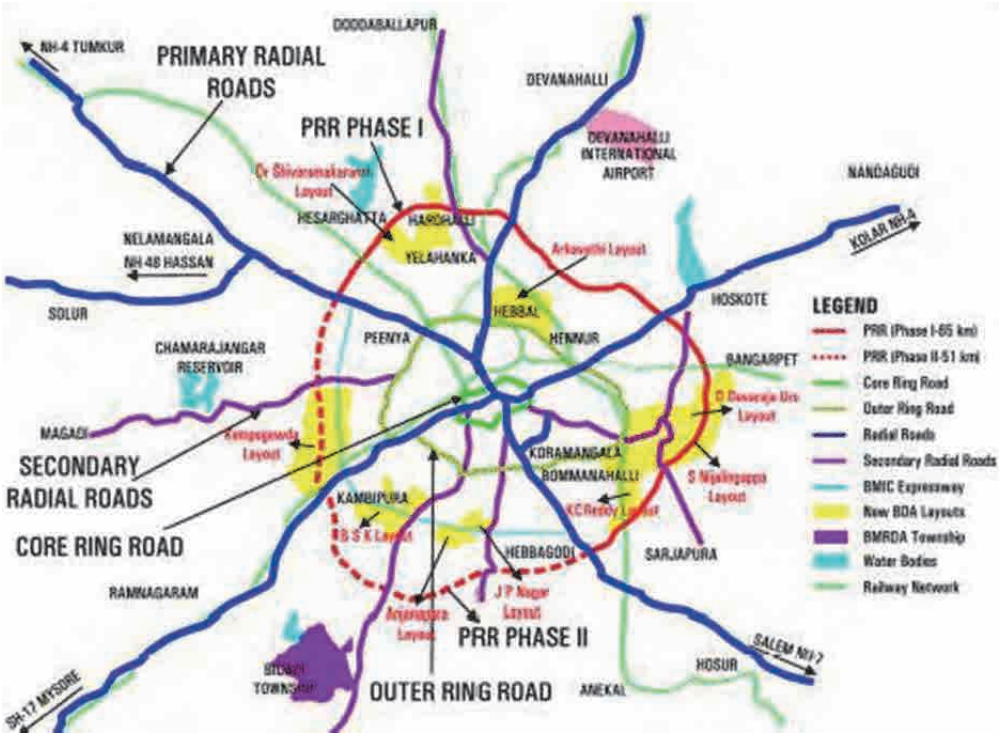
(a) Overview of Urban Development

Bangalore is the capital of Karnataka state with an area of 8,005 km^2 and a population of 5.4 million. It is one of the largest metropolitan cities in the southern India and is the second fastest growing metropolis in India. The city is referred as “Silicon Valley of India” with its information and communication technology development. Major multinational companies such as IBM, Google, Microsoft, Oracle, etc., established their primary development and R&D centres in the city. Major American and European companies established BPO in the city. Software industrial parks such as Software Technology Parks of India (STPI), International Tech Park Bangalore (ITPB) and Electronics city are developed in the city. The development of special economic zones for industrial development along south-west part of city and expansion of software hubs on north-east parts of the city are under consideration.

(b) Road Network

The total road network in Bangalore is approximately 11,000 km. It includes 70 km of inner ring road which forms an important link for the core city area and the information technology corridors through Whitefield – Airport Road – Koramangala – Hi-Tech city (proposed) and finally to Electronics city. The city developed 62 km of outer ring road and 111 km of Nandi Infrastructure Corridor Enterprises Ltd (NICE) Road connecting to Mysore Road.

The current road network of Bangalore is shown below.



(Source: EDIFICE Builders Website, 2010)
http://blog.edificebuilders.com/2010/02/07/almond-tree-villa-valley-appreciates-peripheral-ring-road-prr-off-doddaballapur-road/

Figure 4-6 Road Network in Bangalore

The City Development Master Plan 2035 was prepared. The Bangalore Metropolitan Development Authority (BMRDA) and Bangalore Development Authority plan to develop the following road and transport infrastructure:

- 116 km peripheral ring road (outside outer ring road),
- 130 km intermediate ring road (between inner and outer ring roads),
- 180 km radial roads (from core area leading to outer and peripheral ring roads),
- 204 km satellite ring roads at the outer periphery of the city (connecting all existing and planned satellite towns),
- Eight town ring roads with length of 176 km (separate ring roads for satellite towns near Bangalore), and
- Circular railway network connecting the towns around the outer periphery of the city.

(c) Public Transport Network

The major public transport services in Bangalore are the city buses and metro rail. Approximately 7,000 buses are operated by the Bangalore Metropolitan Transport Corporation (BMTC). The metro rail currently covers 6.7 km route and it is planned total length of 35.6 km to be completed by 2014.

In addition, Bruhat Bangalore Mahanagar Palike (BBMP) is proposed 30 km dedicated bus lane on the outer ring road and BMRDA proposed circular railway network around the outer periphery of the city. The proposed 60 km monorail network is now under consideration of Karnataka government.

2) Transportation Issues

(a) Traffic Flow and Volume Affected by IT Industrial Zone

The traffic pattern in Bangalore is significantly affected by the economic activities in the IT industrial zone located in the southeast suburban area of the city. There exist three major industrial zones along NH-7 including Software Technology Parks of India (STPI), International Technology Park Ltd (ITRL), and Electronics city. The traffic, particularly on NH-7, NH-4, and NH-202, is affected and the road capacity in the area is saturated.

(b) Increased Traffic Volume in accordance with Development of Satellite Cities

The satellite cities around Bangalore city are rapidly growing in recent years. These satellite cities are mainly located along the major roads radially stretching from the city. They include Tumkur and Kokar along NH-4, Chikballapura and Devanahalli along NH-7, and Mgadi and Doddaballapur along other major radial roads. Thus the daily commuter traffic from these satellite cities significantly affects the traffic.

(c) Increasing Road Traffic Caused by Insufficient Last Mile Connection of Public Transportation Network

The mass transit system, such as the metro, has been in operation since 2011. However, likewise the case in Delhi, the road traffic demand has not been sufficiently shifted to public transport in Bangalore yet. The dependency on the road transport still stays high. One of the major reason is insufficient last mile connections to supplement the major public transport network, as in the case of Delhi.

(d) Increasing Road Traffic Caused by Insufficient Connection amongst Different Transport Mode

Like the case in Delhi, the connections amongst different transport modes are not adequately prepared in Bangalore. For example, the metro stations and bus stops are not closely located. Therefore, the commuters are required to walk or take auto rickshaws for a certain distance to take the metro after getting off the city bus. This makes it difficult to shift the road traffic demand to public transport.

(e) Obsolete City Bus

The city bus is a major public transport in Bangalore. But they are generally old-aged and the quality of service is accordingly not satisfactorily high. For example, many buses are not equipped with air conditioning and run keeping the doors opened.

Bangalore is the largest IT industrial area in India. The world’s major IT companies including

IBM, Microsoft, Google, and Oracle are stationed in Bangalore. Under this situation, the proportion of relatively high class population, represented by IT-related employees, is high in Bangalore. Such people tend to hesitate to use such old-aged bus services, and use their own vehicles for comfortable journey. This is also one of the major factors that influence the increasing number of four wheelers.

3) ITS Related Issues

(a) Quantitative Measurement of Traffic and Utilisation of Traffic Data

B-TRAC is operated by the Bangalore Traffic Police for CCTV monitoring at site condition, traffic jumping enforcement, and traffic control at some sections. Their centres are well prepared, compared to other cities. B-TRAC Control Centre is reputed as a role model in India.

However, the major bottleneck is quantitative measurement of traffic and its utilisation for planning and dynamic traffic information provision, like the case DIMTS in Delhi,. The major information collection method by B-TRAC is CCTV monitoring. This cannot be utilised as quantitative traffic data. Thus, it is important to develop the environment which enables the quantitative measurement of traffic data, and its utilisation for traffic and road planning for further expansion of B-TRAC.

(b) Static Information Provided by Variable Message Sign Board

Some variable message sign boards are installed in some locations of the road in Bangalore city. However, like the case in Delhi, the provided message is limited to static information such as warning for over speeding and helmet wearing. The dynamic road traffic information such as the expected travel time to the destination, appropriate alternative route guidance, and congestion level information is not provided. This condition is closely related to the issue mentioned above with regards to the preparation of the environment for measuring, analysing, and utilising the quantitatively collected traffic data.

(5) Mysore

1) Current Condition of Road and Transport Network

(a) Overview of Urban Development

Mysore is the second largest city in Karnataka state and situated at approximately 170 km southwest of Bangalore. Tourism is a major industry in the Mysore city with many historic buildings that attracts tourists from all over the world. The basic principle of Mysore is to promote urban development by preserving environment and conserving historical heritage for attracting the tourists. Thus construction of elevated roads and flyovers are prohibited in the city.

Approximately 3 million tourists annually visit Mysore but foreign tourists are limited to only 3%. Enhancement of tourist facilities, improving access to Mysore by reinforcing the city transport is important to attract more foreign tourists. The City Development Master plan 2031 is under consideration.

(b) Road Network

The total road network of Mysore is approximately 1,907 km. It includes 20 km of inner ring road. 20 km of outer ring road is in operation out of the total 41.5 km.

NH-212, SH-33 and SH-88 passes through Mysore. Four-lane SH-17 is the major road connects Mysore and Bangalore. The cycle lanes in 12 km are prepared to encourage bicycle usage.

The City Development Master Plan 2031 was drafted and awaiting the approval of the state government. The expansion of Mysore urban areas up to 300 km^2 and environment preservation around Chamundeshwari Hill are planned by the master plan.

The current road network of Mysore is shown below.

(Source: Intelligent Transportation System for KSRTC - Detailed Project Report, Central Institute of Road Transport, 2008)

Figure 4-7 Road Network in Mysore

(c) Public Transport Network

The major public transport service in Mysore is city bus. Approximately 500 buses are operated by the Karnataka State Road Transport Corporation (KSRTC). The development of monorail and tram in the city, and high speed bullet train between Mysore and Chennai through Bangalore are under consideration.

2) Transportation Issues

(a) Restriction of Infrastructure Development

A large-scale development in the city is strictly prohibited because of the policy of Mysore for conservation of historical heritage and environmental preservation

The road capacity is not saturated yet. But it is important for the city to maintain such favourable road traffic condition whilst attracting more number of both domestic and international

tourists. Therefore, the measures to maximise the existing road and transportation capacity by utilising ITS would be of great importance for the city.

(b) Increasing Road Traffic Due to Limited Access from Bangalore

The number of flight is limited and only the domestic airlines operate in Mysore Airport. Therefore, most of the tourists who visit Mysore come via Bangalore. But the public transport accesses such as available bus and railway services are limited. Consequently, the tourists tend to use road transport such as their own vehicles and rental cars. This causes the increasing road traffic in Mysore.

Furthermore, the socio-economic dependency of Mysore on Bangalore is high. Thus, it is highly desired by the officials in Mysore to strengthen the accessibility between Mysore and Bangalore.

(c) Increasing Number of Vehicles Due to City Bus Service Level

The major transport within the city of Mysore is the city bus, other than taxis and auto rick-shaws. But the vehicles of the city bus are old-aged and their service level is not high. The tourist understandably tends to avoid using such services. Under such condition, the number of individual taxi driver who provides tourist guide service is increasing. This is also one of the aspects behind the increasing vehicles in Mysore.

3) ITS Related Issues

(a) Provision of Information Related to Tourism

Surrounded by historical heritage and abundant in natural heritage, many tourists visit Mysore every year. However, tourism related information such as available facilities, parking and bus stops near the tourism spots is not sufficiently available in Mysore.

(b) Availability of Information for Tourists

Majority of tourists visit Mysore via Bangalore. However, the information which is helpful for the tourist is not sufficiently available. For example, this includes pre-trip information about available transportation method to access to Mysore from Bangalore, location and detail operational information of bus terminals, details of tourism rickshaws services, available parking lots, railway service detail information and etc. It is preferable if such kind of information is prepared in well coordinated and comprehensive manner and become available at such locations as bus terminals in Bangalore, arrival terminal of the air port in Bangalore and Mysore, at the railway stations and etc.

Coupled with the information mentioned in the section of ‘Provision of Information Related to Tourism’ above, it is highly recommended to prepare proper system for provision of such information, together with ITS which is so-called ‘tourism oriented ITS’ in Mysore.

(6) Chennai

1) Current Condition of Road and Transport Network

(a) Overview of Urban Development

Chennai is the capital city of the state of Tamil Nadu with an area of 1,189 km^2 and population of about 7.7 million people. The city is referred as "Gateway to South India" There is Chennai port which is the second largest in India and it handles automobiles and machinery. The Ennore port is located at 12 km north of the Chennai city and it mainly handles cargo such as coal, and ore etc.

