Appendix - 1

Bengaluru Congestion Pricing Scheme Report

Bengaluru Congestion Pricing Scheme
Final Report

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Executive Summary

The Japan International Cooperation Agency (JICA) had been tasked by the Directorate of Urban Land Transport (DULT) of Karnataka State (i.e. the Client) to carry out “The Master Plan Study on the Introduction of Intelligent Transport System (ITS) in Bengaluru (Bangalore) and Mysore”. A component of this ITS plan is a congestion pricing system for Bengaluru for which Nippon Koei (NK), a consultant working for JICA, has obtained the services of MSI Global Pte Ltd, Singapore.

The objective of the study is to look at the feasibility of implementing congestion pricing in Bengaluru, and also to review an existing study on a pilot congestion pricing scheme on a road (line charging) done by the Client intended to gauge the results and public feedback before proceeding on a larger scale.

MSI staff reviewed the existing reports on Bengaluru’s land use plans, transport plans and current transport policies. They made trips to Bengaluru from 20th to 30th April 2014 and from 23rd June to 4th July 2014 to assess and better appreciate the ground and traffic conditions, arrange surveys and conduct dialogue sessions and workshops with the Client, stakeholders and the JICA Study Team. After the draft final report was completed in January and during the 3rd visit to Bengaluru from 2nd February to 7th February 2015, the Client decided to concentrate on the area charging scheme and drop the line charging pilot scheme.

With the rapid development of the industrial zones as well as satellite cities, the road network is currently already operating close to capacity and certain parts experience congestion during the morning and evening peak periods. From our experience, effective traffic and demand management measures, in addition to better public transport provisions with good connectivity, will be required to rein in traffic congestion.

To select a suitable area for the charging scheme, the team evaluated the central business district (CBD) and 6 other regional centres. Based on the percentage of commercial commercial/administration/ industrial land use of total land use in each area, current availability of a good public transport system and alternative bypass routes, the team shortlisted the CBD and Koramangala as the candidate areas.

The team then analysed the traffic data for CBD and Koramangala to decide if congestion pricing during a morning restricted period would be effective in these areas. CBD is a better candidate than Koramangala because of the presence of a more attractive public transport system. Within the CBD, there is a large bus terminal and future Namma metro rail stations, which makes the restricted area very accessible to travel using public transport. As for Kormangala, it is more residential in nature, public transport is not as extensive as in the CBD and the pre-restricted period traffic conditions will pose more problems than in the CBD. Therefore the CBD is the preferred option for area charging.

An evaluation of the line charging scheme (as originally envisaged) is also included for completeness. The two options for the pilot scheme are Mahatma Gandhi (MG) Rd-Hal Airport Rd (Route 1) and Hosur Rd (Route 2). Although the traffic situation on Route 2 is more critical, land use-wise, Route 1- MG Road-HAL Road is a better choice as it has better public transport choices, especially with the Namma metro serving MG Road.

The proposed CBD charging area of 2 sq. km with 18 entry points for inbound control was chosen to exclude residential and recreational areas and to prevent some of the bypass routes (for vehicles wishing to avoid the restrictions) coming under restrictions, which is undesirable. It is a smaller area when compared to the charged areas implemented in Singapore, London and Stockholm, but as mentioned before there are limitations in expanding the area. However the experience is that when an area charging is introduced, there are also improvements to traffic in the roads leading to it. Nevertheless, the bypass routes will experience heavier traffic flows and some congestion. There will also be short periods of heavy traffic flow during the pre and post restricted period. The details of the actual locations, the feasibility of physically locating control points at these 18 locations and minor traffic management on the adjacent roads need to be studied in greater details if it is decided to proceed with the area charging scheme.

For a charging scheme, the analysis is based on the speed-flow curves for Chennai (which is expected to be similar to Bengaluru). This curve indicates that the trigger point for considering congestion pricing is an average speed of below 24km/hr. Below that speed, traffic flow is at level of service F with stop-go conditions. The average measured speed within the CBD roads is 18.6 km/hr. Imposing congestion pricing during the morning peak period of 1000-1200 hrs for vehicles entering the CBD is likely to result in a 16% reduction in inbound traffic flow (based on Singapore's experience) which will bring the traffic conditions to more acceptable levels of service than the level of service F. All vehicles other than public buses and emergency vehicles are proposed to be included in the restrictions. After discussions and deliberations, we propose an entry charge of Rs150 for cars, which is twice the current fare on an air-conditioned bus and twice the price of a litre of petrol. The passenger car equivalents (as defined in traffic engineering) will be used to fix the charges for other vehicles (e.g. a two wheeler has a pce of 0.5, hence it will be charged Rs 75). Autorickshaws will be charged less and passengers in taxis and autorickshaws will have to pay the charge if they enter the CBD during the restricted periods. An entry charging system using Radio Frequency Identification (RFID) tags attached to vehicles for charging and an Automatic Number Plate (ANRP) system for enforcement by reading number plates of violating vehicles, with backend operations for collection of the charges and issuing summons, are recommended. The financial payback period to recover capital and operational costs is expected to vary between 2.5 to 4 years.

A lead time of at least 12 months will be required to work out the implementation details. MSI proposes that a high level steering committee be set up to oversee all activities. Among others these activities include securing funds, choosing the technology, appointing the contractor, setting up an operations team, increasing public awareness and buy-in of the scheme and ensuring that appropriate legislative measures are in place. Of paramount importance is a good public relations programme which should start as soon as a decision to proceed is made. If necessary, a trial could be carried out on a small scale to test whether the RFID technology is suitable for Indian traffic conditions and to fine-tune the backend operational procedures. A detailed flow chart on how to proceed has been prepared to guide the Client.

In the long term, taking into consideration the future land use and development of Bengaluru City, the Client can look at increasing/decreasing the area to be charged, and other types of charging such as for the length travelled in the charged area.

1. BACKGROUND

1.1. The Project

1.1.1 The Office of the Directorate of Urban Land Transport (DULT), of Karnataka State India and the Japan International Cooperation Agency (JICA) have agreed to carry out “The Master Plan Study on the Introduction of Intelligent Transport System (ITS) in Bengaluru (Bangalore) and Mysore”. The study which covers the Bengaluru Metropolitan Area and Mysore is expected take 18 months to complete, starting from January 2014.

1.1.2 The expected goals are to reduce traffic congestion, improve public transport usage and ensure proper planning and implementation of road infrastructure by using quantitative data on traffic.

1.1.3 A component of this ITS plan is a congestion pricing system for Bengaluru for which Nippon Koei (NK), a consultant working for JICA on the project, has procured the services of MSI Global Pte Ltd, Singapore, for the task.

1.1.4 MSI Global has been appointed to look at the feasibility of congestion pricing for Bengaluru. JICA Study Team’s Client is the DULT. MSI had been working closely within a Work Group comprising staff member of the Client and JICA Study Team (From DULT: Mr Shamanth, Mr. Sivasubramaniam and Ms Ritumoni.)

1.1.5 The Report is divided into the following 9 Sections. Section 1 covers the Background, Section 2 is about Study Methodology, Section 3 is about Congestion Pricing for Bengaluru, Section 4 is about Electronic Road Pricing System, Section 5 is about the Scheme for Bengaluru, Section 6 is on the Recommendation, Section 7 is on Financing, Section 8 is about the contingency plan in the event of a failure and Section 9 summarises the Master Plan for congestion pricing.

1.2. Review of Previous Published Reports on Bangalore (Bengaluru)

1.2.1. Background of Bengaluru

1.2.1.1. Bengaluru, with an area of 800 sq km, is the second fastest developing city in India. Between 1995 and 2010, whilst the population grew by 3.0% per annum, vehicle growth had experienced an annual growth of 10%. The Bengaluru Metropolitan Area had approximately 3.89 million vehicles as at March 2010. It has not been possible, nor is it desirable, that the road development grows to keep in tandem with the ever-increasing vehicle population. Hence, the traffic situation on the road network has deteriorated – for example, the journey speed has reduced by 45% from 2008 to 2011. 72% of the vehicles in the traffic stream are two wheelers (motorcyclists) and 18% private cars.

1.2.1.2. The traffic pattern in Bengaluru is significantly affected by the economic activities in the IT Industrial zone located in the southeast suburban area of the city. The three major industrial zones include the Software Technology Parks of India, International Technology Park and Electronics City, had further contributed to higher vehicular growth thus leading to saturation of road capacity in the area. Satellite cities around Bengaluru have also been growing rapidly. They include Tumkur, Kokar along NH-4, Chikballapura and Devanahalli along NH-7 and Magadi and Doddaballapur along other major radial roads.

1.2.1.3. Bengaluru Metropolitan area's strategic road system is made up of a network of 6,000 km of national expressways, state and national highways. The local road network connects mainly to these major highways with varying 2 to 3 lane widths in each direction. Unfortunately, the road network is not sufficiently developed in terms of connectivity and continuity. The links/roads and intersections are operating at or above capacity and in the coming years it would become increasingly more difficult to manage the traffic congestion levels.

1.2.1.4. The road network is currently already operating close to capacity and certain parts experience congestion during the morning and evening peak periods. The average speed is less than 15 km/hr during the peak periods. The road capacity is hampered by roadside friction, parking and road works. Activities on the footpaths, exacerbated by low maintenance levels, further reduce the road capacity as pedestrians are forced to walk on the road. Inadequate junction management also leads to unnecessary conflicts and delays. Most signalised junctions seem to operate above capacity, prompting manual control by the Traffic Police. The problems are further compounded by poor lane discipline and driving behaviour of drivers. The Bengaluru Metropolitan Transport Corporation (BMTC) and the Karnataka State Transport Corporation operate a fleet of 6,100 buses, which carry peak loads during the rush hours, but are less crowded outside the peak hours. However, whilst the number appears large, buses form only 2% of the vehicle population in Bengaluru, even though 42% of the population uses this mode of public transport.

1.2.1.5. The newly completed Namma Metro has 16 stations operating (with 4 stations under construction in the CBD) but has yet to serve the most congested parts of the city near Majestic in the central business district (CBD). Furthermore, last mile connection to public transport is inadequate and dependency on private transport remains high. Metro stations and bus stops appear not to be closely located to each other and, because of the lack of good connectivity and interchangeability, commuters have to walk or take auto rickshaws (autos) for a certain distance to take the metro after getting off the city bus, with little or no protection from the environment.

1.2.1.6. Nevertheless, there is a willingness to confront the traffic problems and resolve them. Bengaluru Development Authority has constructed several flyovers, with numerous new flyovers and grade separated junctions also being planned. Notable current transportation initiatives to address the traffic congestion include introduction of air-conditioned buses, albeit at higher fares, the Namma Metro rail system being expanded to 61 stations in Phase 2 of its expansion, the improvement to the Outer Ring Road and the possible control of roadside parking by introducing parking meters. The Peripheral Ring Road is currently under planning and works may commence sometime this year. It will be completed together with the other ITS components. There is also a pilot city ITS scheduled for this year and will be implemented full fledge if successful. The Bengaluru Police also operate a close circuit television monitoring system of city traffic in an effort to manage congestion.

1.2.2. Indian National Urban Transport Policy

1.2.2.1. The Indian Central government has a National Urban Transport Policy for cities; the objective of which is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to meet their employment, education, recreation and other needs.

1.2.2.2. The main proposals to be used are:

• Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement

• Encouraging integrated land use and transport planning in all cities so that travel distances are minimized and access to livelihood, education, and other social needs, especially for the marginal segments of the urban population, is improved

• Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus

• Encouraging greater use of public transport and non-motorized modes by giving central financial assistance, if needed.

• Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes

• Introducing Intelligent Transport Systems (ITS) for traffic management

• Addressing concerns of road safety and trauma response

1.2.2.3. The policy sets out the strategies of handling transport and is perhaps no different what many other countries are adopting. The problem is in the judicious implementation of these policies.

1.2.3. Bengaluru Master Plan (2007)

1.2.3.1. Bengaluru Master Plan (2007) for Bengaluru Development Authority has a Vision for 2015, which is to retain its pre-eminent position as a City of the Future through its cosmopolitan character and global presence and to enable and empower its citizens with growth opportunities to promote innovation and economic prosperity, a clean and green environment, high-quality infrastructure for transport and communication, wide-ranging services aimed at improving the quality of life for all, conservation of its heritage and diverse culture and responsive and efficient governance.

1.2.3.2. The Master Plan recognises the rising traffic congestion as one of the key issues in the City. Though the length of roads available is fair, the problem lies with the restricted widths. There is a fairly good bus transport system, but the absence of rail-based commuter system until recently, compounds the problem. In line with the Indian National Urban Transport Policy, the Master Plan proposes development of a networked city through a sustainable transportation system focusing on development of a structured road network, organizing transportation/logistics facilities and developing a multi-modal public transport system. So, it does recognise the need to move along the lines of the national policy.

1.2.4. The Comprehensive Traffic and Transportation Study (CTTS) 2010

1.2.4.1. This was done for the Bengaluru Metropolitan Region (BMR) which covers more than Bengaluru city to develop a long-term transportation strategy (people and goods) to identify practicable and effective investment programmes up to 2031, with a short (2010-16), medium (2016-20) and long range (2021-31) plans.

1.2.5. Comprehensive Traffic and Transportation Plan for Bengaluru (June 2011)

1.2.5.1. This was done for Karnataka Urban Infrastructure Development and Finance Corporation. The main measures that were considered were:

- Extension of mass transport systems to provide wide coverage
- Provision of a large network of medium level transport such as bus rapid transit to cover other areas
- Densification of corridors along mass transport corridors
- Rationalisation of local bus system
- Improvement to traffic management and pedestrian management
- Improving primary, arterial other important roads
- Diverting traffic through a peripheral ring road

1.2.5.2. The study looked at reducing private vehicle usage by a pricing policy or by providing a better level of public transport. It acknowledged the difficulty of implementing road pricing and suggested restricting private vehicles from entering into congested roads during the peak hours. Among the measures that could substantially achieve the objectives were to impose congestion charges on private vehicles entering the outer ring road and the core ring road, but it made no mention of any area charging.

1.2.6. Ministry of Urban Development Directive (2013)

1.2.6.1. In 2013, India's Secretary of the Ministry of Urban Development had given a directive to Chief Secretaries of State in the country calling on them to consider introducing congestion pricing in cities. The Ministry concluded that resolving congestion will be difficult and needs to involve managing excessive use of private vehicles, specifically recommending cities to consider what has been done in Singapore and London. Congestion pricing is a system by which vehicles pay for the use of roads at times and at places when and where they contribute to congestion.

1.2.6.2. Promoting congestion pricing, which is a form of travel demand management is a simple economic concept whereby those who value a scarce resource the most, will pay to use it. It is yet another recommendation of the Indian National Urban Transport Policy which calls for a more equitable allocation of road space and the use of ITS for traffic management. Paying for road use by way of a toll is not new in India since there are many existing toll roads, but there are no congestion pricing schemes in any city yet.

1.2.7. JICA Study Team survey "Intelligent Transport Systems to Urban Transportation of Major Cities in India" (2013)

1.2.7.1. The study was undertaken by JICA Study Team to identify the major issues and challenges with the implementation of intelligent transport systems at 9 cities in India – Delhi, Ahmedabad, Hyderabad, Bengaluru, Mysore, Chennai, Indore, Mumbai and Pune.

1.2.7.2. The major ITS in Bengaluru is the B-TRAC operated by the Bengaluru Traffic Police for closed circuit television (CCTV) monitoring at site, traffic enforcement and traffic control at some sections. However, the major bottleneck is the inability of the CCTV technology to conduct quantitative measurement of traffic data and dynamic traffic information provision. Variable message sign boards are limited to providing static information only

1.2.7.3. The recommendations were made on an all-India basis:

- To have a single body to coordinate the implementation of ITS at the regional level
- To establish an ITS strategy and architecture at regional level
- To establish better traffic infrastructure and traffic manners to enable better capturing of traffic data

• To establish a regional ITS centre to aggregate and integrate subsystems. It shall function as a centre for utilisation of collected data, taking measures for planning and evaluation for road and traffic improvements.

1.2.8. The Master Plan Study of the Introduction of the Intelligent Transport System (ITS) for Bengaluru and Mysore in India (February 2014)

1.2.8.1. The study was carried out on the following technical policies

a) Policy 1 - Effective use of road and traffic data for appropriate road traffic management
b) Policy 2 - Traffic Control using ITS
c) Policy 3 - Integration of ITS
d) Policy 4 - Phased implementation of ITS

Under Policy 2, the proposals are improved traffic signal system and electronic road pricing system. It is mentioned that DULT has also an intention to implement an electronic road pricing system, which is a major component of this Study. A main point of consideration is the selection of an effective area for charging. [During the first visit, it was understood that DULT was considering a road pricing system as a pilot scheme on a road in the first instance]

1.2.8.2. This study suggested some travel demand management measures for Bengaluru city such as Congestion Pricing, Parking Control and Fuel Cess in the long term plan. A system, similar to Singapore's Electronic Road Pricing (ERP) was proposed for the CBD cordon around Vidhana Soudha for a radius of 5 km. Cordon pricing was proposed to be implemented in conjunction with improved transportation options, so that road users have viable alternatives.

1.2.9. Types of Travel Demand Management Measures

Why demand management? Most cities have strived to provide many supply measures such as improved road capacity and more seats in public transport to handle traffic congestion. A worldwide trend in transportation realises that it is impossible to build our way out of congestion. Most transport strategies nowadays include demand management for private transport to prevent its widespread use.

1.2.9.1. It is necessary to rein in travel demand or satisfy that demand by use of more efficient modes of travel. Demand management measures can take the form of fiscal and non-fiscal measures. Both are unpopular and fiscal measures usually present a greater political risk and cities find it difficult to move along this path.

1.2.9.2. The normal measures that can be considered for demand management for the city area (not individual roads) are:

Non-Fiscal Measures

a) Planned congestion in city – this means that no new roads and traffic management schemes will be carried out in the city. The traffic congestion will get so bad over the years that vehicles will be discouraged to come to the city.

In 1975, Nottingham tried the "Collar experiment" whereby the traffic lights along the main road were used to hold back all vehicles other than shuttle buses, which provided quick access to the city. The scheme failed to take off because many car drivers preferred to wait in their cars, rather than ride the shuttle bus.

b) Major ban on vehicles entering the city – this means that only buses and essential vehicles will be allowed to enter the city. Such systems have been tried out in rare cases occasionally such as at Athens, more in an effort to prevent air pollution which was damaging national monuments. A major ban will kill off the vibrancy of many cities.

c) Entry to city for those in need – this assumes that the authority will be in the best position to decide who needs to come to the city. Spurious claims will have to be verified. There will be accusations of favouritism by those who do not qualify. The system could lead to fraudulent and corrupt practices. This is not a viable scheme for any city.

d) Entry rights to city by balloting – All, even those not needing to go to city will participate in such a lottery system. It does not take into account any sound transportation principles. Permits will be sold on the open market or on the black market. Beijing has a system of balloting to own the right to buy new cars, not for their use on the roads. Lottery systems are not a way to manage travel demand in any city.

e) Restrict the provision of car parks/motorcycle parks to discourage entry - if drivers find it difficult to find a car park when they enter the city, they will be discouraged from driving into the city. However, too few car parks will affect those coming to do business in the city. Furthermore, after having driven in, many motorists will park illegally if they cannot find a car park lot. Many Asian cities are experiencing instances of illegal parking along roads and footpaths when car park lots are in short supply. In many cities, this will encourage more to park illegally along some of the narrow roads. Enforcement will present a headache if there are too many offenders. Motorcycles can easily park illegally on footpaths etc, thus adversely affecting their use by pedestrians.

f) Number plate rationing – this assumes that the ending numbers of the vehicle registration plates (0 to 9) are evenly spread. Hence, number plate usage could be restricted on certain days e.g. on odd calendar days, those with number plates ending in odd numbers are restricted. The other alternative is to restrict only 20% of vehicles each day i.e. number plates ending with 1, 2 on one day, 3, 4 on another day and so on. This means that theoretically 20% to 50% of vehicles are off the road each day. Bogota has such a scheme in place Pico y Placa. Many other South American cities have also implemented similar schemes. Enforcement has to be tight and rigid because there is a possibility of fraudulent number plates and drivers having multiple cars.

g) Entry for High Occupancy Vehicles (HOV) i.e. car and van pools, buses – this ensures that vehicles are used optimally. California has HOT (High Occupancy Transit) lanes along freeways for use by HOVs. Jakarta uses 3 in 1 system along two major roads in the city. Only vehicles carrying at least 3 persons, including the driver, are allowed to use the lanes. The system gives no option at all for those who cannot form car pools.

In Jakarta, car jockeys offer their services to ride in the vehicle to make up the car pool for a fee, which defeats the intention of the scheme to cut down vehicle usage. The system also requires enforcement at the entry points, not to mention that the introduction of an element of subjectivity plus the potential of corruption.

Fiscal measures

a) Restrict private vehicle ownership / Increase annual road tax many fold – traffic congestion problems are caused by vehicle usage and not by ownership, although it can be argued that those who own vehicles make more trips than those who do not. Ownership can be restricted by having a monthly/annual quota for new vehicles and getting would-be-owners to bid a price in an auction for the right to own a vehicle before being allowed to purchase one. Increasing the annual road tax is raising the entry requirements to own a vehicle. Road tax has to be increased many fold to achieve the effect, as otherwise many may be prepared to forego some other luxuries in order to own a vehicle.

b) Both Singapore and, to some extent, Hong Kong and Shanghai have introduced such schemes to manage vehicle ownership. Singapore and Hong Kong are city states with limited land and hence such harsh measures are needed to curb excessive vehicle usage.

c) Increased petrol tax – this is a blanket and blunt charge on road usage and does not take into account the fact that a car being used on a minor road in a suburb is not contributing to congestion as a car being used in the city during the rush hours. Increasing petrol prices could be a politically sensitive issue in some cities. This is a crude way to manage congestion.

d) High car park charges – Instead of restricting the number of car park lots in the city, they can be priced heavily for usage. It works on the basis that the high cost of car parking will deter motorists driving into the city. Hong Kong is a good example of traffic restraint through parking controls. It has occurred as a result of very expensive land values, rather than through government control of parking (as originally intended).

e) Many cities are now resorting to increasing parking charges to discourage private vehicles from driving into the city, with fairly good results. Such a restraint policy only affects motorists with destination within the city, but not those who drive through.

f) Congestion pricing– roads within a congestion priced areas can only be accessed on payment of a charge, which will vary by time of day according to the traffic situation. The authorities are not interested in attracting traffic, but more at restraining traffic. Congestion pricing has worked well in Singapore since 1975, in London since 2003 and Stockholm since 2006. It is an effective measure but needs very good planning and staging of implementation. If it is coupled with using the revenue derived for transport infrastructure and operations, it may alleviate some of the initial angst and resistance of the motorists.

So far only 3 cities of Singapore, London and Stockholm have implemented genuine congestion pricing systems. Many have implemented toll road systems, which are NOT road pricing systems. Some others have carried out studies, which we think are not relevant until tried out. The results of the 3 systems can be found in **Table 1**.

Table 1: Results of the 3 systems

Attribute	Area of Restricted Zone		
	Singapore (1975) 7 sq km	**London (2003) 8.5 sq km**	**Stockholm (2006) 14 sq km**
Traffic to controlled area	Reduced by 16%	Reduced by 30%	Reduced by 20%
Speeds in controlled area	Increased	Increased	Increased
Usage of public transport	Increased from 46 to 66% of all trips for work trips	50% of car reductions were transfers to public transportation	The total increase in boarding between spring 2005 and spring 2006 for the service area was 6 %.
Speed of Traffic on the peripheral roads	Decreased for a short period	10% more traffic on the peripheral roads, journey times on them have not increased because traffic signal systems on these roads were adjusted in anticipation of these traffic shifts.	Traffic on relief roads, bypass E4/E20 and Södra länken, have increased by about 5% since 2005
Accidents in the charged area	Reduced, but main reasons are the large numbers of traffic management schemes done to improve safety	-	-

Air pollution	About 32% reduction in carbon monoxide levels, no appreciable reduction in other pollutants (when the scheme started)	NOX emissions fell by 17%, PM10 by 24% and CO2 by 3%.	Reduction in the inner city of 10-14% in Carbon Dioxide), 7% in NOX and 9% in particulates
Public acceptance	Reluctantly, area has been increased over the years	Reluctantly, area has been reduced once	Referendum resulted in a wafer thin majority in favour

1.3. Toll roads (in India) vs. congestion pricing

1.3.1. It is important to make a distinction between toll roads and congestion pricing. Many cities in India, including Bengaluru, have toll road systems in operation. In a toll road system, the operator is happy to attract more users because it generates revenue for him, whereas in a congestion pricing scheme, which is to manage congestion, the Authority prefers that vehicle owners switch to using more efficient forms of transport and be discriminating in paying. Revenue is not the major consideration in the case of congestion pricing.

1.3.2. As mentioned before, traffic congestion issues can be addressed by a combination of two methods; transport supply i.e. provision of more transport infrastructure such as highways and reliable, efficient and safe public transport alternatives and by non-fiscal and fiscal travel demand management. Congestion pricing comes under the umbrella of Travel Demand Management (TDM).

1.3.3. These previous studies set the background for the development on an ITS Master Plan that also includes congestion pricing.

1.4. JICA Study Team's Client

1.4.1. The Client is the Directorate of Urban Land Transport (DULT) headed by the Commissioner. Other local stakeholders are road/traffic administrators, public transport operators, Bengaluru city authorities, etc.

1.5. Objectives and Scope of the Study

1.5.1. The objective of the study is to look at the feasibility of congestion pricing in Bengaluru, as part of the ITS Master Plan. The study will evaluate and recommend congestion pricing measures, suitable for the short and long terms, and recommend an Action Plan, including policy, regulatory framework, technical standards, service and performance standards, infrastructure and technology requirements. The study will be at the macro level, rather than at the micro level which is only possible at the detailed design stage after a decision is made to implement congestion pricing.

1.5.2. The overall scope of the study is as follows:

a) Review existing relevant information/data related to congestion pricing, including Bengaluru's transport policy/planning and relevant studies/traffic data being collected by the Client;

b) Review existing study on a pilot Congestion Pricing project proposed by/discussed with DULT, which shall be reviewed from a more comprehensive viewpoint on how to implement in the short term;

c) Propose other congestion pricing schemes, such as area charging (JICA Study Team ITS Study) in the medium and long terms

d) Evaluate step-wise implementation, if the pilot scheme is successful;

On 7th February 2015 meeting, it was discussed and decided that the line charging would not be called as 'pilot'. Instead, the major focus will be paid to area charging including the necessity of pilot and the secondary focus will be paid to line charging including reviewing the line pricing considered by DULT.

e) Advise on:

- Types of vehicles to be covered and/or exempted
- Indication of charges
- Criteria for deciding the implementation boundaries
- Enforcement issues
- Need for acceptable alternatives for those affected
- Technologies that can be considered
- Legal, operational and organisational aspects
- Administrative measures for implementation area charging schemes

f) Provide an Action Plan, as applicable that identifies projects for implementation, as part of Policy 2 Traffic Control Utilising ITS in the JICA Study Team ITS Master Plan

1.5.3. To meet the objectives, MSI had conducted meetings with key stakeholders, conducted site visits and prepared information and discussion papers, with the aim of:

a) Introducing TDM concepts and sharing Singapore's experience and international best practice in terms of development, implementation and management of congestion pricing policies and measures;

b) Guiding and discussing with the Client and the JICA Study Team on the issues related to the feasibility and possible effectiveness of congestion pricing;

c) Gathering relevant data from the Client with the assistance of the JICA Study Team for evaluation; and

d) Identifying key indicators, expectations and requirements in order to evaluate recommendations.

1.6. Details of area and work in Bengaluru

1.6.1. The study will cover approximately the whole of Bengaluru city. The proposed study area is shown in **Figure 1** and is based on the plan from DULT.

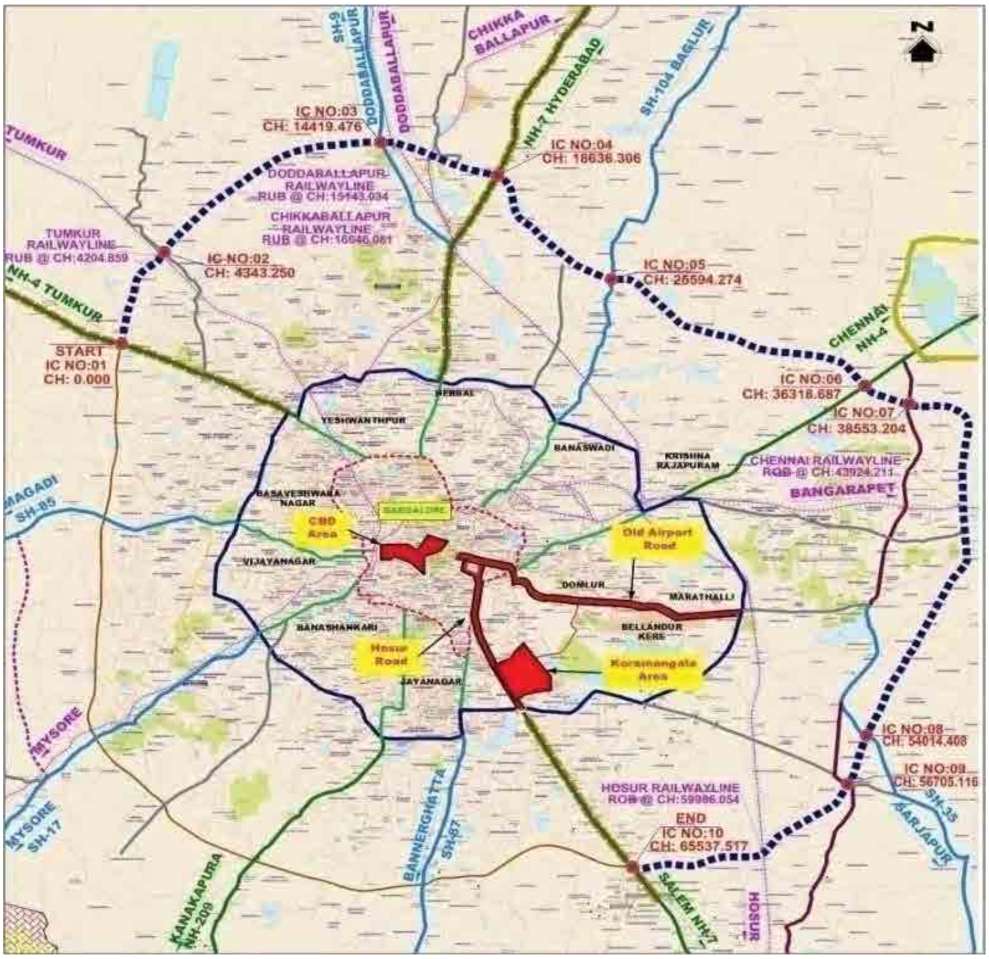


Figure 1: Proposed Study Area (Source: JICA Study Team)

1.6.2. The Singapore team, consisting of 3 MSI staff, made the first trip to Bengaluru from 20th to 30th April 2014, and the second trip by two members from 23rd June to 4th July 2014. The third visit which had been held in abeyance since July 2014 pending receipt of more information and data was carried out in February 2015.

1.6.3. The purpose of these visits are to appreciate the ground conditions, arrange for surveys and conduct dialogue sessions and workshops with the Client, stakeholders and JICA Study Team to better understand the overall transport condition and objectives and to finalise the contents of the Final Report.

1.6.4. **Table 2** summarizes the activities achieved from the 9-day visit in April. **Table 3** shows the work during the second and third visits

Table 2: Activities achieved from the 9-day visit in April

Day	Description of Activity
21 April 2014	AM– Meeting with JICA Study Team and DULT working group and reviewing Bengaluru planning reports and JICA Inception report. PM – Meeting with DULT Commissioner and staff and briefing on work that DULT had done on a pilot congestion pricing scheme on one route.
22 April 2014	AM – Site visit to Mahatma Gandhi (MG) Road- HAL Airport Road- Old Madras Road, the site of the pilot scheme and collection of sample traffic data. Clarification of DULT's pilot scheme and on availability of survey plans and traffic data. Discussions on data collection being carried out by JICA Study Team. PM – Briefing on car park operations and controls in Singapore to DULT staff. Reviewing the workshop material with Commissioner.
23 April 2014	AM – Fine-tuning workshop presentation. Sourcing availability of data PM – Congestion pricing workshop elaborating on Singapore's ERP system, why Bengaluru needs congestion pricing and the pre-requisites for congestion pricing followed by feedback by participants
24 April 2104	AM– A walk around the Central Business District, a potential congestion pricing area (as opposed to a single route) to review traffic conditions, car parks, location of side roads etc. PM – A bus ride from Majestic to DULT office to experience bus travel in the city. Night – A ride on Namma Metro and visit to operations centre.
25 April 2014	AM – A review of the work done up to date with DULT working team and JICA Study Team PM – Discussion on another possible route for pricing – road to Hosur Road Review of available plans and data
26 April 2014	AM– Site visit to Hosur Road and Outer Ring Road connecting Hosur Road PM – Preparation of traffic surveys and information request for potential congestion pricing area.
28 April 2014	AM – Preparation of plans for site visit to Hosur Road and its parallel routes PM – Site visit to Hosur Road and its parallel routes
29 April 2014	AM – Preparation of plans for site visit to parallel routes of MG and Hal Airport Roads.

Day	Description of Activity
	PM – Site visit to parallel routes of MG and Hal Airport Roads.
30 April 2014	AM – Preparation of traffic surveys and information request for Hosur Road and its parallel routes. Meeting with DULT and JICA Study Team to finalise the requested information and items to be followed up. PM – Meeting with DULT and JICA Study Team to finalise the approach to congestion pricing in Bengaluru city.