The Chennai city is also referred as "Detroit of South India", with thriving automobile industry and it accounts for 25% of the national production. Many car companies such as Nissan, Mitsubishi, BMW, Ford, Daimler, Hyundai, etc. established their businesses in Chennai with large scale investments. The production sites exist mainly along the national highway in the outskirts of north, northeast and south of the city.

Chennai city is also developed as one of India's leading industrial city in the south region of India for electronics, textiles, chemical products, etc. The plan for "Indian Industry Southern Economic Corridor" was approved by the Government of India in 2008. It is intended to promote the development of industrial clusters and infrastructure along the corridor which connects to Bangalore.

(b) Road Network

The total road network of Chennai is approximately 2,780 km. It includes 35 km inner ring road, 29.65 km outer ring road. National Highways, such as NH-4, NH-5, NH-45 and NH-205 pass through Chennai. Chennai Metropolitan Development Authority approved the 32 km stretch of outer ring road (Phase-II) and it is expected to complete by 2013.

The City Development Master Plan 2026 was prepared for expansion of Chennai Metropolitan Area up to 1189 km^2. The three corridors, namely: Sriperumbudur, Mamallapuram, and Gummidipoondi, were identified for major industrial development.

The current road network of Chennai is shown below

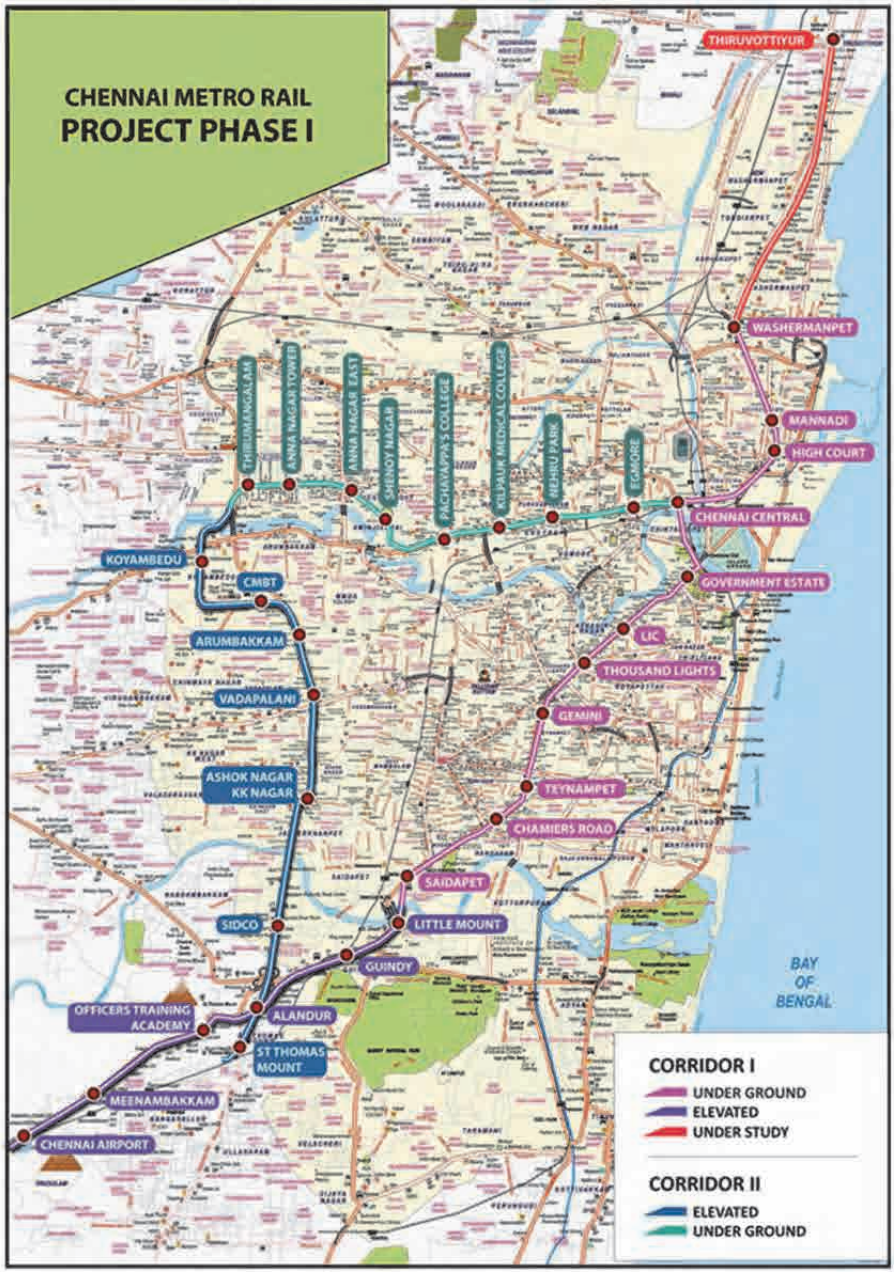
(Source: Road Traffic Technology Website)
http://www.roadtraffic-technology.com/projects/chennai-ringroad/

Figure 4-8 Road Network in Chennai

(c) Public Transport Network

The major public transport services in Chennai are the city buses and suburban trains. Approximately 3,497 buses are operated by Metropolitan Transport Corporation (MTC).The suburban trains are available on six lines operated by Indian railways. The metro rail project of length 45 km is under construction. The monorail with length in 111 km is planned as well.

The planned metro rail network of Chennai is shown below



(Source: Chennai Metro Rail Corporation Website)
http://chennaimetrorail.gov.in/route.php

Figure 4-9 Chennai Metro Rail Network Plan

2) Transportation Issues

(a) Reinforcement of Industrial Corridor to Access Ennore Port

As the capacity of Chennai Port is reaching saturated, Ennore Port is becoming increasingly important. But the major current bottleneck is access to the Ennore Port. The reinforcement of the road condition by preparing the industrial corridor to Ennore Port is one of the urgent issues in Chennai.

(b) Reinforcement of Access to Manufacturing Bases along Major Roads in Suburban Area

The manufacturing bases of the enterprises mainly exist along the major roads in the suburban area. These roads include NH-4, NH-5, NH-45, and NH205. They are facing serious congestions due to increasing traffic volume in recent years. The conditions of the access roads to the ports are particularly adverse. It is important to reinforce such accesses in view of enhancing more productivity for further economic growth in the region of South India.

3) ITS Related Issues

(a) Limited Facility of Traffic Police In Spite of Size of City and Traffic Volume

The facilities of the traffic police for traffic management in Chennai are scarce. They operate quite limited number of CCTVs at small monitoring room. Thus, they are facing difficulties in carrying out proper traffic management. The reinforcement of the facilities to enable proper traffic management is an urgent and imperative issue in Chennai, particularly considering the traffic volume, size and importance of the city as the industrial centre in South India,

(b) Organization Framework Required for Effective Introduction of ITS

It is important to develop ITS in Chennai, particularly considering the current condition of scarce ITS facilities, and its industrial and geographical importance and scale of the city.

A number of different bodies are involved in planning, developing and operating ITS. Therefore, it is recommendable to establish a single organisation in charge.

However, basic structures which can be basis for such organisation arrangement do not exist in Chennai.

(7) Indore

1) Current Condition of Road and Transport Network

(a) Overview of Urban Development

Indore is the largest city in the state of Madhya Pradesh and is a commercial centre in the region, with an area of 505 km^2 and a population of about 3.7 million. It is located approximately 200 km southwest from the capital city of the state, Bhopal. Pitanpuru, located in about 20 km southwest of Indore, is a major industrial area in the region. Special economic zone was developed to encourage major domestic companies with a focus on the automotive industry. Dewas is another Industrial area located in the northeast of Indore.

The Indore City Development Master Plan 2021 was prepared and approved with goals 1) expansion of the city area up to 505 km^2, 2) creation of a transport hub in 175 hectares outside the Indore city, 3) improvement of Devi Ahilyabai Holkar Airport.

(b) Road Network

Indore Development Authority (IDA) recently developed 8.5 km super corridor which connects to the airport, 4.6 km road white church road which joins to bypass road and 11.45 km BRTS corridor. Indore also developed Inner ring road with the length of 23 km. National and State Highways, NH-3, NH-59/NH-59A, SH-27 and SH-34 pass through city.

The current road network of Indore is shown below

(Source: Presentation Material, Indore Development Authority, 2012)

Figure 4-10 Road Network in Indore

(c) Public Transport Network

The major public transport service in Indore is city bus. Approximately 119 buses are operated by Atal Indore City Transport Service Company Limited (AICTSL). The AICTSL is a SPV formed for the purpose of managing public transport in Indore such as city bus, BRTS and taxi services.

IDA developed 11.6 km BRTS corridor funded by World Bank and JnNURM. It is planned to operate by December 2012. IDA plans to develop a total 109 km of BRTS network.

2) Transportation Issues

(a) Road Infrastructure

The road infrastructure conditions are more serious than other studied cities. The major examples include inconsistent road alignment, absence of sufficient lane marking, stop lines, encroachment of peddlers on carriageway and etc. In addition, there are some locations where two way road suddenly changes to one way, causing confusions of the drivers.

(b) Bus Stops

There are some bus stops where the bus driver is unable to stop beside the bus stop due to improper design/insufficient development of bus stop such as muddy unpaved spaces in front of the bus top and the bus stop closely located near intersection. The driver is therefore forced to stop the buses on carriageway, disturbing traffic in the city.

3) ITS Related Issues

(a) ITS Facilities for BRTS

The development of BRTS in Indore is multi-financed by the World Bank, the central government, and state government. It is planned to commence the BRTS operation by December 2012. It was originally planned to establish an operation monitoring system by installing CCTVs along the corridors, control centre and providing the bus information at the bus stops. There is a high possibility that the BRTS will be operated without such operation monitoring system due to the suspended approval on the ITS portion. The proper operation of such mass urban transport systems as BRTS is important.

(8) Mumbai

1) Current Condition of Road and Transport Network

(a) Overview of Urban Development

Mumbai is the capital of Maharashtra and largest city in India. It is located in the west coast of India. The population of the Mumbai metropolitan area, including the Navi Mumbai is approximately 15 million. It has the biggest deep natural harbour and busiest port in India. Mumbai accounts for about 5% of Indian GDP, 25% of Industrial products and 40% of shipping from India. As one of the Asia's leading financial centres, the Mumbai city has offices of major multinational companies.

MMRDA prepared the city development plan 2025 with objectives of expansion of Mumbai Metropolitan area, construction of missing link roads and bridges between city Islands, Navi Mumbai and other metropolitan areas. It focuses on improvement of the road network, public transport, and decentralization of suburbs from the core city area, development of water and sanitation facilities, and medical facilities to the slum areas.

(b) Road Network

The total road network of Mumbai is approximately 1,941 km. Mumbai developed three expressways, namely: Mumbai-Pune Expressway, Mumbai-Nashik Expressway and Mumbai-Vadodara Expressway. The Bandra-Worli Sea Link Bridge and Mahim Causeway link the island city to the western suburbs. The city has connectivity to national highways such as NH-3, NH-4, NH-8, NH-17 and NH-222.

(Source: Aamchi Mumbai Website, 2011)

http://www.aamchimumbai.net/mumbai-city-info/mumbai-road-map/mumbai-road-map.html

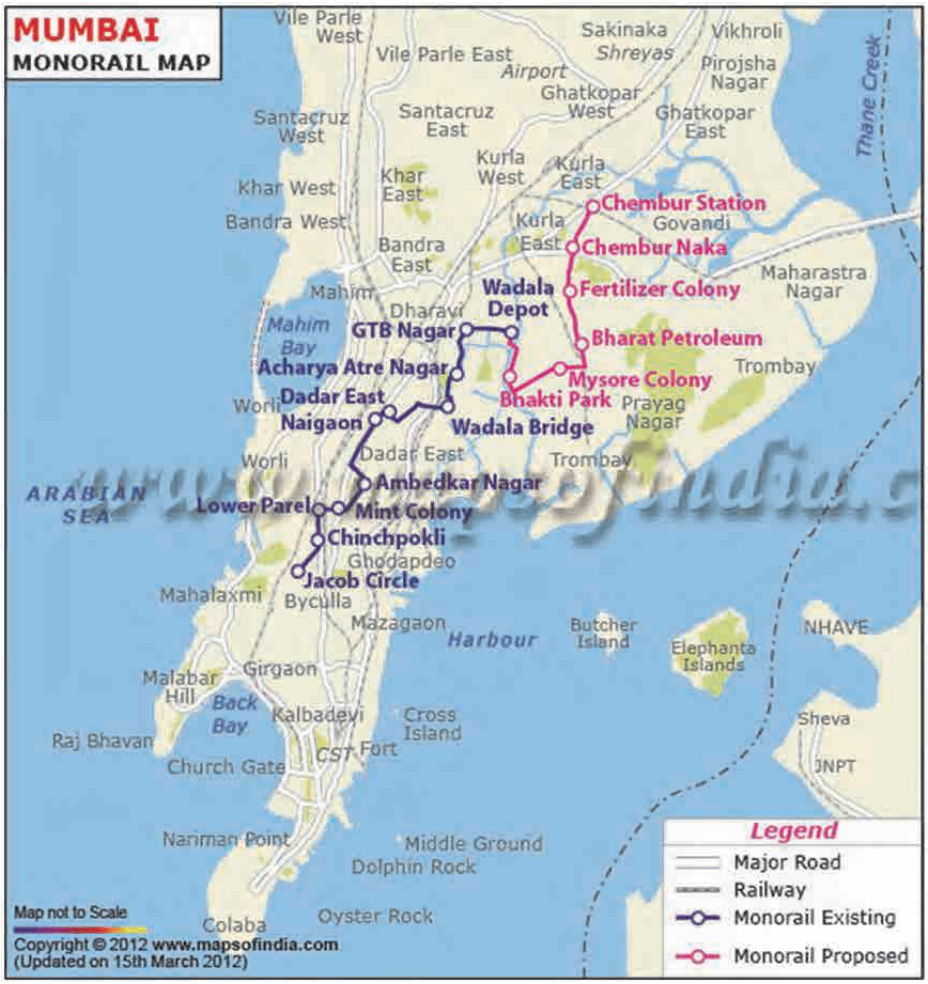
Figure 4-11 Road Network in Mumbai

(c) Public Transport Network

The major public transport services in Mumbai are city buses and suburban rail. Approximately 4,000 city buses are operated by Bombay Electric Supply and Transport (BEST). Many suburban rail services are operated by Mumbai Railways. The public transport (bus and rail) carries approximately 7 million passengers per day.

MMRDA planned to construct the 146.5 km metro rail system in three phases in which 33.5 km is underground. Phase I (Line-1) is expected to operate by end of 2013 and Line-II and Line-III by 2019. MMRDA proposed to develop 135.21 km of monorail on seven corridors and the 115 km stretch was approved. The 9 km monorail will be in operation from January 2013, and 11 km by end of 2013. The MMRDA is planning to develop BRTS on two corridors.

The planned monorail network of Mumbai is shown below.



(Source: Maps of India Website, 2012)
http://www.mapsofindia.com/maps/mumbai/monorail-route.html

Figure 4-12 Mumbai Monorail Network Plan

2) Transportation Issues

(a) Reinforcement of East-West Direction Transport Network

Mumbai city is located in the island. The road and transport networks are developed along the north-south direction. For example, the NH-8 runs in the west of the island from north to south. The NH-3 runs in the east of the island from north to south. The railway has the same case. It would be challenging to assure the east-west direction transport network due to the geographical restriction of mountainous area in the north section of the island. Nonetheless, reinforcing the east-west direction transport is one of the major issues in Mumbai, particularly under the condition where the traffic volume is significantly increasing nowadays,

(b) Disperse the Traffic Demand towards Suburban Area

The economic activities are concentrated in the southern part of the island and are surrounded by the mountainous region due to the geographical restriction. The spaces in the island are almost saturated. Thus, dispersing the activities to the suburban areas is increasingly becoming important through such measures as reinforcing/preparing the bridges connecting to Navi Mumbai. Shifting the economic activities to the suburban areas is also critical.

(c) Old-Aged City Bus

The adverse affect of the old-aged city buses on increasing road traffic is also prominent in Mumbai like in the case of Bangalore and Delhi. The proportion of middle class population is high in Mumbai. They tend to avoid such bus services and instead use their own vehicle for transport. The proportion of four wheelers stands at approximately 40% in Mumbai, which is higher than in other cities.

(d) Reinforcement of Traffic Signal Facilities

The roadside facilities such as traffic signals and CCTVs are monitored by the Municipal Corporation of Greater Mumbai. There is also a well established traffic control centre in Mumbai. The traffic police control the traffic signals at this centre. However, according to the officials in the traffic police, approximately only 50% of the traffic signals are operated by remote control and connected to the centre. The rest of the 50% are stand-alone signals. There is a great necessity to provide a green-light priority to the VIP vehicles for security purposes particularly in Mumbai. The crowd advances onto the roads during festival times. The traffic needs to be regulated by changing the traffic signal in the stand-alone signals in such events. Great portion of human resource is spent on controlling the traffic signals at the site, adversely affecting the activities of the traffic police.

3) ITS Related Issues

(a) Quantitative Measurement of Traffic and Utilisation of Traffic Data

The Mumbai Traffic Police operate the traffic control centre. The basic components of the centre include CCTV monitoring at the site, enforcement of red traffic light violation, and signal control at some sections. This centre is also well prepared like in the case of Delhi and Bangalore. Furthermore, the roadside facilities are monitored by the Municipal Corporation of Greater Mumbai. The collaboration between the Mumbai Traffic Police and Municipal Corporation of Greater Mumbai is sufficiently made. However, even under such idealistic situation, major issues are the quantitative measurement of traffic and its utilisation for transport, road planning, and dynamic information provision by generating the congestion information. Thus, the environment which enables the quantitative measurement of traffic data needs to be equipped.

(b) Static Information Provided by Variable Message Sign Board

The variable message sign boards are installed at some locations on the roads in Mumbai. However, the provided messages are limited to static information such as warning for over speeding, helmet wearing, and stoppage at stop lane in intersections. Dynamic information such as the expected travel time to the destination, appropriate alternative route guidance, and congestion level information are not provided. This condition is closely related to the issue raised above with regards to the preparation of the environment for measuring, analysing, and utilising the quantitatively collected traffic data. This issue can also be applied to other studied cities.

(9) Pune

1) Current Condition of Road and Transport Network

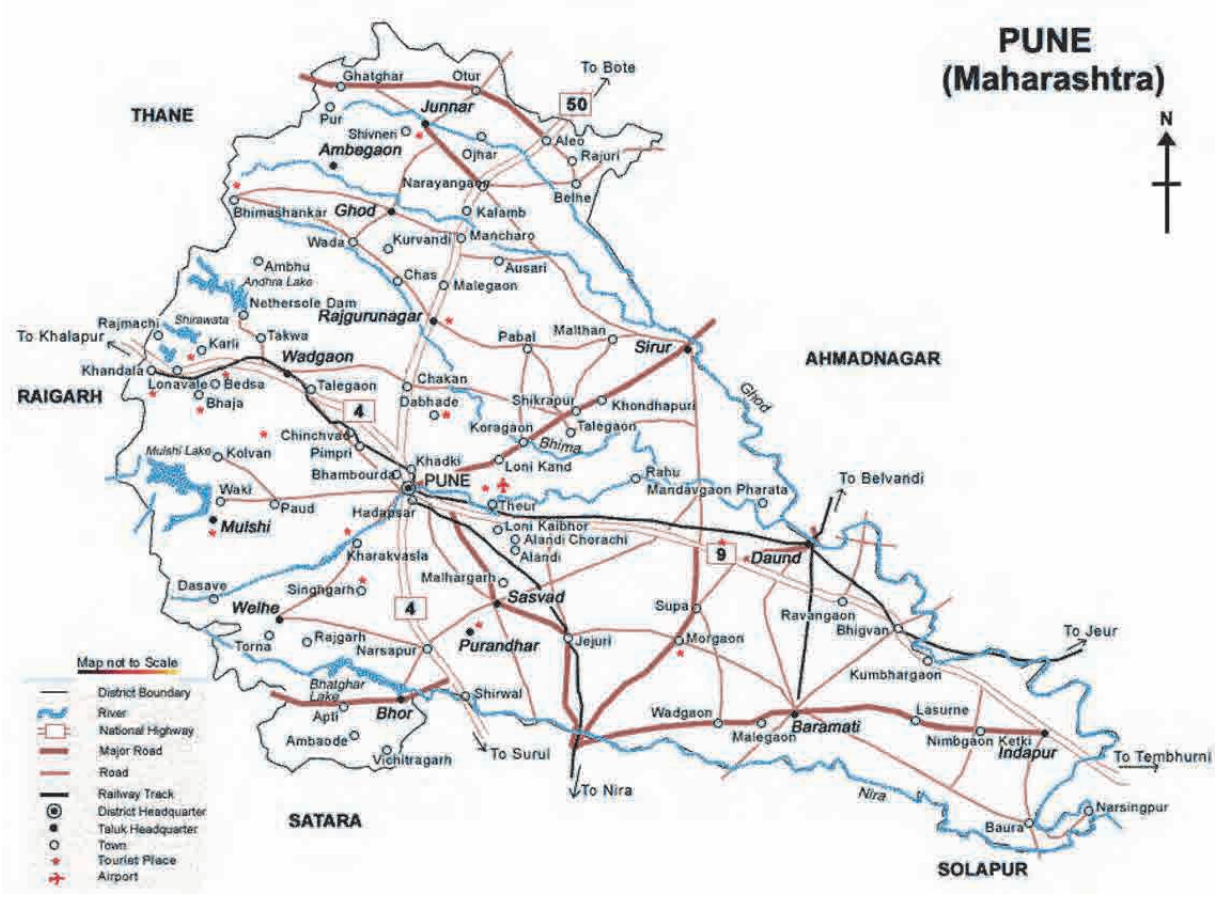
(a) Overview of Urban Development

Pune is one of the largest cities in Maharashtra state after Mumbai. Population of Pune is around 5 million. In recent years it became the economic hub after Mumbai. Automobile and Information technologies industry is rapidly growing.

(b) Road Network

The total road network of Pune is 757 km. National Highways, NH-4, NH-9 and NH-50 pass through Pune. Pune Municipal Corporation developed 30 km cycle track and planned to develop 30 km inner ring road.

The current road network of Pune is shown below



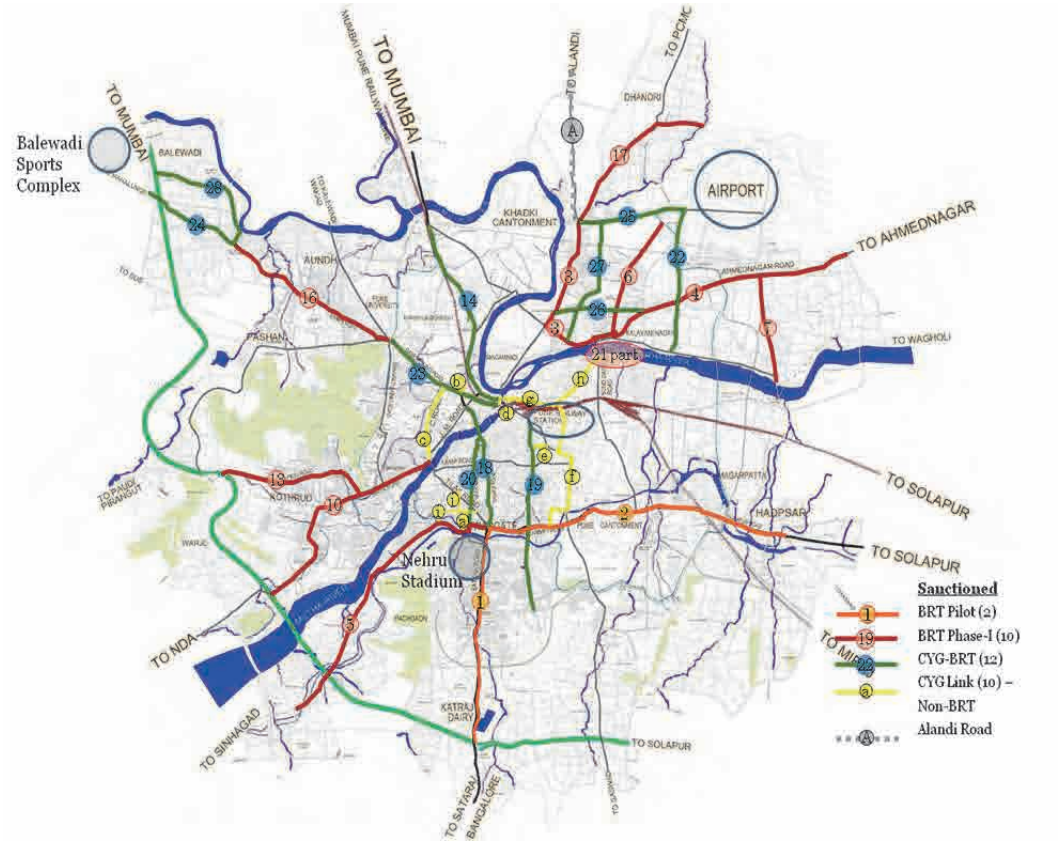
(Source: City Development Plan, Pune Municipal Corporation, 2006)

Figure 4-13 Road Network in Pune

(c) Public Transport Network

The major public transport service in Pune is the city bus. Approximately 1,825 buses are operated by Pune Mahanagar Parivahan Mahamandal Limited (PMPML). Pune is the first city in India which implemented the BRTS and currently 15.5 km BRTS is in operation. The metro rail with length of 31km is planned.