Table 3: Work during the second and third visits

Day	Description of Activity
30 June 2014	AM– Discussion on MSI's proposals for the week Review progress by MSI, DULT, JICA Study Team on Outstanding items PM - Review data collected up to date Discussions on the two alternatives for the pilot scheme for route charging
1 July 2014	AM &PM Review the 6 Discussion and Information Papers on congestion pricing prepared and sent by MSI.
2 July 2014	AM - Further discussion on the 6 MSI papers to come up with possible quantitative values for time of charging, types of vehicles to be charged, the fee for the charge. PM Discussion on two possible alternatives for Area Pricing
3 July 2014	AM and PM Site visits to Koramangala area, Hosur Road, MG Road, 100 feet road Sample collection of public bus volumes and car occupancy (MSI/DULT)
4 July 2014	AM - Recap of what was agreed and how to proceed (MSI/DULT/NK) PM - Discussion of further work and schedule (MSI/ JICA Study Team)
2 Feb 2015	AM and PM – Clarification with DULT on Pilot Study for line charging.
3 Feb 2015	AM – Clarification with JICA Study Team and DULT on Area Charging PM- Site check on preferred Pilot Route (MG Rd- Hal Airport Rd)
4 Feb 2015	AM and PM Site check on preferred Area Charging (CBD/ Majestic Area)
5 Feb 2015	AM and PM – Further discussion on the schemes with JICA

Day	Description of Activity
	Study Team and DULT
6 Feb 2015	AM and PM – Preparing briefing slides
7 Feb 2015	AM – Lecture on Traffic Management to DULT staff (special request) PM – Briefing to Commissioner (DULT) on draft final report

1.6.5. In addition, numerous Skype discussions were held between MSI, DULT, JICA Study Team members to clarify matters, such as progress of data collection, etc. In November 2014, some members of the DULT and NK team were in Singapore to participate in the Land Transport Authority Academy's ITS programme and to visit the ITS Centre. MSI officers also met the 2 DULT staff to review progress.

1.6.6. The traffic data was received in batches from DULT/JICA Study Team in November/ December 2014 and First Quarter of 2015.

2. STUDY METHODOLOGY

2.1. Introduction

2.1.1. In this project, MSI worked closely with the DULT working group and JICA Study Team. Most of the information and data collection were provided/done by the DULT/JICA Study Team. These organisations also shared their local knowledge so that MSI is able to filter out measures that are deemed to be less suitable in Bengaluru

2.1.2. MSI has reviewed the following from reports and further elaborated on from the Skype discussions:

a) Details of new transport initiatives for the next 5 years (roads/traffic management and public transport) - there are some plans to upgrade the outer ring road, improve bus services and extend the metro system

b) Speed-flow curves for traffic lanes in India - obtained from Chennai Indian Institute of Technology (IIT) (Reference : "An optimal Traffic Stream Model for Indian Traffic Conditions" by Ajitha, Vanajakshi and Subramanian in Transport Research Board 2011 Annual Meeting)

2.2. Main tasks of the study

2.2.1. Is Congestion Pricing as a TDM policy / measure being considered?

2.2.1.1. Bengaluru is now considering congestion pricing as part of its policy. The Comprehensive Traffic and Transport Study for the Bengaluru Metropolitan Area of 2010 mentioned some form of travel demand management for the CBD area. The Comprehensive Traffic and Transport Plan for Bengaluru (2011) suggested imposing congestion charges on private vehicles entering the outer ring road and the core ring road. The JICA Study Team ITS Master Plan (2014) mentioned an area-wide electronic road pricing and MSI concurs with it.

2.2.1.2. Motorists in Bengaluru are not used to the concept of paying for road usage, although they are familiar with paying toll on National Highways.

2.2.1.3. In response to the directive from the Ministry of Urban Development of the Central Government, DULT would like to try out a pilot scheme on congestion pricing to gauge the results and public feedback before proceeding further. DULT has, on its own, proposed a route for a pilot congestion pricing scheme, which has jointly been investigated by the Client and MSI against another alternative route. DULT wanted to try out pilot congestion pricing on a limited basis to gauge its acceptance by the motorists and the public before implementing a large-scale area scheme, if deemed necessary. On 7th February 2015 meeting, it was discussed and decided that the line charging would not be called as ‘pilot’. Instead, the major focus will be paid to area charging including the necessity of pilot and the secondary focus will be paid to line charging including reviewing the line pricing considered by DULT. For completeness, the evaluation of the pilot congestion pricing is included in this report.

2.2.1.4. The two options for the pilot scheme of DULT that will be evaluated are [Mahatma Gandhi (MG) Rd-Hal Airport Rd (Route 1) and Hosur Rd (Route 2)].

2.2.1.5. Congestion pricing is normally done area-wide encompassing the most congested area of any city, which is the around Central Business District (CBD), because it attracts a lot of vehicles because of its activities and the large number of car parks. Singapore, London and Stockholm, which are the 3 cities that had implemented congestion pricing, have introduced it in the vicinity of the CBD. Singapore

(1975) and London (2003) introduced congestion pricing without any trials. Stockholm (2016) introduced it after a trial period of 7 months in 2006 showed it to be effective and followed it with a referendum in September 2006, on whether to continue the system. The "yes" vote was 51.3%, "no" was 45.5% and the rest undecided/invalid. Area wide charging reduces traffic within the area and on the roads leading to the area. Hence, it is the most effective congestion pricing, if the area is fairly sizable. Congestion pricing on a route will be less effective than one for an entire area.

2.2.1.6. As part of the overall ITS Master Plan by JICA Study Team, congestion pricing for a suitable area is proposed. The two areas that will be evaluated are the Central Business District (CBD) and Koramangala (commercial area).

2.2.1.7. The congestion pricing for the chosen area, if approved, could be preceded by a trial to test the technology and operation procedure (See **Appendix A** for the ERP in Singapore). This will be the medium term plan.

2.2.1.8. The long term plan will be to increase/decrease the number of charged roads, modify the charged area (if implemented) and introduce other types of charging.

2.2.1.9. Based on information and data provided, MSI advises the following for consideration:

- Travel demand management, as part of transport policy
- Need for a full package of measures in transport policy
- The different options for congestion pricing for a road/area
- How the pilot scheme/area scheme should work
- Type of control, whether per entry into an area or when using the roads in the area or distance based charging
- Restricted vehicles/exempted vehicles
- Restricted times
- Preferred congestion charge/fines
- Determining charges for different classes of vehicles
- Measures for alternatives for those affected by the congestion pricing
- Diverted traffic
- Publicity
- Administration and enforcement
- Dedicated team for ERP implementation

- Legislation
- Monitoring
- Timeline
- Measure of effectiveness for a pilot scheme to be considered to determine success
- Mitigating measures
- Use of revenue from congestion pricing
- Contingency plans
- Short term, Medium term and Long term plans

2.2.1.10. Ultimately, whether the decision is to proceed with congestion pricing, or even a pilot scheme, is political in nature. MSI can only offer advice based on its extensive first-hand experience garnered from the Singapore scheme. Not all the issues raised in the Singapore scheme may be applicable and a judgement call by the Client will be required. The ultimate decision to proceed, or otherwise, has to be made by the Client.

2.2.1.11. Once the decision is made to proceed with congestion pricing, much more work needs to be done by the Client on the site details of the final scheme and the technology selected, which are broadly covered in this consultancy to make decisions.

2.2.1.12. A lead time of at least 12 months will be required to work out the implementation details once the Client has set up a dedicated team for congestion pricing. This dedicated team may have to involve staff from DULT, the Roads Authority, the Traffic Police and other authorities that have an interest in congestion pricing. The dedicated team has to work out among others, the details of locations where site equipment has to be installed, ensuring a watertight system to ensure that illegal entries are negated, on the type of on-board units to be used (if any), location and feasibility of enforcement points and method of revenue collection. The other actions needed before implementing the pricing scheme are detailed in this Report.

2.2.2. How sensitive are drivers to a charge?

2.2.2.1. Economists have plenty of solid research showing that prices affect travel behaviour, but non–economists often cite anecdotal evidence that travel is insensitive to price and so argue that price reforms are an ineffective way to affect travel behaviour. For example, they will point to a news article showing that a recent jump in fuel prices had little effect on private car use, or data showing that people who live in countries with high fuel taxes continue to drive cars. "Motorists love their cars too much, they won't give them up", goes the claim. Such claims are only partially true.

2.2.2.2. As it is usually measured, demand for car travel is inelastic, meaning that a percentage price change causes a proportionally smaller percentage change in vehicle mileage (i.e. demand). For example, a 10% fuel price increase only reduces car use demand by about 1% in the short run and 3% over the medium run. (Ref Victoria Transport Policy Institute " Changing Vehicle Travel Price Sensitivities" Todd Litman – 2012) Even a 50% fuel price increase, which seems huge to consumers, will generally only reduce vehicle mileage by about 5% in the short run; a change too small for most to notice, although this will increase over time as consumers take the higher price into account in their longer-term decisions, such as where to live or work. The demand for motorcycle travel is however elastic because many come from the lower income group.

2.2.2.3. But fuel price is a poor indicator of the elasticity of driving, because over the long term, motorists will purchase more fuel-efficient vehicles. Over the last few decades, the real (inflation adjusted) price of vehicle fuel has declined significantly, and vehicle-operating efficiency has increased. Real fuel costs are now a third lower and an average car is nearly twice as efficient. Residents of countries with high fuel taxes tend to purchase more fuel-efficient vehicles and drive fewer annual miles per capita. For example, fuel taxes are about 8 times higher in the United Kingdom than in the United States, resulting in fuel prices that are about three times higher. UK vehicles are about twice as fuel efficient, on average, so per–mile fuel cost is only about 1.5 times higher, and cars are driven about 20% less per year, so annual fuel cost is only 1.25 higher than in the US. Similar patterns can be found when comparing other countries with different fuel prices. This indicates that car use is somewhat sensitive to price. Motorcyclists are definitely sensitive to price.

2.2.2.4. The relatively low elasticity of driving with respect to fuel prices hides a much higher overall elasticity of driving. Fuel is only about a quarter of the total cost of driving. The price sensitivity of driving is more evident when measures with respect to parking fees and toll charges. A modest parking fee or road toll can have a major effect on travel demand. Some of these result in changes in destination and route, but it also includes changes in mode and travel distance When per-mile or per trip costs increase, motorists tend to drive less and rely more on the other alternative modes.

3. CONGESTION PRICING FOR BENGALURU

3.1. Objective of congestion pricing for Bengaluru

3.1.1. The objective is to charge vehicles for use of the roads at times and at places when and where they cause congestion. This section deals with the choice of areas or single roads for congestion pricing.

3.1.2. There is a fundamental difference in the usage of roads between area charging and line charging. In an area scheme, the majority of motorists will be affected in some way of other because they are going to a destination there. In a line charging, the majority of the motorists are less affected because they are just passing by and can avoid the road.

3.1.3. For long roads with many cross junctions, it is possible that more control points would be required than for area charging.

3.2. Area Charging (Location – Land use selection)

3.2.1. Traffic congestion is caused mainly by the journey to work in the morning. Individual roads or a number of roads within a zone can become candidates for congestion pricing. Different cities may have different criteria for defining congestion or for designating any area or road to be brought under congestion pricing.

3.2.2. A quantitative method to define congestion is to consult the speed-flow curves derived for different types of roads in the city. MSI has obtained copy of the speed-flow curve derived for a three lane per direction major arterial road in Chennai provided by the Indian Institute of Technology which is shown in **Figure 2**. The speed-flow is a standard method of working out traffic levels of service. Traffic flow is categorized from Level of Service A (very free flowing) to Level of Service E (roads reaching their vehicle carrying capacity) to Level of Service F (very slow traffic when there are stop-go conditions). The traffic flow breaks down at the bullet nose of the curve which is at a speed of 24 km/hr. So speeds below 24 km/hr (called the critical speed) occur for normal Indian roads before we get into the undesirable Level of Service F. This is a theoretical curve obtained from practical measurements. Only the top part of the curve can be measured. The bottom half cannot be measured and is obtained from calculations. Hence the curve is, at best, an indication of what is happening, rather than an accurate description of the situation. We have assumed that the road operations in Chennai are not very much different from that in Bengaluru. Having been driven on the roads in Bengaluru, the MSI team feels that the assumption is reasonable.

3.2.3. This critical speed for Singapore roads is 17 km/hr because there are many closely spaced traffic signal junctions, which is not so in Chennai or Bengaluru.

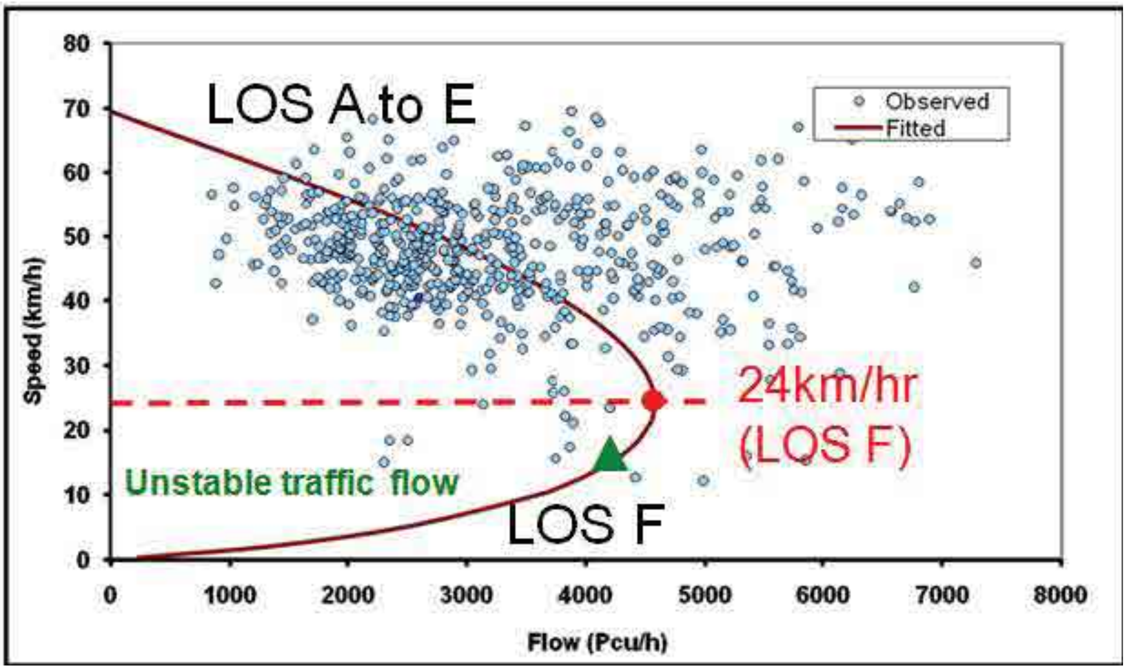


Figure 2: Speed-Flow Curve in Chennai by Indian Institute Technology (Source: "An optimal Traffic Stream Model for Indian Traffic Conditions" by Ajitha, Vanajakshi and Subramanian in Transport Research Board 2011 Annual Meeting)

3.2.4. For a city considering congestion pricing, the trigger point can be when the average speed along the roads in an area or a particular road falls below the critical speed. See **Appendix B** for details of Speed-Flow Curve.

3.2.5. A restricted area is to include locations with land use which attract traffic. These will be the areas with offices, commercial activities and with large car parks which are used by the motorists visiting these buildings. Such areas are usually defined as the Central Business District or Regional Centres. Congestion pricing usually operates during certain restricted period when there is congestion (usually morning peak and evening peak periods).

3.2.6. Since there will be a congestion charge to enter the restricted area or move within the area, it is desirable to exclude residential areas as far as practicable so as not to inconvenience residents. This is not always possible because there will be residences in the area. However, residential areas on the boundary of the restricted area can be excluded if they can get independent access from outside the area.

3.2.7. The first step is to demarcate the various land use – commercial/ administrative (office), industrial, recreational, institutional and residential. A boundary has to be drawn along the roads to exclude as many residential areas as possible. This assumes that there will be major or minor roads separating the residential areas from others. If not, some residential areas may have to be absorbed into the restricted area. The drawing of the boundary should also take into account new and approved commercial/office development and the future road network. Delineating a boundary for an area is always controversial, especially at the boundary and if some residences need to be included in the area.

3.2.8. Other land use may be problematic, if included within the restricted area. These are educational and religious institutions, especially if they attract trips at the same time as the normal starting hours of work trips. While many motorists may accept that it is reasonable to impose a congestion charge for the work trips to ease congestion, it will be more difficult for them to accept that they have to pay to drop off/pick up their children at their schools or for visiting places of worship.

3.2.9. Commercial areas, such as shops and supermarkets, will raise objections if they start their operations early in the morning. Otherwise, fewer problems will be faced, if the restricted period to enter or use the restricted area is not too long in the morning. If there are markets that cater to housewives for buying fresh food (vegetables, meat, fish, etc) in the morning, they are bound to be badly affected. This may be a temporary problem because over time, the market will respond to the challenge and move to outside the restricted area as shoppers change their places of shopping.

3.2.10. Warehouses are buildings from which goods are sent out to retail outlets. If there are warehouses in the restricted area, they should be advised to do their operations outside the restricted hours. Again over a time, land prices and traffic problems will persuade these land uses to relocate.

3.3. Size of restricted area

3.3.1. Too large an area results in too many entrances that have to be controlled. Too small an area results in the congestion pricing system being less effective. Areas of restriction are usually around the CBD. Singapore's area of restrictions is 7 sq km. The CBD itself is about 2 sq km and the enveloping commercial and civic district areas (where there are very few residences) together with the CBD make up the restricted area of 7 sq km. When first implemented in 1975, this was also the administrative centre with almost 90% of the government offices within the area. Over a time of about 40 years, many of the government offices have shifted outside the restricted area to be near the train stations for ease of accessibility by the public. London's area is 8.5 sq km and Stockholm's area is 14 sq km. They are also around the CBD and also include the administrative areas. But it must be remembered that congestion pricing in an area results not only in improvements within the area, but also on the roads leading to it. The determination of the area is controlled by the land use distribution. Nevertheless, any area chosen is bound to lead to a reduction in traffic volume.

3.3.2. There is nothing to prevent the restricted area from being expanded or reduced. Singapore expanded the area from 6.5 sq km, when land was reclaimed from the sea and when some residential areas were redeveloped into commercial areas. London initially expanded its area after a couple of years and then reduced the area after a new mayor was elected into office.

3.4. Boundary

3.4.1. The boundary should preferably run along major roads and minor roads. The area should be bounded by roads which have minimum number of entrance roads into the area. Some minor roads could be made one-way out of the restricted area, so that no entry control is required; however motorists (especially motorcyclists, if they are included) may enter illegally if there is inadequate enforcement.

3.4.2. There may be direct entrances from the boundary road to some developments. If these are residential developments, schools and religious institutions then these areas could be excluded. If these are office or commercial developments, then it could pose problems. If the number of car parking lots in the development is small, it could be excluded. If the number is large i.e. more than 50, then the entrance needs to be controlled. The main requirement is that if an area on the boundary is excluded, it should not have any other access into the restricted area without entry control.

3.4.3. At all major entrance roads into the restricted area, there should be escape routes so that motorists are not forced to enter the restricted area if they do not want to. Where it is not possible to provide such escape routes, adequate warning signs should be put up to forewarn the presence of the restricted area. On minor roads, vehicles not wishing to enter the restricted may be allowed to make an about turn to avoid entering it.

3.4.4. If there are one-way roads that lead out of the restricted area, motorists from buildings with entrances into such one-way roads will be forced out of the restricted area once they come out and have to pay to get back into the restricted area. This will cause unhappiness. This has to be managed by making the roads two-way for certain periods or having an intervening connecting road that allows them to get into the restricted area without paying.

3.4.5. It is preferable to have a perimeter road that is continuous around the restricted area so that motorists can use it to go around it, instead of entering into the restricted area. It is better if this perimeter road is something like a ring road with sufficient traffic carrying capacity. If it does not exist, then an assessment has to be made on the alternative routes.

3.5. Options for Bengaluru

3.5.1. All the cities have implanted congestion pricing for the Central Business District (CBD) and its surrounding area. This is because the CBD tends to have the type of land uses that are amenable to congestion pricing. The CBD and its surroundings are usually the most congested area in any city. Furthermore, if congestion pricing is introduced in other areas, the first question that will be asked will be why the scheme is not introduced in the CBD. In that sense, the CBD is a neutral area.

3.5.2. Congestion pricing is seldom proliferated but confined to only one area because of its unpopularity. In Singapore, the possibility of a second area, a regional centre was considered but rejected because of the expected opposition by road users.

3.5.3. In Bengaluru, a number of logical areas, which are CBD and 6 other regional centres where there were commercial activities were identified together with DULT before the final selections were made. These were areas facing traffic congestion in varying degrees during the peak periods. These were the CBD around Majestic, Koramangala, Electronic City, Whitfield, Malleswaram, Yashwantpur and Jayanagar.

3.5.4. The evaluation consisted of the percentage of commercial/administration/ industrial land use of total land use in each area, availability of good public transport and of alternative routes. After evaluation the two selected areas are CBD and Koramangala. The Matrix table can be found in **Appendix C**.

3.5.5. CBD and Koramangala area are chosen as the land use is mainly for commercial and administration, well served by public transport and availability of periphery roads for motorists to avoid the area.

3.5.6. Traffic surveys are carried out by DULT and JICA Study team. For the CBD and Koramangala area, classified traffic counts, origin-destination surveys and journey time surveys were carried out. For the traffic counts surveys, classified traffic counts requires the counting of the type of vehicles, the occupancy rate of public buses and whether heavy goods vehicles are loaded or empty. Classifieds traffic count is applied to vehicles entering and exiting the proposed charging area. For the origin-destination survey, number plate matching is used to match the vehicles entering and exiting the proposed area for charging. Link counts and junction counts are also carried out along bypass routes. For journey time survey, the travel time from start to end of a particular route and the length of route is required to calculate the journey speed within the restricted area and also along bypass routes. Please refer to **Appendix D** for details of the survey request.

3.6. Details of CBD of Bengaluru

3.6.1. The CBD and its surroundings have land uses varying from administrative, offices, commercial, recreational and residential. Based on the Bengaluru Metro Model for one morning peak hour, the number of passenger trips from different origins ending in CBD as a destination is 10,481. About 25% of the land is estimated to be government offices and a small percentage of residential areas. If the boundary is drawn to exclude much of the residential and recreational area, but to include the administrative and some commercial areas, the area to be controlled is about 2 sq km, which is low compared with other working schemes. The CTTS (2010) had recommended an Electronic Road Pricing (ERP) for the CBD cordon around Vidhana Soudha for a radius of 5 km. This will make the area larger. If a radius of 5 km is drawn, the restricted area will include many residential areas, many temples, mosques and churches, all of which are not large attractors of traffic during the peak periods. Including them will have negative consequences. Extending the area will result in some of the bypass routes coming under restrictions, which is undesirable because it is good to leave them for the vehicles not wishing to enter the restricted area to use.

3.6.2. There is a large bus terminal and a future metro station in the Majestic area, which makes the restricted area very accessible by public transport. 4 stations are under construction within the CBD. There will be 18 entry points to the area (Traffic volume were only given for 13 major entry points and extrapolated proportionally for a total of 18 entry points. Hence the ratio of 18/13 was used to get the final figure). At the start, it is better to start with an entry charging system (charge only as vehicle enter the area) and change to other types such as charging per distance later as the Authority, which handles congestion pricing, acquires more experience.

3.6.3. The bypass roads are along the following roads (shown in **Figure 3**).

- Seshadri Road
- Palace Road
- Rajbhavan Road
- Dr Ambedkar Road
- Nrupathunga Road
- District Office Road

* KG Road

  The bypass roads that skirt around the area are Seshdari Road, Race Course Road, Kasturba Road and KG Road.

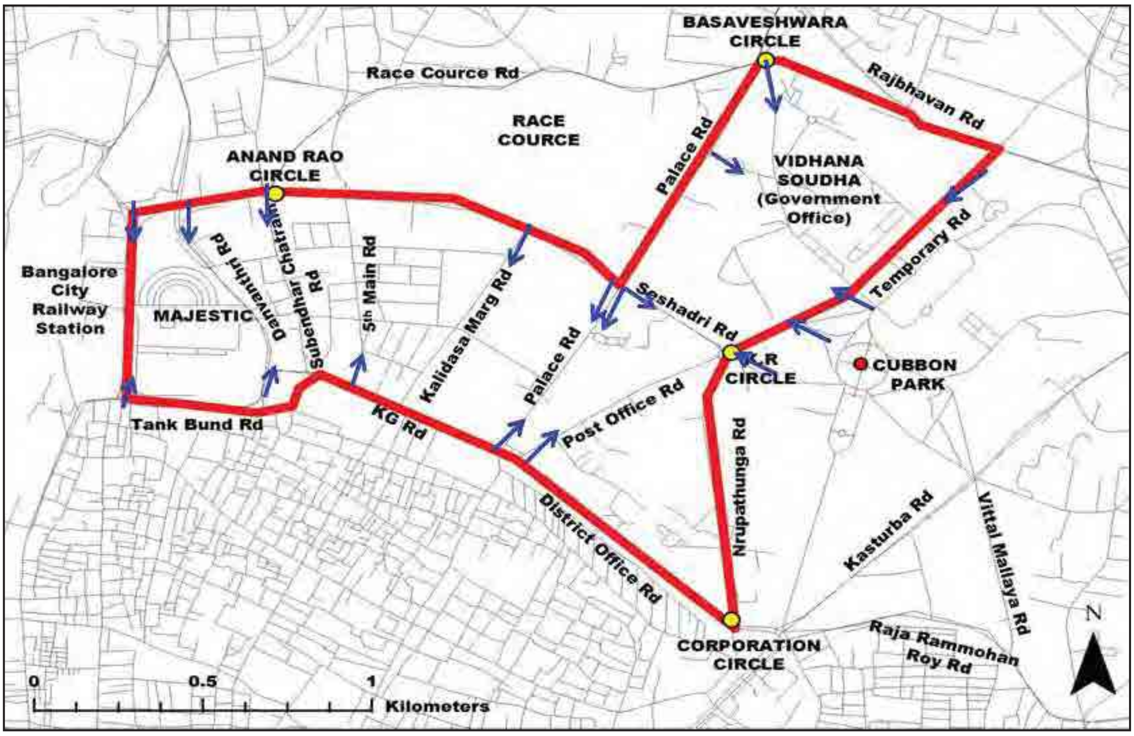


Figure 3: Boundary of CBD Area
(Source: Map from JICA Study Team)

3.6.4. The current traffic conditions in the area yield an operating level of service F with average speeds of 18.6 km/hr as measured (on a few important roads), or very slow with stop-go conditions at some times (this is below the critical speed of 24 km/hr). So the area is a candidate for congestion pricing because the imposing a charge will reduce traffic volume and move the traffic flow out of the level of service F into a better level of service.

3.6.5. **Table 4** shows the reduction of traffic in the three cities with ERP systems. MSI is using the Singapore value (-16%) for reduction because it is the most conservative of the three. According to FHWA, area wide charging in Singapore, London and Stockholm resulted in 10 to 30% or greater reduction in traffic in the priced zone and has sustained the reductions over time. Pricing has influenced travellers to change their behaviour by changing modes of travel, times, routes, or trip frequency. Therefore, the reduction percentages have always been based on operational congestion pricing and not on theory.

3.6.6. With the 16% reduction in traffic, the traffic situation on a typical main road in the area will improve from level of service F to a level probably D to E with better speeds and the avoidance of stop-go conditions, if a significant charge is levied. See **Appendix B** for explanation.

Table 4: Reduction of traffic volumes with 3 ERP systems

Charging experience from 3 cities	Total Inbound Traffic Volume (veh) (during proposed restricted hours - from 1000 to 1200hrs)
Without charging	84,439
With charging (Singapore -16%)	70,929
With charging (Stockholm -20%)	67,552
With charging (London -30%)	59,108

3.6.7. The morning peak hours has the highest economic value because people are going to work. So at the start, it is proposed to control only for 2 hours; at a later date, the period could be extended if deemed necessary. The period of morning operation, as determined by the traffic volume profile of a typical main road in CBD, is between 1000 and 1200hrs when traffic volume is at its highest (shown in **Table 5**).

Table 5: Total Inbound Traffic Volume into the CBD Area

Time (hrs)	Current Total Inbound Traffic Volume (veh)	Expected Total Inbound Traffic Volume (veh) (With ERP)
0900-1000 (pre-ERP period)	31,792	34,971 (10% increase)
1000-1100 (ERP period)	43,358	36,421 (16% decrease)
1100-1200 (ERP period)	41,082	34,508 (16% decrease)

3.6.8. What will happen to the 16% traffic that is deterred from entering the CBD during this period? Some will abandon the trip or choose other destinations. Some will stagger their arrival hours to arrive before or after the restricted hours, some will divert to public transport and yet others who use the CBD as a short cut (without having a destination in the CBD) will divert the peripheral road to bypass the area.

3.6.9. Those who stagger the arrival to before the hours of restriction (1000 to 1100hrs) is expected to increase to about 34,971 vehicles (an increase of 10% based on Singapore experience) (shown in **Table 6**) which makes the traffic volume in pre-restriction period of 0900 to 1000hrs of 34,971 still lower than the current highest traffic volume of 43,358 vehicles (without charging) during the period of 1000 to 1100hrs. Therefore, the rush before the restrictions start is not expected to be worse than the current peak hour conditions. The number entering before 1000hrs (pre-ERP) and after 1200hrs (post-ERP) are expected to be less than the current peak hour situation (1000 to 1100hrs).

Table 6: Expected Total inbound traffic volume during pre and post-restriction period

Time (hrs)	Current Total Inbound Traffic Volume (veh)	Expected Total Inbound Traffic Volume (veh) (with charging from 1000hrs to 1200hrs)
0900-1000	31,792	34,971 (10% increase based on Singapore's experience)
1200-1300 (Estimated Figures)	39,027	40,979 (5% increase based on Singapore's experience)

3.6.10. The shift to public transport, which is the most desirable, is difficult to estimate. Currently, there are 1300 bus trips going into the Majestic area of CBD per day. The number of passengers getting down at CBD from 0800 to 1200hrs as given by BMTC is 131,850, which is about 33,000 passenger trips per hour. The percentage of public transport usage in Bengaluru city is about 50% based on Bangalore Mobility Indicators (2010-2011) (Ref: Passenger Transport Mode Shares in World Cities, LTA ACADEMY Publications Journeys – Nov 2014). A metro system will attract more users than a bus system. Therefore with the extension of Namma metro, the numbers diverting to public transport will increase.

3.6.11. There are no current figures of the percentage of traffic that uses the CBD of Bengaluru as a through route from one end to another without having a destination in the CBD. Such vehicles are unlikely to pay a congestion charge just to pass through the CBD and will divert to the bypass roads increasing the traffic volume on these roads. The expected increase will be about 10% (based on Singapore's experience), resulting in worsening the traffic situation on the bypass roads. This is inevitable in all congestion pricing systems. In Singapore, the ring road around the restricted area (which was also the alternative bypass road) was widened. It does not seem to be feasible to widen these bypass roads in Bengaluru because of the highly built-up nature of the CBD. However, it may be worthwhile to look at some traffic management schemes for them. The bypass roads for the CBD area (Seshdari Road, Race Course Road, Kasturba Road, KG Road) vary between two to three lanes. Some of them are one-way streets and the possibility of converting them into two ways should be looked into. If the traffic congestion on the bypass road gets worse, the diverted traffic will look for other less convenient alternatives.

3.7. Details of Koramangala Area

3.7.1. The shortlisted Koramangala Area is made up of mostly residential and commercial areas and is about 3 sq km (larger than CBD area). Based on the Bengaluru Metro Model for one morning peak hour, the number of passenger trips from different origins ending in Koramangala as a destination is 10,046. There are 34 entry points into that area (Traffic volume were only given for 12 entry points. It is normal to use the ratio of 34/12[approximately 3] to get the final figure, but many of the roads not counted were minor roads and hence multiplying by 34/12 will inflate the figures unreasonably. Hence a factor of 2 was used multiply to get the final figure). The bypass roads are along the following roads (shown in **Figure 4**).