Pune city developed a 30 km cycle track and plans to provide rent-free bicycle services, equipped with 300 cycles and 25 cycle stations.



(Source: Pilot BRTS in Pune, Pune Municipal Corporation, 2010)

Figure 4-14 Pune BRTS Route Map

2) Transportation Issues

(a) Reinforcement of Road Network for Pune Metropolitan Area

The Pune Metropolitan Area is developing towards the northwest direction where Pimprichinchiwad exists. There are NH-4 and NH-48 running to the northwest direction from Pune. Some satellite towns surrounding Pune city are also being developed. The Pune area is becoming an increasingly important area specifically due to geographical proximity to Mumbai. Therefore, increasing number of private enterprises are investing in this area. Under such condition, assuring the traffic movement within the metropolitan area of Pune is important.

(b) BRTS Improvement

It is widely recognised that the BRTS in Pune is not a successful case in India. The spaces of the corridor in some sections are shared with the general traffic. It caused severe decrease of the travel time. Also due to the design mistakes, there is a height discrepancy between the floor of the bus and bus stops. Therefore, the passengers are required to step on the ground before taking the bus. Because of these failures, the operation of BRTS is currently suspended. Significant measures are required to improve the BRTS in Pune.

3) ITS Related Issues

(a) Reinforcement of Collaboration with Traffic Police for Pune Control Centre

The control centre is established and operated by the Pune Municipal Corporation. The major functions include CCTV monitoring at the site and BRTS corridor, BRTS operation monitoring, and signal control. The Pune Municipal Corporation is a road administrator. Thus, the authority for controlling the traffic is vested with the traffic police. But the traffic police in Pune do not have their traffic control system/centre of this kind. They are not stationed in the centre for daily operation. The municipal corporation contacts the traffic police to take necessary action in case of traffic hazard on the road.

There is a background that the centre was prepared solely by the municipal corporation, without sufficient collaboration with the traffic police. Such situation is also affecting the current operation scheme as described above. As a result, the function of the centre is restricted. Thus, reinforcing the collaboration with the traffic police is critical.

Chapter 5. Summary of Current Conditions and Issues

The current conditions and issues are summarised in the form of table as shown in the following pages.

5-1 Current Status in City

The comparison of the traffic conditions of the cities by indicators is shown in the table below.

Table 5-1 Comparison of Traffic Conditions by Indicators

Indicator	Delhi	Ahmedabad	Hyderabad	Bangalore	Mysore	Chennai	Indore	Mumbai	Pune	Over View by Indicator
Congestion Level	0.47	0.30	0.37	0.40	N/A	0.37	N/A	0.47	0.20	●Congestion situation is worse in Mumbai and Delhi during peak hours ●Followed by Bangalore
Access to Public Transport	1.09	2.49	1.62	1.01	N/A	1.38	N/A	1.34	3.15	●Serious in Bangalore, Delhi and Mumbai ●Favourable in Pune and Ahmedabad
Access to Office	16.36	21.54	6.08	13	N/A	12	N/A	17	54.35	●Serious in Hyderabad, Chennai, Bangalore ● Excellent in Pune
Serviceability for Pedestrian	0.87	0.85	0.68	0.63	N/A	0.77	N/A	0.85	0.81	●Serious in Bangalore, Hyderabad, Chennai ●Better in Delhi, Mumbai, Ahmedabad ●Skywalk is prepared: Consideration for pedestrian environment in Mumbai
Fatal Accident	0.32	0.14	0.06	0.11	N/A	0.07	N/A	0.25	0.22	●Serious in Hyderabad, Chennai, Bangalore ●Excellent in Delhi
Supplemental Traffic	75.6	73.9	76.6	89.7	N/A	64.18	N/A	88.3	106.2	●Serious in Chennai, Ahmedabad, Delhi ●Excellent in Pune
Illegal Parking Disturbance	2.82	2.03	1.24	1.28	N/A	1.26	N/A	2.80	0.98	●Serious in Delhi, Mumbai, Ahmedabad ●Better in Pune ●Multi-layer Parking in only Bangalore
Over View by City	●Facing chronic congestion	●Better condition of road saturation than other cities (especially in new town area) ●Serious congestion in old town	●Facing chronic congestion ●Alternative route not exist	●Facing chronic congestion ●Alternative route not exist	●Better condition of road saturation than other cities	●Facing chronic congestion ●Alternative route not exist	●Better condition of road saturation than other cities	●Facing chronic congestion ●Successful restriction of 3 wheelers into core area of city ●Alternative route not exist	●Facing chronic congestion ●Alternative route not exist	●Chronic congestion in the cities other than middle sized cities (Ahmedabad, Mysore and Indore) ● Alternative route: almost absent in these cities ● More consideration for pedestrian in Delhi and Mumbai than other cities

(Source: Prepared by JICA Study Team based on Study on Traffic & Transportation Policies & Strategies in Urban Areas in India, Ministry of Urban Development, 2012)

The supplemental remarks of the indicators are given as follows;

- **Congestion Level**：Formula [1-A/M] A：Peak Hour Highway Traffic speed, M：30km/h **Higher value means lower travel speed.**
- **Access to Public Transport：** Reciprocal number in terms of ratio of average access distance to location for transfer e.g. bus stops, stations and etc. **Higher value means shorter distance for access to the public transport.**
- **Access to Office**：Access ratio to reach to work places in 15 minutes. **Higher value means shorter time required to access to the office**.
- **Serviceability for Pedestrian**：Formula [W1 * (Footpath Length / Arterial Road Length) + W2 * (Score Obtained by Interview on Pedestrian Facilities)] W1, W2: Supposedly Set at 50%. **Higher value means better facilities for pedestrian.**
- **Fatal Accident**：Formula [1/Fatality indicator] Fatality Indicator：Number of accidental deaths per 100,000. **Higher value means safer.**
- **Supplemental Traffic：**Number of para-transit per 10 000 person. Ancillary Transportation ＝3-wheeler, mini-bus, taxi etc.. **Higher value means more options of alternative transport mode e.g. 3 wheeler, mini bus, taxi and etc.**
- **Illegal Parking Disturbance**：Formula [1/(W1*Length of Arterial Road Used for Parking+W2*On-Street Parking Demand] W1, W2: Supposedly Set at 50%. **Higher value means more disturbances caused by the illegally parked vehicles**.

Note: The referred report, Study on Traffic & Transportation Policies & Strategies in Urban Area, was prepared in 2008. The urban mass transportations such as metro and BRTS, were developed after the report had been prepared. It is expected that the condition of the urban mass transportations are not correctly reflected. Thus, these indicators are omitted.

The conditions of the road traffic and public transport by city are summarised in the table below.

Table 5-2 Road and Public Transport Condition by City

Item	Delhi	Ahmedabad	Hyderabad	Bangalore	Mysore	Chennai	Indore	Mumbai	Pune	Over View by Item
Number of Registered Vehicles	6.9 Million	2.6 Million	3.6 Million	4 Million	0.4 Million	3.6 Million	0.7 Million	4 Million	2.3 Million	●Largest proportion of 2 wheelers in all cities ●High proportion of 4 wheelers in Delhi and Mumbai ●High growth ratio in Chennai and Hyderabad
Vehicle Growth Ratio	7.5%	8%	10%	7-10%	N/A	10.5%	9%	7%	8%	
2 Wheeler Ratio	63%	73%	74%	71%	75%	76%	70%	55%	73%	
4 Wheeler Ratio	31%		15%	17%	12%			31%	14%	
Public Transport Usage	43%	24%	50%	55%	45%	50%	22%	90%	45%	●Particularly high in Mumbai. This is due to the background that the railway network was developed in the area of British colony.
City Bus: Serviceability Ratio	43.86	12.99	31.88	39..22	N/A	33.39	N/A	16.66	16.43	●Particularly high in Delhi, followed by Bangalore ●Serious in Ahmedabad and Pune
Total City Buses and Routes	Buses: 5,667 Routes :773	Buses: 1,100 Routes: 212	Buses :3,872 Routes: 850	Buses: 7,000 Routes: 300	Buses: 500 Routes: 100	Buses: 3497 Routes: 729	Buses: 119 Routes: 50	Buses: 4000 Routes: 700	Buses: 1825 Routes: 369	
City Bus: Operation Monitoring Condition	Operated 4000 GPS Buses	Operated 400 GPS Buses Considered: Reinforcement	Planned	Operated 500 GPS Buses Considered: Reinforcement	Operated 500 GPS Buses (World Bank Funded)	Operated 550 GPS Buses Considered: Reinforcement	Operated 119 GPS Buses Considered: Reinforcement	Operated 1200 GPS Buses Considered: Reinforcement	Not Operated (GPS Buses/Centre not existed)	●Not operated in Hyderabad and Pune ●Planned in Hyderabad ● Indore: Considered to integrate BRTS and City Bus Monitoring
City Bus: Information Provision at Bus Stop	Provided: Arrival Time Operation Status	Not Provided Considered	Not Provided	Not Provided Considered	Not Provided	Provided: Arrival Time Operation Status Considered: Expansion	Provided: Arrival Time Operation Status	Provided: Arrival Time Operation Status Considered: Expansion	Not Provided	

Item	Delhi	Ahmedabad	Hyderabad	Bangalore	Mysore	Chennai	Indore	Mumbai	Pune	Over View by Item
BRTS	Operated: 1 corridor (14.5km) Considered: 106.5km	Operated: 45km Planned: 80km	Not Planned	Not Planned	Not Planned	Not Planned	Operated: 11.6km (1 Corridor) Considered: 7 Corridors (109km)	Not Planned	Operated: 1 Corridor (15.5km) Considered: 5 Corridors (112km)	●Delhi: BRTS lane was opened due to adverse affect on road traffic ●Ahmedabad: BRTS is planned to extend to the old town. But the similar result as the case in Delhi is expected due to the difficulty of land acquisition, consequently occupied the road space by the BRTS lane.
Metro Rail	Operated: 7 Lines (190km) Planned: 140km	Planned: 5 Lines (76km)	Under Construction: 3 Lines (71km)	Operated: 1 Line (6.7km) Under Construction: 2 Lines (35.6km) Planned: 2 Lines (72km)	Not Planned	Under Construction: 2 Lines (45km)	Not Planned	Under Construction: 2 Lines (43km) Planned: 7 Lines (103km)	Planned: 2 Lines (31km)	●Delhi Metro: user per day reaches 1.6 million people. ●Mumbai and Chennai: Consideration is made for assuring the connectivity with bus transport
Monorail	Considered 3 Lines (47.8km)	Considered 30km	Not Planned	Considered: 60km	Not Planned	Considered: 110km	Not Planned	Under Construction: 20km Considered 115km	Not Planned	●The monorail is considered as supplementary connection to the metro network ●Mumbai: The rail network was developed in North-South direction. The urban mass transport (e.g. Monorail) is to supplement the East-West direction railway network.

Note: Planned: Approved by Central and State Government, Considered: Not Approved by Central and State Government
The supplemental remark of the indicator is given as follows;

・**City Bus Serviceability Ratio**：Total number of public and private bus service per 100,000 people. **Higher value means higher service level.**

The conditions of ITS by city are summarised in the table below.

Table 5-3 Conditions of ITS by City

Item	ITS Overview in 9 Cities			
ITS Development Overview	**Delhi** • **More Advanced than other cities** (DIMTS Centre)	**Bangalore** • **More Advanced than other cities** (B-TRAC by Traffic Police)	**Indore** • **Lags behind other cities**	**Overview** • **Delhi, Mumbai and Bangalore:** ITS developments are advanced. • **Pune**: Advanced feature: Traffic control centre by Pune city. • **Other Cities**: More or less lags behind.
	Ahmedabad • **Lags behind other cities**	**Mysore** • **Lags behind other cities**	**Mumbai** • **More Advanced than other cities** (Traffic Control Centre by Traffic Police, and Facility Monitoring Centre by Mumbai city)	
	Hyderabad • **Lags behind other cities**	**Chennai** • **Lags behind other cities**	**Pune** • **Partially more advanced than other cities** (Traffic Control Centre by Pune city)	
Prominent Features Observed	**Delhi** • **DIMTS Centre (Concept and Feature)** • It was established as a single agency for planning, introduction/expansion and operation of ITS in Delhi. • The basic role is currently for BRTS operation. • But the functions are expected to expand. • It is reputed as model case in India.	**Bangalore** • **Advanced than other cities** (B-TRAC by Traffic Police) • The traffic monitoring system is centralised. • It is reputed as model case in India.	**Indore** • Not found in particular	**Overview** • **Good Practices of Control Centre:** DIMTS Centre in Delhi, Traffic Control Centre and Facility Monitoring Centre in Mumbai, Traffic Control Centre (B-TRAC) in Bangalore Traffic Control Centre in Pune • **Best Practices of Road Management:** **Road Inventory Preparation in Hyderabad and Mumbai.** They can be useful reference by other cities. • **Best Practices of Road and Traffic Management:** **Accident Database in Chennai** It can be useful reference by other cities.
	Ahmedabad • **BRTS Preparation** • It is reputed as model case in India because of the successful operation. • It is the first case of BRTS which went for full scales operation on commercial base in 2009.	**Mysore** • Not found in particular	**Mumbai** • **Traffic Control Centre by Traffic Police** • **Facility Monitoring Centre by Mumbai city** • **Road Inventory** All were prepared supported by World Bank	
	Hyderabad • **ITS Master Plan** • Under preparation supported by JICA • It is the first case of its kind in India. • The regional ITS centre is under preparation. • **Road Inventory** • Under preparation supported by JICA • It covers the major roads in Hyderabad Metropolitan Area.	**Chennai** • **Accident Data Base Funded by World Bank** • The data and operations are shared amongst related agencies e.g. traffic administrator, road administrator, planning agency, central government and etc. • The data is intended to reflect on Indian Road Congress.	**Pune** • **Traffic Control Centre by Pune city** • It was prepared and is operated by Pune city.	

Traffic Control Centre by Traffic Police

Delhi
- **Not sufficiently prepared**
- The construction of traffic control centre and preparation of associated equipment is under planning. (The fund has been approved.)

Bangalore
- **Well prepared and advanced (B-TRAC)**
- The upgrade of the existing centre and expansion of the associated equipment is under planning.
- It is reputed as model case in India.

Indore
- **Not sufficiently prepared**
- The reinforcement of the traffic control centre is under consideration.

Ahmedabad
- **Not sufficiently prepared**
- The introduction of traffic control centre is under consideration.

Mysore
- **Not sufficiently prepared**
- The reinforcement of the traffic control centre is under consideration.

Mumbai
- **Well prepared and advanced**
- The expansion of the associated equipment is under planning.

Hyderabad
- **Not sufficiently prepared**
- The upgrade of the existing facilities and centres are under planning. (The fund has been approved.)

Chennai
- **Not sufficiently prepared**
- The reinforcement of the traffic control centre is under consideration.

Pune
- **Not sufficiently prepared**
- The reinforcement of the traffic control centre is under consideration.

Overview
- The traffic control centres of the traffic police in all cities, except in Bangalore and Mumbai, are not sufficiently prepared.
- Particularly, the centres in Delhi and Chennai are not adequately in place in consideration of the size of the city and traffic volume in the city.
- The upgrade, reinforcement, or expansion of the centre and associated equipment are either planned or considered in all cities.
- The funds are approved for upgrade of the centre in Delhi and Hyderabad.
- Others are still under the stage of consideration.

Basic Institutional Environment Required for ITS Introduction and System Environment Required for Centralisation

Delhi
- **Systematically and institutionally well established environment is in place: DIMTS Centre**
- It monitors bus operation and BRTS.
- It plans to expand taxi monitoring system.

Bangalore
- **The basic environment is in place: B-TRAC Centre**
- The traffic management is implemented in centralised manner.

Indore
- Basic system/institutional environment for centralisation are not in place.

Ahmedabad
- Basic system/institutional environment for centralisation are not in place.

Mysore
- Basic system/institutional environment for centralisation are not in place.

Mumbai
- **Systematically and institutionally well established environment is in place:** Traffic Control Centre by Traffic Police and Facility Management Centre by Mumbai city
- The operational and systematic coordination are well in place between traffic police and Mumbai city.

Hyderabad
- Basic system/institutional environment for centralisation are not in place.
- ITS Centre is under preparation by JICA

Chennai
- Basic system/institutional environment for centralisation are not in place.

Pune
- Control centre of Pune Municipal Corporation monitors traffic and bus operation.
- Thus basic environment is in place.

Overview by Item
- **Basic Institutional Environment**
- The cities where the basic institutional environment required for ITS introduction and operation exists at certain level are Delhi, Bangalore, Mumbai and Pune.
- **Basic System Environment for Centralisation**
- The cities where the basic system environment required for system integration exists at certain level are Delhi, Bangalore, Mumbai and Pune, as well.

<table>
<tr>
<td>Smart Card</td>
<td>
<table>
<tr>
<td>Delhi
• Individual Card:
Introduced by public bus, BRTS and Metro
• Common Card:
The pilot project is underway amongst above transport modes.</td>
<td>Bangalore
• Individual Card:
Introduced by public bus and metro.
• Common Card:
Considered amongst above transport modes.</td>
<td>Indore
• Individual Card:
Not introduced, Not planned
• Common Card:
Not introduced, Not planned</td>
<td rowspan="3">Overview by Item
• The common cards have not been introduced in any city in India yet.
• Delhi: The preparation stage is mostly progressed for the common card. The pilot project is underway.
• Mumbai, Chennai, and Bangalore: The common card is under consideration.
• Ahmedabad: They have intension for introducing the common card, though the plan has not been substantially progressed yet.</td>
</tr>
<tr>
<td>Ahmedabad
• Individual Card:
Introduced by BRTS
Considered by City Bus
• Common Card:
Not introduced, Not planned</td>
<td>Mysore
• Individual Card:
Not introduced, Not planned
• Common Card:
Not introduced, Not planned</td>
<td>Mumbai
• Individual Card:
Introduced by public bus. Planned by Monorail and Metro.
• Common Card:
Considered amongst above transport mode</td>
</tr>
<tr>
<td>Hyderabad
• Individual Card:
Not introduced, Not planned
• Common Card:
Not introduced, Not Planned</td>
<td>Chennai
• Individual Card:
Planned by public bus, metro and monorail
• Common Card:
Considered amongst above transport modes</td>
<td>Pune
• Individual Card:
Not introduced, Not planned
• Common Card:
Not introduced, Not planned</td>
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<tr>
<td>Knowledge on ITS of the Involved Personnel</td>
<td>
<table>
<tr>
<td>Delhi
• The personnel of DIMTS are exceptionally high</td>
<td>Bangalore
• Certain level of knowledge was found in traffic police and ministry of urban development.</td>
<td>Indore
• Not found in particular.</td>
<td rowspan="3">Overview by Item
• The knowledge on ITS and capability of personnel DIMTS in Delhi and traffic police and Mumbai city are excellent. The Bangalore traffic police and Pune city follow next.
• Personal in other cities are more or less same.</td>
</tr>
<tr>
<td>Ahmedabad
• Certain level of knowledge was found in road administrator and bus operator.</td>
<td>Mysore
• Relatively limited knowledge overall..</td>
<td>Mumbai
• The excellent knowledge by traffic police, road administrator and planning agency.</td>
</tr>
<tr>
<td>Hyderabad
• Not found in particular.</td>
<td>Chennai
• Certain level of knowledge was found in Metro and bus operator.</td>
<td>Pune
• Sufficient level of knowledge was found in Pune Municipal Corporation. But not others in particular.</td>
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Other Donors Activities

Delhi
- N/A

Bangalore
- N/A

Indore
- The World Bank
- BRTS to be funded. (But the approval of the central government's fund is suspended. Thus the project is mostly expected to be implemented without ITS component.)

Ahmedabad
- N/A

Mysore
- The World Bank: Bus monitoring system (under preparation)

Mumbai
- The World Bank: Traffic control centre and facility monitoring centre
- The World Bank: Road Inventory Database
- The above are the same project.

Hyderabad
- No activities by other donors

Chennai
The World Bank:
- 1) Accident Database
- 2) Enforcement System

Pune
- The World Bank: BRTS

Overview by Item
- The World Bank is actively supporting in the field of ITS in India.
- The systems in Mysore, Indore, and Pune were prepared under the 'Sustainable Urban Transport Project.

Traffic Information Collection

Delhi
- The location information collected by GPS (City Bus, BRTS) by DIMTS
- The site condition monitored by CCTV by DIMTS
- The site condition monitored by CCTV by traffic police.

Bangalore
- The site condition is monitored by CCTV by traffic police (B-TRAC).
- The location information is collected by GPS by city bus.

Indore
- The site condition is monitored by CCTV by traffic police.
- The location information is collected by GPS by city bus.

Ahmedabad
- The site condition is monitored by CCTV by BRTS
- The location information collected by GPS by BRTS
- The traffic police do not have any facilities for monitoring.

Mysore
- The site condition is monitored by CCTV by traffic police.
- The location information is collected by GPS by city bus.

Mumbai
- The site condition is monitored by CCTV by traffic police.
- The location information is collected by GPS by city bus.

Hyderabad
- The site condition is monitored by CCTV by traffic police.
- The **quantitative traffic data collection** is planned by HMDA supported by JICA.
- The **utilisation of the collected quantitative traffic data for traffic/road/urban development** is planned by HMDA supported by JICA.

Chennai
- The site condition is monitored by CCTV by traffic police.
- The location information is collected by GPS by city bus.

Pune
- The site condition is monitored by CCTV by road administrator (Pune Municipal Corporation).
- The location information is collected by GPS by BRTS.
- The traffic police do not have any facilities for monitoring.

Overview by Item
- **The traffic condition monitoring depends on CCTV in all cities.**
- **The quantitative measurement of traffic is not realised in any cities in India.**
- **Thus, the ITS is not utilised for planning and evaluation of road/traffic/urban development in quantitative manner in India**.
- **Hyderabad**: Planning is mostly advanced.
  i) Quantitative measurement of traffic, and ii) Utilisation for road/traffic/urban development are planned by Hyderabad Metropolitan Development Authority, supported by JICA.
- The location information is collected by GPS by BRTS/city bus, but it is for their own operation purpose and not utilised for traffic information.

Traffic Information Provision

Delhi
- Limited traffic information is provided by SMS, Internet by traffic police.
- Bus arrival and operation information is provided at bus stop by DIMTS.
- Some variable message sign boards are in place. But only static warning messages are provided, not dynamic traffic information.

Bangalore
- Limited traffic information is provided by SMS, Internet by traffic police.
- Some variable message sign boards are in place. But only static warning messages are provided, not dynamic traffic information.

Indore
- Traffic information is provided by the speakers at junction by traffic police.
- Bus arrival and operation information is provided at bus stop

Ahmedabad
- Bus arrival and operation information is provided at bus stop by BRTS.

Mysore
- Limited traffic information is provided by SMS by traffic police.

Mumbai
- Limited traffic information is provided by SMS, Internet by traffic police.
- Bus arrival and operation information is provided at bus stop.
- Some variable message sign boards are in place. But only static warning messages are provided, not dynamic traffic information.

Hyderabad
- Limited traffic information is provided by SMS by traffic police.
- Introduction of VMS is planned by Traffic Police and Hyderabad city.
- **Dynamic traffic information provision through VMS, SMS, Internet and etc is planned by HMDA supported by JICA.**

Chennai
- Limited traffic information is provided by SMS, Internet by traffic police.
- Bus arrival and operation information is provided at bus stop.

Pune
- Limited traffic information is provided by SMS by traffic police.
- Bus arrival and operation information is provided at bus stop.

Overview by Item
- The information provided by the traffic police is based on the monitoring by CCTV or report by the police staff at site. **The information is not dynamically generated by processing.**
- **Some variable message sign boards are found in Mumbai, Delhi and Bangalore. But the provided information is limited to the static warning message, e.g. warning message on keeping speed limit, not such as dynamic route guidance, expected arrival time, planned road closure etc.**
- **Many of the VMS in these cities are not placed on the suitable location, e.g. merging point of the arterial road to divert the traffic by providing the dynamic road/traffic information.**
- The provided traffic information is: i) limited information by SMS, Internet by traffic police, ii) arrival time and operation information at bus stop.
- The bus information (arrival time, operation status) is not provided to the users at bust stop in Hyderabad, Bangalore and Mysore.

Traffic Signal Control

Delhi
- The signals along the BRTS corridor are controlled to provide the priority of BRTS to the general vehicles by DIMTS.
- The traffic police do not hold the authority to control these signals along the corridor.