- Hosur Road
- Ganapathi Temple Road
- 80 Feet Main Road
- Sarjapur Main Road
- Madivala Rd

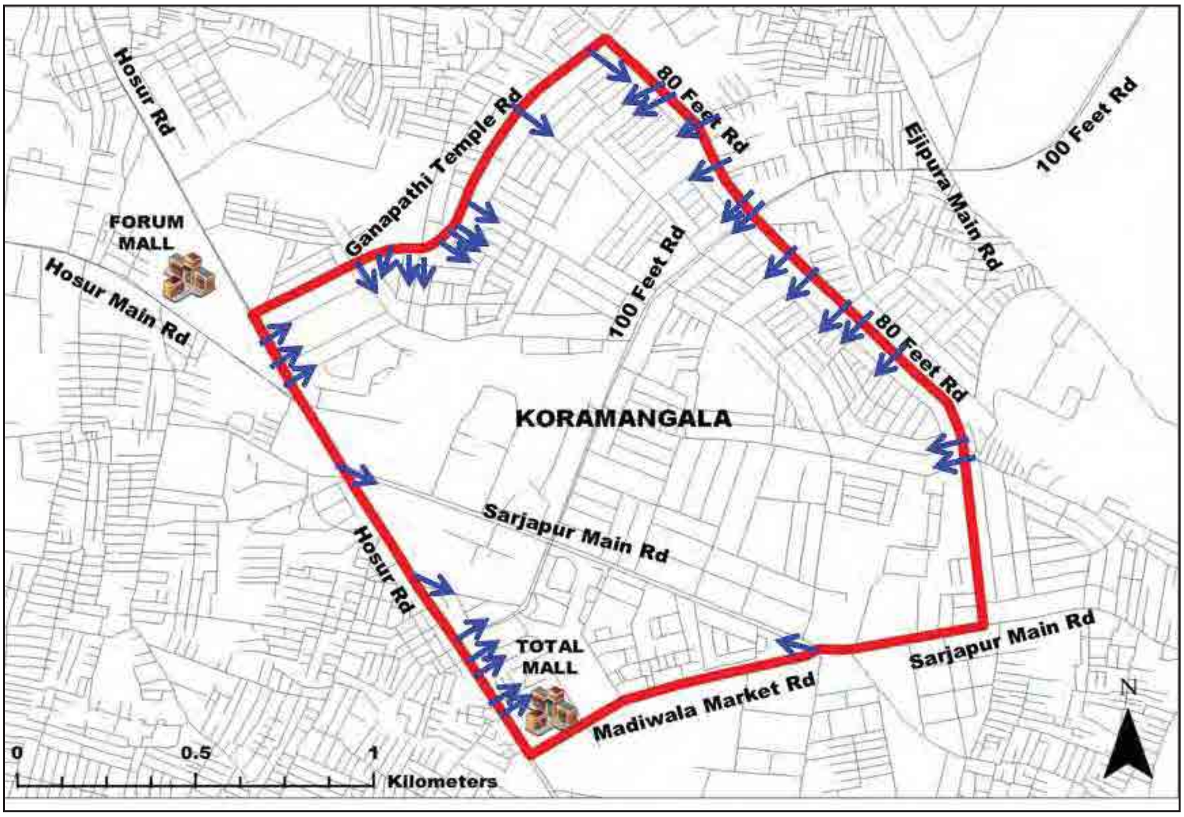


Figure 4: Boundary of Koramangala Area
(Source: Map from JICA Study Team)

3.7.2. The current average traffic speeds in the area is 17 km/hr (lower than average speeds within CBD) which is an operating level of service F i.e. very slow with stop-go conditions at some times (below the critical speed of 24 km/hr). If the congestion charge is imposed, this may result in a 16% reduction in traffic. The traffic situation on a typical main road will improve from the level of service F to a level with better speeds and the avoidance of stop-go conditions. The reduction of traffic based on the three cities' experience can also be found in **Table 7.**

Table 7: Reduction of traffic volumes with 3 ERP systems

Charging experience from different countries	Total Inbound Traffic Volume (veh) (during proposed restricted hours - from 0900 to 1100hrs)
Without charging	56,574
With charging (Singapore -16%)	47,522
With charging (Stockholm -20%)	45,259
With charging (London -30%)	39,602

3.7.3. The period of morning operation as determined by the traffic volume profile of a typical main road in Koramangala Area is between 0900hrs and 1100hrs (as compared to time period from 1000 to 1200hrs in CBD) when traffic volume is at its highest (shown in **Table 8**). Koramangala is mainly commercial/ residential whereas CBD is commercial/ administrative in nature. Nevertheless, the morning peak hours has the highest economic value because people are going to work. So in the beginning, it is necessary to control only for 2 hours; at a later date, the period could be extended if needed.

Table 8: Total inbound traffic into the Koramangala Area

Time (hrs)	Current Total Inbound Traffic (veh)	Expected Total Inbound Traffic(veh) (With ERP)
0800-0900 (pre-ERP period)	25,974	28,571 (10% increase)
0900-1000 (ERP period)	29,250	24,570 (16% decrease)
1000-1100 (ERP period)	27,324	22,952 (16% decrease)
1100-1200 (post-ERP period)	24,876	26,120 (5% increase)

3.7.4. Similar to the congestion charge area proposed in the CBD, the 16% traffic that is deterred from entering the CBD during this period may abandon trip or choose other destinations; use public transport; stagger their arrival hours; and others who used the Koramangala Area as a short cut will divert to the peripheral road to bypass the area.

3.7.5. Those who stagger the arrival to before the hours of restriction of 0900hrs is expected to increase to about 28,571 vehicles (10% increase) (shown in **Table 9**) which makes the traffic volume in pre-restriction period of 0800 to 0900hrs higher than the current traffic volume of 27,324 vehicles during the period of 1000 to 1100hrs when it is charged. Hence, congestion may set in during the pre-ERP period from 0800 to 0900hrs. Based on Singapore’s experience, there will be a 5% increase in traffic during the post-restriction period of 1100 to 1200hrs (shown in **Table 8**).

Table 9: Expected Total Inbound traffic during pre and post restriction period

Time (hrs)	Current Total Inbound Traffic (veh)	Expected Total Inbound Traffic (veh) (with charging from 0900 to 1100hrs)
0800-0900	25,974	28,571 (10% increase)
1100- 1200	24,876	26,120 (5% increase)

3.7.6. The shift to public transport, which is the most desirable is difficult to estimate. Currently, there are 210 bus trips serving the Koramangala area with an estimate of about 45 serving during the hours of 0800hrs to 1200hrs. However, for the case of Koramangala Area, there is no metro system, although the bus services are fair. Hence, there is a lack of sufficiently attractive public transport alternative to cater for those who stop driving or to encourage the motorists to change their mode of travel.

3.7.7. There are no current figures of the percentage of traffic that uses the Koramangala area as a through route from one end to another without having a destination in the area. Such vehicles are unlikely to pay a congestion charge just to pass through the area and will divert to the bypass roads increasing the traffic volume on these roads. The expected increase will be about 10%, resulting in worsening traffic situation on them.

3.7.8. In summary, CBD is a better candidate than Koramangala area for congestion pricing because of the lack of sufficient attractive public transport for Koramangala area. Furthermore, charging for the period where the traffic volume is the highest could result in congestion in the pre-restriction period in Koramangala area, as vehicles rush in to beat the charged hours. There are also more residential land uses in Koramangala as compared with CBD, which may prompt more complaints.

3.7.9. CBD is the preferred option for the area charging. The details of the actual locations, the feasibility of locating control points physically and minor traffic management need to be worked out if it is decided to proceed with the congestion pricing.

3.8. Line charging for Bengaluru

3.8.1. DULT wanted to try out a pilot scheme on a congested road before embarking on a possible area scheme in the future. The pilot scheme will allow the technology to be tested, gauge the reaction of motorists and give the experience to the operating Authority, for further extension of ERP to other roads or areas, if needed in the future. The proposed corridor by DULT was a congested road, the 13.5 km MG Road- HAL Airport Road.

3.8.2. Congestion pricing for individual roads can be done in a number of ways

3.8.2.1. Option 1 - The road is divided into sections between each junction in both directions. All vehicles entering each section from any junction is charged whenever they turn left or right into the section. However, if there is a road with a T-junction that only leads to the charged road, motorists will have no choice but to enter and pay. Similarly, residents coming out of their houses could also be forced to pay. Vehicles that go straight across a junction are not charged. The charging will be when a vehicle goes under each control point, but the charge will be capped to a maximum value if the journey is made within a specified period. If there is no cap, then vehicles that go from one end to the other will be charged very high. This option is most suitable for long roads with only a few junctions.

3.8.2.2. Option 2 - If the road in Option 1 has many junctions, then there will be many control points. If it is decided to cut down the number of entry control points, then the entry points will only be on stretches on the road from major junctions with heavy traffic volumes. This means that if there are two minor roads joining the road between the charged points, vehicles can go from one minor road to another minor road without being charged since they do not go under any charged point. Similarly, the issue mentioned in Option 1 for T-junctions applies as well. Therefore, the charged points have to be carefully selected to ensure that not many travel without paying. As before the charge will be capped to a maximum value.

3.8.2.3. In both cases, vehicles are charged only when they go under a control point.

3.8.2.4. There is also a possibility of charging for distance travelled on the charged road with the same number of control points. This is only possible if the charging is done at the backend by a central computer. The system will record all the control points that the vehicle went through and will compute the charge for the distance travelled between the first control point that the vehicle entered the charged road and the last control point at which the vehicle left the charged road. The ERP charge has now to be in rupees/km rather than a flat fixed rate per entry. This is similar to toll road systems that charge for distance travelled between entry and exit to the toll road. The backend computation power has to be much more. It is better to start with the per entry system in the beginning and migrate to the distance charging if need be at a later date.

3.8.2.5. Option 3 - Option 3 treats the charged road as an area. There will only be two control points on the road itself, the rest will on the side roads where the vehicles enter. The disadvantage of this system is that even vehicles that are just crossing the road will be charged. It will be difficult to justify and hence is not recommended. **Figure 5** shows the 3 options explored for line charging scheme.

Figure 5: 3 options explored for line charging scheme (Source: Map from DULT)

3.8.3. Analysis of the line charging scheme

3.8.3.1. Two routes were selected for evaluation. Route 1 (MG Road-HAL Airport Road) was already decided by DULT as a possible line charging scheme. Route 2 (Hosur Road) was chosen for evaluation. Routes 1 and 2 can be found in **Figure 6** and **Figure 7** respectively. The two routes lead to the Outer Ring Road which is an important road in the Bengaluru network. The locations of the control points can be found in **Appendix E**.

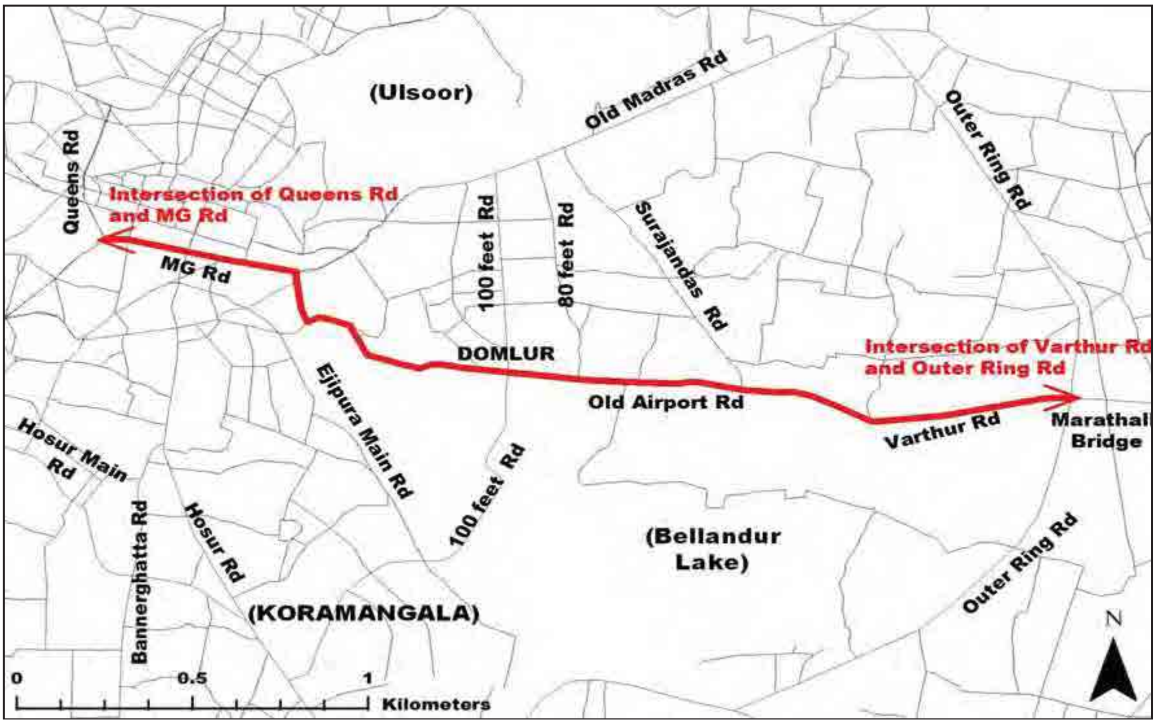


Figure 6: Map showing MG Rd- Hal Airport Rd (Route 1)
(Source: Map from JICA Study Team)

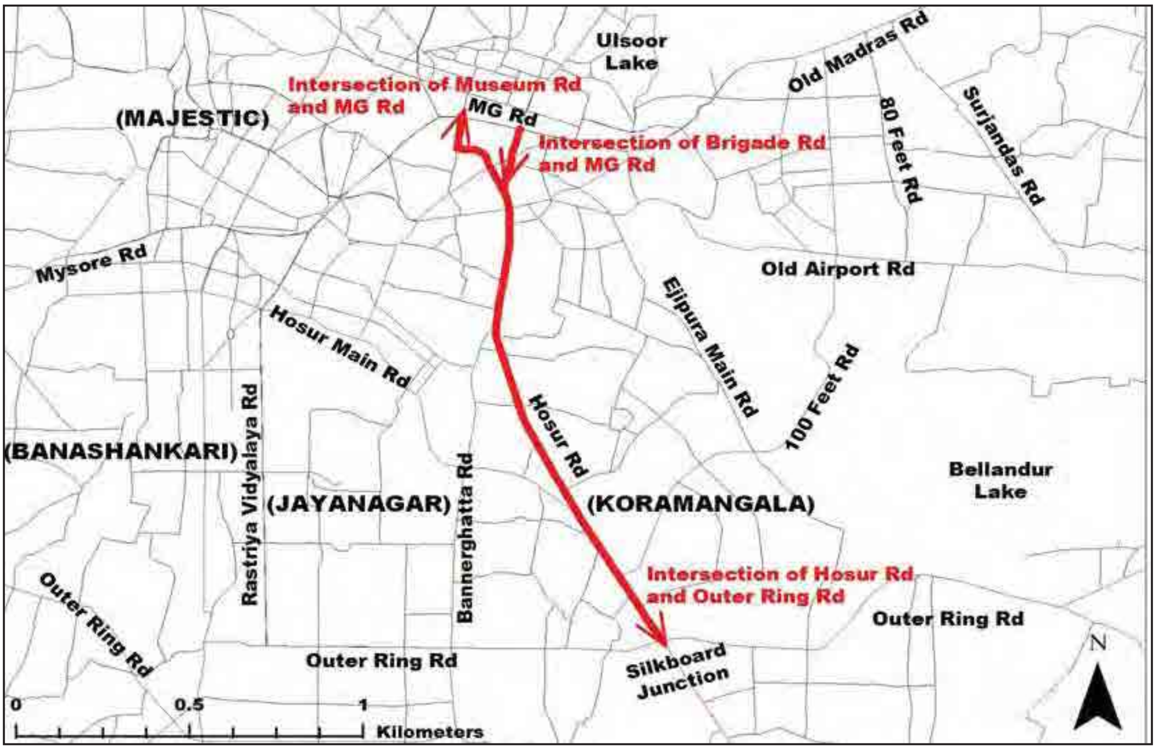


Figure 7: Map showing Hosur Rd (Route 2)
(Source: Map from JICA Study Team)

3.8.4. Traffic surveys are carried out by DULT and JICA Study team. Classifieds traffic counts and journey time surveys were carried out for MG road to HAL airport road and for Hosur road. For the traffic counts survey, classified traffic counts requires the counting of the type of vehicles, the occupancy rate of public buses and whether heavy goods vehicles are loaded or empty. Classifieds traffic count, link count and junction counts are carried out for the main proposed charging road as well as alternative roads. For journey time survey, the travel time from start to end of a particular route and the length of route is required to calculate the journey speed for the proposed charging route as well as alternative routes. Please refer to **Appendix D** for details of the survey request.

3.8.4.1. **Table 10** shows the analysis during the period from 0800 to 1100hrs.

Table 10 – Analysis of Line Charging Scheme

<table>
<tr><th>Items</th><th>MG Rd – Hal Airport Rd

(Route 1) about 13.5km

(varies between 2 to 3 lanes in each direction, although not marked)</th><th>Hosur Rd

(Route 2) about 7km

(varies between 2 to 3 lanes in each direction, although not marked)</th></tr>
<tr><td>Description of land use</td><td>a)MG Rd – mostly commercial with some residential

b) Hal Airport Rd- mostly residential (military cantonment) with some commercial</td><td>a) mostly residential with some commercial near Silk Board</td></tr>
<tr><td>Average speed in direction 1 during peak period and level of service</td><td>14.4km/hr (LOS F)

(towards MG Rd)</td><td>13.5km/hr (LOS F)

(towards MG Rd)</td></tr>
<tr><td>Average speed in direction 2 during peak period and level of service</td><td>17.2km/hr (LOS F)

(towards Marathalli)</td><td>9.8km/hr (LOS F)

(towards Silk Board)</td></tr>
<tr><td>Proposed period of morning restriction based on traffic profile</td><td>0900hrs-1100hrs

(based on the 2 highest hours in Figure 8)</td><td>0900hrs-1100hrs</td></tr>
<tr><td>Current

Traffic Volume (veh)</td><td><u>Hal Airport Rd (all LOS F)</u>

<table><tr><th>Time (hrs)</th><th>Towards Domlur</th><th>Towards Marathalli</th></tr><tr><td>0900-1000</td><td>5,826</td><td>6,273</td></tr><tr><td>1000-1100</td><td>5,249</td><td>5,849</td></tr></table></td><td><u>Hosur Rd (all LOS F)</u>

<table><tr><th>Time (hrs)</th><th>Towards Silk Board</th><th>Towards Dairy Circle</th></tr><tr><td>0900-1000</td><td>7,445</td><td>7,218</td></tr><tr><td>1000-1100</td><td>7,277</td><td>6,903</td></tr></table></td></tr>
<tr><td>Expected Traffic volume after reduction as a result of congestion pricing (veh)

(Expected 12% reduction) based experts' view that the traffic on Delhi-</td><td><u>Hal Airport Rd</u>

<u>(will move out of LOS F into a more acceptable LOS)</u>

<table><tr><th>Time (hrs)</th><th>Towards Domlur</th><th>Towards Marathalli</th></tr><tr><td>0900-1000</td><td>5,127</td><td>5,520</td></tr><tr><td>1000-1100</td><td>4,619</td><td>5,147</td></tr></table></td><td><u>Hosur Rd</u>

<u>(will move out of LOS F into a more acceptable LOS)</u>

<table><tr><th>Time (hrs)</th><th>Towards Silk Board</th><th>Towards Dairy Circle</th></tr><tr><td>0900-1000</td><td>6,552</td><td>6,352</td></tr><tr><td>1000-1100</td><td>6,404</td><td>6,075</td></tr></table></td></tr>
</table>

<table>
<tr><td>Gurgaon Expressway will increase by 12 - 15% when toll is removed in 2014)</td><td></td><td></td></tr>
<tr><td>Number of control points</td><td>Option 1 - 64 control points

Option 2 – 36 control points</td><td>Option 1 - 67 control points

Option 2 – 26 control points</td></tr>
<tr><td>Possible alternative parallel roads and their current traffic volumes (veh)</td><td>Old Madras Rd
<table><tr><th>Time (hrs)</th><th>Towards K.R.Puram</th><th>Towards Ulsoor</th></tr><tr><td>0900-1000</td><td>3,355</td><td>3,571</td></tr><tr><td>1000-1100</td><td>3,306</td><td>3,414</td></tr></table></td><td>Bannerghatta Main Rd
<table><tr><th>Time (hrs)</th><th>Towards Bannerghatta</th><th>Towards Dairy Circle</th></tr><tr><td>0900-1000</td><td>4,960</td><td>5,314</td></tr><tr><td>1000-1100</td><td>4,430</td><td>4,204</td></tr></table></td></tr>
<tr><td>Expected traffic (veh) along alternative parallel roads due to the charging at the pilot scheme (13% increase based on ERP for Singapore expressways)</td><td>Old Madras Rd
<table><tr><th>Time (hrs)</th><th>Towards K.R.Puram</th><th>Towards Ulsoor</th></tr><tr><td>0900-1000</td><td>3,791</td><td>4,035</td></tr><tr><td>1000-1100</td><td>3,736</td><td>3,858</td></tr></table></td><td>Bannerghatta Main Rd
<table><tr><th>Time (hrs)</th><th>Towards Bannerghatta</th><th>Towards Dairy Circle</th></tr><tr><td>0900-1000</td><td>5,605</td><td>6,005</td></tr><tr><td>1000-1100</td><td>5,006</td><td>4,751</td></tr></table></td></tr>
</table>

3.8.5. Singapore's experience on ERP on individual expressways shows that when route pricing is used, motorists prefer to use alternative routes rather rush in during the pre-ERP hours. Signboards indicating alternative roads to Outer Ring Road (which link to these routes) should be provided to let the motorists know of alternative non-charged roads.

3.8.6. From **Table 10**, traffic situation on the charged roads will improve and they will move out of the LOS F zone to a better level of service. The possible parallel roads which are already operating with high traffic volumes could get more congested. In such cases, the traffic will find its own level and motorists will find other less convenient alternative roads

3.8.7. Although the traffic situation on Route 2 is heavier, land use-wise, Route 1- MG Road-HAL Road is a better choice if it were decided to proceed. Route 1 has better public transport choices, especially with

Namma metro serving MG Road. Route 1- MG Road-Hal Airport Road is the chosen candidate. The details of the actual locations, the feasibility of locating control points physically and minor traffic management need to be worked out if it is decided to proceed with the line charging scheme.

3.8.8. Route 1 has a total of 64 control points under Option 1 and 36 control points under Option 2, if done in both directions. Under Option 2, some of the minor roads entering the charged road will have no control points when they turn left or right; and vehicles enter free, but they will only be able to travel free for a short distance before they meet a control point. So it is likely that they will travel free from one minor road to another minor road. Site investigations show that the maximum distance vehicles will be able to travel free is 1.3 km (HAL Road to the minor road near K B Munivenikata Reddy House). This short distance is acceptable and we recommend Option 2. The peak period directional split of traffic is 0.48:0.52 which is almost close to being equal. So charging is proposed in both directions.

3.8.9. Improvements such as proper making up of the road surface, provision of footpaths, road markings, traffic and directional signs should be done along MG Road-Hal Airport Road and in the vicinity. This is to let the motorists know that improvements have been done to the roads before imposing a charge.

3.8.10. MSI also investigated the traffic volume profile on HAL Airport road to check whether the restrictions should apply for the whole day or only during the peak hours. **Figure 8** shows the traffic volume profile. The highest volumes are from 0900 to 1100hrs. Traffic thins out after that and achievable speeds after these hours (from our travel experience) range much higher than those experienced for a LOS F. Currently, it is not necessary to impose charges during other periods, but this could be reviewed after the implementation and monitoring.

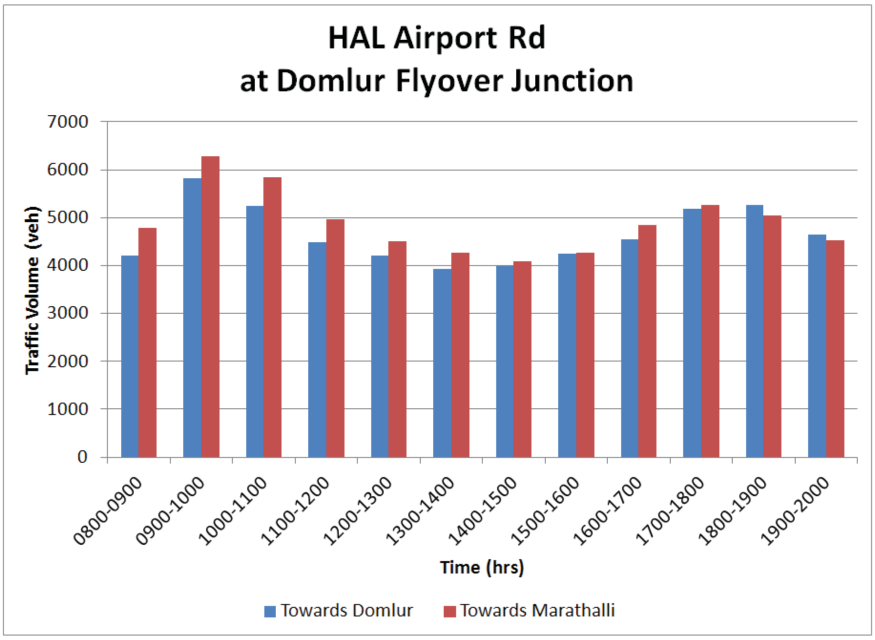


Figure 8: Traffic volume profile along HAL Airport Road at Domlur Flyover Junction
(Source: Counts from DULT)

3.8.11. Hudson circle was not included in this first evaluation form MG – HAL Road because it is a major node used by traffic to and from many directions, going to many different destinations. If it is to be included, 5 more control points are required, 3 in one direction and 2 in the other.

3.9. Vehicles to be included

3.9.1. In theory, any motorised vehicle that adds to congestion should be charged.

3.9.2. In Singapore, all motor vehicles other than ambulances, fire fighting vehicles, and marked police cars are charged for using roads within the restricted period. There is a scheme for even charging foreign registered vehicles. In London, residents pay less; foreign vehicles, buses and handicapped vehicles do not pay. Stockholm has exemptions.

3.9.3. Evaluation

3.9.3.1. **Table 11** shows the reasons for charging and exemption and the decisions made together with DULT at the second visit in June 2014.

Table 11: Reasons for charging and exemption based on discussion with DULT

Type of vehicle	Reason for charging	Reason for exemption	Remarks
Car	Uses road space. Large numbers of users and steadily growing.	None	Include
Motorcycle (Two wheelers)	Uses road space. Largest numbers on the road. Exemption may lead to greater numbers, especially if cars are charged	Contributes much less to congestion. Easy for them to avoid paying	Include
Goods vehicle	Uses road space. Can schedule and avoid peak hours to move	Will recover the charge from the clients that they serve	Include
Bus	Uses road space. The charge per passenger will be small as compared to a car which has a smaller occupancy	Efficient user of roads during peak hours, hence merit special consideration	Exempt those running public transport but not interstate, intercity and private buses
Taxi/ Autorickshaw (Auto)	Uses road space and the passenger should pay the charge	Taxis/Autos unlikely to cruise empty into a charged area/road and hence shortage could be expected	Passenger to pay, Autos may get a reduction. If a backend system of payment is used, it may be necessary to include a standard surcharge that the taxi/auto collects in addition to the fare if the passenger is going into the charged area/road or books a taxi from there.
Residents within controlled area	Uses road space. May be able to schedule trips to avoid paying	Have no say in the choice of the controlled area	They will only be affected if they leave and return during the restricted period.

Out of Karnataka registered vehicles	Uses road space. Numbers may be small	Difficult to administer charging unless there are methods to collect	Include if regular visitors Such vehicles may have special stations for installation of any gadgets One-off vehicles not allowed to enter
Government and military vehicles	Uses road space. No reason to exempt. Will prevent indiscriminate use and encourage officials to seek better transport alternatives during the peak periods	Charges can be considered as paying from the right pocket to the left pocket	Include (this may cause unhappiness to government officers if they are included, but the other cities have taken the stand that government officers should set an example themselves.
Emergency vehicles	Uses road space. Numbers are small.	Merit special consideration because of the nature of their services	Exempt ambulances, fire trucks and marked police cars
Diplomatic cars	Uses road space. Numbers are small.	To follow protocol	Exempt

3.10. Method of charging

3.10.1. The normal method is to designate a control area as a Charged Area (CA). In Bengaluru, the Line Charging (LC) involves designating a road.

3.10.2. The restricted vehicles wishing to use this area within the hours of operation will be required to pay a charge. The alternative methods of charging are:-

3.10.2.1. Option 1 – Per Pass (per entry) System. Per entry - vehicles pay as they go under the control point. They are free to move around or leave the CA/LC without incurring further charges. Vehicles that are already in the CA/LC and move around without leaving do not pay the charge. This is the simplest method as the vehicle has only to be tracked at the defined entry points. Singapore uses this system

3.10.2.2. Option 2 – Per Movement in the CA/LC. Vehicles pay as they enter the CA/LC and/or if they use the roads within the CA or LC. Those who are already in the CA/LC also pay if they move. There is no payment when they leave the CA/LC. Tracking points are required at many locations in order to capture all movements to effect the charging. London uses this system because they have many cameras to catch movements

3.10.2.3. Option 3 – Per Distance Travelled in the CA. Vehicles are tracked as they enter the CA/LC and as they leave the CA/LC and charged for the distance travelled. This is a common method of charging on toll roads. It is suitable for charging along a single road where tracking can be done at entry and exit (whose distances are fixed), but preferably the number of entrances and exits should be small. For charging in an area, this would require a device within the vehicle that measures distances travelled, once the vehicle enters the area. Tracking points are required at many locations, in order to capture all movements to effect the charging. Germany uses this system for charging toll for heavy goods vehicles on their autobahns.

3.10.3. Whichever system is adopted, congestion pricing improves traffic conditions not only within the CA/LC but also on roads that lead in (or out) of it because of the reduced numbers of vehicles being which are discouraged by the charge.

3.10.4. Evaluation: For Bengaluru, it is recommended to use the simple per pass at entry (Option1) in the first instance. This is the simplest and cheapest system, as less equipment is needed than others and has lesser adverse effect on residents in the CA/LC.

3.10.5. Over time and with experience, it could be upgraded to other methods of charging, if deemed necessary.

3.11. Times of operation for congestion pricing

3.11.1. Most central business districts (or regional centres) and main roads experience two peak periods – one in the morning caused by the journey to work and one in the evening caused by the journey home. The duration of the peak periods depends on the intensity of activities. In between the two peak periods, there is the off-peak period, which may also exhibit slightly higher traffic usage during the lunchtime. The night time hours have less traffic.

3.11.2. The government has a duty to ensure that people get to work in time. Therefore morning peak period charging is essential. It can be argued that the economic value of time is highest during the morning peak. It is often erroneously assumed that morning charging will result in a mirror image effect in the evening i.e. if morning charging improves traffic condition as a result of reduced traffic, there would be corresponding reduction of traffic flow in the evening.

3.11.3. Looking at the traffic volume profile. The morning peak periods are as follows

CBD (area)	1000 to 1200hrs
Koramangala (area)	0900 to 1100hrs
MG Road – Hal Airport Rd	0900 to 1100hrs
Hosur Rd	0900 to 1100hrs

3.11.4. **Figure 9** shows an example of the traffic profile for CBD.

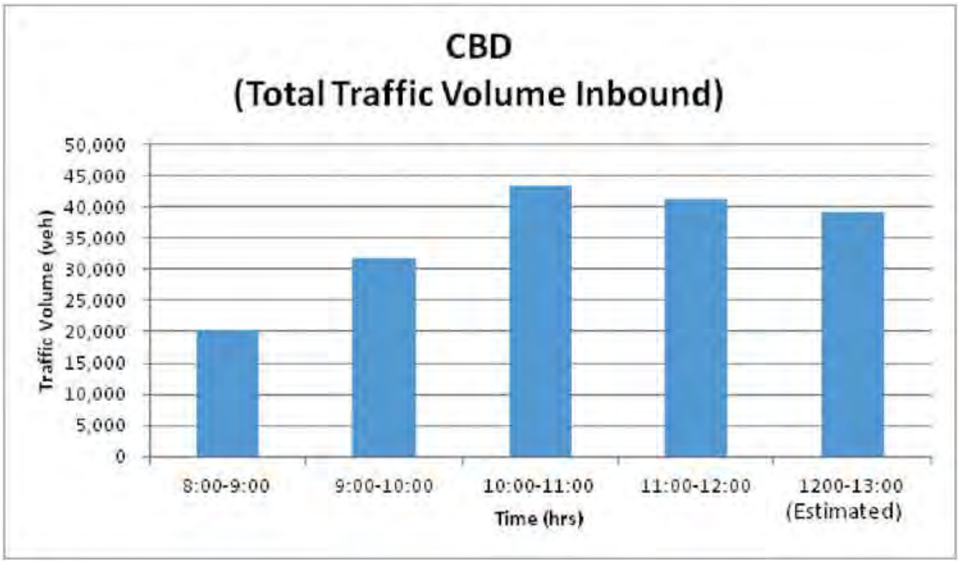


Figure 9 – Traffic profile for CBD

3.11.5. Evaluation : For a start, it is better to fix the hours of charging to the morning peak hours and later extend it as more experience is gained and as the monitoring system gives a better idea of shifts in traffic movements.

3.12. Fixing the first rates for charging

3.12.1. Fiscal measures are the most effective way of travel demand management. A system that charges differently for use of the roads (LC) or a restricted area (CA) at different time periods gives the motorists many choices. The difficulty is in determining the first charge. If it is set too high, many motorists will avoid the area/road resulting in underutilization of the road network that has been built at high cost. If it is set too low, the numbers of vehicles avoiding the area/road will be small resulting in no traffic flow improvements and the accusation that the charges are levied to collect money from motorists.

3.12.2. The charge could be varied at different time periods of the day to take into account the traffic conditions and to encourage the spread the traffic load over the whole working day so as to avoid sharp peak periods.

Demand price elasticity = % change in demand/ % change in price

$$\text{(PE)} = \frac{[(\text{new demand} - \text{old demand})/\text{old demand}] \times 100}{[(\text{new charge} - \text{old charge})/\text{old charge}] \times 100}$$

3.12.3. Demand in this case is the traffic volume per hour entering the CA (or LC) and the charge is what is levied for congestion pricing. PE is negative because demand decrease with increase in charge.

3.12.4. PE cannot be used to fix the first charge (because the old charge is 0). It can be estimated once the system is in operation and the charges are changed subsequently. Thus PE can be used to change future charge to get the desired traffic flow reduction results.

3.12.5. It is natural to expect PE for different types of vehicles to be different. Values of PE above 1 indicate that the demand is very elastic i.e. small changes in the charges see large changes in the demand. Experience shows that PE for cars is usually less than 1, hence demand is not that elastic i.e. users value the freedom and convenience offered by the car. PE for motorcycles tends to be higher because they are possibly owned by the less well-off. PE for goods vehicles is also not very elastic because the charge is passed on to the clients. PE for buses is low because buses run on fixed schedules and cannot change their times of operation. In the case of Autos and taxis, the passenger pays the charge unless the vehicle is cruising empty, the PE is difficult to determine.

3.12.6. As a first step, it is usual to decide on the congestion charge to be imposed on cars because congestion pricing targets mainly their inefficient use.

3.12.7. The proper way to assign the charges to other vehicles is by using the passenger car equivalents (pce). The pce describes the dynamic effect of the various types of vehicles in a moving traffic stream.

3.12.8. Common pce values that can be used as recommended by the Indian Road Congress are as agreed with DULT at the June visit can be found in **Table 12**.

Table 12 – Passenger Car Equivalent used by Indian Road Congress

Class of vehicle	Passenger car equivalent (pce)
Car/taxi	1
Pick up van	1
Motorcycle (two-wheeler)	0.5
Light goods vehicle	1.4
Heavy goods vehicle	2.2
Bus	2.2
Trailer	4
Auto-rickshaw	1.2, but to use 0.5 (on advice of DULT)

So, if a charge for a car is set at a certain value, then the charge for the motorcycle will be half that value because the pce is 0.5.

3.12.9. Based on these considerations, two possible options are considered for fixing the congestion pricing charge.

3.12.10. Option 1: Fix a price for car and apply to other vehicles based on the pce.

3.12.11. Option 2: In Bengaluru, large number of motorcycles (two wheelers) contribute to congestion. By considering the local traffic conditions, it is appropriate to use two wheelers to set the price and apply to other vehicles based on the pce.

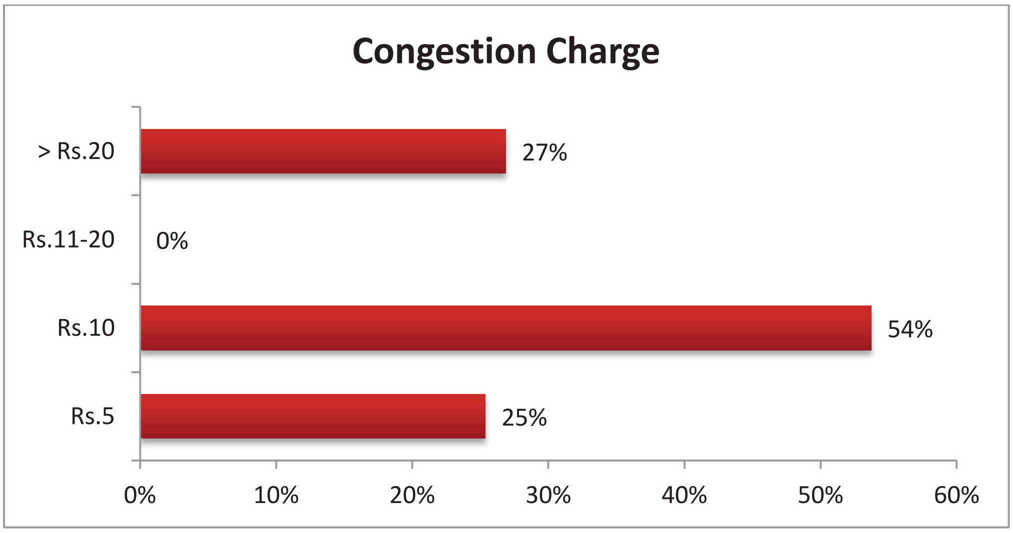
Option 2 is the preferred option.

3.12.12. Instead of assigning an arbitrary value for the first price, it is preferable to tie it up with some known charge.

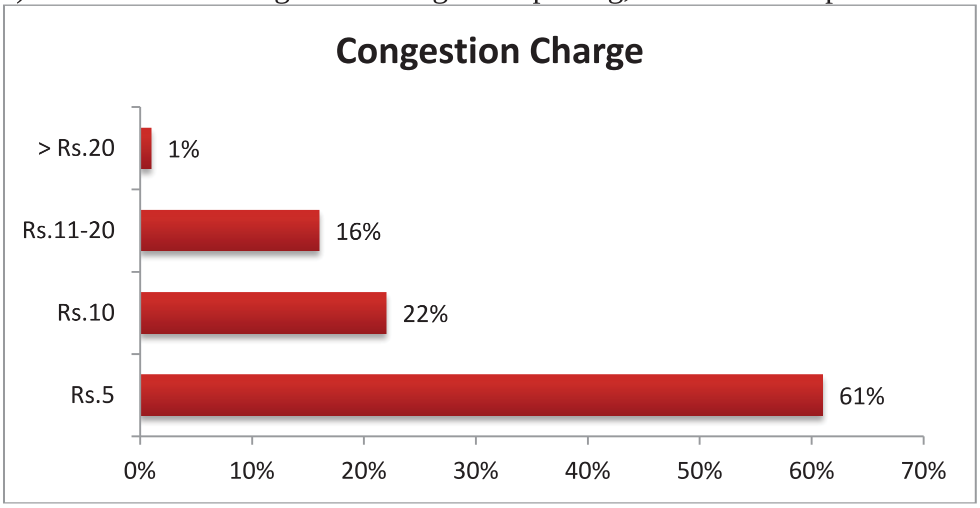
3.12.13. For example, in Singapore, the cost of parking for a whole day in the city was S$3 in 1975. Since the first charge was set at $3 daily per entry, the cost of using the car in the city doubled, which was considered a sufficient disincentive to discourage the widespread use of the car during peak periods under the prevailing economic situation in Singapore at that time. London pegged the congestion charge in the beginning to a multiple of the public transport fare in the city.

3.12.14. Opinion Surveys carried out by JICA Study Team on congestion charge in 2014 with sampling limited to 150, revealed the following:

1) Motorcycle users - 46% agreed to congestion pricing, 8% did not respond.



2) Car users- 46% agreed to congestion pricing, 5% did not respond.



3.12.15. While these are the stated preference of the motorists, the values are low and will have no significant effect on reducing traffic flow and managing congestion. These rates should not be used.

3.12.16. Other indicators of Bengaluru (provided by DULT) are

a) Cost of petrol/litre
- Rs 66 per litre

b) Fare for 10km bus journey
- Rs 10-20 for adult
- Rs 50-80 for adult (for Air Conditioned Service)

c) Cost of street parking
- On street parking in city: Rs 10 per hr
- Off street parking: Rs 20 per hr (government carpark) to Rs 80 per hr (private car park)

d) Cost of toll charged by National Highway Authority of India on the national highways in Karnataka
- Rs 115 from 3 May 2014

e) Cost of Autorickshaw fare
- Minimum fare of Rs 25 for first 1.9km, Rs 13/km for subsequent km.

f) Cost of taxi fare
- Rs 13 to Rs 21 per km (with variable fixed minimum amount)

3.12.17. While the figures above could give some indication of the costs incurred in transportation, the actual fixing of the rates is best left to the discretion of the authorities, in the local context.

4. ELECTRONIC ROAD PRICING SYSTEM

4.1. Current Technologies for congestion pricing

4.1.1. Electronic Road Pricing (ERP) is an automatic form of congestion pricing scheme which is able to:

- Detect the presence of a vehicle
- Determine the classification of vehicle (car, motorcycle, goods vehicle etc.)
- Impose a charge on the vehicle driver
- Alert of any violation act of not paying the charge or on technical errors

It is capable of performing these functions with minimum manual intervention.

4.1.2. The ERP uses a pay-as-you-use principle. It is a fair system because the vehicles are charged at times and places when and where they cause congestion.

4.1.3. It is most effective when used area-wide because it results in traffic improvements within the area and on the roads leading to it. The usual candidate is the central business district of the city with commercial/ administrative activity and large number of car parks.

4.1.4. If used on a single road, its effectiveness is limited to that road only. It is more like a toll road.

4.1.5. If implemented properly, ERP can be effective in maintaining a desired optimal speed range within the area and manage traffic congestion.

4.2. Singapore Electronic Road Pricing (ERP)

4.2.1. An example of a working system is given

Figure 10 (OBU and prepaid-card)

Figure 11 (OBU on windscreen, ERP overhead gantry)

4.2.2. How it works - The ERP system is Multi-Lane-Free-Flow (MLFF) system comprises 3 key subsystems:

- On-board unit (OBU) (**Figure 10**) - the OBU is permanently fitted on the windscreen of the vehicle or on the handle bar of a motorcycle. The OBU accepts prepaid card (a stored-value integrated chip card) for deducting charges when the vehicle passes an operating gantry;
- ERP Gantry (**Figure 11**) – the on-road infrastructure that detects vehicle and communicates with the OBU via dedicated-short-range-radio-communication (DSRC); and
- Central Computer System (CCS) – that processes transactions and violation information from the gantry. The CCS also monitors continuously the status of the gantries and if any fault is detected, alerts the operators who in turn dispatch the maintenance personnel

on-site. The gantries are connected to the CCS via communication lines.

4.2.3. The ERP system is designed to be simple to use. All that it required of the driver is to insert the prepaid-card (a stored-value integrated chip card) into the OBU before he starts the journey. Upon card insertion, the OBU automatically communicates with the card and displays the card balance. If there is a problem with the prepaid card, or if the card is not inserted properly, the driver will be alerted so that remedial action can be taken before he starts the journey.

4.2.4. The OBU has a low balance indicator, whereby the driver will be alerted if the cash balance stored in the prepaid-card falls below a pre-defined amount (in Singapore case, it is S$5.00) to minimise occurrence of insufficient card balance. The cash cards can be conveniently topped up at ATM machines, convenience stores and petrol stations. Motorist using the new generation contactless stored-value-card (CEPAS card) can also opt to have the card top-up automatically via credit cards or interbank GIRO when there is insufficient card balance.

4.2.5. The overhead gantries are used to indicate the location of the congestion pricing. When the vehicle passes under the ERP overhead gantry (**Figure 11**), the appropriate ERP charge is deducted from the prepaid card. There is a short beep, signifying a successful transaction, and the remaining cash balance in the prepaid cash card is displayed on the OBU LCD panel momentarily.

4.2.6. Should there be insufficient cash in the prepaid cash card or should there be no prepaid card inserted in the OBU, the enforcement cameras on the gantry will take a photo of the rear licence plate of the vehicle. Similarly, if the vehicle has no OBU installed in it, the enforcement cameras will also take a photo of the violating vehicle. The captured photo is sent back to the control centre where the vehicles' registration numbers are automatically read using Optical Character Recognition (OCR) software, and the corresponding particulars of the vehicle owner retrieved from the Vehicle Registration database. The vehicle owner is then issued with a request letter to made payments.

4.2.7. For cases of insufficient cash balance or no prepaid cash card in the OBU, an administrative charge of S$10 plus the outstanding ERP charge is imposed. If this payment is not made within the prescribed 28-day period, a summons will follow. This carries a penalty of S$70. For cases where vehicles pass through the ERP gantry with no OBU, summonses of $70 are issued immediately. Failure to pay the penalty can result in the offender being called up to appear in the Courts.

4.2.8. Photos are also taken if there are technical errors in the system, such as if the OBU is malfunction. In such situation, the driver will be issued a vehicle inspection notice to have his OBU checked.

4.2.8.1. Road Pricing Policies - The Singapore Land Transport Authority (LTA) reviews the traffic conditions on the roads in the area and other individual roads where the ERP system is in operation, on a quarterly basis and during the June and December school holidays. Based on the desired travel speeds of the related road(s) (the range of 20-30 km/hr), the ERP rates would then be adjusted where necessary to minimise congestion on the roads.

4.3. Types of systems (Passive vs. Active system)

4.3.1. Active ERP System:

i. The ERP charge is debited from the On-Board Unit (OBU) installed in the vehicle or the pre-paid cash card inserted into the OBU at the front-end (ERP overhead gantry control point) on a real-time basis when the vehicle passes under the overhead gantry at the control point. No backend prepaid account or monthly billing is necessary;

ii. In this case, OBU used can be a type is seldom used nowadays) or with a pre-paid cash card inserted into the OBU; (**Figure 12**)

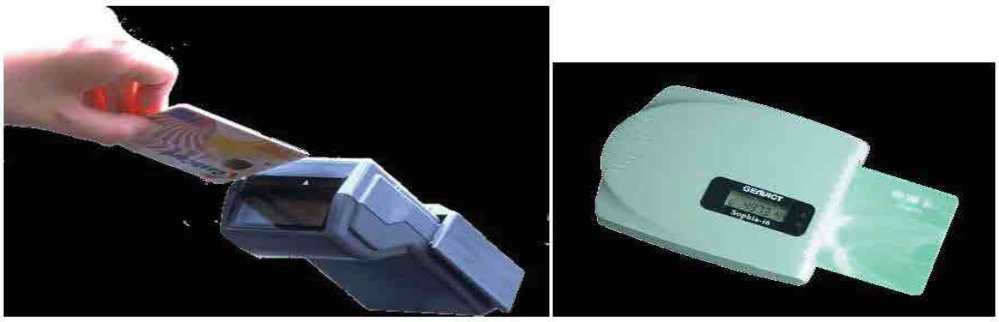


Figure 12: Active OBU and cash card

iii. This is also considered as a Thick Client solution and the OBU is normally more intelligent, complicated and hence more expensive;

iv.As the debiting is done at the front-end at the overhead gantry level from a pre-paid cash card (electronic Money transaction is involved), Key Management is an important consideration and the system security level is higher and hence the front-end is more complicated/expensive to configure.

v. The provision of a pre-paid cash card also means that a sophisticated Card Management system with high security level is needed. This means the system is more expensive.

vi.Advantages of this system are:

- The driver knows the balance of money in the cash card (or the OBU in case of e money) for making subsequent trips;
- He knows that the debiting is successful or not when he passes under the gantry after hearing a confirmation "beep" sound of a deduction of the charge from the OBU;
- He is made aware that he has to pay for the price of using the road. i.e. the pain of paying helps him to make informed choices of travel

4.3.2. Technologies that can be deployed are:

a. Direct Short Range Communications (DSRC): 5.8 GHz (Powered OBU) Note: The powered OBU has an internal power source like a battery to work on the internal electronics and broadcast a signal to the reader/antenna mounted on the overhead gantry continuously. It has to be noted that such system may need the type approval from the local telecommunication authority depending on the local telecommunication acts and regulation

b. Direct Short Range Communication (DSRC): 5.8 GHz (Non-powered OBU) Note: The non-powered OBU does not have an internal power source like a battery. It gets the electromagnetic waves from the reader/antenna mounted on the gantry to power up the internal electronics.

Singapore uses the active ERP system since 1998 but deploying DSRC 2.45 GHz (Not 5.8 GHz) non-powered OBU. The non-powered OBU does not need the type approval from local

Telecommunication Authority but the Land Transport Authority must get the permission to use the frequency band of 2.45Ghz. Direct Short Range Communications Infrared – currently no systems are operating

4.3.3. Passive ERP System

i. The driver has to create an account at the backend office with the ERP authority and deposit a fixed sum of money in it, or open an virtual account which ties up to his bank account, in relation to the vehicle he is driving, i.e. the account is tied to the identity of the OBU (identification id) which is installed in the vehicle; (**Figure 13**). The OBU identity is tied to the number plate of the vehicle.

Figure 13: Passive OBU

ii. When a vehicle passes under the ERP overhead gantry, the reader/antenna reads the OBU id and sends this id back to the backend office. An appropriate amount is deducted from the pre-paid back office account; alternatively, a monthly bill can be compiled and sent to the motorist;

iii. This is also known as a Thin Client solution because the OBU is simpler and less expensive;

iv. Key management (for authenticating communications) is not as critical as the debiting is done at the backend office, under a more secure environment;

v. It is a cheaper option and is commonly used in most electronic toll collection systems. It is also easier to implement as the sophisticated

Card Management System as required in the Active ERP system is not required. Hence, there will be many vendors who can install the system.

vi.The disadvantages of this system are:

- The driver is unaware of the balance of his prepaid account which resides at the backend office; a mechanism, such as an automatic paging or SMS system, should be in place to inform him of his balance and to alert him when the balance reaches a predefined "low balance";
- The driver is not aware whether the debiting is successful or not when he passes under a gantry. The characteristic "beep" sound is missing in such case.
- Intrusion of privacy can be an issue as the driver's travel record is kept in the back office;
- It needs an accurate and up-to-date database of the vehicle registration tied to the owners of vehicles
- Backend office work is heavy

4.3.3.1. Technologies that can be deployed:

4.3.3.2. DSRC:

-5.8 GHz (powered OBU);
- 5.8 GHz (non-powered OBU);
- Infra-Red

4.3.3.3. Most of the European Electronic Toll Collection systems are deploying the DSRC 5.8 GHz (non-powered OBU) technology based on the CEN TC 278 Standards. DSRC 5.8 GHz (powered OBU) is used in Japan currently. They are using these for electronic toll collection, not for ERP.

4.3.3.4. Radio Frequency Identification (RFID ISO 18000 6C) where the OBU is called a tag

- Powered tag,(with an internal power source)
- Non-powered tag (without an internal power source)

4.3.3.5. The RFID started for single lane barrier electronic toll collection (ETC) systems. When such a system identified a valid RFID tag, the toll barrier would be raised automatically. Advances in RFID technology now permit it to be used for barrier- free (free-flow) multi-lane ETC systems known as Open Toll Road (OTR) commonly in the US. Taiwan deploys RFID technology in their single lane free flow system (without barriers) and is having a trial for its multilane free flow application. Turkey is in the progress of deploying this technology for their ETC.

This technology is getting more popular mainly due to its cost advantage (low RFID tag cost and the subsequent operation and maintenance cost) and ease of installation as compared to the DSRC microwave or infrared OBU technology.

4.3.3.6. Automatic Number Plate Recognition System (ANPR) system

4.3.3.7. The method used in this system is simple: photographs of the license plates of all vehicles passing under the ERP gantry or of all vehicles moving around along the charged road or in the area are captured by cameras (or video footage) at selected locations and sent to the back office for further processing. Payment by drivers is either by monthly billing (post-paid) deduction from an account created with the ERP authority (pre-paid) at the back office or by an advance payment scheme (according to the route he wants to take or the areas he wants to enter) before the driver leaves his home. The driver can also be allowed to pay the ERP charge within a fixed period after he uses the controlled areas by SMS, internet etc.

4.3.3.8. What the system does daily is that it matches all the captured licence plate numbers and the licence plate numbers that pay. The exceptions are the violators. The system needs to have a massive backend operation.

4.3.3.9. London uses the ANPR system for the whole ERP operations within its congestion price area. Singapore uses ANPR only for enforcement of violating vehicles. (Payment of ERP charges in the Singapore system is by a non-powered OBU and pre-paid card).

4.3.3.10. Because of privacy concerns, the image of the rear license plate is normally captured. It is also necessary that the courts of law accept the captured license plates as evidence, if so required.

4.3.3.11. There are two common methods of triggering the camera to capture the photographs of the passing vehicles

i. By detector

a. detector wire loop embedded 25 mm below on the road surface – most common, cheap, but high maintenance cost as the wire loops get damaged often

b. motion or overhead ultrasonic detector – reasonable cost, but not so accurate

c. laser detectors – highest cost, but most accurate method

ii. By video

a. cheap – no need for any of the former devices and can capture the images at the same time with the same camera - not so accurate

b. The maximum speed of passing vehicles need be considered when designing any ANPR system. At the backend office, these photographs are read by an optical character system (OCR) to extract the license plate number (**Figure 14**). The standardization of vehicle number plates in terms of size, font, materials and colour will be an advantage to the OCR process. As expected, the ANPR read rate will be lower at night, unless strobe lighting is used to illuminate the number plates.

4.3.3.12. The ANPR/OCR process can be done at the front-end or at the backend (office)

Figure 14 - ANPR

4.3.3.13. For the front-end processing, ANPR license (i.e. payment for use) will be embedded in each camera, requiring better cameras and more licenses (1 per camera). Smaller bandwidth is required on the data lines to send the processed data (the number plate information) to the backend control centre. Please refer to **Figure 14**. For the backend processing, cheaper camera units could be used and only 1 or 2 licenses will be required (to be installed in the back-end). However, a higher bandwidth is required to transmit the whole image to the office. (Singapore uses this, but only images of violating vehicles are sent back to the office).

4.3.3.14. Advantage of this system is that it is cheap and easy to implement. However, there are also disadvantages:

- Difficulty to read the license plates and to extract the license plate numbers from the licence plates because of various reasons: blockage by other vehicles, shadows from the surrounding structure causing uneven lighting on the vehicle license plates, dirt, bad weather, night time. This can lead to higher unsuccessful read rates and heavy human intervention
- There is need a robust and reliable OCR system
- There is a need for a large number of cameras to be installed at the ERP entry points and at other vantage points.
- High maintenance cost of the many camera – which need to be cleaned regularly;
- Backend office work is heavy and operational costs can be high
- A complete and up-to-date computerised vehicle database is important

4.3.3.15. Sweden also implemented the congestion tax for Stockholm city centre in 2007 based on the ANPR technology. The congestion tax follows a cordon-based charging scheme. Charges apply per inbound and outbound trips.

4.3.3.16. For their system, cameras, laser detectors, antennas, and information signs are mounted on a set of gantries at each control point. A picture is taken of the vehicle's license plate and the information is then matched with the registered vehicle. Payment is done backend.

4.3.4. GNSS/CN (Global Navigational Satellite System/Cellular Network) systems

4.3.4.1. GNSS/CN is being used in Germany for commercial vehicle tolling across its highways but not for ERP yet, which is normally implemented in a city area where the high-rise buildings can cause deflection of the GNSS signals and result in high error rates. The location of the vehicle is tracked using GNSS receiver installed in the vehicle which transmits the location information to the control centre using Global System Mobile (GSM) or 3G networks for calculation of the charge. (**Figure 15**)

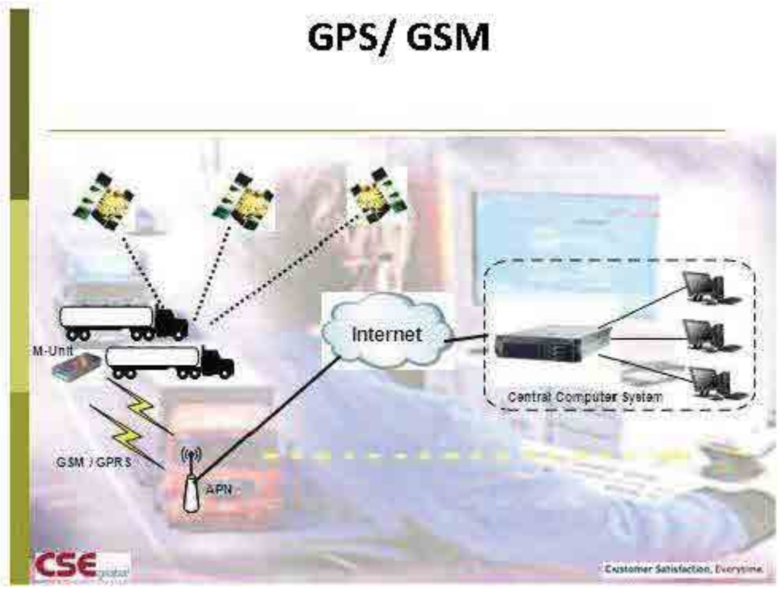


Figure 15: Global Navigation Satellite System (Source: CSE)

4.3.4.2. Such method eliminates the need of overhead ERP gantries across the roads. However, such system performance is subjected to a lot of factors such as the weather conditions, the surroundings (high rise buildings and dense trees), tunnels, shifting of GNSS satellites intentionally or unintentionally, etc. Without overhead gantries it will be difficult to mount enforcement cameras at all entry points to the charged area. Therefore enforcement of violations will be on a selective basis and this will become a great challenge. Intrusion of privacy is another growing issue of concern, as the vehicle will be tracked whenever the motorist moves his vehicles around.

4.4. Road infrastructure

4.4.1. ERP is unlike toll road systems. Hence, there are no toll booths and barriers. ERP is barrier free and allows multilane free flow. The usual infrastructure will be an overhead steel gantry at the control point on which are fixed the antenna/readers for DSRC and RFID. The overhead gantry indicates the charge point. The overhead gantry can also have the enforcement cameras mounted on them to take photographs of violating vehicles at close range. Both these systems will have outstations with a local controller at the overhead gantry location

If the road is narrow, the enforcement cameras can also be fixed on lamp posts, overhead bridges and buildings to cover all the lanes.

4.4.2. When videos and cameras are used for ANPR, they can also be fixed on the overhead gantry, lamp posts, overhead bridges and buildings. For ANPR, there are no outstations as such. The charge zone is indicated by normal signs.

4.4.3. GNSS tries to do away with the overhead gantry signs. Hence enforcement is selective and the cameras can be mounted on overhead bridges, lamp posts and buildings. There are no outstations as such. The charge zone is indicated by normal signs.

4.5. Telecommunications

4.5.1. Data transmission facilities for ERP are needed between the Control Centre and the various outstations (ERP Control Points/gantries)

4.5.2. The data transmission facility can be 3G or 3.5G (or any other latest radio technology) or fixed dedicated data lines, depending on the types and amounts of data to be sent back to the Control Centre or the commands transmitted from the Control Centre to the outstations. The data transmission facility should not affect the quality of data being transmitted. In the event of communication failure during the course of data transmission, the system should be able to re-establish the connection automatically and resend the data (stored within the local controller at the outstation, where they exist) within a reasonable time after the connection is recovered.

4.5.3. The operating frequencies of the system are subject to the approval of the local telecommunications authority.

4.6. Electric Power Supply

4.6.1. The ERP control centre, the outstations and all equipment need reliable electric power supply. Usually the control centre gets supply from two power feeds, one serving as a backup.

4.7. Comparisons

4.7.1. The comparison of different technologies can be found in **Table 13**.

Table 13 – Comparison of different technologies

Technologies	Microwave /Infra-Red On Board Unit (OBU)	Radio Frequency Identification Tag (RFID)	Automatic Vehicle Detection and Identification	Enforcement Camera System	Backend cost for cash settlement and enforcement
Direct Short Range Communications (DSRC)	High Price	-	Yes	Yes (close to 100% enforcement possible)	Low
Radio Frequency Identification (RFID)	-	Low Price	Yes	Yes (close to 100% enforcement possible)	High
Automatic Number Plate Recognition ANPR (Video)	No cost of OBU or tags for vehicles, since not needed		Identification of number plate only using cameras	Yes (totally reliant only on cameras for detection and enforcement))	Highest
GNNS	Highest Price	-	Yes	Yes (selective enforcement, not close to 100%)	Low

5. SCHEME FOR BENGALURU

5.1. RFID Tags

5.1.1. For Bengaluru, it is suggested to start with the simplest solution first, which is the proven passive RFID tag with a strong backend operations.

5.1.2. When drivers apply for these tags, they should be required to fill up particulars of licence plate and particulars of owners and driver. For those who opt for the tags, the database of records of particulars will be captured and updated. The licence plate number will be linked to the tag number. There will be a small deposit for the tag. They will be required to maintain a bank account from which the ERP charges will be deducted as they use it. The other option will be for them to open an account with the ERP Authority and make regular cash top-ups. The backend system will capture all details of all entry of vehicles with tags. Those who are in arrears of payment will be highlighted. One of the problems of systems with accounts is that there will be bad debts and there is a need for a system of recovering bad debts.

5.1.3. The system only recognises tags not vehicles and will not pick up vehicles with no tags. This requires enforcement cameras catching violators. There are two ways of capturing the rear licence plates of violators. One way is to capture photos of all vehicles and then to sieve out at the backend those which have valid tags and then send enforcement notices only to the others. The other way is to capture photographs of only vehicles which have no valid tags which needs more sophisticated enforcement camera systems.

5.1.4. Enforcement cameras can be at each ERP gantry which means close to 100% enforcement, which will be very expensive. A cheaper alternative is to enforce only at selected locations, which would mean reduced costs.

5.1.5. Some considerations for equipment specifications are :

a. Ease and simplicity of maintenance
b. Minimum moving parts
c. Long duration to Mean-Time-Before-Failure (MTBF)
d. Long duration before obsolescence

5.1.6. Completely relying on automatic enforcement at the start is not advisable. Not everything can be caught on camera. Since two wheelers and autorickshaws are charged less than the car, there may be the temptation to switch the RFID tags between vehicles. One way of minimising this problem is to colour code the RFID tag for different types of vehicles. On their regular patrols, the police could keep an eye on switched tags by observing the type of vehicle. The control centre could also do some manual checks selectively to compare the charges deducted from the deposit and check whether it conforms to the charges for that type of vehicle. The enforcement cameras expect standard number plates to be at a particular location on the vehicle for automatic number plate recognition. For Bengaluru, the standard number plate and the standard position have yet to be implemented. Also it is understood that not all owners transfer the ownership status when they sell their vehicles. Police at the gantry points could selectively stop vehicles which have no tags (and whose drivers hope they will not be identified by the camera system or who hope that the authority will not be able to trace them for sending out summonses) and get their particulars for checking with the control centre and sending out summonses. Two wheelers can drive through footpaths and small byways to circumvent the overhead gantry. Within the first few days, such loopholes will be known and the police could mount surprise checks at these locations.

5.1.7. Enforcement photos need to be sieved out by an ANPR system. Currently, the number plates are not standardised. Please refer to **Figure 16**. For recognition, it may be necessary so standardise the sizes and locations of number plates. We understand that there is a tender for this installation in progress. Also there is a need for a good computerised database tying the names of owners to vehicle registration plates. Currently, there is no mechanism to update the information because the motorists pay the one-off road tax when buying the vehicles and not annually as is done in other cities. Bengaluru should consider a regular method of updating the vehicle records for ease of enforcement. Hence at the start, some on-the-spot mobile enforcement may be needed before.

Figure 16: No-standardised number plates used in Bengaluru

5.2. Fines for violation

5.2.1. In Singapore, the violations are vehicles with no OBU, insufficient money in the smart card and no smart card in the OBU. A $70 fine is imposed for no OBU in the first offence. For insufficient in the smart card or no smart card in the OBU, a fine of $10 will be imposed.

5.2.2. For the case of Bengaluru, the amount of fine should follow the scheduled of fines used by Traffic Police.

5.3. RFID Business Model (Central Clearing House System) for Bengaluru

5.3.1. A Central Clearing House System is needed at the high level to distribute the revenue according to the business rule.

a) Provide RFID tag “Free” to car owners, the tag to be programmed with vehicle registration number and vehicle classification (necessary if different vehicles charged differently). One RFID to one vehicle (Non-transferable) and permanently fixed. “Free” with condition to give details of vehicle and owner and to set up a back end pre-paid account with the Authority with a predetermined amount.

b) Headlamp RFID strips for Motorcycle; windscreen RFID for all other vehicle

c) Vehicles that pass the gantry without valid tags shall be subject to be photographed (rear licence plate) with backend licence plate recognition capability and image with vehicle licence plate shall be taken as proof of passage.

d) Account shall be transferred to new owner if the vehicle’s ownership is transferred

e) Payment Model - Backend Pre-paid

- An ERP account is maintained by the motorist with the Authority
- Various Top-up channels to top-up ERP account

- Money is deducted at ERP points identified by RFID tag as the vehicle passes the point. This is called a transaction which is done at the backend.
- Money from the account shall be transferred the Authority once and RFID tag transaction has taken place. Notification shall be generated to motorist if the account fund falls low by automatic SMS or e-mail.
- If the motorist fails to top up and still uses the ERP, he is incurring a bad debt.
- Digital Image with the rear vehicle number plate is captured as evidence of passage for those vehicles with no RFID Tag.

f) Important Factors to Consider

- Encourage Good RFID take up rate.
- Provide "Free" to motorist, but ownership with Authority, so that tampering becomes an offence.
- Higher ERP charges for vehicle without RFID. Make it convenient for them to pay the charges by e-payment.
- Tie-up with new vehicle sales agent to install RFID upon new car registration.
- Strict and Effective Enforcement Action for non-payment case
- Heavy fine for fraud involving RFID tag tampering
- Fine for unpaid ERP charge

g) Convenience to Use

- Lots of installation centers for RFID installation
- Easy for car owner to use the system
- Easy and lots of ways to top up the account
- Reliability
- Good and accurate RFID read rate (> 99.9%)
- Good and accurate Licence Plate Recognition read rate (> 90%)
- Good and accurate Vehicle Classification rate (> 90%)

5.4. Legislation

5.4.1. Singapore Legislation 1998 (Electronic Road Pricing) as an example:-The Road Traffic (Electronic Road Pricing System) Rules. In 1998, the Electronic Road Pricing System came into operation. Each vehicle had to permanently install an on-board unit (OBU) The ERP entry point referred to a point on the road where an overhead gantry was installed to charge vehicles automatically. The Rules specified as follows:-

a) OBU

- No person shall during the restricted hours travel into the ERP entry point without an installed OBU)
- The Registrar (Land Transport Authority) shall keep a record of all serial numbers of all OBU's that have been installed.
- Only persons authorized by the Registrar shall manufacture, sell/supply, install/remove/replace or carry out maintenance on OBUs
- The Registrar may at his discretion allow the owner of a motor vehicle to transfer his OBU to a new vehicle if the old vehicle has been deregistered and the owner has the new vehicle of the same class as the old one.

b) Levying of road user charge

- A road user charge shall be paid each time a vehicle is ridden past a specified entry point
- The charge shall be paid by using an ERP card with an OBU and this charge shall be debited against the stored value in the ERP card
- The driver shall ensure that the ERP card has sufficient stored value of an amount that is sufficient to pay for any road user charge which may be incurred

c) Offences

- Unlawful entry is defined as:-
    - There is no OBU in vehicle
    - OBU has not been properly installed
    - OBU is defective
    - OBU has been taken unlawfully from another vehicle
    - OBU has been tampered with
    - No ERP card in OBU
    - ERP card inserted wrongly
    - ERP card has insufficient balance
    - ERP card is forged or defective

- For these offences, the Registrar may require the offender to pay a fine or administrative charges or be relieved from the fine if he so proves that any defectiveness resulted through no fault of his own.
- Any person riding into an entry point in a manner to evade the payment of the road user charge shall be guilty of an offence.

- Any person who does any act to interfere with the transmission of signals between the OBU and the ERP facility shall be guilty of an offence.
- Any person who hinders the view of any identification marks of any offending vehicle shall be guilty of an offence.

d) Types of OBU Units and installation. **Table 14** specifies the type of OBU and the method of installation

Table 14 – Rules for OBU and method of installation for different vehicles

Type	Vehicle	Manner of installation
1 and 1A	Motorcycle, scooter	Handle bar
2 and 2A	Motorcar, Light goods vehicle	Windscreen
3	Taxi	Windscreen
4	Heavy Goods vehicle, Small bus	Windscreen
5	Large bus, omnibus	Windscreen
6	Ambulance, fire engine, marked police vehicle	Windscreen

DULT has informed that Bengaluru's Road Traffic Act may have the relevant clauses to deal with the legal aspects and there might not be a need to change the legislation.