Bangalore
- The traffic signals by single junction are controlled in normal case.
- The signal timing, the signals grouped by some intersections can be controlled from the centre when necessary.

Indore
- The traffic signals by single junction are controlled (not from the centre)

Ahmedabad
- Limited number of traffic signals monitored by the road administrator, as the facility monitoring purpose.

Mysore
- The traffic signals are not controlled.

Mumbai
- The signal timing, the signals grouped by some intersections can be controlled from the centre when necessary.

Hyderabad
- The traffic signals are not controlled.

Chennai
- The traffic signals by single junction are controlled. (not from the centre)

Pune
- The traffic signals by single junction are controlled (not from the centre)

Overview by Item
- The traffic signals in Mumbai are mostly advanced.
- They were prepared by the World Bank Fund.

5-2 Summary of Issues

The issues at national and regional level are summarised based on the reviews thus far as follows.

Table 5-4 Issues at National Level

Issues at National Level		
Planning	Absence of Upper Level Plan of ITS	There is no higher level planning of ITS such as national level ITS master plan with long term vision. Under such situation, the ITS at regional level are being independently introduced.
	Absence of National ITS Architecture	The national level ITS architectures are not prepared yet. It is favourable that the national level ITS architectures are prepared based on the upper level ITS planning. The ITS at regional level shall be deployed based on the ITS architecture at regional level under the framework of the national level ITS architecture.
Institution	Weakness of Institutional Framework for Inter-Ministerial Collaboration for ITS Promotion	The inter-ministerial institutional framework is critical for promotion of ITS. The ITS taskforce was formulated in 2007, initiated by the Ministry of Urban Transport. However it was observed that the intuitional structure and capability were not sufficient yet. The substantial activities and discussions have not been sufficiently carried out yet.
	Weakness of Institutional Framework for Industry, Government and Academia Collaboration and International Network	The collaboration of industry, government and academia, and international network are also critical for promotion of ITS, as well as the inter-ministerial collaboration. However, the institutional framework and nodal point for international activities are still weak in India.

Table 5-5 Issues Commonly Observed Across Cities

Traffic Issues		
Infrastructure	Road Infrastructure	The road infrastructures are not properly prepared in the cities in India, although the conditions somehow differ by city. Except some limited areas in such cities as Delhi and Mumbai, the proper road infrastructure such as road alignment, lane-marking, intersection structure, footpath, pedestrian crossing, and etc., are not sufficiently in place. Moreover, a number of religious obstacles remain on the road at many locations in the cities in India, and they are adversely affecting the smooth traffic flow.
	Saturation of Road and Intersection Capacity	The cities in India are facing serious traffic congestion due to rapid increase of the road traffic. The road and intersection capacities are reaching saturated level specifically during peak hours. The middle-class population is rapidly increasing in India in accordance with economic growth in recent years. The people who belong to the middle-class hold the economic capability for purchasing their own vehicles. It is mostly assumed that such back ground also significantly contributing to the increasing adverse condition of the road traffic.
	Absence of Space for Pedestrian	It can be said that India is, so called, a ‘vehicle-prioritised society’, and the spaces for the pedestrians are not adequately in place in the cities except the limited areas in Delhi and Mumbai. The typical examples are extremely narrow sections and frequent missing sections of the footpaths along the road, a number of the obstacles standing in the middle of the sidewalk areas, unacceptably insufficient number of the pedestrian crossings, skywalks and pelican-crossings. The pedestrians are consequently forced to walk on the areas of the carriageway. Thus in India, the spaces for the vehicles and people are not clearly demarcated in the city, and the walking spaces are not practically functioning.
	Insufficient Parking Space	The cities in India are facing the illegal parking issues and generally do not have enough spaces for construction of the parking. However in addition to the physical restrictions for the spaces, it needs to be pointed out that the parking is not strategically planned at such locations as connection point of the public transport for assurance of smooth transit, commercial complex, industrial areas and business centres for accommodating the vehicles.
Manner	Traffic Manner	The traffic manners in India are adverse condition. The typical examples are opposite driving, lane hogging, traffic signal violation, lane mark violation, riding motorbikes without helmet and excess number of the passengers and etc. The crossings of the road by the pedestrians are frequent scene everywhere specifically due to the absence of the spaces for the pedestrian in the city, as raised above.
Public Transport	Insufficient Last mile Connection and Arrangement of Connection amongst Different Transport Modes	The urban mass transit systems such as metro, BRTS and monorail are increasingly developed in the major cities in India in recent years. However, the last mile connections which ensure the movement of the people, for example, between the residential areas and the stations of the trunk line of the public transport, are not satisfactorily in place. The connections which assure the transit to the different transport mode such as parking around the stations and proximity of the bus and metro stations are not adequately arranged. Thus, the people select the road transport and, consequently, the traffic demand has not been diverted to the public transport.
	Obsolete City Bus	The modern vehicles are generally introduced for the BRTS. However, the city bus vehicles are obsolete in general in the cities in India. The replacement of the old city bus to the new vehicles equipped with the air condition is underway in some cities under the scheme of Jawaharlal Nehru National Urban Renewal Mission. But the number of the renewed vehicles is still limited. The people especially the middle-class population who hold the economic capability to purchase their own vehicles tend to choose their own cars for commute, for example. This background is also adversely contributing to increasing traffic congestion in the cities.
Manage-	Road Management	The basic information of the road is not sufficiently prepared and properly managed in the cities. In general, the city government is responsible for construction and maintenance

Traffic Issues		
ment		of the general roads in the city, the National Highway Authority of India is for construction of the national road in the city, the state government is for maintenance of the national road in the city and construction and maintenance of the state road and the planning agency for road network planning. The general observation found that the road inventory and drawing of the roads are not sufficiently prepared and managed by any of these agencies. Consequently, the proper road management is not adequately carried out.
	Traffic Accident Information Management	The traffic police are basically responsible for management of the traffic accident information. However there is no standard for the management of the traffic accident management. Thus, the accuracy, contents, duration of storage and management methods significantly different by city. The information of the traffic accident is not sufficiently shared amongst other related authorities such as the road administrators and planning agencies, consequently resulting in the situation that the accident information is not satisfactorily utilised for improvement of the measures for the traffic and road management.
Management and Infrastructure	Necessity of Intersection Improvement and Obsolete Traffic Signal Facilities	There are many cases that the traffic signals are not working due to the insufficient maintenance, and the traffic police personnel carry out the traffic regulation on the street. The traffic police are required to spend their limited human resources on regulating the traffic, seriously affecting the police activities. Thus, the renewal of the traffic signals is strongly desired by the traffic police in almost all cities. However, it shall be stressed that the intersection structures are not properly prepared in many of the places in the city in India, and the effect will be quite limited by only replacing the traffic signals. Therefore, it is important that the structures of the intersections are improved before simply replacing the traffic signals.
ITS Issues		
Planning	Upper Level Planning at Regional Level	There does not exist any higher level planning of ITS at regional level such as road map and regional ITS Master Plan with long term vision. Under such situation, the ITS introductions are independently underway. There is a risk that the inefficient system will be in place and double-investment resulting in unnecessary higher cost may occur.
	Regional ITS Architecture	The regional level ITS architectures are not prepared yet. It is expected that more or less similar kinds of the ITS menus may be required in the cities in India. However, the ITS architectures which reflect the regional requirement are necessary. The regional ITS shall be deployed in accordance with such regional ITS architectures.
	ITS Deployment Plans	The ITS deployment shall be thoroughly planned under the framework of the regional ITS Master Plan and ITS architectures. Some studies and plans such as the comprehensive mobility plan touches on the ITS in some cities. However, the contemplation and description are not sufficient yet.
Institution	Institutional Framework for ITS Promotion	A number of different agencies are involved for planning, introducing and operating ITS. In particular in the case of India, the jurisdiction is complicated. For example, the city government is responsible for installation and maintenance of the facilities, the traffic police is for operation. But the actual maintenance and operations are outsourced to the private agencies by these different governmental bodies. Thus, the cross-sectorial institutional framework is important for effective planning, introduction and operation of ITS particularly in India.
Management	Facilities Not Properly Maintained Due To Management Structure	The road side facilities such as CCTV and traffic signals are not sufficiently maintained. It is mostly assumed that the complex jurisdictional feature, as described above, can be one of the reasons for this, in addition to chronic budget constraint. For example, the city government procures, owns and maintains the facilities. The traffic police use them and thus don't have the budget. The actual maintenance is outsourced to the private companies. But they are out of jurisdiction of the traffic police. Consequently the requirement for improvement of the facilities required by the traffic police as a user is not smoothly reflected to the necessary measures. Then it results in abandoning the facilities which are not maintained.
Technology	Quantitative Measurement and Utilisation of Traffic Data	The traffic management is solely dependant on CCTV monitoring in India and the systems for quantitative measurement on traffic by such methods as road side sensors and probe system are not in place. Therefore, the traffic conditions are not quantitatively comprehended and the measured traffic data is not utilised for generation of the dynamic traffic information and planning/evaluation for traffic, road infrastructure and urban development.
	Road and Traffic Information Provision	Some VMS are available in the limited locations in the cities such as Delhi, Mumbai and Bangalore. However the provided information is limited to the static messages such as the warnings on wearing the helmet and speed limit. The dynamic road and traffic information including the expected arrival time, congestion level, alternative route guidance, planned road closures and etc is not provided. Furthermore, the VMS are not placed on the proper locations such as the diverting point.
	Number Plate	The vehicle number plates are not standardised in India. They employ different materials, fonts, character sizes, languages, equipping positions on the vehicles and etc. It is technically difficult to automatically detect and recognise the number plate by the system in such condition. If the automatic detection is realised, it can be utilised for improvement of the enforcement by tracing particular vehicles. Moreover, it can be also utilised for planning for road infrastructure and traffic measurement. For example, there is a possibility to utilise for preparation of the improvement plan of the industrial corridor by detecting the origin-and-destination of the commercial vehicle circulating in and around the city. It may be able to contribute to preparation of urban planning or public transport improvement by detecting origin-and-destination of the 2/4 wheelers.
	Difficulty in Tracing Violated Vehicles in Relation to Current Vehicle Registration	The enforcement systems such as e-Challan system are in operation in many cities in India. The number plate of the violated vehicle is captured by the cameras installed on the intersection. The fine is issued to the vehicle owners identified from the vehicle database by retrieving from the vehicle number which is manually inputted onto the system by the personnel at the centre who is referring the captured picture of the number plate. The registration database is linked to the owners' addresses. However, the database is prepared by state. Thus the vehicles from other state can not be traced. In addition, there is no system as residential registration in India. Therefore, the vehicle owner who changed his address and not reported can not be properly traced.

The major issues observed by city are summarised in the table below.

Table 5-6 Major Issues Observed by City

Item	ITS Overview in 9 Cities		
Traffic Issues	**Delhi** • **Road Infrastructure** • Increasing traffic spread in suburban areas due to rapid development of satellite cities. • **Public Transport** • Insufficient last mile connection • Insufficient connection amongst different transport modes • BRTS - Land Acquisition - Existing Route and Insufficient connection to different transport modes	**Bangalore** • **Road Infrastructure** • Traffic flow influenced by IT industrial area • Increasing traffic spread in suburban areas due to rapid development of satellite cities • **Public Transport** • Insufficient last mile connection • Insufficient connection amongst different transport modes • Obsolete city bus	**Indore** • **Road Infrastructure** • Road infrastructures lagged behind other cities • **Public Transport** • Inadequately prepared bus stops
	Ahmedabad • **Road Infrastructure** • Increasing traffic towards suburban areas due to development • Traffic congestion in old town area • Religious objects on the street • **Public Transport** • BRTS - Pedestrian crossing - Land acquisition for planned route in the old town • **Others** • Insufficient logistic facilities • Inefficient procedures for approval of commercial vehicle passage	**Mysore** • **Road and Traffic Infrastructure** • Limitation of large-scale development due to the policy of heritage and environmental preservation • Accessibility between Bangalore • Road traffic increase in view of city policy for environmental preservation • Increasing road traffic used by the tourists due to service level of city bus	**Mumbai** • **Road and Transport Network** • Insufficient road and transport network of east-west direction • Increasing concentration of traffic in the core area of the city • **Public Transport** • Insufficient last mile connection • Insufficient connection amongst different transport modes • Obsolete city bus • **Facilities** • Insufficient number of centrally connected traffic signals
	Hyderabad • **Road Infrastructures** • Road infrastructures lagged behind other cities • Absence of pedestrian spaces in the city • Religious objects on the streets • **Road and City Planning** Road and city planning in accordance with traffic change	**Chennai** • **Road Infrastructure** • Accessibility to the port, specifically ennore port • Accessibility for industrial areas developed along the major roads in suburban areas	**Pune** • **Road Infrastructure** • Reinforcement of road network for assuring smooth traffic movement within Pune metropolitan area • **Public Transport** • Design of BRTS

Note:

- There exist a number of traffic issues in each city. Thus the major issues amongst them which are particularly observed by the site survey or identified through the interviews in the city are listed above.