6. RECOMMENDATION FOR BENGALURU

6.1. Technology and Operation

6.1.1. The RFID tag is recommended at the On-Board Unit (OBU) for Bengaluru.

6.1.1.1. Assumptions:

a) Technology: Radio frequency identification tags issued to vehicles, with vehicle identification and detection by overhead gantries. Payment deducted from a deposit placed with authority. Enforcement by photos
b) For Bengaluru's CBD area, 19 to 20 control points and 100,000-150,000 tags are assumed

6.1.1.2. Tasks for operation

a) RFID Tag Management – Logistic Operation **(1 supervisor + 4 staff)**

- Order, receipt of RFID Tag from supplier
- Monitor stock level of RFID Tags
- Distribute RFID tags to various service counter (points of sales) for distribution
- Update vehicle –owner database of those who apply for RFID tags

b) External parties supporting authority for RFID Tag Management

- Tag Supplier
  - Manufacture and supply of RFID Tag upon order
- Warehouse & Distribution
  - Provide warehousing facility for storage of Tags received from Tag supplier
- Distributor at Point of Sales

  - Provide necessary distribution facility (point of sales) for Tag distribution to various installation points
    In Singapore 250 distributors, mainly mechanical workshops were designated as Point of Sales (POS) distributors to fit about 600,000 units over a period of 10 months. These locations were distributed all over the island. Drivers received notices offering them free units (valued at S$150) and rostering them to any workshop during a certain one month period. About 60,000 vehicles were rostered in one month. The fitting took about 20 minutes because the unit had to be permanently fitted connected to the vehicle battery. Land Transport Authority (LTA) paid the workshops the

fitting fee of $30. New vehicle all come fitted with the units, so there was no need to keep all the workshops open. The units come with a five year warranty and LTA has appointed a few workshops for drivers to repair defective units or replace them.

In Bengaluru, the RFID tag is much easier to fit and may take about 10 minutes to do so. The numbers of POS, locations, commission etc can be decided during the detailed design of the system. But a cue can be taken from the Singapore system of appointing a few reputable workshops located throughout Bengaluru for fitting the tags. Procedures have to be worked out for them to collect relevant information from the owner, collect the deposit and transfer the money and data to the authority. The workshops have to be around for a long time because new vehicles do not come fitted with the tags. There will also be a need to install new tags.

c) Customer Service for Tag distribution – Service Counters (**1 supervisor + 8 staff at the start and reducing to 4 staff when the rush to get Tags is over)**
- Tag registration/ programming and installation
- Handle Tag Account opening, replacement and termination.
- Provide Tag Account Top-up and Refund
- Settlement of Fines
- Perform Tag inspection for faults

d) External parties supporting customer service
- Call Centre
  - Provide Hotline phone service for any enquiry, complaints etc.
- Inspection Centre
  - Inspect Tag if suspected faulty, replace it with new Tag

e) Payment Management – Settlement & Clearing (1 supervisor + 2 staff)

- Ensure payment and top up are settled
- Perform daily transaction reconciliation
- Check and verify blacklist for non-payment account with insufficient fund in account
- Ensure fine payment is properly processed

f) External parties supporting Top up
- Account Top-up Agent
- Provide the necessary tag account top-up facility
- Provide the facility for fine settlement (if any)

g) Monitoring and Control Operation Team (**1 supervisor + 8 staff for two shifts**)
- Monitor the operation status of all equipment
- Ensure all roadside equipment has the latest blacklist
- Ensure all equipment are properly time synchronised
- Control the operation status of all equipment
- Activate the maintenance team for any fault reported
- Monitor the performance of the maintenance team

h) External parties supporting frontend and backend system
- Frontend Systems and Backend Maintenance Contractor
- Provide corrective maintenance
- Provide routine preventive maintenance

i) Enforcement – Image processing, investigations **(1 supervisor + 6 staff**)
- Manual verification of violation images that cannot be processed automatically by system
- Investigation of complaints of fines or payment received from call centre
- Take enforcement action on owner of vehicle with long overdue outstanding payment

j) External parties supporting Enforcement
- Law Enforcement Agency [External]

- Typically this is traffic police authority or others that have the necessary enforcement powers to deal with motorists with outstanding payment, no Tags etc.

6.1.1.3. Maintenance

- The RFID tags should be specified with a 5 year warranty. If the tag fails before that, the driver should be entitled to a one-for-one replacement.
- With the main contract for the installation of the congestion pricing system (RFID-based), there will be a one year defects liability period within which the contractor maintains the infrastructure and systems free of charge. It is preferable at the calling of the main contract to get the successful contractor to also quote his price for annual maintenance for a period of 2 years, after which renewal is subject to the decision of the authority.

- The specifications for the maintenance contract should specify For any structures
  a. Structural Principal Inspections by a Professional Engineer (once every 4 years)
  b. Yearly Maintenance Inspections
  c. Painting of steel structures (, dependant on climate & location)
  d. Washing of the steel structures (about 2X per year,)

- For the equipment at the gantry locations and central systems
  a. Quarterly Preventive Maintenance all equipment (system checks, calibration, equipment cleaning)
  b. Replacement of consumable parts (as per manufacturer's recommendation)
  c. Replacement of equipment parts (as per manufacturer's recommendation)
  d. Full equipment end-of-life replacement (once every 10 years, serviceable lifespan of equipment)

- In addition there should be a standby crew to attend to faults at the equipment of the overhead gantries and the central control centre. This standby crew could be at the control centre or at the contactor's premises. The response time (1 or 2 hours depending on traffic conditions) for the contractor to reach the location should be specified.

6.2. How motorist will react

6.2.1. Congestion pricing in the restricted area offers motorists many choices

a) Pay the charge and enjoy fair traffic conditions

b) Change time period of travel to pay less (if charges are changed for different time periods) or pay nothing

c) Change the route (especially if they are not going to the area) and pay nothing

d) Change destination

e) Change mode of travel (i.e. public transport)

f) Group trips so as to avoid paying for each trip

g) Abandon trip

6.2.2. Congestion pricing on a single road (line charging scheme) offers the following choices

a) Pay the charge and enjoy fair traffic conditions

b) Change time of travel to pay less/nothing

c) Use a parallel road to pay nothing

d) Change destination to avoid the route

e) Change mode of travel (i.e. public transport)

f) Abandon trip

6.2.3. Authorities' responsibility – no charging/ shoulder charging. In both instances, for alternative (b), there will be periods of the day when there will be no charges and motorists can enter free. But when periods of congestion pricing increases as it is bound to happen when traffic congestion spreads to times other than the peak periods, this window of opportunity for motorists to enter free of charge diminishes. In the beginning, there it is proposed to have a flat charge for the four half-hours of restrictions (total 2 hrs), but it is possible to have a slightly lower charge for the first half-hour and the last half-hour. This is called shoulder charging.

6.2.4. For this, it is possible to have shoulder charging so that charges change throughout the restricted period. There will be peak periods with high charges and shoulder periods (periods adjacent to peak periods) with low charges or no charge. With electronic road pricing systems, such variations in charging are possible.

6.2.5. Authorities' responsibility – bypass routes. For alternative (c) for an area will be used by those motorists who currently use the roads within the charged area to go from one place to another without having any business in the area itself. Such motorists are unlikely to pay a charge just to go through the roads within the charged area. They will need some fair alternatives. These alternatives may not be as convenient as going through the charged area and probably require a longer travel time. Hence, it is necessary to identify a route that skirts around the area, which those motorists wishing to bypass, can use. This road has to have sufficient capacity to cater for such vehicles. If such a direct road does not exist, motorists should be given information on a few alternative roads which could use to avoid the charged area in the publicity.

6.2.6. Alternative (c) for a road (line charging scheme) will be used by motorists who use that road but now want to avoid paying. The parallel and the most direct road, though not as convenient is what they would use. Hence it is necessary to identify a fairly good alternative route and inform the motorists of its existence.

6.2.7. As many measures should be taken to increase the traffic carrying capacity of these alternative roads in both cases by road widening, traffic management and banning parking and restricting roadside activities which hinder traffic flow. It must be stressed that while congestion pricing may improve traffic flow in the area or a road, congestion will transfer to outside the area or to another route .What is being done is only to ensure that this congestion on the alternative roads is for shorter duration and of less intensity than what the charged area or the charged route will experience.

6.2.8. Authorities' responsibility – adequate public transport. Alternative (e) which is change the mode of travel to public transport is a much desired option. Public transport should be improved and rerouted, including recommending bus priority schemes.

6.2.9. The capacity of the public transport system to serve the charged area is a critical factor. It is essential that those who divert to public transport as a result of congestion pricing find places in the buses/metro to get to their destination. Immediate action is needed to increase the capacity of public transport.

6.2.10. With the adoption of a line charging scheme, traffic on the charged road will be lighter because of the charging and hence buses will find it easier to travel. However, it must be stressed that not many will transfer to public transport by the charging of a single road as opposed to charging for an area. Nevertheless, the opportunity should be taken to increase the capacity of public transport on the route; even proposals such as providing bus lanes and premium buses to attract motorists to use public transport.

6.2.11. Motorists changing destinations

6.2.12. Some motorists may change destinations and this gives rise to the fear that many firms and offices will relocate to outside the charged area to be free of the restrictions. With the line charging scheme, this fear may not be there.

6.3. How effective is ERP?

6.3.1. Generally with ERP, traffic flow is more evenly spread over the hours hence avoiding sharp peaks. The average speeds can be kept at reasonable levels with the correct ERP charge. Motorists will be more aware of the cost of congestion and avoid multiple trips, non-essential trips or by-pass trips into the charged area or the single-charged road; and this will result in reduction in traffic volumes and hence less congestion.

6.3.2. ERP is not the answer to all traffic problems. Singapore experience shows that traffic congestion can migrate to non-charged roads or to non-charged periods. There will be a pre-ERP and post ERP rush by motorists who want to avoid paying and this will have to be managed. Motorists may speed just before ERP starts and loiter and wait along approach roads for ERP to end. If there are no viable alternatives for motorists, they will be forced to pay the charges to use the area or roads and this will cause unhappiness. It is inevitable that the less-well off motorists will be more affected that the affluent ones.

6.3.3. There is also the risk of technology -whether motorists will be charged accurately or whether they will be able to defraud the system.

6.4. Steps for implementation of congestion pricing (see **Appendix F** for the flowchart)

6.4.1. As explained before, the most effective congestion pricing occurs when it is implemented in an area, especially the central business district.

6.4.2. These recommended lengthy steps are for successful congestion pricing implementation in an area. In the long term, Bengaluru may have to consider area pricing to manage traffic congestion.

6.4.3. Set up a High-level Steering Committee to oversee all activities.

6.4.3.1. This is very important because there should be a clear intention at the highest level to proceed with congestion pricing. Ultimately, the decision to implement congestion pricing will be a political one, not a technical one.

6.4.3.2. This Committee has to bear in mind the following:-

i. Accessibility and mobility are to be maintained to protect economic viability.

ii. The mobility of the private vehicle is a benefit and restrictions on their uses are to apply only when and where they are needed to combat congestion.

iii. The scheme should be easily administered.

iv. Efficient, reliable and attractive alternatives are to be provided for those who may be discouraged from driving into the charged area or road

6.4.3.3. There are many different parties that have an interest on the traffic situation in Bengaluru, these being the DULT, Traffic Police and the

Bengaluru Development Authority. It is suggested that the Steering Committee be drawn from very senior officials of these organisations, headed by DULT, The early formation of this committee representing various viewpoints is important.

6.4.3.4. Steering Committee will appoint committees for the following roles

a) Work on required legislation for congestion pricing. Enacting legislation is a lengthy process. Hence, it is necessary to embark on this vital activity very early in the process of decision making. For a pilot scheme, there may be other ways to carry out the trials without full legislation.

b) Set up a technical committee to work on technical requirements and implementation, in the overall context of the JICA Study Team ITS Master Plan being developed for Bengaluru.

c) Set up an institutional arrangement of an implementing group and an operational group. It should be noted that the number of staff required to operate the congestion pricing system depends on the technology chosen; hence this decision on the number of staff required can only be made after the award of the contract for implementation.

6.4.4. Any congestion charging system will require planning, building, operating and enforcing. It is unlikely that there will be one authority with jurisdictions over all these issues. One possibility is to create a new one and the other is to use the existing setup of authorities to implement the system. In the latter case, there is a need for a lot of coordination. For a new implementing authority, it is best that staff be drawn from the technical committee members. Competitive tenders have to be invited and the successful tenderers asked to train operators and build an operational centre.

6.4.5. Set up a special fund to receive revenue from congestion pricing and dedicate it to build infrastructure for roads/intelligent transport system/public transport (ring-fencing). (London and Stockholm both ring fence the revenues, while Singapore does not)

6.4.6. The Namma metro is a welcome alternative, though it might take some time for it to achieve its full potential.

6.4.7. Bengaluru operates buses, air-conditioned buses and a Namma metro system which are assets that the city can count on. They are the best alternatives for motorists affected by congestion pricing. The bus services are still below par as far as motorists are concerned. They need to be improved in comfort, reliability and numbers. If it is seen that efforts are being made to improve public transport and to divert part of revenues from congestion pricing for its improvement, there will be credibility that congestion pricing is not meant to raise revenue for government. Start a dialogue with bus companies and Namma Metro to further improve types of services– air-conditioned, express, limited stops services, new services to complement congestion pricing.

6.4.8. Start dialogue with all interested parties and the public. The interested parties will include motorists' organisations, motor traders' organisations chambers of commerce, trade unions, grassroots organisations, public transport companies and academia. The success of any controversial scheme requires its general acceptance from the users.

6.4.9. There is an Indian Union government directive to consider and implement congestion pricing in major cities, but MSI feels that the message has not been propagated very much to the masses. The Indian motorist may be accustomed to paying toll for new roads quite willingly, which the National Highway Authority (NHAI) has introduced for the golden quadrilateral road projects. Even then, toll collections have stopped on major highways such as Gurgaon to Delhi. So even toll system may have short lives. Therefore, to ask motorists to pay for use of roads that have been in existence for a long time in Bengaluru for free, will invite adverse comments which need to be managed.

6.4.10. To bring congestion pricing into the public's mind, it is necessary to start talking about the possibility publicly, especially when political leaders declare open new roads, traffic management or metro projects. Some high profile visits by politicians and Steering Committee members to cities with congestion pricing with a lot of media publicity will also help to imprint congestion pricing into the minds of the Indian public.

6.4.11. In Singapore in 1975 (prior to congestion pricing), there was general agreement that the traffic situation was bad and something needed to be done. There was little disagreement on the need to impose some type of travel demand management or car usage restraint, but only on the type of restraint measures to be taken. Issues that were raised by the Singapore public on the Congestion Pricing system are shown in the **Appendix G**.

6.4.12. It is likely that Bengaluru authorities will get adverse feedback. All feedback has to be carefully considered and dealt with in a satisfactory manner. For this, the assistance of a public relations firm is recommended.

6.4.13. Appoint a Public Relations Firm (unless the authorities have a strong PR department) to start work on proposing why it is necessary to introduce congestion pricing for Bengaluru and why a pilot scheme is being tried out first

6.4.14. Congestion pricing has been “sold” as part a “Big Picture” of a total package that also included transport planning, road building, traffic management (including intelligent transport systems nowadays), continual improvement and upgrading of public transport. Assurances are also given that the government will not depend solely on congestion pricing for solving traffic problems.

6.4.15. Some of the concerns of motorists (especially so if on-board units (OBU) are proposed in Bengaluru) which have to be managed:

i. Will the driver be considered as a violator if there is a system failure?
ii.Are the electronic radiations transmitted by OBUs to human health?
iii. What would happen if his OBU is stolen or vandalized (especially for motorcycles)?
iv.Will his movements be tracked?

6.4.16. However, much as the scheme is explained, it will only be accepted reluctantly and the issues of “perceived” unfairness by those affected will surface from time to time. This is the Singapore experience even after 40 years of operation. Each time a change is made to the scheme, which will be necessary, the debate on the “need” for congestion pricing will surface.

6.4.17. In Singapore, the main grouse of affected motorists is that they are not given sufficient alternatives acceptable to them. In a sense they are right. Nothing can compare with the freedom to use their own car/motorcycle to go to any place they want to. The authorities can never hope to provide an equally convenient alternative, but the motorist should be made aware that alternatives are always being sought after and provided (although not to the level he expects)

6.4.18. Keep a close scrutiny of the progress on alternative infrastructural measures that are planned/or considered, needed to be implemented for those motorists affected by congestion pricing (ring roads, parallel road, traffic management, intelligent transportation systems). This oversight ensures that the total “package” concept is strictly followed.

6.4.19. Obtain budget for the electronic congestion pricing scheme.

6.4.20. The technical committee will work out details of the proposed congestion pricing (area or route, type of vehicles, times of operations, congestion charge, technology, compatibility of OBU with other ITS projects etc.) and draw up a budget for its implementation. This should not be done in isolation but in the context of the ITS Master Plan for Bengaluru. The Steering Committee will have to scrutinize the budget proposals and send to the relevant authorities to obtain the funds for the implementation and subsequent operations.

6.4.21. Instruct the technical committee to come up with a regular monitoring regimen of the congestion pricing.

6.4.21.1. If congestion pricing is implemented, a target should be set beforehand on what is considered to be a success. In Singapore, the initial target was to get the peak hour traffic volume down to the level of the off-peak hour volume. The off-peak hour volume was 33% lower and that was the initial target, although it was an even higher drop when first implemented in 1975. Of course, over the years, traffic volume has crept up to a reduction of 16% over a period of 15 years. The amount of reduction is dependent on the initial amount charged. This would mean that the authority should be prepared to adjust the rates if deemed necessary. Therefore, close monitoring and regular dialogue with the public is important. MSI suggests a conservative reduction in traffic of 20% of vehicles (slightly higher than the 16% reduction assumed in analysis) entering the CA. This can be achieved through a trial and error method of tweaking the charges. The road users should also be informed of this 20% reduction target and that the charges will be set to achieve this result. In case a greater reduction is achieved, it may be advisable to reduce the charge so as not to give the impression that the congestion pricing scheme is not a revenue generating measure.

6.4.21.2. The evaluation items on the success of congestion pricing in the area should refer back to the objective and hence monitoring will consist of

a. Total inbound counts (should have a reduction)
b. Average speeds in the area (should go up from Level of Service F)
c. Mode share of public transport (should go up)
d. Traffic conditions on peripheral roads (will deteriorate, but to ensure only so for short periods of time, and not over the two hours of restriction- somehow traffic finds its own level)
e. (Optional) Accident reduction
f. (Optional) Air Pollution severity index reduction

6.4.21.3. As for the scheme for an area (in the future) if implemented, it is inevitable that traffic volumes will creep up over the years as vehicle population grows. Increases in the area and charges may become necessary for congestion pricing to remain effective. Increases in charges are warranted with the declining value of money and if there is a gradual creep in the inbound traffic into the charged area. In Singapore, it took about 14 years for major changes. It is unlikely that any city will have two separate areas for congestion pricing - what will happen will be the enlargement of the charged area. This is required when areas that are mainly residential adjacent to the charged area change their land use character to commercial and attract traffic. In Singapore, it took place twice over a period of 40 years- so it will not be a frequent event unless the city area develops fast.

The speed-flow curve as described in Section 3.2.4 can be used after measuring the average speeds in the new area to decide whether it is in LOS F. If so, the boundary has to be redrawn to include the area. Then the relevant steps mentioned in Section 3.4 have to be applied to bring in the new area.

6.4.21.4. In Singapore, monitoring is done at 3 monthly intervals. This is used to adjust congestion pricing rates. For Bengaluru, monitoring could be done at 6 monthly intervals, but changes in rates should only be considered after the Authority has some years of experience with operating ERP.

7. FINANCING

7.1. Financed by Government

7.1.1. It is assumed that the system will be financed by the Union, state or municipal government. The revenue will therefore go to the financing body. If the revenue is hypothecated for transport purposes (including building/improvement of roads, intelligent transport systems, improvement of buses/metro), then there will be less resistance from motorists who pay.

7.2. Public Private Partnership (PPP)

7.2.1. Traditionally, the public sector (government) engages the private sector merely to construct facilities or systems. The public agencies own and operate the systems or engage separate maintenance and operations companies to do so.

7.2.2. Public Private Partnership (PPP) is a long-term partnering relationship between the public and private sectors to deliver services. Through PPP, the public sector seeks to bring together the expertise and resources of the public and private sectors. The private sector is less rigid and has greater flexibility to innovate during the course of the contract.

7.2.3. With PPP, the government will focus on acquiring services at the most cost-effective basis, rather than directly owning and operating assets.

7.2.4. There are many possible PPP models, including joint-ventures, strategic partnerships to make better uses of government assets, Design-Build-Operate and Design-Build-Finance-Operate.

7.2.5. **Table 15** shows the Advantages and Disadvantages of PPP.

Table 15: Advantages and Disadvantages of PPP

Advantages	Disadvantages
Investment decisions based on long term view rather than short term concerns	Inflexible, long term contracts Debt is incurred long before the benefits appear because of the long term nature of PPP projects
More certainty of project timings and costs leading to better value for money. Where PPPs are not completed to budget, costs are usually borne by private sector	Costly and Lengthy Procurement Process Involvement of a number of parties and the long term nature of their relationships may result in complicated contracts and complex negotiations, and therefore high transaction and legal costs. PPP projects can take years to complete
Borrowing/Financing of the projects is incurred by the private sector	Sometimes the government can borrow at cheaper rates than it could via the private sector
PPP projects are seldom subject to political interference	Service discontinuity if private provider fails Potential risk of the private sector party becoming solvent or making large profits during the course of the project resulting in political problems for the government
Cost efficiency is achieved through lifecycle optimisation. Combination of design, build, maintain and operation function in the same contract with the provider will give a strong incentive for the provider to ensure the project design take into consideration operational and lifecycle costs.	
Potential innovation and better efficiency through cross-transfer of public and private sector skills, knowledge and expertise. Incentives and efficiency are also created because payments to the private sector in PPP projects are usually linked to how they perform	

7.3. Use of PPP

7.3.1. Many toll road projects use the Build Operate Transfer (BOT) model. The private sector builds the roads, operates it for a fixed number of years, collects the road toll approved by government and hands it over to government at the end of the fixed number of years. Motorists accept it because they get a new road, well operated by the private sector.

PPP is an option for area charging scheme. In this case, the motorists are not getting any new facility, they are now being asked to pay for the use of an existing facility. The opposition that is bound to be generated (by any congestion pricing scheme) is better handled by government as otherwise it may be seen that the government is letting the private sector make a "profit" from existing roads. The objectives of the private sector and the government for congestion pricing are different. By this scheme, the government wants to cut down road usage; which is probably not what the private sector wants. In toll road, the incentive is the toll collection, so in this case, the government needs to provide additional incentives other than the ERP collection.

Appendix H evaluates three models for implementing and operating the congestion pricing system. Option 1 is totally by government and Option 3 totally by a private partner. Option 2 is a combination of government with operations being contracted out, Option 2 is the system used in Singapore and London. It is also recommended for Bengaluru.

7.3.2. Recommendation on the incentives to be given to motorists.

7.3.3. In Singapore, as a "sweetener", the annual road taxes that the motorists pay was reduced when the ERP was introduced in 1998. The advice was that the motorist could decide either to keep the savings or use it to pay for congestion charges when he uses the ERP system.

7.3.4. Bengaluru can investigate alternatives for "sweeteners", if it is possible.

7.4. Cost-Benefit Analysis of congestion pricing systems

7.4.1. There are a large number of studies concerning calculated effects of proposed congestion pricing systems. Most proposed systems have never been realised, so there are a significantly larger number of model-based studies than studies of existing systems such as Singapore, London and Stockholm (which were used for the Bengaluru study). Therefore these studies are to be more relied upon than the model-based studies.

7.4.2. Singapore's system was required by its transport strategy of having travel demand management. Transport planning models were not used to justify because no one had experience with congestion pricing. Hence, the cost benefit analysis was done only after implementation

7.4.3. Based on the Singapore experience, the capital cost for the area charging for the central business district was recovered within 2.5 years (payback period). This was based purely on financial costs – cost of implementation (S$197 million) and operations/maintenance (S$16 million per annum) against revenue (S$90 million per annum) from the system. Singapore's system costing S$197 million was expensive because it was sophisticated and also the on-board units were given free of charge to the existing vehicle fleet in 1998.

7.4.4. Singapore was using sophisticated direct short range radio communications and an in-vehicle unit with a cashcard to deduct the congestion charge as the vehicle went under the overhead gantry at the control point and to take enforcement photos of the number plates of violators. Hence the backend costs for the control centre to process payments was low, but the capital costs were high

In-vehicle units (about 650,000) given free	= S$92 million
35 Overhead gantries at control points (structures, radio antennae, optical sensors, Enforcement cameras)	= S$70 million
Central control (control room, computers, modems, operation and application software)	= S$35 million
Total	**= S$197 million**

Annual Revenue for the central business district = S$90 million

Annual Operation and maintenance cost = S$16 million

Hence financial payback period is about 2.5 years

7.4.5. No attempt was made to do this payback period on an economic basis. To do this on an economic basis will also require the monetary value of benefits from savings in travel time of road users, from reduced cost of accidents, from reduced costs on air pollution and additional costs because of congestion on the peripheral roads. The savings in travel time will be at the core of the analysis on economic benefits and it is not easily and accurately available from transport modelling.

7.4.6. From the "Lessons learned from International Experience in Congestion Pricing" published by the US Federal Highway Administration (FHWA) in 2008, the following is a summary:

Without exception, area wide pricing strategies that have been implemented abroad have met their principal objective of reducing congestion and sustaining the relief of congestion over long periods. Area wide pricing in Singapore, London and Stockholm resulted in 10 to 30 percent or greater reduction in traffic in the priced zone and has sustained the reductions over time. Pricing has encouraged travellers to change their behaviour by changing modes of travel, times, routes, or trip frequency.

Singapore's Area Licensing Scheme (Manual Road Pricing System) 1975 program is estimated to have achieved a rate of return on investment of at least, 15%, even without inclusion of realised savings other than the value of time savings and without the exclusion of the costs of expensive and poorly utilized park-and-ride facilities. Some believe that the returns would have been higher also if the price had been somewhat lower. The economic returns also would have been much greater had variable instead of flat pricing had been used.*

London scheme is estimated by Transport for London to have generated a benefit/cost (B/C) ratio of 1.4. Again, it is believed that a different charge and/or variable prices tied more closely to congestion levels likely would have achieved higher B/C ratio.

* Singapore is now using variable pricing which could be changed at half-hour intervals.

7.4.7. According to the September 2009 article “Traffic Congestion Pricing Methods and Technologies” by André de PALMA and Robin LINDSEY (ECOLE POLYTECHNIQUE CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE):

The London Congestion Charge has been closely monitored since it was introduced in 2003.The fifth annual report (Transport for London, 2007) estimated the gross annual benefits of the original scheme at £200 million ($326 million) and the total costs at £88 million ($143 million), resulting in a net benefit of £112 million ($183 million) and a benefit-cost ratio of 2.27. Stockholm’s congestion charge began as a seven-month Trial in 2007 and, after a successful referendum became permanent in 2007. Based on results of the trial, Eliasson (2009) estimated the annual benefits net of operating costs to be about SEK 650 million/year ($92 million) and investment and start-up cost of about 1.9 billion SEK ($268 million) yielding a social surplus payback time of only four years.

7.4.8. Therefore based on 3 existing projects, the payback period for any scheme is between 2.5 to 4 years. Bengaluru can also expect similar range of payback period if the charges are reasonably set.

7.4.9. Trial of congestion pricing before actual implementation

7.4.9.1. Singapore’s trials have been discussed in **Appendix A.** That is one way of doing the trial.

7.4.9.2. A cheaper way will be to get prospective tenderers to choose a section of road and demonstrate that

a) RFID tags work in a multilane barrier-free environment
b) RFID tags can be fixed for the type of vehicles on Indian roads
c) enforcement cameras are able to capture the photos of the rear licence plates of various types of vehicles found on Indian roads
d) the communications between the overhead gantry and the RFID tag is accurate

e) the backend operational procedures can be set up from this small system

8. CONTINGENCY PLANS IN THE EVENT OF FAILURE OF SYSTEM

8.1. Possibilities

8.1.1. The possibilities are

a) ERP technology does not work.

b) Insufficient enforcement leads to motorists violating often – This requires a good database of vehicles registered in Bengaluru. Without such a database, it is difficult to send the violation notices to the correct person. Until such a database is available, some random on the spot enforcement by police will be useful to check whether the vehicles travelling in the restricted road or area have OBUs.

c) Collusion between operator and motorists – this may result in deletion of entry records for certain vehicles at the control centre so that the drivers do not need to pay. This can be minimised by screening potential employees, regular rotation of staff in the control centre and by surprise audits.

d) Civil disobedience/ vandalism – The motorists in large numbers protest by driving in without OBUs or by masking them, resulting in overwhelming the backend processes. They may also vandalise the roadside equipment. If ERP has been implemented after proper consultation with the motorists and after a good public relations exercise, then there is less likelihood of this happening.

9. CONCLUSION

The objective of this study is to look at the feasibility of congestion pricing in Bengaluru. After reviewing the transport planning policies, seeking DULT's expertise on the local traffic situation as well as analyzing local traffic data as furnished by DULT and JICA Study

Team, MSI's conclusion and recommendation is that it is possible to implement an area congestion pricing scheme in the Central Business District in the medium term. The CBD charging boundary which encloses an area of 2 sq km is chosen after considering the various types of land uses in the area, availability of good public transport and existence of alternative routes for those affected by congestion pricing. For congestion pricing, recommendations are made on the trigger point, the charges, the technology and operational details required to be employed.

Based on the speed-flow curves for roads in Chennai (which is assumed to be similar to Bengaluru), the trigger point for congestion pricing is below 24km/hr and it is observed that the average speed of roads in the CBD fall below this speed. For a start, it is recommended to impose congestion pricing only during the morning peak hours which is likely to result in a 16% reduction in traffic flow into the CBD, based on Singapore's experience. An entry charging system using a Radio Frequency Identification (RFID) tag for identification and an Automatic Number Plate Recognition (ANPR) system for enforcement, with strong backend operations, is recommended.

After discussing with DULT and JICA Study Team, MSI proposes a charge of Rs150 for cars, which is twice the current fare on an air-conditioned bus and twice the price of 1 litre of petrol. The passenger car equivalents will be used for other vehicles except public buses and emergency vehicles which will not be charged. Based on the experience of Singapore and other countries, the financial payback period was between 2.5 to 4 years. For Bengaluru, this may depend upon various factors which influence the implementation and operation of congestion pricing.

A lead time of at least 12 months will be required to work out the implementation details. MSI proposes that a high level steering committee be set up to oversee all activities. These include finalizing the congestion pricing scheme, setting up an operations team, securing funds for the project, public relations and ensuring appropriate legislative measures.

Of great importance is the public relations programme which should start as soon as a decision is made to proceed. A small trial of the system could be tried out to check reliability and applicability of RFID technology to Indian traffic conditions and to fine tune operational procedures before the whole scheme is rolled out.

In the long term, taking into consideration the land use and development of Bengaluru City, DULT can look at modifying the charged area and introduce other types of charging, tweaking the charges and considering additional fiscal travel demand management measures (e.g. increased carpark charges, higher vehicle ownership costs and higher petrol/diesel costs).

Appendix A

Trials for congestion pricing to test technology and operational procedures (Singapore)

1 Technology

In 1990, when Singapore considered electronic road pricing systems, there was no such technology. Technology was available for electronic toll collection, which could not operate in a multilane road and without barriers. There was a need for the prospective tenderers to tailor-make a system to Singapore’s requirements and to show that it performs to the required reliability, before considering the award of the tenders. If Singapore had just asked them to show a working system, they would just have demonstrated the electronic toll collection systems that most of them were already marketing, but which did not meet the requirements for free flow multi-lane charging.

The first step was to invite technical and cost proposals from pre-qualified tenderers for the ERP system based on functional specifications. There were 5 tenderers. Each tenderer was offered a sum of S$1.5 million to tailor-make a mini-system consisting of one ERP working gantry point and a simulated central control system. Three of them who accepted the offer were each allotted a test site and asked to arrange test run with vehicles fitted with their proposed vehicle on-board unit and using the smartcards for cash deduction for a period of 6 months. The results of the reliability figures from the demonstration tests were taken into consideration in the final evaluation of the three tenders.

By being thorough and insisting on a tailor-made system to suit local conditions, Singapore got a better deal from the tenderers. It helped to gauge that it was possible to have a system to meet the requirements and specifications. It was also fair to the tenderer as he was able to gauge his ability to meet the specifications. It gave him a chance to fine-tune his design requirements for the system, even prior to getting the contract.

Based on the technical proposals, the cost and reliability figures of the demonstration, a successful contractor was chosen for the project. The whole tendering exercise took a period of 2 years, whereas a normal process of tendering for major projects would not have taken more than a year.

2 Operations

An important event was the test drive that was initiated three months prior to ERP from June - August 1998. By this time, most of the vehicles had their onboard units (In vehicle unit IU) fitted and the smartcards (Cash cards) were readily available. Most of the ERP overhead gantry points were switched on with zero charging for the period 0700-1900 hrs. Motorists were advised to check their IUs and the Cash cards by driving under any ERP gantry that was in the test mode. By doing this they became familiar with the system.

The data coming from the ERP gantries tested the reliability of the system to deduct “money”, catch “violators” and required messages. The operational procedures at the control centre were fine-tuned over the 3 months with this data, without affecting the motorists in anyway.

Appendix B

Speed-Flow Curve

Speed – Flow – Density Relationships

- A mathematical relationship between the primary elements of a traffic stream in a single lane/or single direction:
  - Flow – The traffic volume moving
  - Traffic Density – The number vehicles per unit of length
  - Speed – The velocity that vehicles are traveling at
- Because density is a variable, traffic is compressible

Relationships (refers to per lane/ or one direction)

$$q = u \times k$$

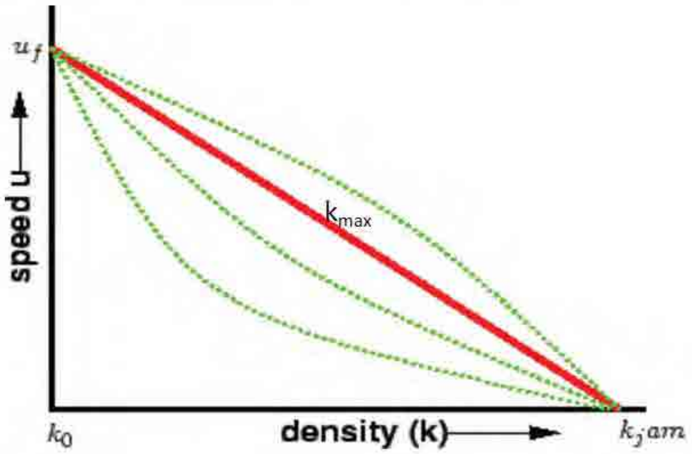
q = traffic flow (veh/hr)

k = density (veh/km)

u = speed (km/hr)

Fundamental diagrams

- Speed-density (u k) curve



Fundamental diagrams: speed-density - only this is measurable on the road

- Speed-density (u k) curve
  - Maximum speed is free flow speed u_f
  - Zero flow density is jam density k_j
  - At zero density, speed is free flow speed
  - At jam density, speed becomes zero
  - Most simple assumption is a linear relationship for speed-density ($u = u_f - a k_j$ where a is a constant)
  - Non-linear relationships area also possible
  - At around mid-point at k_{max} ,traffic flow breaks down into stop-go conditions

Derived curve

- The speed-flow curve is derived from the formula

  $q = u \times k$

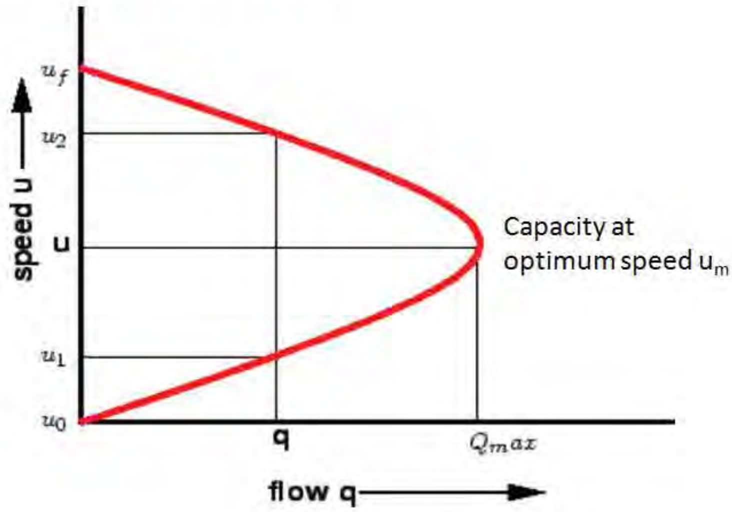
If we assume speed-density relationship is a line

$u = u_f - a\,k_j$ where a is a constant

The $q = u\,(u_f - a\,k_j)$ giving a parabolic curve

Fundamental diagrams (parabola)

- Speed-flow (u q) curve



Fundamental diagrams

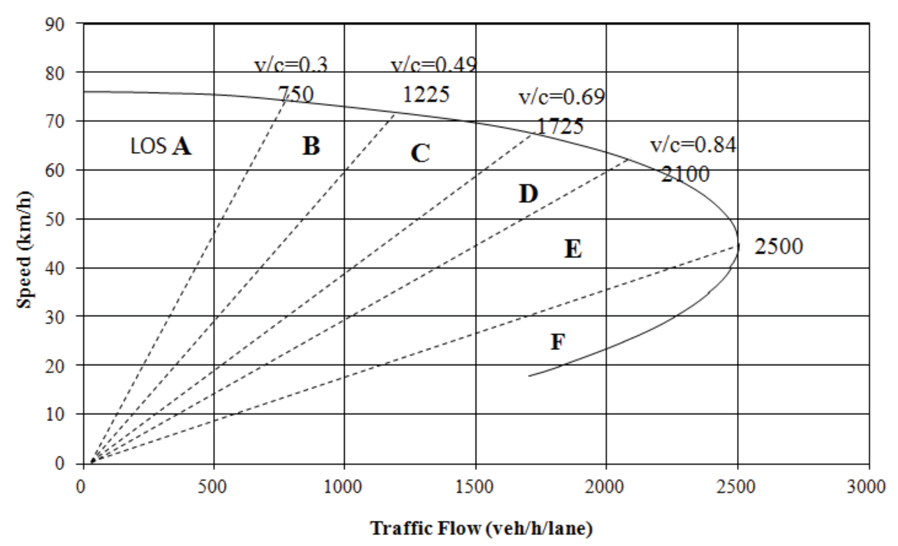
- Speed-flow (u q) curve
  - Flow is zero either because there is no vehicle or there are too many vehicles so that they cannot move
  - At maximum flow q_{max} (also called capacity) , the speed will be in between zero and free flow speed. It is the optimum speed u_m after which the traffic flow breaks down into stop-go conditions

Level Of Service

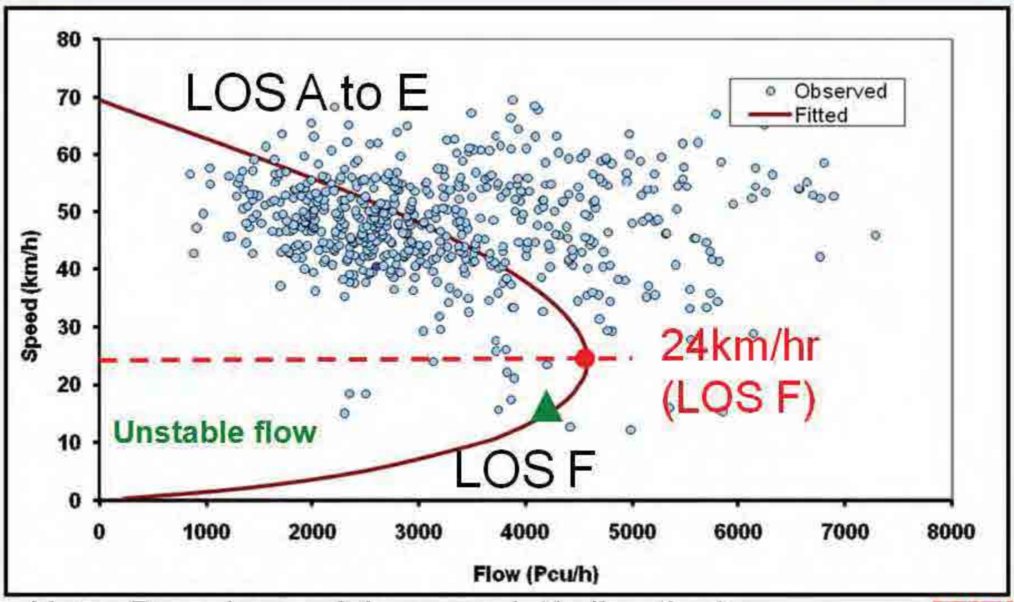
- A= Very Free flow
  B= Reasonably free flow
  C= Stable flow
  D= Heavy but acceptable traffic flow
  E= Flow nearing capacity
  F= Unstable flow with stop-go conditions

Speed-flow graph for single lane of Singapore expressway (note LOS F is only indicated and not brought down to zero)

Figure 1: Speed-Traffic Flow Curve for Expressways



Indian Speed- flow curve for a 3 lane road with Levels of Service (LOS) - not symmetrical because speed-density curve is not assumed to be a straight line



Note: Based on a 3-lane road (1 direction)

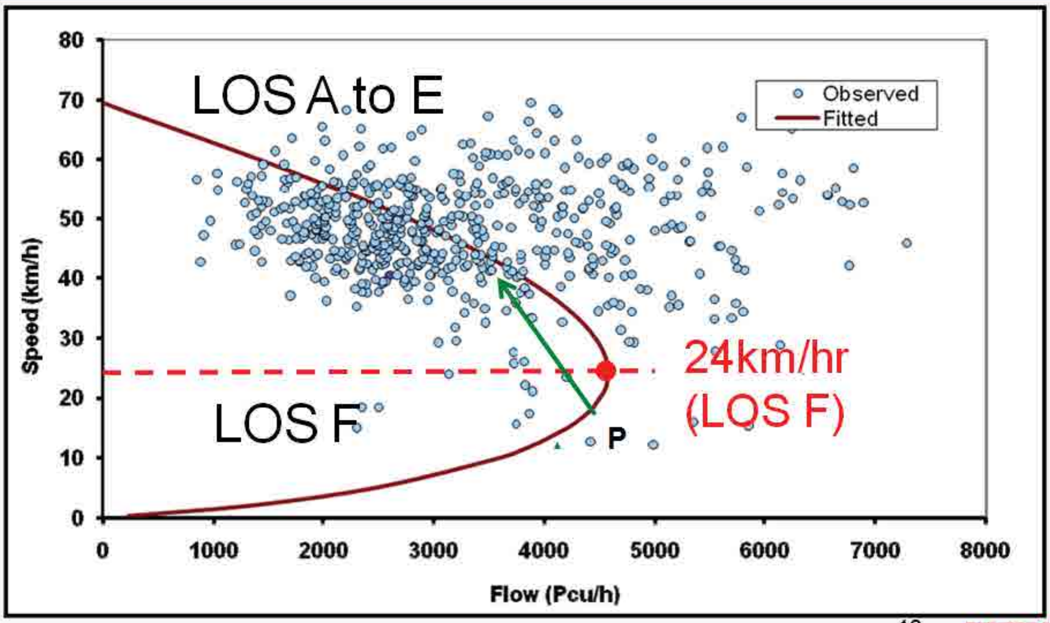
Indian speed flow curve

- This is for 3 lanes

- Capacity is about 4500 veh/hr. If more try to use the road , it results in stop-go conditions in LOS F with lower traffic volumes and lower speeds than optimum speed of 24 km/hr

- The curve is brought down all the way to zero in LOS F

A congestion charge will bring the current speed of 18.6 km/hr above optimum speed of 24 km/hr



13

Interpretation

- The average speed for a typical road in Bangalore CBD is 18.6 km/hr (below optimum speed of 24 km/hr), -exactly what traffic volume (flow) it is, we are unable to tell because the bottom part of curve is derived and not actual (the point P is only an indication)
- We can introduce a congestion charge to reduce traffic volume (lower than at P). The theoretical speed-flow curve indicates that there could be two speeds for reduced traffic volume, one that is higher and one lower than the optimum speed. Logic tells us that the higher one is correct i.e. when volume drops, speeds must go up not down.
- This means we will be in LOS higher than F. That is what ERP intends to do.

Interpretation

- We can impose a charge to bring the traffic out of LOS F. That much we can be sure of
- Only with the experience and data on what happens after ERP are we able to say exactly what range of speeds we can achieve
- In Singapore we are able to predict the speed range because of the analysis of data over many years

Appendix C (Source: Information from DULT and JICA Study Team)

S/No.	Name of Selected Area	Types of landuses Commercial/ administrative/ institutional/ residential	Approx % age of comm and admin area of total area	Name of two Major roads to gauge speed from JICA study	How well is area served by public transport (VG/G/ Fair/Poor)	Are there peripheral roads for vehicle to avoid the area	Why do people travel there? work/shop / Entertainment (Give all	Any National highway Toll Roads within Area	Any new road develop-ment within the next 5 years	Peak periods	Concerns/ Remarks	Rank
1	CBD at Majestic	Commercial/administration	80%	1) Palace Rd (towardsKG Rd)- 14.6km/h, 2) Palace Rd (towards Seshadri Rd) - 11.4km/hr	Good	yes	work/shop	No	Namma Metro	10am to 12noon	Logical choice for congestion pricing because many cities intoduce in the CBD	1
2	Koramangala-100 Feet – Indiranagar	Commercial/residential	50%	1. Old Airport Rd (5.07km/h - inbound, 15.62km/h -outbound) 2.Hosur Rd (4.26km/h -inbound, 12.89km/hr -outbound)	Fair	Yes	Home,Work , shop and entertainment	No. there is toll road nearby	Yes	8:30 to 10:30 17:30 to 20:00	1. Only 50% of Commercial and Admin 2. There will be new road development within the next 5 yrs	2
3	Electronic City	Industrial/commercial/ administrative/residential	60 to 70%	1.Hosur Rd (8.75km/h –inbound, 11.20km/h-outbound) Note: Roads within area (Bommasandra Jigani Link Rd, Huskur Rd)	Good	Yes	Work	Yes	Peripheral ring road	08:00 to 11:00 17:00 to 21:30	1. there is existing toll road 2. too far away from the city to be a stand-alone congestion charging area	3
4	Whitefield	Software companies and IT residences.	30 to 40 %	1.Whitefield Rd (16.1km/h - inbound, 10.1km/h -outbound) 2. ORR (28.13km/h-ORR_Rt, 27.5km/h –ORR_L) Note: Roads within area (Hoodi Main Rd)	Good	Yes	Home, work and shopping	Yes	Yes	08:00 to 10:00 16:00 to 20:00	1. Only 30 to 40% of commercial and Admin 2. there is existing toll road 3. there will be new road development within the next 5 yrs,	4
5	Jayanagar	Commercial/residential	30%	1.Rastriya Vidyalaya Rd (5.17km/h –inbound, 14.29km/h –outbound) 2.ORR (16.97km/h-ORR_Rt, 14.16km/h-ORR_L) Note: Roads within area (10th Main Rd, 1st Main Rd)	Good	Yes	Home, shopping	No	No	09:00 To 11:00 17:00 to 20:00	Only 30% of commercial and Admin	5
6	Malleswaram	Residential-cum-commercial-institutional	30%	1. ORR (10.83km/h-ORR_Rt, 19.82km/h-ORR_left) 2. Bellary Rd (13.33km/h-inbound, 42.26km/h-outbound) Note: Roads within area (CV Raman Rd, 15th Cross Rd)	Good	No	Home, work education and shopping	No	Yes	08:00 to 10:00 18:00 to 21:00	1. Only 30% of commercial and Admin 2.there will be new road development within the next 5 yrs 3.. No peripheral roads to avoid the area	6
7	Yashwantpur	Residential-cum-industrial	70%	1. ORR (10.83km/h-ORR_Rt, 19.82km/h-ORR_left) 2. Bellary Rd (13.33km/h-inbound, 42.26km/h-outbound) Note: Roads within area (CV Raman Rd, MSR Rd)	Very good	No	Transfer trips, entertainment, home	Yes	No	08:00 to 09:00 17:00 to 19:00	1. Industrial area 2. No peripheral roads to avoid the area 3. Transfer trips 4. there is existing toll road	7

Appendix D

Traffic Surveys

Classified Traffic Counts (Restricted Area)

Requirements for Classified Traffic Counts

1. Survey Dates: 1 Weekday(Tues – Thurs),
2. Avoid Public holidays and eve of public holidays

2. Time Period: 9am to 7pm

3. Classify the vehicle counts into the following

   a) Motorcycles

   b) Autorickshaw

   c) Cars/ Taxi

   d) Buses

   e) Light Goods Vehicles

   f) Heavy Goods Vehicles

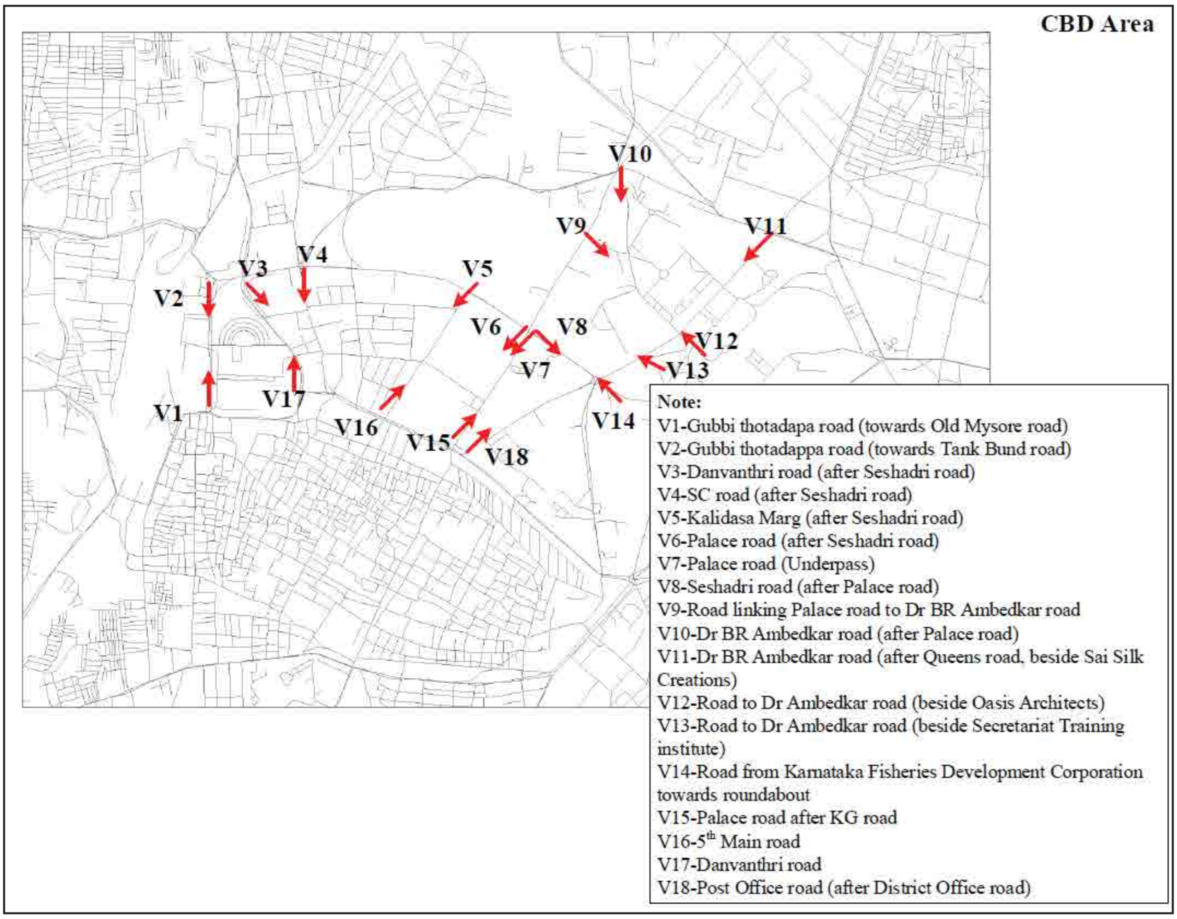
   g) Others (military vehicles)

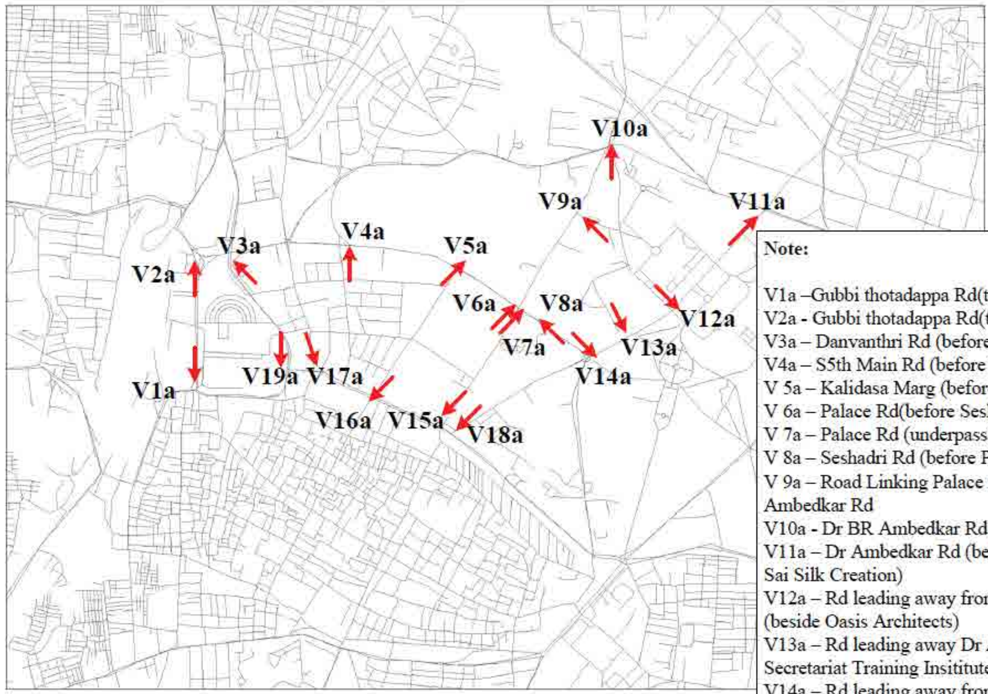
4. For road counts, usually the counts will be done along it. There may be cases where there is a flyover, there will also be a road parallel to the flyover. In this case, count along the road and on the flyover.
5. Apart from counting the number of buses, we will need the surveyors to indicate the occupancy for each public bus on the candidate road (whether its occupancy is empty, quarter full, half full, three-quarter full or full) and indicate them in term of these 5 categories.
6. Apart from counting the number of heavy goods vehicles, we will need the surveyors to indicate if the heavy goods vehicle is empty or loaded with goods and count them in term of these 2 categories.
7. To indicate the number of lanes for the locations where the data is collected

Requirements for Number Plate Matching (OD surveys)

1. Survey Dates: 1 Weekday(Tues – Thurs), Avoid Public holidays and eve of public holidays
2. Time Period: 9am to 7pm
3. To indicate the number of lanes for the locations where the data is collected
4. To Match the vehicles entering the proposed Restricted (RZ) Area to the vehicles leaving the RZ area. E.g. V1 vs V1a, V1 vs V2a, V1 vs V3a , ..., etc
5. Instruction: To match the first 2 digits and last 2 digits of the Registration Plate Number

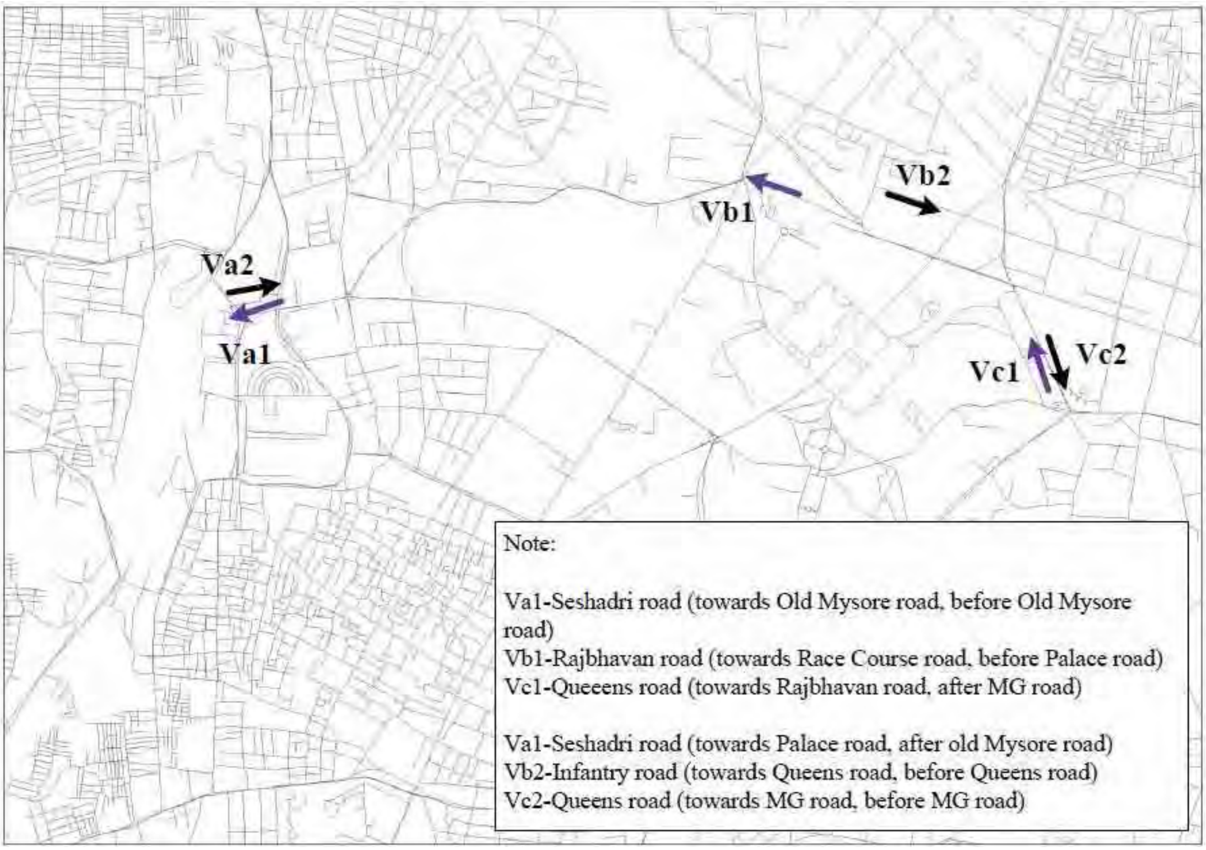
(WILL SEND EXAMPLE)





Note:

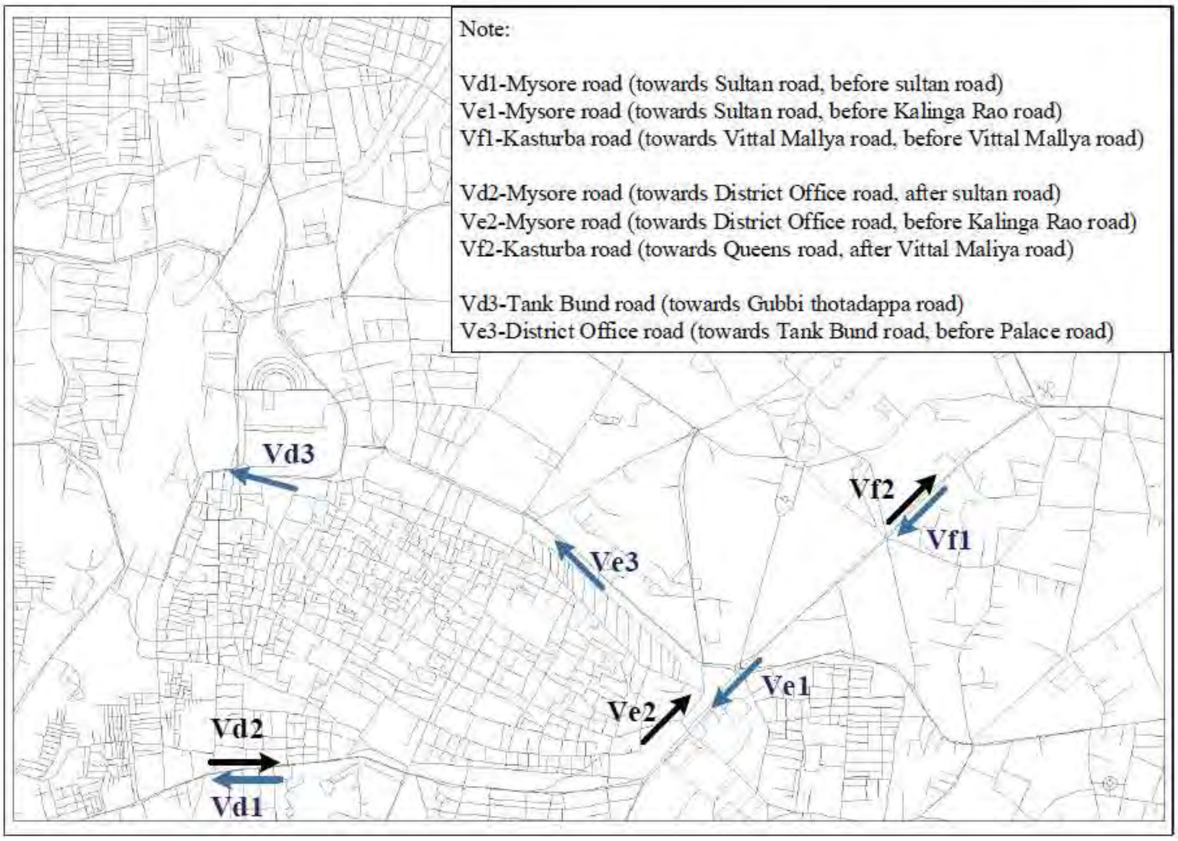
V1a –Gubbi thotadappa Rd(towards Tank Bund Rd)
V2a - Gubbi thotadappa Rd(towards Old Mysore Rd)
V3a – Danvanthri Rd (before Seshadri Rd)
V4a – S5th Main Rd (before Seshadri Rd)
V 5a – Kalidasa Marg (before Seshadri Rd)
V 6a – Palace Rd(before Seshadri Rd)
V 7a – Palace Rd (underpass)
V 8a – Seshadri Rd (before Palace Rd)
V 9a – Road Linking Palace Road to Dr BR Ambedkar Rd
V10a - Dr BR Ambedkar Rd before Palace Rd
V11a – Dr Ambedkar Rd (before Queens Rd- beside Sai Silk Creation)
V12a – Rd leading away from Dr Ambedkar Rd (beside Oasis Architects)
V13a – Rd leading away Dr Amberdkar Rd (beside Secretariat Training Insititute)
V14a – Rd leading away from Karnataka Fisheries Development Corporation ,away from roundabout
V15a – Palace Road before KG Rd
V16a - Kalidasa Marg
V17a – SC Rd
V18a – Post Office Rd (before District Office Rd)
V19a – Darvanthri Rd (before Tank Rd)

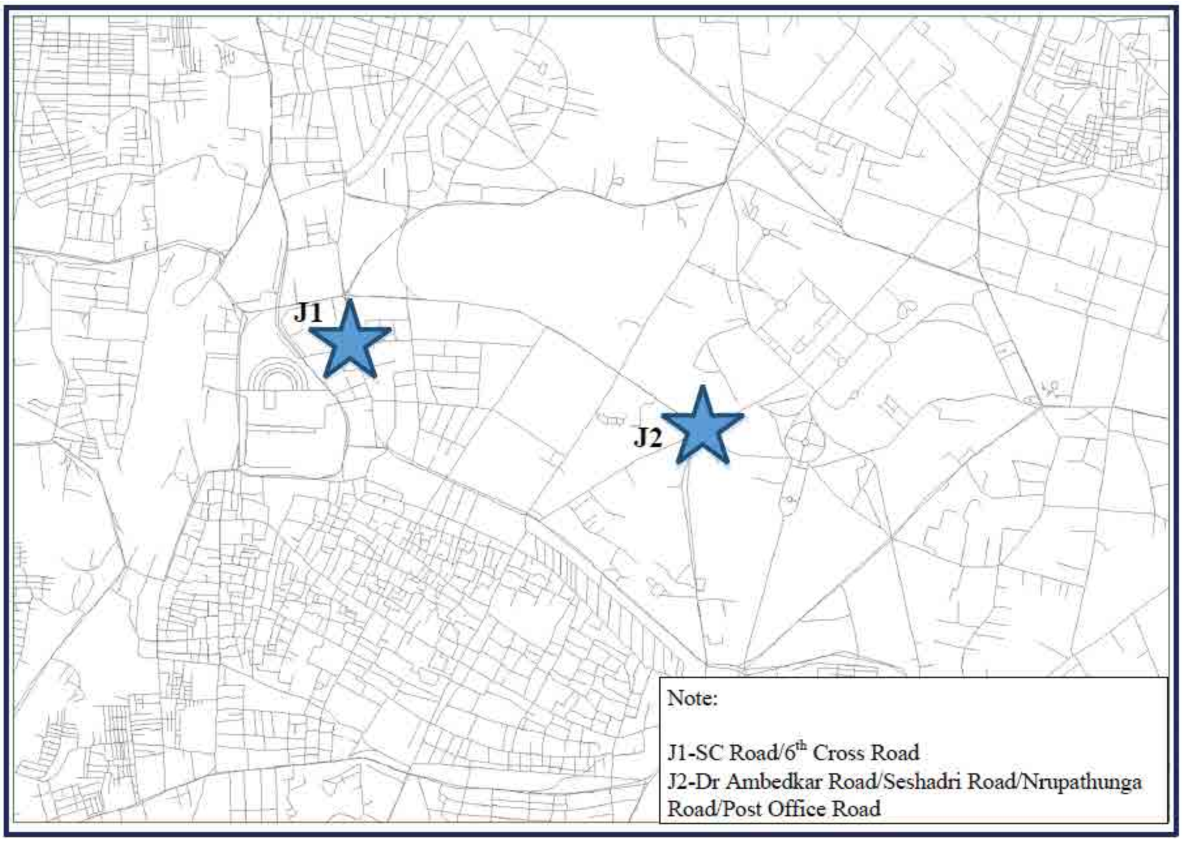


Note:

Va1-Seshadri road (towards Old Mysore road, before Old Mysore road)
Vb1-Rajbhavan road (towards Race Course road, before Palace road)
Vc1-Queeens road (towards Rajbhavan road, after MG road)

Va1-Seshadri road (towards Palace road, after old Mysore road)
Vb2-Infantry road (towards Queens road, before Queens road)
Vc2-Queens road (towards MG road, before MG road)