Table 5-7 Major Issues Observed by City

Item	ITS Overview in 9 Cities		
ITS Issues	**Delhi** **Traffic Control Centre (Traffic Police)** • Preparation of traffic control centre and associated facilities for proper traffic control due to scarcity of the required facilities in consideration of the size of the city and traffic volume. • **Reinforcement of Function of DIMTS Centre** • Quantitative measurement of traffic and utilisation for planning and traffic information provision • Dynamic traffic information provision • **Institutional Issues** • Clarification of demarcation between DIMTS and traffic police, and reinforcement of coordination amongst them	**Bangalore** • **Reinforcement of Function of Traffic Control Centre (B-TRAC)** • Quantitative measurement of traffic and utilisation for planning and traffic information provision • Dynamic traffic information provision • **Facility Management** • Reinforcement of facility management because the existing centre is up to the required level. • **Institutional Issues** • Reinforcement of cross-**sectorial** institutional framework based on the existing organisation of the traffic police. • **Others:** Introduction of common card	**Indore** • Reinforcement of ITS facilities on BRTS • **Institutional Issues** • Reinforcement of cross-sectorial institutional framework based on the existing organisation of the traffic police. • **Others:** Capacity building
	Ahmedabad • **Traffic Control Centre (Traffic Police)** • Preparation of traffic control centre and associated facilities for proper traffic control due to absence of the centre and facilities of the traffic police • **Facility Management** • Reinforcement of facility management because of improper maintenance compared to the other cities • **Institutional Issues** • Preparation of basic institutional framework due to absence of the basic cross-sectorial institution • **Others: (**Capacity building; Introduction of common card)	**Mysore** • **Reinforcement of Information Provision in Relation with Tourism** • Provision of tourism related information e.g. tourist spot, location of the tourism related facilities to attract more tourists • Provision of pre-trip information to the tourist • **Traffic Control Centre (Traffic Police)** • Preparation of traffic control centre and associated facilities for proper traffic control because of the absence of the centre and facilities at the traffic police • **Institutional Issues** • Preparation of basic institutional framework because of the absence of the basic cross-sectorial institution • **Others:** Capacity building	**Mumbai** • **Reinforcement of Function of Traffic Control Centre** • Quantitative measurement of traffic and utilisation for planning and traffic information provision • Dynamic traffic information provision • Provision of more traffic signal • **Institutional Issues** • Reinforcement of cross-sectorial institutional framework based on the existing organisational arrangement of planning agency, traffic police and Mumbai city. • **Others:** Introduction of common card
	Hyderabad • **City Bus Operation System** • Preparation of city bus operation and monitoring system because of the absence of such system • **Facility Management** • Reinforcement of facility management because of the improper maintenance compared to the other cities • **Institutional Issues** • Preparation of basic institutional framework because of the absence of the basic cross-sectorial institution (Currently under the process supported by JICA) • **Others:** Capacity Building	**Chennai** • **Traffic Control Centre (Traffic Police)** • Preparation of traffic control centre and associated facilities for proper traffic control because of the absence of the centre and facilities at the traffic police, particularly in consideration of the size of the city and traffic volume • **Institutional Issues** • Preparation of basic institutional framework because of the absence of the basic cross-sectorial institution • **Others:** Introduction of common card	**Pune** • **Traffic Control Centre** • Preparation of traffic control centre for proper traffic control because of the absence of the required facilities • **Reinforcement of Function of Existing Traffic Control Centre** • Quantitative measurement of traffic and utilisation for planning and traffic information provision • Dynamic traffic information provision • **Institutional Issues** • Clarification of demarcation between Pune city and traffic police, and reinforcement of coordination amongst them

Note:

- The above listed are the major issues particularly observed by site survey/identified through interviews.
- Others (Capacity Building): The capacity building is required for all the major cities of India. It was particularly observed the non-availability of such knowledge for the cities covered under the current study.
- Other (Common Card): The above listed are the cities where the introduction is either considered or planned, and there exist the urban mass transit system such as metro and BRTS. The pilot project for the common card is underway in Delhi. Thus the Delhi is excluded from the above list.

Chapter 6. The Way Forward

6-1 Required Measures and Implementation Schedule

Based on the review so far, the required measures and draft implementation schedule at the national and regional level is proposed in the following pages.

Table 6-1 Proposed Implementation Schedule

	Counter Measures	Schedule										Remarks
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
National Level	Reinforcement of Inter-Ministerial Framework											
	Reinforcement of Collaboration amongst Industry, Government and Academia, and International Network											
	Preparation of Upper Level Plan of ITS											To be continuously carried out after completion of 1st edition (*)
	Preparation of ITS Architecture											To be continuously carried out after completion of 1st edition (*)
	Improvement of Accident Information Management and Nation-Wide Expansion											
	Improvement of Vehicle Registration											
	Standardization of Number Plate											
	Improvement of License System											
	Improvement of Road Management Information											
	Creation of Fund											To be continuously carried out in accordance with ITS expansion
	Capacity Building											To be continuously carried out
Regional Level	Establishment of UMTA											
	Establishment of Agency for Planning, Introducing, Operating, and Expanding ITS											
	Preparation of Upper Level Plan of ITS											To be continuously carried out after completion of 1st edition (*)
	Preparation of ITS Architecture											To be continuously carried out after completion of 1st edition (*)
	Preparation of ITS Implementation Plan											To be continuously carried out after completion of 1st edition (*)
	Preparation of Basic Environment for Quantitative Measurement on Traffic											
	Preparation of Regional ITS Centres											
	Integration and Expansion of ITS											To be continuously carried out
	Capacity Building											To be continuously carried out
	Measures to Be Taken in Parallel											
	Improvement of Road Infrastructures											To be continuously carried out
	Improvement of Public Transportation											To be continuously carried out
	Improvement of Traffic Manners											To be continuously carried out

Note (*): The above shown schedule is for completion of the 1st edition.

The measures shown above are explained in the following pages.

6-2 Required Measures at National Level

The required measures that shall be taken at national level, shown in the proposed schedule in the previous page, are explained below.

(1) Organization Framework

1) Reinforcement of Inter-Ministerial Framework

As described in previous sections, the national level ITS vision and ITS Master plan is not yet established in India. Under such circumstances, each region is independently introducing individual ITS facilities. Therefore it is critical to establish an upper level national ITS plan. However, such ITS plan needs to be prepared by sufficiently collaborated manner amongst the involved agencies. Therefore, reinforcement of inter-ministerial collaboration is urgently required in India. Although ITS task force was established in 2007 led by MoUD, substantial progresses have not been achieved yet since its formulation. The ITS Task Force shall be a core group for inter-ministerial collaboration. Thus, strengthening the functions, roles, capabilities and members of the ITS task shall be more accelerated.

2) Reinforcement of Collaboration amongst Industry, Government and Academia, and International Network

The collaboration amongst government, academia and industries, and international network with ITS related organisations in other countries are critical in order to promote ITS.
AITS is expected to play such roles in India. Thus, such organisational framework shall be more reinforced at the core of the AITS.

(2) Planning

1) Preparation of Upper Level Plan of ITS

In recent years, high level national policies such as National Urban Transport Policy and the five-year plan of India highlighted the importance of ITS technologies in urban transport. But as mentioned above, upper level national ITS plan is not yet formulated in India. Thus, a long-term and comprehensive national ITS master plan which shows a roadmap of ITS deployment in India is urgently required in India. Importantly, such plan shall be prepared in line with the related national policies such as five-year plan of India, National Urban Transport Policy, National IT Strategies, and etc.

2) Preparation of ITS Architecture

ITS architectures were prepared in Japan and other developed countries such as the United States and Europe. It is required to develop ITS architecture at the national level in India as well. It shall provide an overview of the entire system including the ITS services to be made available over a period of time under the framework of national ITS plan. The regional ITS architectures shall be prepared under the framework of the national ITS architecture.

(3) Preparation of Required Environment for ITS

1) Improvement of Accident Information Management and Nation-Wide Expansion

The city of Chennai is preparing the accident database, supported by the World Bank. The city database is shared with the central government, traffic administrators, road administrators, planning agencies, vehicle registration authorities and etc. It is also intended that the accident information is reflected on the road related guidelines by sharing with the Indian Road Congress. This model shall be replicated to other cities for improving the traffic management efficiency.

2) Improvement of Vehicle Registration

The enforcement systems for traffic signal violation, over speed and etc are important system in India. However the issue is that it is difficult to trace the violated owner who belong to other state and changed his address, and the traffic administrators are facing difficulties in collecting the sufficient fines. The vehicle registration shall be improved in a comprehensive manner. The measures include establishing a standardized database across states, linking with the personal ID system which is under planning by Indian government, introduction of vehicle inspection, and combination of these.

The strengthening of the enforcement mechanism is increasingly important under the situation where deployment of the electronic toll collection systems is expected to expand across the state in the near future. The congestion based charging system also requires the established enforcement mechanism.

3) Standardisation of Number Plate

The vehicle number plate is not standardized in the country and the number plate is placed on vehicles at different places with different letter fonts and colours. It is technically difficult to automatically detect the vehicles' number plate by the system in such circumstance. Thus, the number plate standardization is required for better traffic enforcement and reducing the revenue loss from toll collection. From the view point of road traffic engineering, it helps in planning of traffic measures and infrastructure development by comprehending the origin and destination (OD) of the vehicle. For example, it contributes to planning industrial corridor by detecting the OD of large sized commercial vehicles. It can be also utilised for improvement of infrastructures for transfer by comprehending the OD of 2 wheelers and 3 wheelers.

4) Improvement of License System

The driving licensing system in India is rather liberal when compared to the developed countries such as Japan and USA. The issuance of driving license is quite easy in India by simple oral and practical tests. The driving licenses are issued to the individuals for 10 years and any renewals/reviewing of the licence are not required during the 10 years. In countries such as Japan and USA, the driver's license is temporarily suspended or cancelled depending on severity of traffic violation. But in India, the faulted driver is cleared from the traffic violation by paying a challan issued by traffic police. Therefore it is important to improve the license mechanism by introducing the similar system as in other countries.

5) Improvement of Road Management

The road management information such as the drawings is not stored and properly managed by the road administrators and planning agencies. Thus the proper road management such as planning of road improvement is not realised.

The preparations of road inventory database in Mumbai and Hyderabad are underway supported by the World Bank and JICA, respectively. Such role models shall be replicated to other cities.

6) Preparation of Fund

The financial sources of ITS applied in city are generally limited. In the case of toll roads, the cost for installation, operation and maintenance can be covered by the revenue generated by toll collection. However in the case of the city roads, such revenue can not be expected. The conceivable sources for the revenue would include congestion charge collected by Electronic Road Pricing (ERP), sales of road/traffic data generated by the control centre, income collected by the smart card, utilisation of taxes or fines of traffic violation, advertising revenue, and etc.

It is mostly expected to require certain years when the ERP is deployed at substantial scales, considering the current overall conditions in India, because it involves a number of issues that need to be resolved. It also may require certain periods until the collected and accumulated road traffic data becomes a product which can be sold at commercial bases after deploying ITS. The utilisation of the revenue of the smart card to the city ITS may require a series of coordination and consensus amongst the involved agencies, particularly the public transport bodies, because the smart card system would most likely be the asset in the public transport sector. The utilisation of taxes and fines of the traffic violation would be the same in terms of the required consensus. It is not clear whether the advertisement revenue is able to sufficiently cover the required entire cost for the system.

Therefore, a special scheme for the funds needs to be elaborated at national level, considering such difficulties for assuring the financial resources for the city ITS.

7) Capacity Building

The capacity building is one of the most important factors for sustainable ITS implementation. The attention shall be focused on the decision makers in view of the capacity building at the national level. In particular, as mentioned above, the reinforcement of collaborative structures amongst ministries, industry, academia is urgently required for preparation of a high level ITS strategies and plans. It is mostly expected that the ITS task force which was established in 2007 and AITS will be core groups for such organisational structures to initiate the ITS in India.

Thus, the capacities of the members involved in these need to be preferentially strengthened, particularly concerning the fact that the substantial achievements have not been made since the formulation of ITS task force in 2007.

6-3 Required Measures at Regional Level

(1) Organization Framework

1) Establishment of UMTA

The UMTA was established in some cities and others are still in process. The purpose of UMTA is for coordination and high-level decision-making for urban transport in the major cities. Such authority holds significant importance for ITS, specifically considering multi-sectorial and interdisciplinary features of ITS.