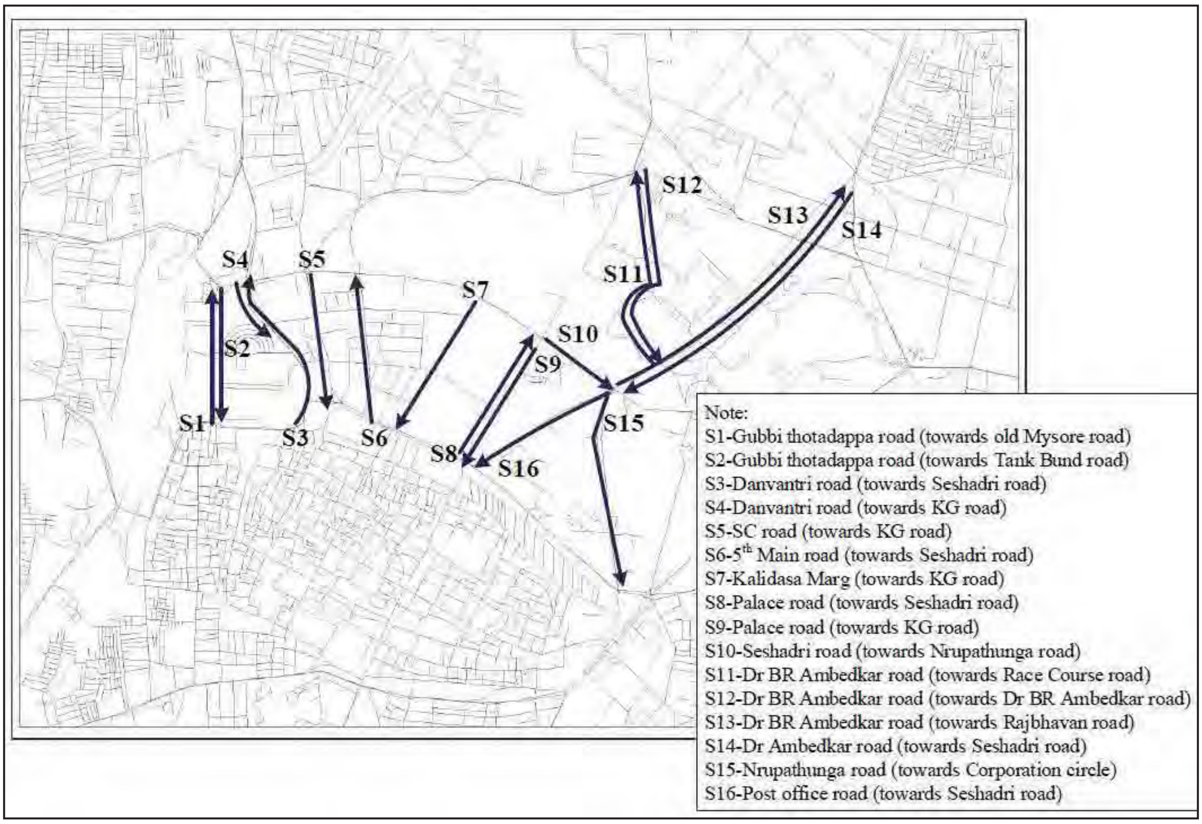

Note:
Vd1-Mysore road (towards Sultan road, before sultan road)
Ve1-Mysore road (towards Sultan road, before Kalinga Rao road)
Vf1-Kasturba road (towards Vittal Mallya road, before Vittal Mallya road)
Vd2-Mysore road (towards District Office road, after sultan road)
Ve2-Mysore road (towards District Office road, before Kalinga Rao road)
Vf2-Kasturba road (towards Queens road, after Vittal Maliya road)
Vd3-Tank Bund road (towards Gubbi thotadappa road)
Ve3-District Office road (towards Tank Bund road, before Palace road)
Vd3
Vf2
Vf1
Ve3
Ve1
Ve2
Vd2
Vd1

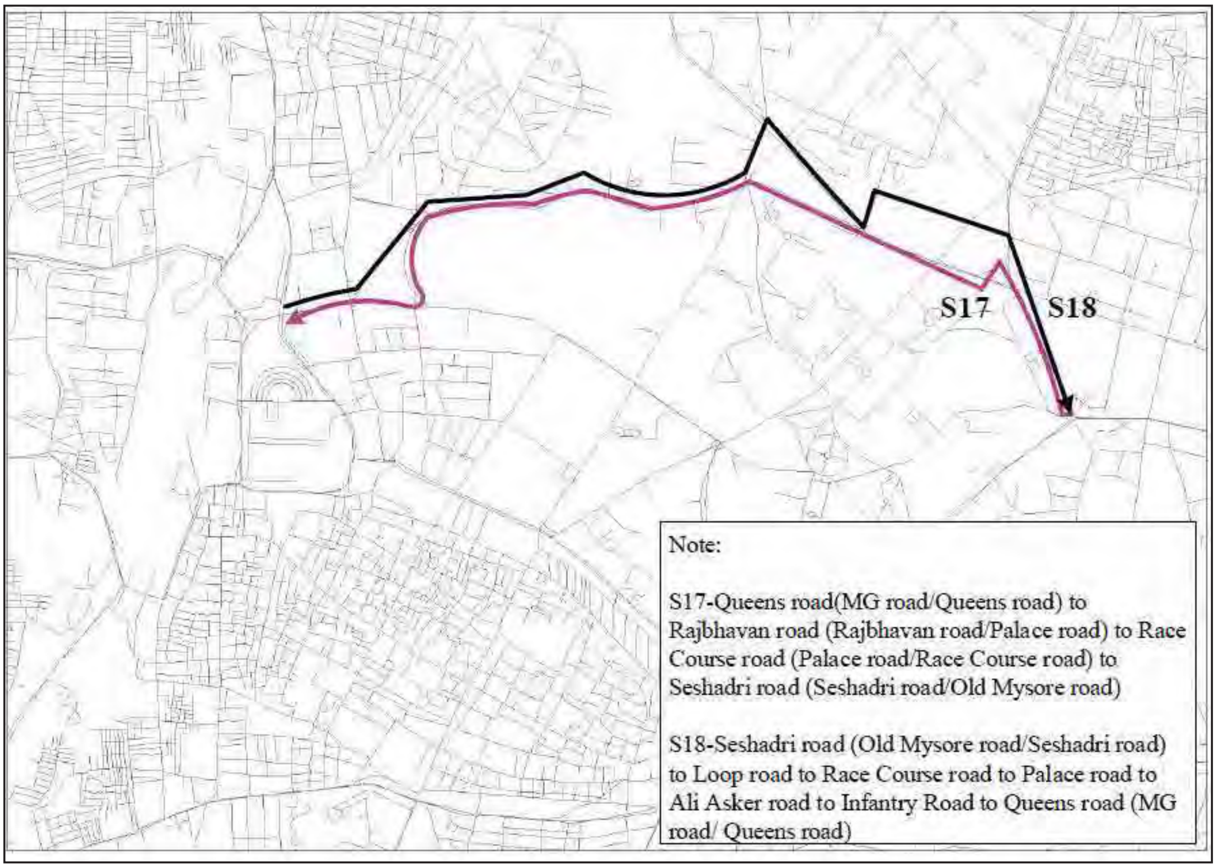

J1
J2
Note:
J1-SC Road/6th Cross Road
J2-Dr Ambedkar Road/Seshadri Road/Nrupathunga Road/Post Office Road

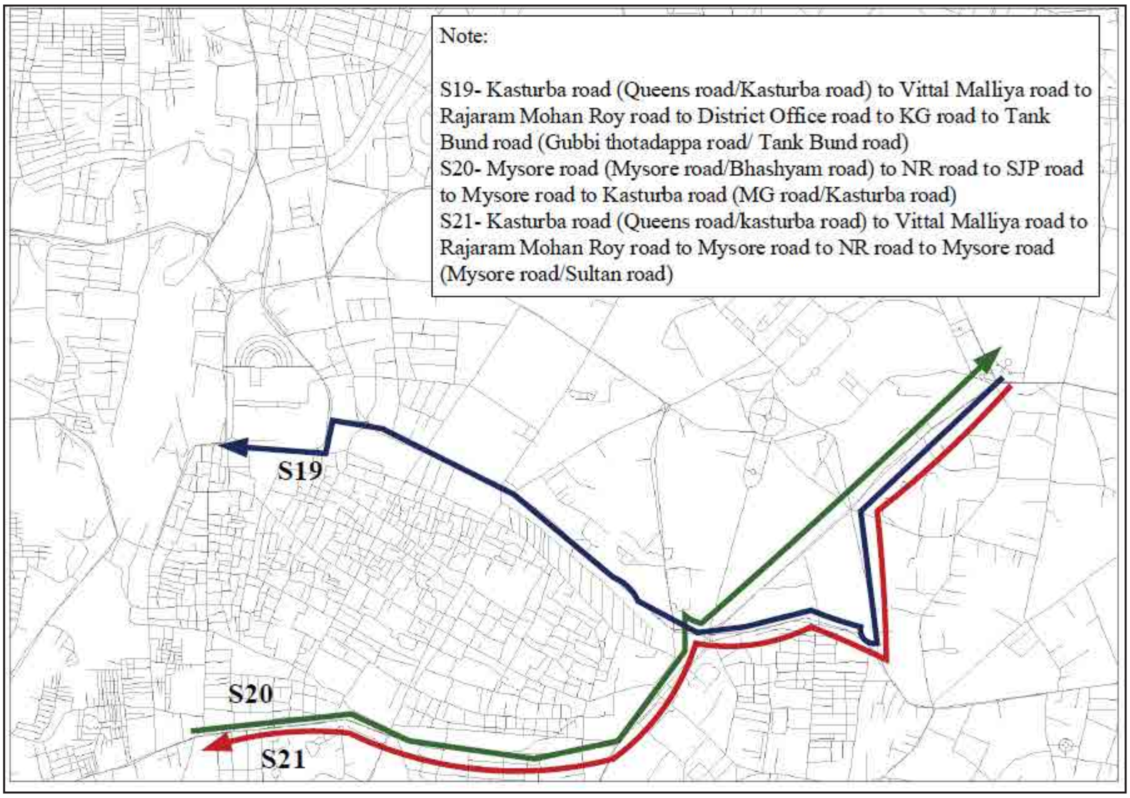
Traffic Time Surveys (Restricted Area)

Requirements for Journey Time surveys

1. Routes : all routes indicated
2. Survey Dates: 1 Weekday(Mon – Thurs), Non-public holidays, non- eve of public holiday
3. Time Period: One peak period, one off-peak hour period
4. Do not use underpass
5. To provide the following:
   a. Length of route
   b. Travel Time from start to end


S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
Note:
S1-Gubbi thotadappa road (towards old Mysore road)
S2-Gubbi thotadappa road (towards Tank Bund road)
S3-Danvantri road (towards Seshadri road)
S4-Danvantri road (towards KG road)
S5-SC road (towards KG road)
S6-5th Main road (towards Seshadri road)
S7-Kalidasa Marg (towards KG road)
S8-Palace road (towards Seshadri road)
S9-Palace road (towards KG road)
S10-Seshadri road (towards Nrupathunga road)
S11-Dr BR Ambedkar road (towards Race Course road)
S12-Dr BR Ambedkar road (towards Dr BR Ambedkar road)
S13-Dr BR Ambedkar road (towards Rajbhavan road)
S14-Dr Ambedkar road (towards Seshadri road)
S15-Nrupathunga road (towards Corporation circle)
S16-Post office road (towards Seshadri road)


S17
S18
Note:
S17-Queens road(MG road/Queens road) to Rajbhavan road (Rajbhavan road/Palace road) to Race Course road (Palace road/Race Course road) to Seshadri road (Seshadri road/Old Mysore road)
S18-Seshadri road (Old Mysore road/Seshadri road) to Loop road to Race Course road to Palace road to Ali Asker road to Infantry Road to Queens road (MG road/ Queens road)


Note:
S19- Kasturba road (Queens road/Kasturba road) to Vittal Malliya road to Rajaram Mohan Roy road to District Office road to KG road to Tank Bund road (Gubbi thotadappa road/ Tank Bund road)
S20- Mysore road (Mysore road/Bhashyam road) to NR road to SJP road to Mysore road to Kasturba road (MG road/Kasturba road)
S21- Kasturba road (Queens road/kasturba road) to Vittal Malliya road to Rajaram Mohan Roy road to Mysore road to NR road to Mysore road (Mysore road/Sultan road)
S19
S20
S21

Classified Traffic Counts (Koramangala Area)

Requirements for Classified Traffic Counts

1. Survey Dates: 1 Weekday(Tues – Thurs),
2. Avoid Public holidays and eve of public holidays

2. Time Period: 9am to 7pm

3. Classify the vehicle counts into the following

   a) Motorcycles

   b) Autorickshaw

   c) Cars/Taxi

   d) Buses

   e) Light Goods Vehicles

   f) Heavy Goods Vehicles

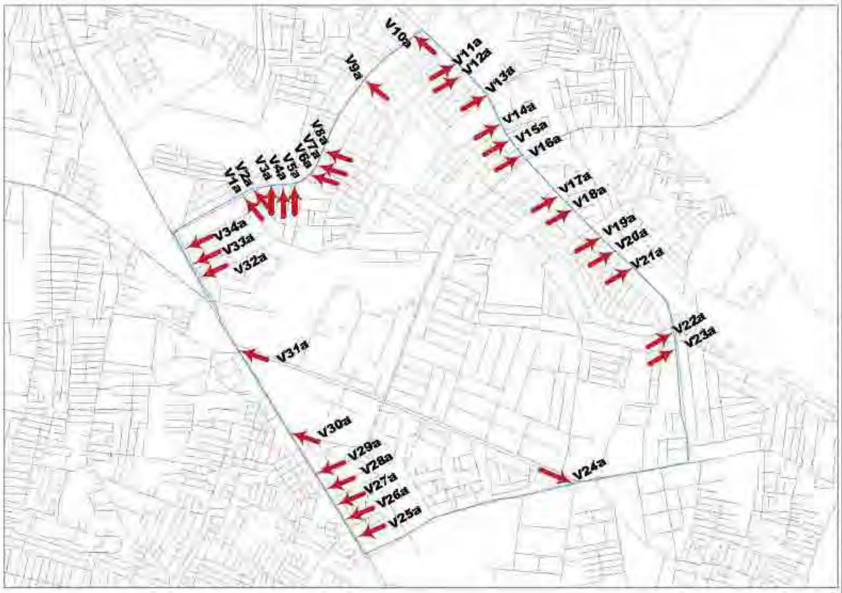
   g) Others (military vehicles)

4. For road counts, usually the counts will be done along it. There may be cases where there is a flyover, there will also be a road parallel to the flyover. In this case, count along the road and on the flyover.
5. Apart from counting the number of buses, we will need the surveyors to indicate the occupancy for each public bus on the candidate road (whether its occupancy is empty, quarter full, half full, three-quarter full or full) and indicate them in term of these 5 categories.
6. Apart from counting the number of heavy goods vehicles, we will need the surveyors to indicate if the heavy goods vehicle is empty or loaded with goods and count them in term of these 2 categories.
7. To indicate the number of lanes for the locations where the data is collected

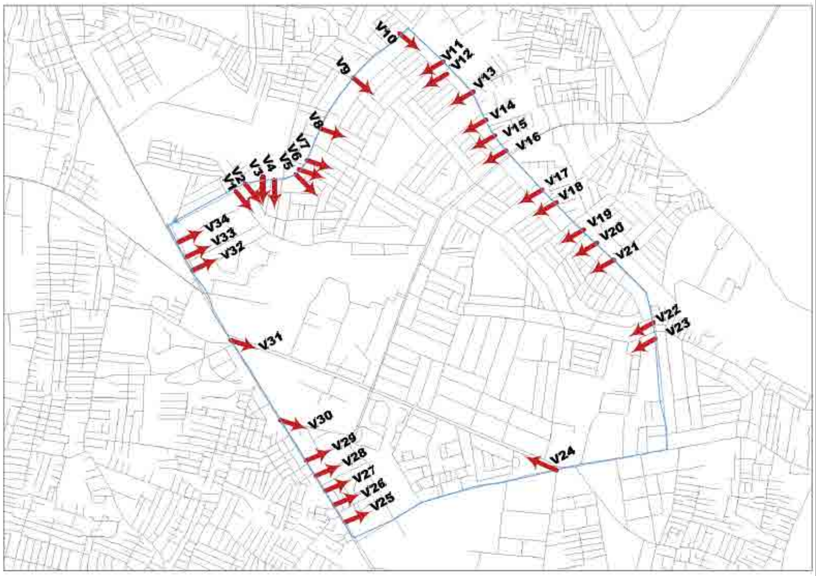
Requirements for Number Plate Matching (OD surveys)

1. Survey Dates: 1 Weekday(Tues – Thurs), Avoid Public holidays and eve of public holidays
2. Time Period: 9am to 7pm
3. To indicate the number of lanes for the locations where the data is collected
4. To Match the vehicles entering the proposed Restricted (RZ) Area to the vehicles leaving the RZ area. E.g. V1 vs V1a, V1 vs V2a, V1 vs V3a , ……, etc
5. Instruction: To match the first 2 digits and last 2 digits of the Registration Plate Number

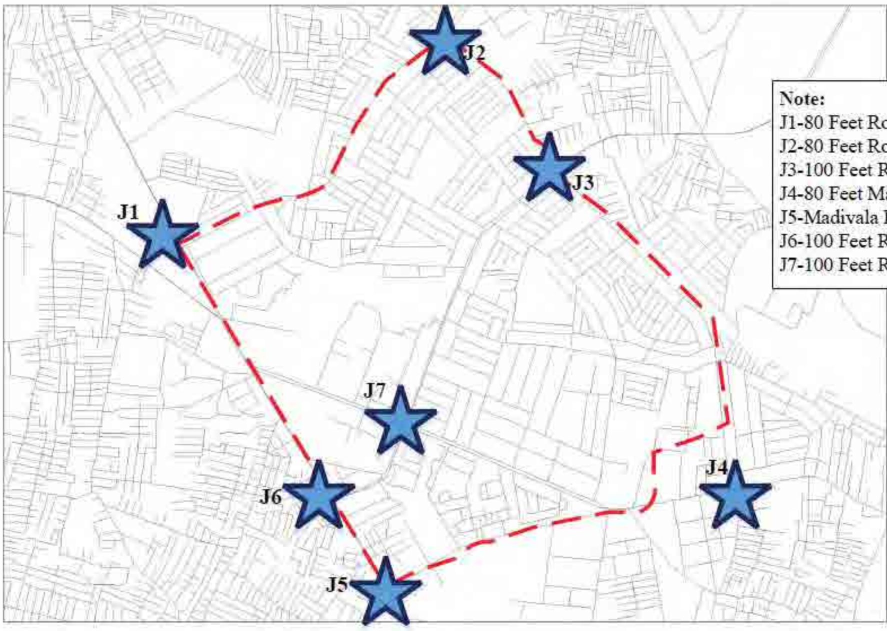
(WILL SEND EXAMPLE)



Note:
V1a-1st Cross Road
V2a-2nd Cross Road
V3a-Road towards 80 Feet Road
V4a-17th Main Road
V5a-17th H Main Road
V6a-3rd Cross Road(Beside Temple)
V7a-3rd Cross Road(Beside Platinum Nilayam)
V8a-4th Cross Road
V9a-5th Cross Road
V10a-6th B Cross Road
V11a-18th Main Road
V12a-17th G Main Road
V13a-18th F Main Road
V14a-17th D Main Road
V15a-Road towards 80 Feet Road(Near BMTC)
V16a-100 Feet Road
V17a-16th Main Road
V18a-15th Main Road
V19a-12th Main Road
V20a-11th Main Road
V21a-10th Main Road
V22a-1st Cross Road
V23a-7th Cross Road
V24a-Sarjapura Main Road
V25a-1st Road from Hosur Road to Area (Al-Ameen Education Society)
V26a-2nd Road from Hosur Road to Area (Al-Ameen Education Society)
V27a-4th Cross Road (Hosur Road)
V28a-3rd Cross Road (Hosur Road)
V29a-100 Feet Road
V30a-Road linking Hosur Road to 100 Feet Road (Beside St John Medical College Tennis Court)
V31a-Sarjapur Main Road (Hosur Road)
V32a-Jyothi Nivas College Road
V33a-4th B Cross Road
V34a-1st Main Road



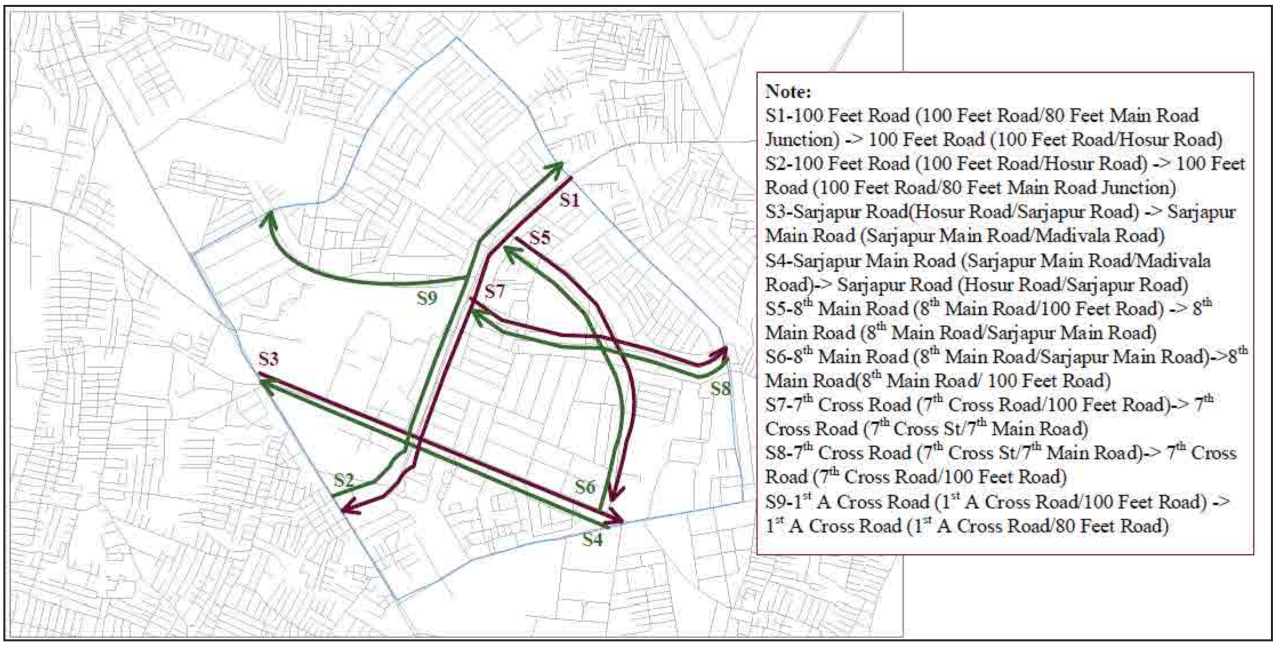
Note:
V1-2nd Cross Road
V2-Road from 80 Feet Road
V3-17th Main Road
V4-17th H Main Road
V5-3rd Cross Road(Beside Temple)
V6-3rd Cross Road(Beside Platinum Nilayam)
V7-4th Cross Road
V8-60 Feet Road
V9-5th Cross Road
V10-6th B Cross Road
V11-18th Main Road
V12-17th G Main Road
V13-18th F Main Road
V14-17th D Main Road
V15-Road after 80 Feet Road(Near BMTC)
V16-100 Feet Road
V17-16th Main Road
V18-15th Main Road
V19-12th Main Road
V20-11th Main Road
V21-10th Main Road
V22-1st Cross Road
V23-7th Cross Road
V24-Sarjapura Main Road
V25-1st Road from Hosur Road to Area (Al-Ameen Education Society)
V26-2nd Road from Hosur Road to Area (Al-Ameen Education Society)
V27-4th Cross Road (Hosur Road)
V28-3rd Cross Road (Hosur Road)
V29-100 Feet Road
V30-Road linking Hosur Road to 100 Feet Road (Beside St John Medical College Tennis Court)
V31-Sarjapur Main Road (Hosur Road)
V32-Jyothi Nivas College Road
V33-4th B Cross Road
V34-1st Main Road

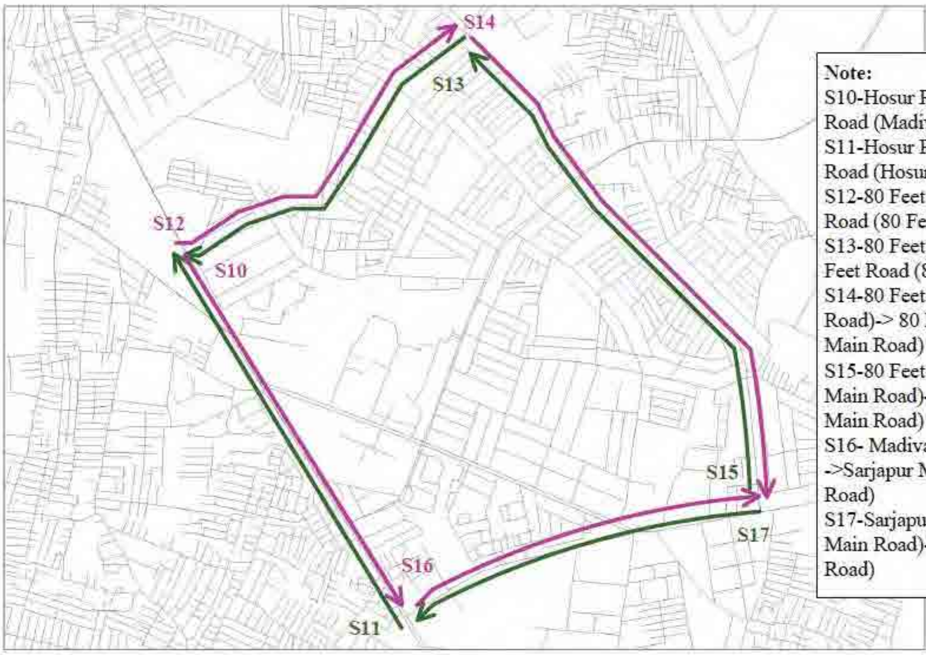


Note:
J1-80 Feet Road/Hosur Road Junction
J2-80 Feet Road/80 Feet Main Road Junction
J3-100 Feet Road/80 Feet Main Road Junction
J4-80 Feet Main Road/Sarjapur Main Road Junction
J5-Madivala Road/Hosur Road Junction
J6-100 Feet Road/Hosur Road Junction
J7-100 Feet Road/Sarjapur Main Road Junction

Requirements for Journey Time surveys

1. Routes : all routes indicated
2. Survey Dates: 1 Weekday(Mon – Thurs), Non-public holidays, non- eve of public holiday
3. Time Period: One peak period, one off-peak hour period
4. Do not use underpass
5. To provide the following:
   a. Length of route
   b. Travel Time from start to end



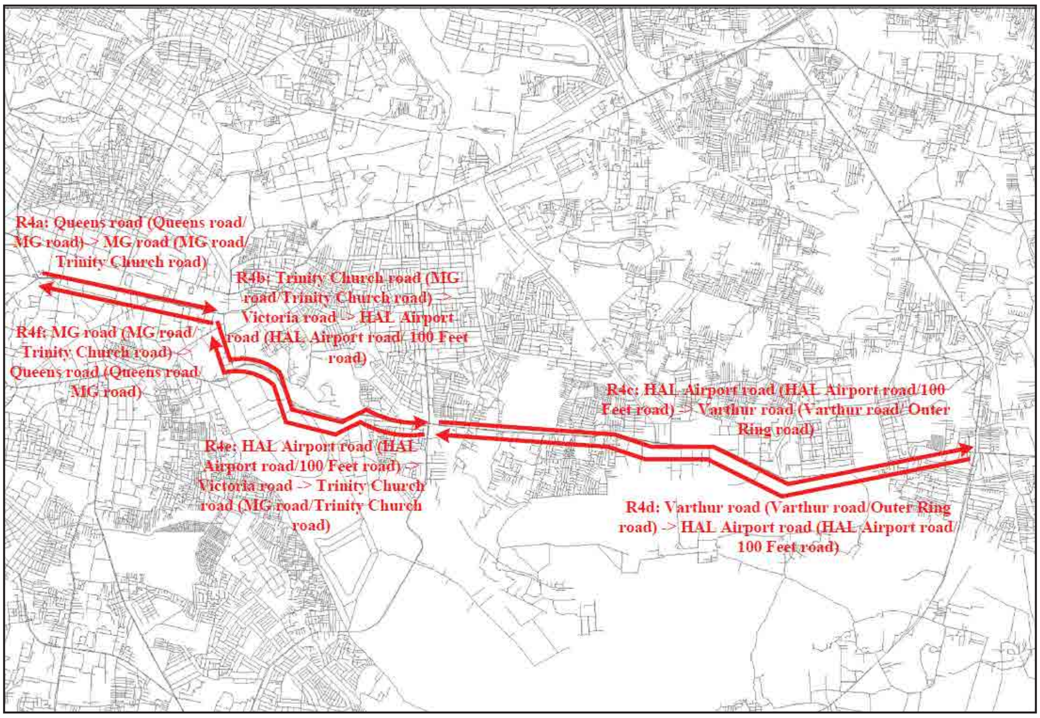


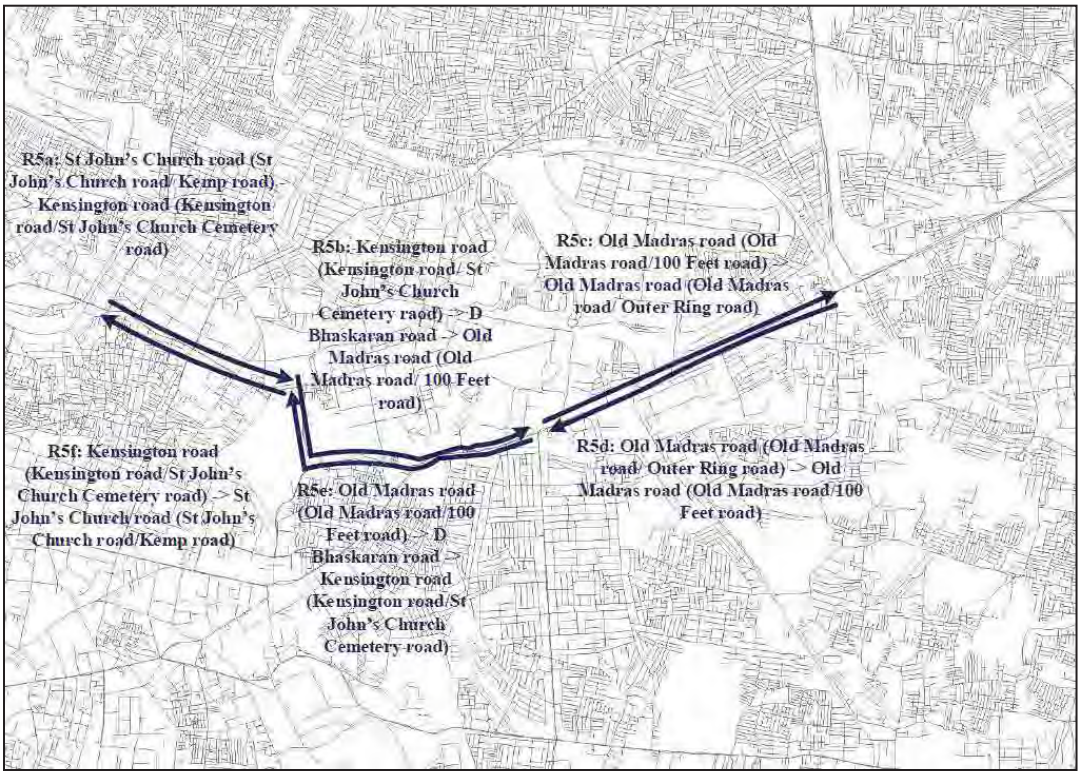
Note:
S10-Hosur Road (Hosur Road/80 Feet Road)-> Hosur Road (Madivala Road/Hosur Road)
S11-Hosur Road (Sarjapur Road/Hosur Road)->Hosur Road (Hosur Road/80 Feet Road)
S12-80 Feet Road (80 Feet Road/ Hosur Road)->80 Feet Road (80 Feet Road/80 Feet Main Road)
S13-80 Feet Road(80 Feet Road/80 Feet Main Road)->80 Feet Road (80 Feet Road/Hosur Road)
S14-80 Feet Main Road (80 Feet Road/80 Feet Main Road)-> 80 Feet Main Road (80 Feet Main Road/Sarjapur Main Road)
S15-80 Feet Main Road (80 Feet Main Road/Sarjapur Main Road)-> 80 Feet Main Road (80 Feet Road/80 Feet Main Road)
S16- Madivala Road (Madivala Road/Hosur Road) ->Sarjapur Main Road (80 Feet Main Road/Sarjapur Main Road)
S17-Sarjapur Main Road (80 Feet Main Road/Sarjapur Main Road)-> Madivala Road (Madivala Road/Hosur Road)