Thus, it is highly recommended for the cities where the UMTA has not been formulated yet to accelerate the process of establishment of UMTA. It is also recommended for the cities where the UMTA is already in place to vest the roles/purposes/responsibilities of the matters of ITS on the UMTA.

2) Establishment of a Single Body for Planning, Introducing, Operating and Expanding ITS

The multiple agencies are involved in the planning, introduction and operation of ITS. Meanwhile, the above said UMTA is a coordination and decision making body. Specifically considering a complex administrative structure in India, a single nodal agency is required and it shall be responsible consistently for planning, introduction, operation and expansion of ITS at regional level.

It would not be necessarily need to begin from the scratch in some cities. For example, the DIMTS, of which original concept is for a single nodal agency for ITS, already exists in Delhi. The coordination is idealistically made amongst MMRDA, MCGM and traffic police in Mumbai. It was observed, in Pune, that PMC possesses a certain level of capability on ITS and therefore there is a potential to become a basic body. HMDA in Hyderabad is initiating introduction of ITS covering the entire Hyderabad metropolitan area, supported by JICA.

It would not be practical to immediately establish such a single agency because a series of coordination and efforts are required. Therefore, it is highly recommended to reinforce the organisational arrangement based on these potential bodies, aiming to evolve into or creating such a single nodal agency.

(2) Planning

1) Preparation of Upper Level Plan of ITS

Likewise the case at national level, high level ITS plans do not exist at the regional level either. The individual bodies are introducing ITS by themselves under this circumstance.

Thus, it is important to formulate the regional ITS master plan under the framework of the national ITS strategy in order to prevent inconsistencies, inefficiencies and cost escalations due to double investment.

2) Preparation of ITS Architecture

The same can be said as to the ITS architecture at regional level. The regional ITS architecture needs to be prepared incorporating the local requirement under the framework of the national ITS architecture.

3) Preparation of ITS Implementation Plan

It is essential to develop a concrete ITS implementation plan in the region under the framework of the high level ITS strategies and architectures at regional level. It shall be consistent with the regional transportation plan such as CMP.

(3) Critical Factors for Effective ITS Implementation

1) Preparation of Basic Environment for Quantitative Measurement on Traffic

The traffic management is nearly solely dependant on CCTV monitoring in the cites, and the quantitative measurement on traffic has not been in place. Thus, objective comprehension on the traffic as to how much, where and when the congestion occurs in the city is not realised. Furthermore, utilisation of the collected and accumulated road traffic data on road and traffic measures is one of the most important roles of ITS, as well as providing dynamic road traffic information to the users. One of the most critical issues in regard of ITS implemented in India now is the absence of such mechanism. Thus, it is critical to prepare the basic environment which enables to utilise the quantitatively collected and accumulated road traffic data on planning and dynamic information provision.

2) Preparation of Regional ITS Centre

Various subsystems of ITS will be deployed in future based on the regional ITS deployment plan. It is thus necessary to prepare the regional ITS centre to aggregate and integrate these subsystems. It shall function as a centre for collection, accumulation and analysis of the road traffic data, taking measures for planning and evaluation for road and traffic improvement, responsible for expansion of ITS and assuring compliance with national level ITS strategies/policies in future.

In this view point, the regional ITS centre shall function under the jurisdiction of the above said single nodal agency.

3) Integration and Expansion of ITS

The additional functions and subsystems shall be gradually expanded based on the above regional ITS centre under the framework of the regional ITS master plans and architectures. It shall be expanded in accordance with improvement of the road infrastructures, public transport and traffic manners, particularly considering the current surrounding conditions in India.

4) Capacity Building

The capacity building is imperative factor at the regional level as well. It involves quite broad range of fields for the capacity building. But it shall preferentially focus on strengthening the capabilities of the personnel of the planning authorities, traffic and road administrators, considering the current situation in India. It is observed that the implementation of ITS including designing, installation and operation throughout the entire life cycle of ITS is largely dependant on the private sector in India. The conceptual design is even left to the private agencies in many cases.

Therefore, know-how on ITS has not been accumulated in the government side. And, it is difficult for them to make proper judgement on the proposal provided by the private side. If such situation is not improved in India, the government side will be eventually controlled by the private side, and it will consequently lead higher cost in the end.

Thus, it is strongly recommended that the capabilities of the personnel of the planning and implementation agencies shall be significantly strengthened at least at the level where they can make proper judgement by themselves.

(4) Measures Need to Be Taken in Parallel

1) Improvement of Road Infrastructures

The road infrastructures are not properly prepared in the cities in India, although the conditions somehow differ by city. Except some limited areas in such cities as Delhi and Mumbai, the proper road infrastructure such as road alignment, lane-marking, intersection structure, footpath, pedestrian crossing, and etc., are not sufficiently in place. Moreover, a number of religious obstacles remain on the road at many locations in the cities in India, and they are adversely affecting the smooth traffic flow. In addition, the illegal parking of vehicles is a common problem in all India cities. Therefore such infrastructures shall be improved in parallel to maximise the effect of ITS.

2) Improvement of Public Transportation

The urban mass transit systems such as metro, BRTS and monorail are increasingly developed in the major cities in India. However the major problems are insufficient last mile connection to supplement the main public transport and absence of facilities for transfer to other mode of transport, such as parking spaces near the stations, stations of metro and bus which are closely located each other and etc. The people consequently tend to opt the road transport due to inconvenience of the public transport, and consequently the demand of road traffic has not been sufficiently shifted to the public transport.

3) Improvement of Traffic Manners

The traffic manner in India is in adverse condition. The typical examples are opposite driving, lane hogging, traffic signal violation, lane mark violation, riding motorbikes without helmet, excess number of the passenger and etc. Crossing road by the pedestrians is frequent scene everywhere. The reasons include a wide range of issues including absence of sufficient spaces for the pedestrian in the city such as footpath and zebra-crossings, educations, penalties on the traffic violation, driving license scheme and so on, many of which were described in the previous chapters. Therefore, comprehensive measures including all these shall be continuously taken, together with improvement of road infrastructure and public transport.

Chapter 7. Workshop

7-1 Purpose

In conclusion of the field survey of the study on ITS in the nine (9) cities, the Ministry of Urban Development (MoUD) and JICA jointly organized the workshop. It was held on the 25th September 2012 in Delhi. The purposes of the workshop are:

1. To share survey findings, observations and the preliminary recommendations on various ITS initiatives from the JICA Study Team.
2. To be advised on the requirements as well as issues/difficulties facing from workshop participants so that such inputs can be incorporated into further considerations of successful implementations of ITS in India.
3. To exchange opinions amongst stakeholders and study team to deepen understanding of the above.

7-2 Participants

The participants include Secretary, Ministry of Urban Development (MoUD), Government of India, Officer on Special Duty (OSD), Urban Transport, MoUD, Government of India, Chief Representative, Japan International Cooperation Agency (JICA), India, Representative, JICA India, Senior Vice President, ITS Japan, Japan, authorities of the city administrative agencies of Delhi, Ahmedabad, Hyderabad, Bangalore, Mysore, Chennai, Indore, Mumbai and Pune, and the representatives from the agencies including National Highway Authority of India (NHAI), Delhi Integrated Multi Modal Transit System Ltd (DIMTS), Centre for Development of Advanced Computing (C-DAC), Delhi Metro Rail Corporation (DMRC), Association for Intelligent Transport Systems (AITS), Department of Electronics and Information Technology (DeitY), Delhi Development Authority (DDA), Society for Indian Automoile Manufactures (SIAM), Chennai Metropolitan Development Authority (CMDA), Indian Instituite of Technology Chennai (IIT Chennai), Bangalore Metro rail Corporation Limited (BMRCL), etc.

7-3 Session Details

(1) Opening Session

The workshop was commenced by the opening speech of the Secretary, Ministry of Urban Development (MoUD), Government of India. He welcomed the participants and stressed the need and importance of ITS implementations in India. He also highlighted the recent initiatives of the Ministry in the area of ITS including formulation of the ITS core group and setting up of the sub-committee for development of the national ITS architecture.

The Chief Representative, Japan International Cooperation Agency (JICA), India in his key-note address explained about the projects and initiatives in the transport sector taken up in India. He also expressed the willingness of active support in this area.

(2) Introductory Session

The Representative, JICA India Office, presented the JICA's engagement in the urban transport sector and outlined the ITS projects taken up by JICA in India including, 'Assistance for the Introduction of ITS Related to the Hyderabad Outer Ring Road Constructio Project', 'JICA Special Assistance for Project Implementation (SAPI) for the Assistance for the Introduction of ITS on Road Network in Hyderabad Metropolitan Area', and 'Data Collection Survey on the Introduction of ITS to the Urban Transportation of Major Cities in India', which is this study.

It was followed by the General Manager, Hyderabad Growtih Corridor Limited (HGCL), an implementation agency of the projects, for the details of the above ITS projects in Hyderabad.

(3) Session One

The JICA Study Team explained in detail on the findings and preliminary recommendations at national and regional levels for the nine (9) Indian cities. These include the issues, recommendations and the way forward for proper and sustainable implementation of ITS in the Indian cities.

(4) Session Two

The Senior Vice President, ITS Japan, introduced the roles of ITS Japan and history of ITS development in Japan. He highlighted the potential of utilisation of probe system for the road and traffic management, and stressed importance of collaboration amongst private sectors and cooperation between public and private sectors by introducing the examples of utilisation of the probe system on the occasion of the great earthquake in Japan.

The Joint Director, C-DAC, introduced various initiatives of research and development of ITS technologies amied to suite the peculiar local conditions in the Indian cities. He also shared the issues and challenges for implementation of ITS in India.

The Officer on Special Duty, Urban Transport, MoUD, provided closing remarks of the workshop.

7-4 Comments Provided by Participants

The major comments provided and opinions exchanged on the workshop are summarised as follows;

- The states/cities in India are facing difficulties in preparing the satisfactory detail project report (DPR) on ITS, which is required to be funded by the central government of India under the schemen of Jawaharlal Nehru National Urban Renewal Mission (JnNURM), due to lack of capacity/knowledge on ITS.
- The central government of India holds strong willingness to provide the financial assistance for ITS projects under the JnNURM Phase II because of increasing importance of ITS for India if the states/cities are ready for the DPR on ITS.
- The Indian side acknowledges and all parties shared the importance of developing the individual transport scenarios in the different cities, and absence of data for the road/traffic and infrastructure planning, common ticketing systems, qualified public transport services, transport network integration, information provision to the users and etc, and they reasoned the great necessity of ITS in India.
- The participants shared the importance of building the technical capabilities of ITS in the states/cities, necessity of the technical experts assistance for ITS projects, technical support for preparation of the DPR on ITS and deliberating the short-term, mid-term and long-term solutions.
- The Indian academic institute highlighted the usefulness of preparation of guidelines/tool kits for ITS implementation, necessity of establishment a meaureable method of benefits brought by ITS and importance of formulation of legitimate coordination bodies for ITS promotion at both national and regional levels.
- The government of India requested the Japan side to consider the financial and technical assistance for the above.

Chapter 8. Conclusion

The rapid growth of urban population and sprawl development of urban area in the cities, coupled with increasing traffic, are putting a lot of pressure on the existing urban infrastructure and necessitates the development of new infrastructures. The existing road infrastructure is insufficient to accommodate the traffic demand in the cities. The conditions in India are characterised by absence of hierarchical road classification, insufficient infrastructure including sidewalks encroachment, inadequate parking spaces, improperly designed junctions/intersections, signals which are not properly working and etc.

ITS, in general, is a tool to maximise the capacity of existing road and transport infrastructures in a situation where large number of additional infrastructures can not be constructed anymore in the city. However in order to gain sufficient effect of ITS, proper road and transport infrastructures need to be in place.

The study report took into consideration of the national and regional aspects and proposed the required measures to be taken for effective implementation of ITS at national and regional level. It highlighted the importance of preparation of ITS strategy and standardization at both national and regional level. Such approach would help in smooth and efficient implementation of ITS and pave way for an effective expansion. It would be recommended to initiate immediate measures such as preparation of national ITS master plan, national ITS architecture and other relevant measures.

At regional level, the ITS preparation in each city shall be coupled with the improvement of the basic road and transport infrastructure. The regional ITS master plan and ITS architecture shall be prepared under the national framework. It would also be recommended at regional level to take measures such as acceleration of UMTA establishment, establishment of a nodal agency responsible for planning, development and operation of ITS, preparation of basic environment that enables quantitative measurement on traffic and establishment of regional ITS centre. The objective planning by the relevant authorities including road & traffic administrator, and planning authorities for road & traffic measures utilising ITS are important. Then the ITS shall be gradually expanded in accordance with improvement of road and transport infrastructures.