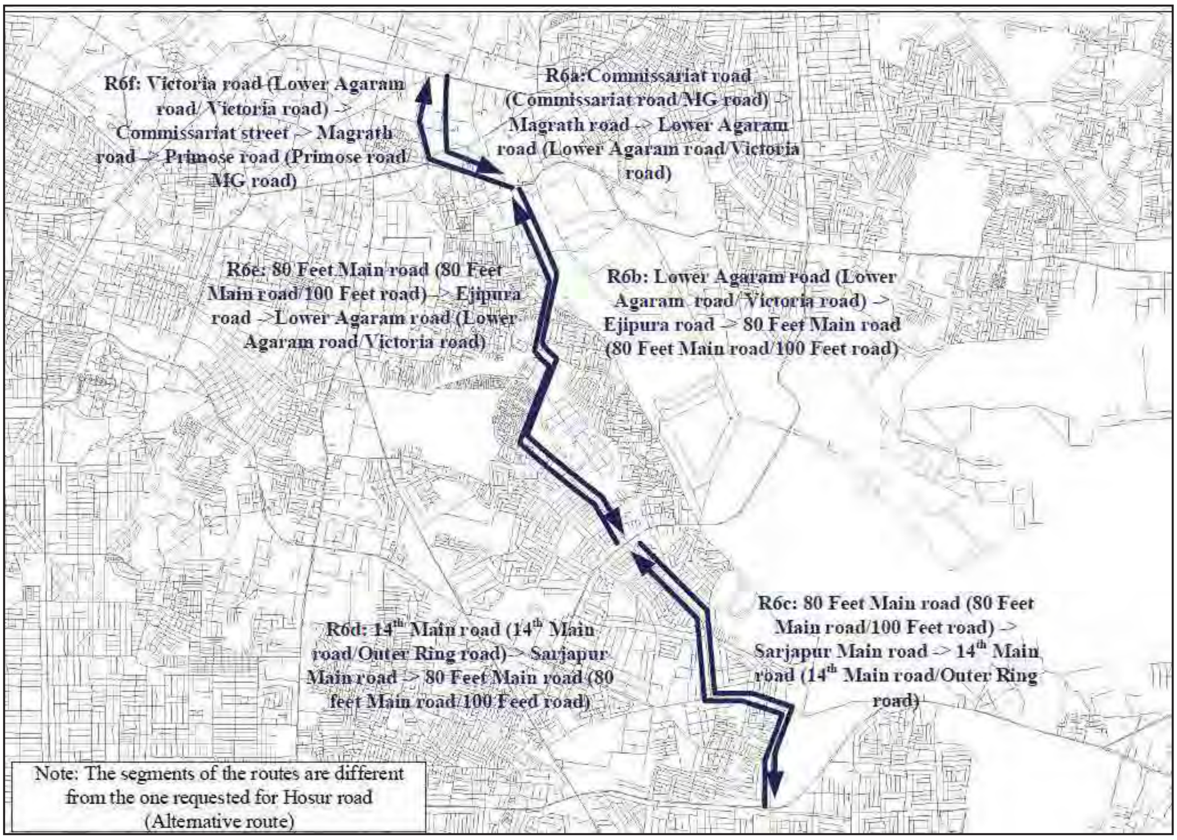
MG Rd – HAL Airport Rd
(Line Pricing)

Requirements for
Journey Time surveys

1. Routes : all routes indicated
2. Survey Dates: 1 Weekday(Mon – Thurs), 1 Fri
   Non-public holidays, non-eve of public holiday
3. Time Period: 9am to 7pm
4. At least one data point for every 15 minutes interval
5. Do not use underpass
6. To provide the following:
   a. Length of route
   b. Travel Time
   c. Journey speeds

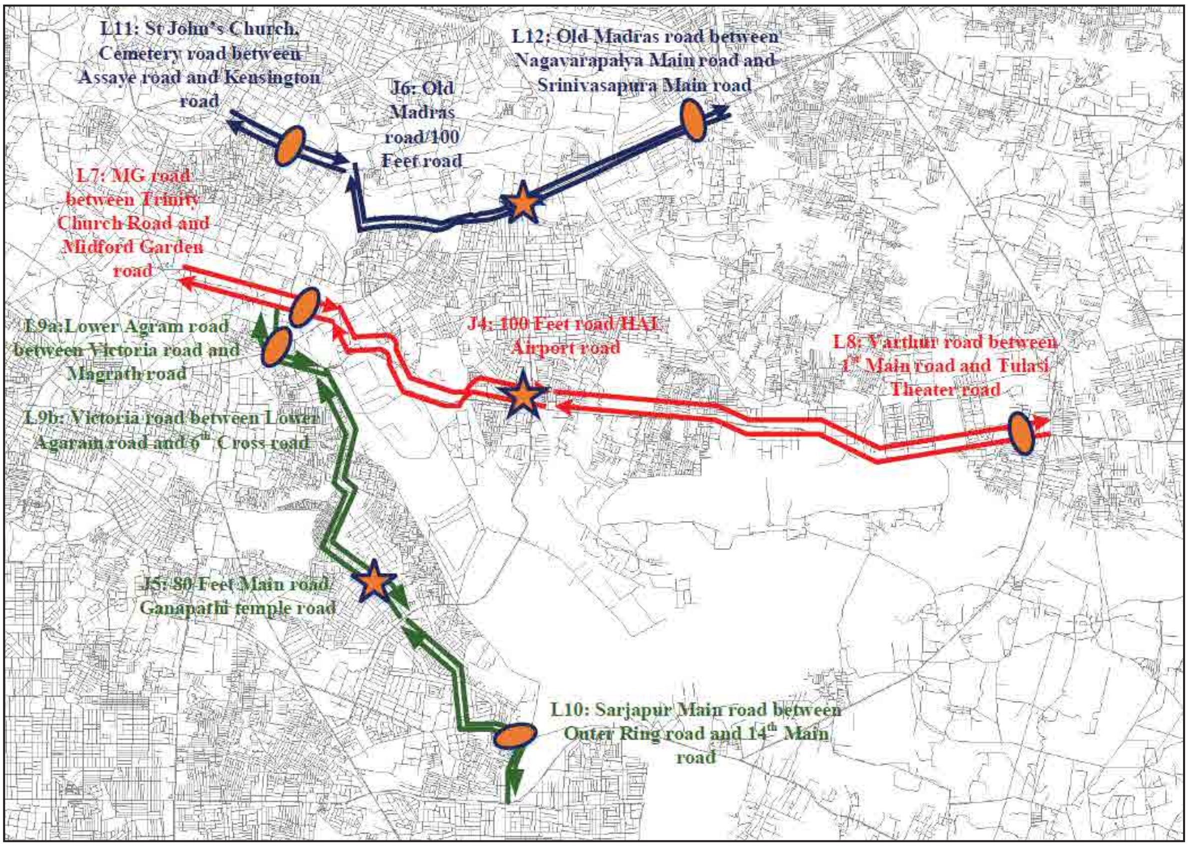

R4a: Queens road (Queens road/ MG road) -> MG road (MG road/ Trinity Church road)
R4b: Trinity Church road (MG road/Trinity Church road) -> Victoria road -> HAL Airport road (HAL Airport road/ 100 Feet road)
R4f: MG road (MG road/ Trinity Church road) -> Queens road (Queens road/ MG road)
R4c: HAL Airport road (HAL Airport road/100 Feet road) -> Varthur road (Varthur road/ Outer Ring road)
R4e: HAL Airport road (HAL Airport road/100 Feet road) -> Victoria road -> Trinity Church road (MG road/Trinity Church road)
R4d: Varthur road (Varthur road/Outer Ring road) -> HAL Airport road (HAL Airport road/ 100 Feet road)


R5a: St John's Church road (St John's Church road/ Kemp road) -> Kensington road (Kensington road/St John's Church Cemetery road)
R5b: Kensington road (Kensington road/ St John's Church Cemetery road) -> D Bhaskaran road -> Old Madras road (Old Madras road/ 100 Feet road)
R5c: Old Madras road (Old Madras road/100 Feet road) -> Old Madras road (Old Madras road/ Outer Ring road)
R5f: Kensington road (Kensington road/St John's Church Cemetery road) -> St John's Church road (St John's Church road/Kemp road)
R5d: Old Madras road (Old Madras road/ Outer Ring road) -> Old Madras road (Old Madras road/100 Feet road)
R5e: Old Madras road (Old Madras road/100 Feet road) -> D Bhaskaran road -> Kensington road (Kensington road/St John's Church Cemetery road)



Requirements for Classified Traffic Counts

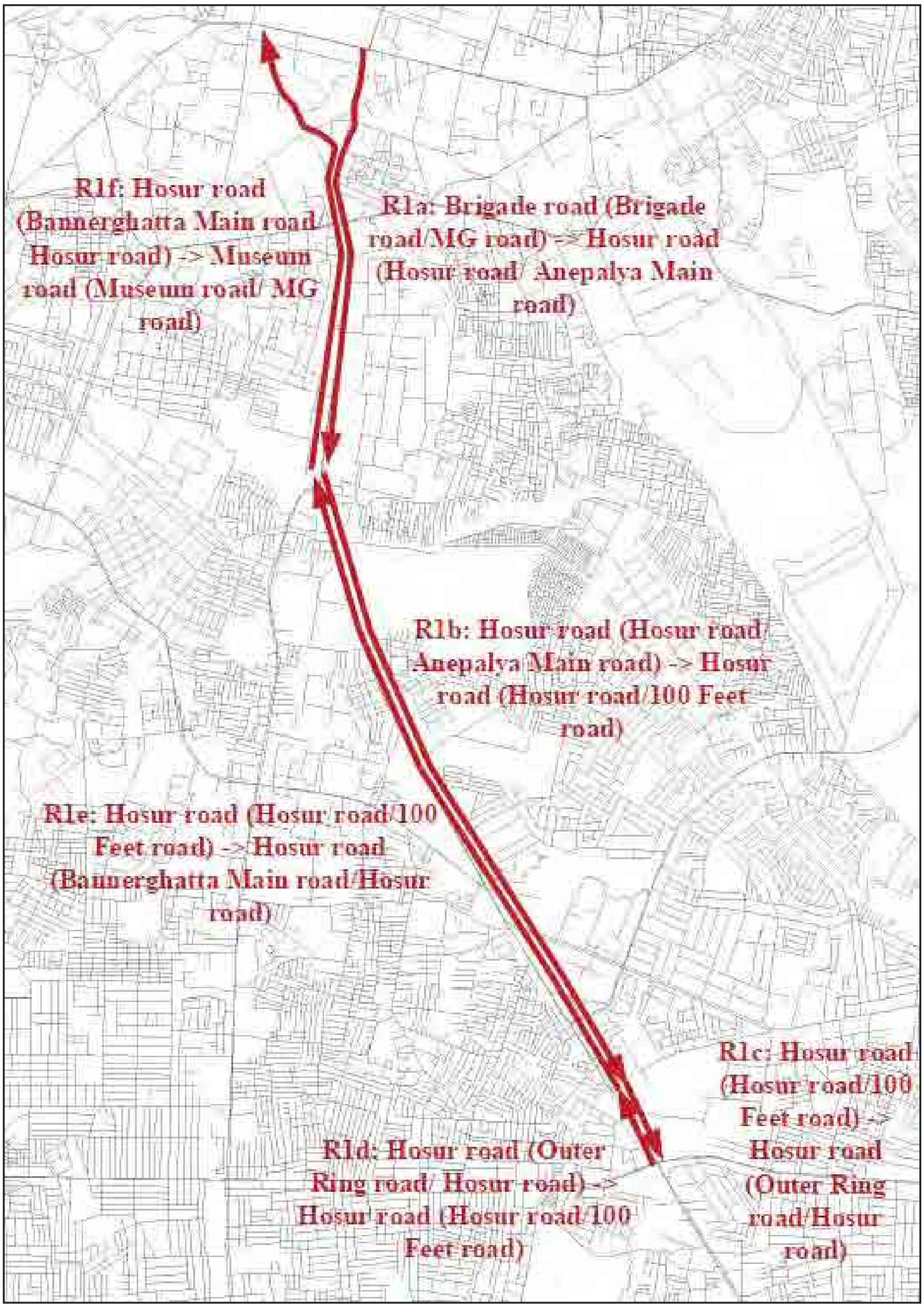
1. Survey Dates: 1 Weekday(Tues – Thurs), 1 Fri
   Non-public holidays, non- eve of public holiday
2. Time Period: 9am to 7pm
3. Classified the vehicle counts into the following
   a) Motorcycles
   b) Auto
   c) Cars/ Taxi
   d) Buses
   e) Light Goods Vehicles
   f) Heavy Goods Vehicles
   g) Others (military vehicles)
4. If there is Flyover or underpass, please carry out the counts for all of them. That is, at grade counts, flyover and underpass counts and slip roads
5. Apart from counting the number of buses, we will need the surveyors to indicate the occupancy for each public bus on the candidate road (whether its occupancy is empty, quarter full, half full, three-quarter full or full) and count them in term of these 5 categories.
6. Apart from counting the number of heavy goods vehicles, we will need the surveyors to indicate if the heavy goods vehicle is empty or loaded with goods and count them in term of these 2 categories.

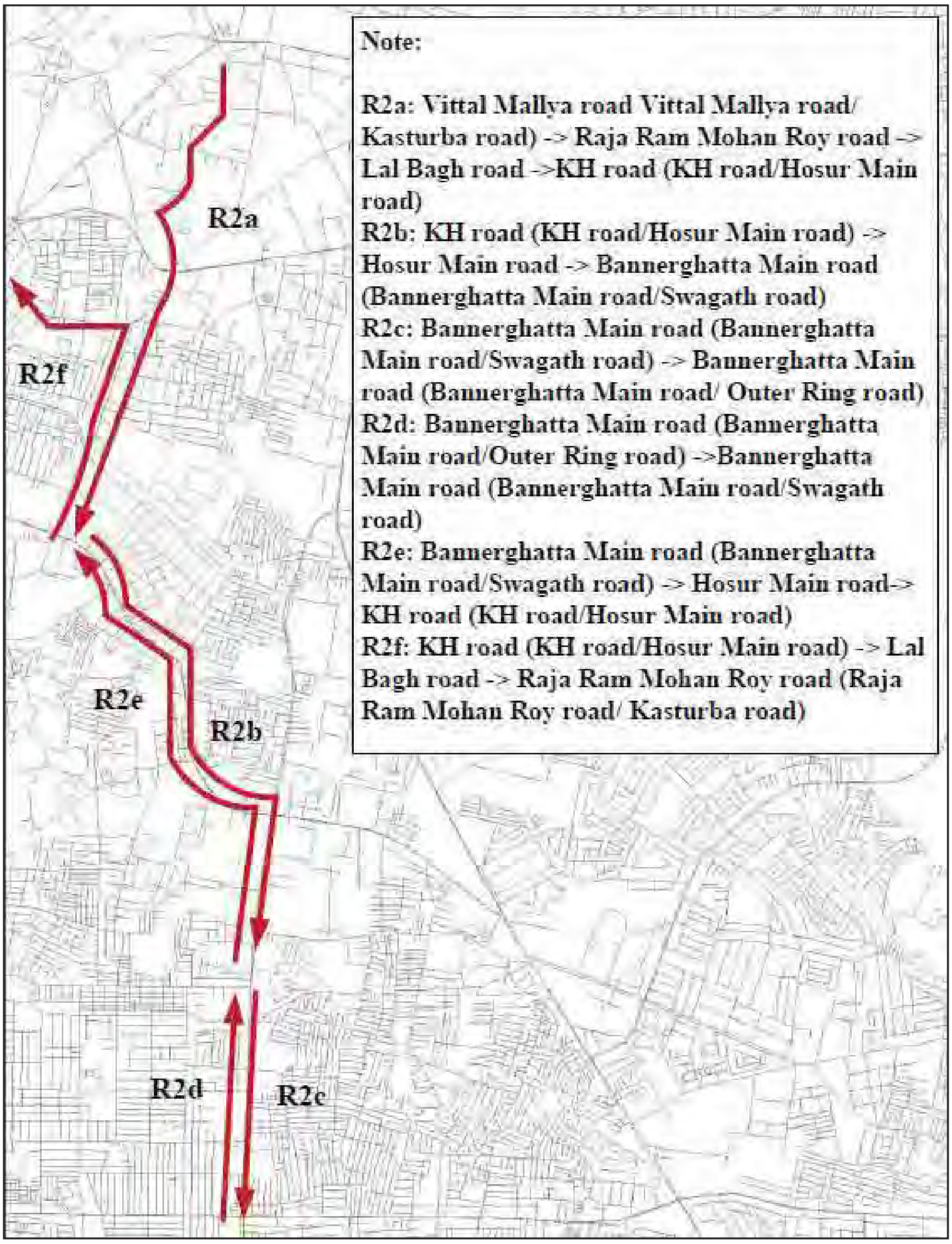

L11: St John's Church, Cemetery road between Assaye road and Kensington road
J6: Old Madras road/100 Feet road
L12: Old Madras road between Nagavarapalya Main road and Srinivasapura Main road
L7: MG road between Trinity Church Road and Midford Garden road
L9a: Lower Agram road between Victoria road and Magrath road
J4: 100 Feet road/HAL Airport road
L8: Varthur road between 1st Main road and Tulasi Theater road
L9b: Victoria road between Lower Agaram road and 6th Cross road
J5: 80 Feet Main road/ Ganapathi temple road
L10: Sarjapur Main road between Outer Ring road and 14th Main road

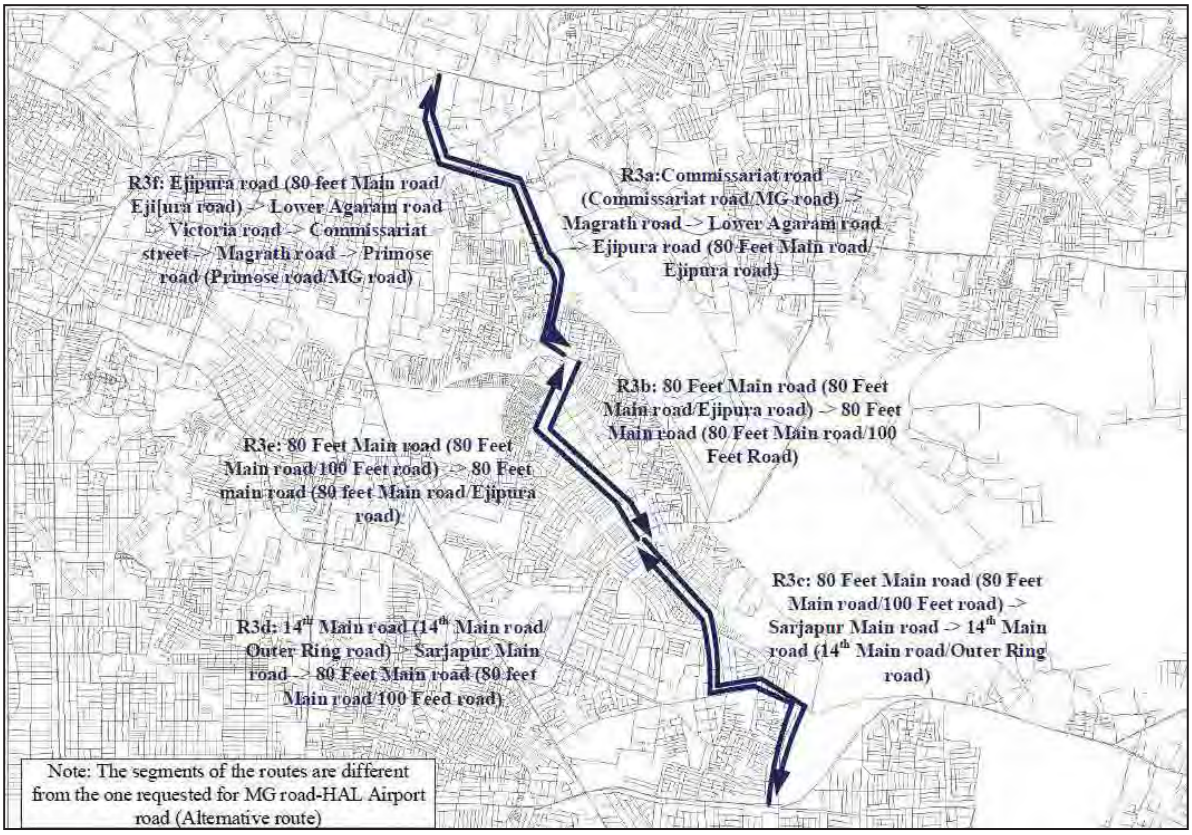
Brigade Rd - Hosur Rd
(Line Pricing)

Requirements for Journey Time surveys

1. Routes : all routes indicated
2. Survey Dates: 1 Weekday(Mon – Thurs), 1 Fri
   Non-public holidays, non-eve of public holiday
3. Time Period: 9am to 7pm
4. At least one data point for every 15 minutes interval
5. Do not use underpass
6. To provide the following:
   a. Length of route
   b. Travel Time
   c. Journey speeds

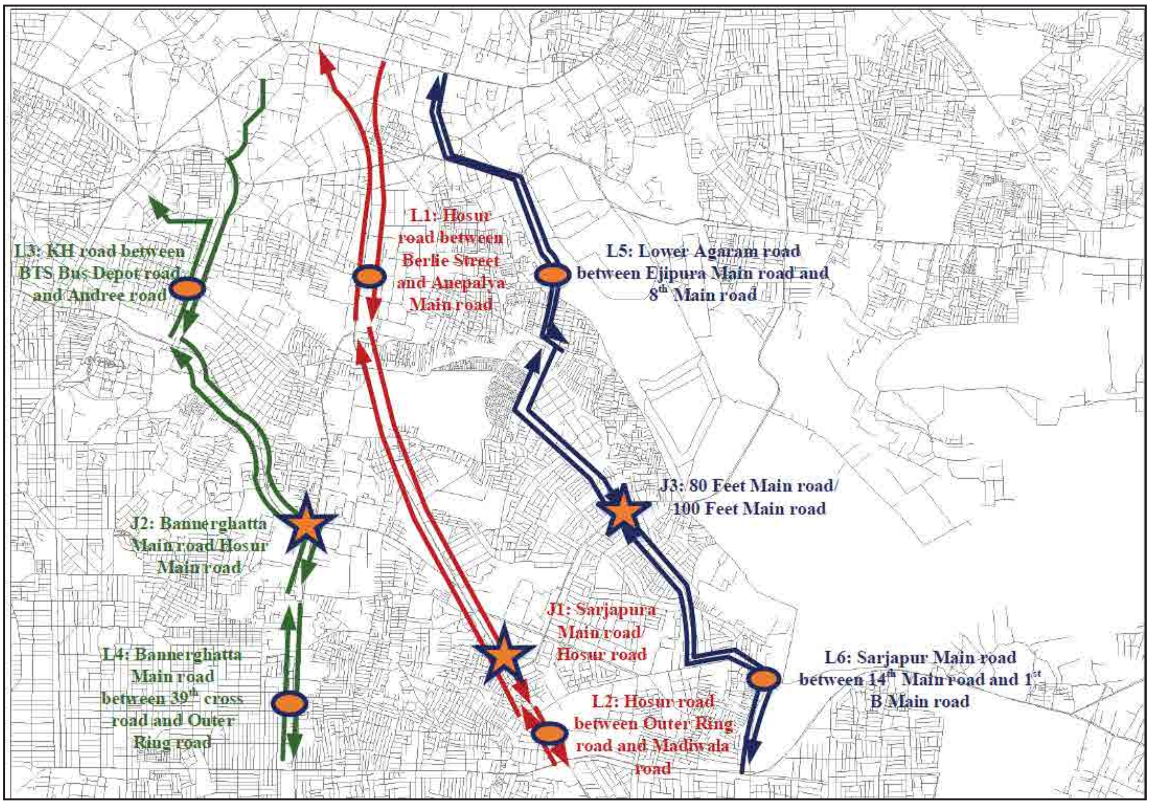

R1f: Hosur road (Bannerghatta Main road/ Hosur road) -> Museum road (Museum road/ MG road)
R1a: Brigade road (Brigade road/MG road) -> Hosur road (Hosur road/ Anepalya Main road)
R1b: Hosur road (Hosur road/ Anepalya Main road) -> Hosur road (Hosur road/100 Feet road)
R1e: Hosur road (Hosur road/100 Feet road) -> Hosur road (Bannerghatta Main road/Hosur road)
R1c: Hosur road (Hosur road/100 Feet road) -> Hosur road (Outer Ring road/Hosur road)
R1d: Hosur road (Outer Ring road/ Hosur road) -> Hosur road (Hosur road/100 Feet road)


Note:
R2a: Vittal Mallya road Vittal Mallya road/ Kasturba road) -> Raja Ram Mohan Roy road -> Lal Bagh road ->KH road (KH road/Hosur Main road)
R2b: KH road (KH road/Hosur Main road) -> Hosur Main road -> Bannerghatta Main road (Bannerghatta Main road/Swagath road)
R2c: Bannerghatta Main road (Bannerghatta Main road/Swagath road) -> Bannerghatta Main road (Bannerghatta Main road/ Outer Ring road)
R2d: Bannerghatta Main road (Bannerghatta Main road/Outer Ring road) ->Bannerghatta Main road (Bannerghatta Main road/Swagath road)
R2e: Bannerghatta Main road (Bannerghatta Main road/Swagath road) -> Hosur Main road-> KH road (KH road/Hosur Main road)
R2f: KH road (KH road/Hosur Main road) -> Lal Bagh road -> Raja Ram Mohan Roy road (Raja Ram Mohan Roy road/ Kasturba road)
R2a
R2f
R2e
R2b
R2d
R2c



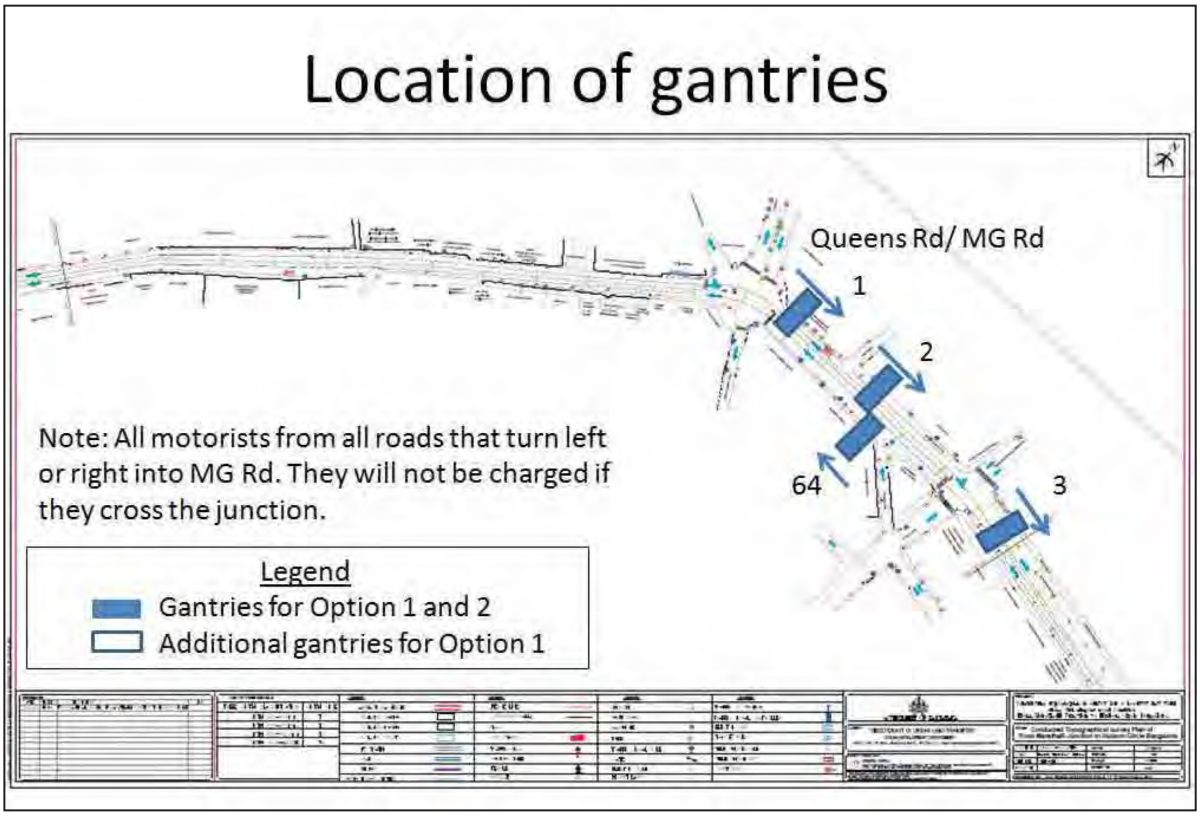
Requirements for Classified Traffic Counts

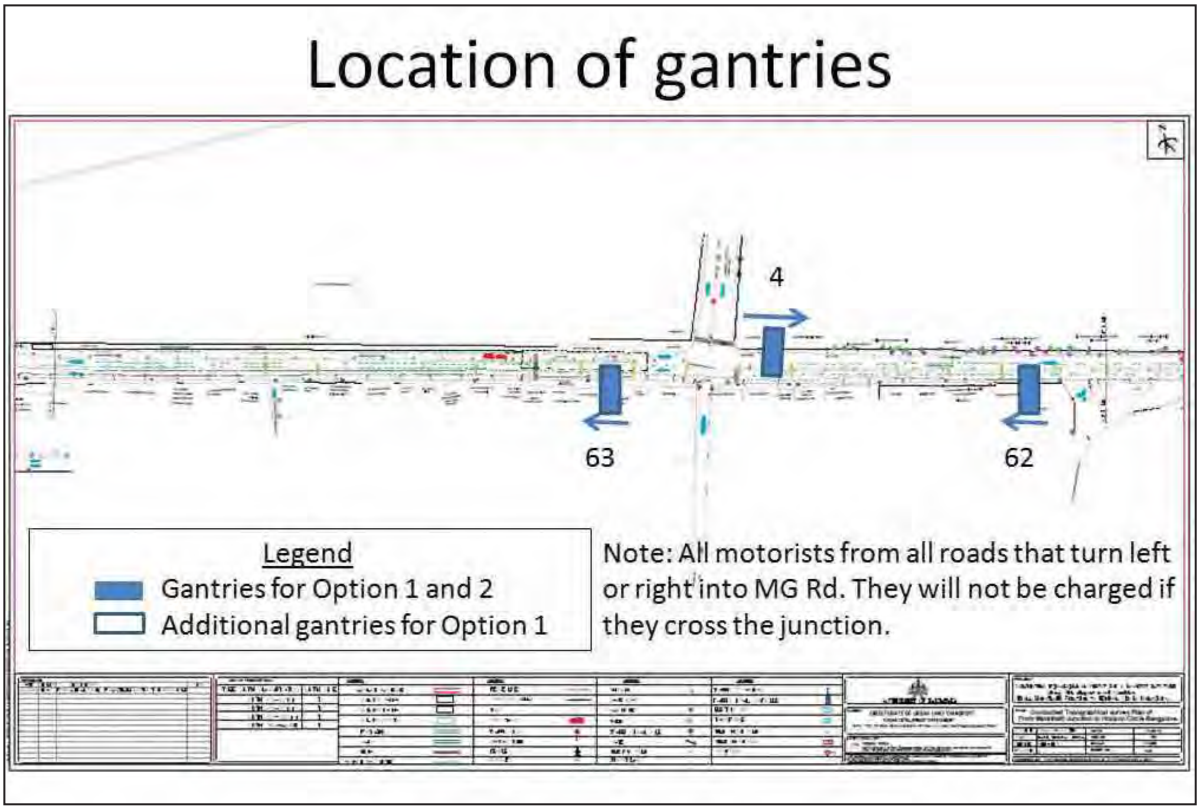
1. Survey Dates: 1 Weekday(Tues – Thurs), 1 Fri
   Non-public holidays, non- eve of public holiday
2. Time Period: 9am to 7pm
3. Classified the vehicle counts into the following
   a) Motorcycles
   b) Auto
   c) Cars/ Taxi
   d) Buses
   e) Light Goods Vehicles
   f) Heavy Goods Vehicles
   g) Others (military vehicles)
4. If there is Flyover or underpass, please carry out the counts for all of them. That is, at grade counts, flyover and underpass counts and slip roads
5. Apart from counting the number of buses, we will need the surveyors to indicate the occupancy for each public bus on the candidate road (whether its occupancy is empty, quarter full, half full, three-quarter full or full) and count them in term of these 5 categories.
6. Apart from counting the number of heavy goods vehicles, we will need the surveyors to indicate if the heavy goods vehicle is empty or loaded with goods and count them in term of these 2 categories.


L1: Hosur road between Berlie Street and Anepalya Main road
L5: Lower Agaram road between Ejipura Main road and 8th Main road
L3: KH road between BTS Bus Depot road and Andree road
J3: 80 Feet Main road/ 100 Feet Main road
J2: Bannerghatta Main road/Hosur Main road
J1: Sarjapura Main road/ Hosur road
L6: Sarjapur Main road between 14th Main road and 1st B Main road
L4: Bannerghatta Main road between 39th cross road and Outer Ring road
L2: Hosur road between Outer Ring road and Madiwala road

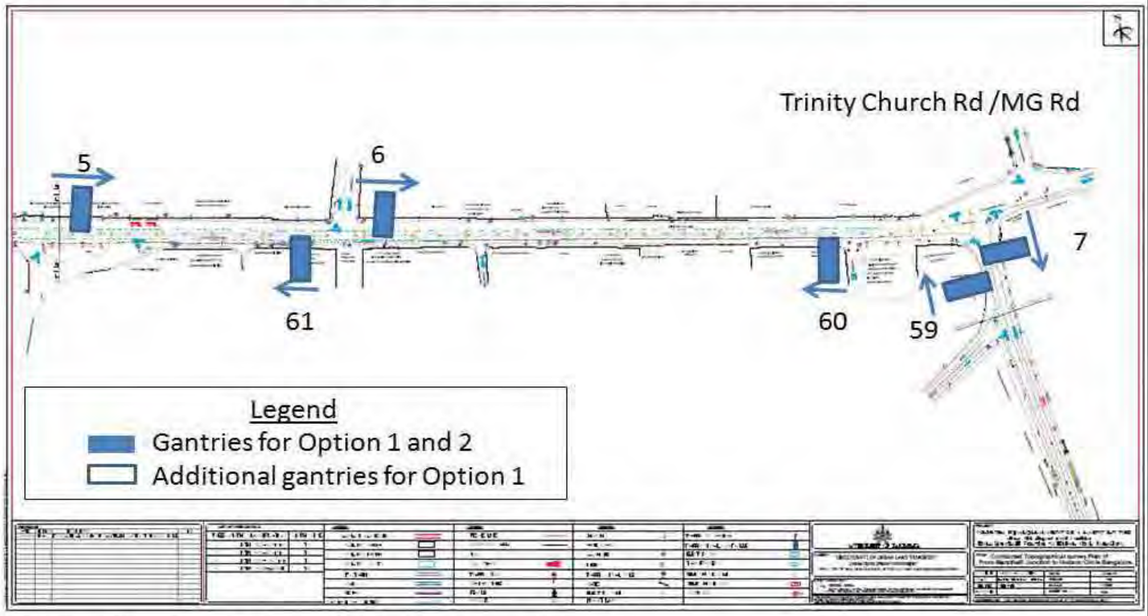
Appendix E

MG Rd- HAL Airport Rd



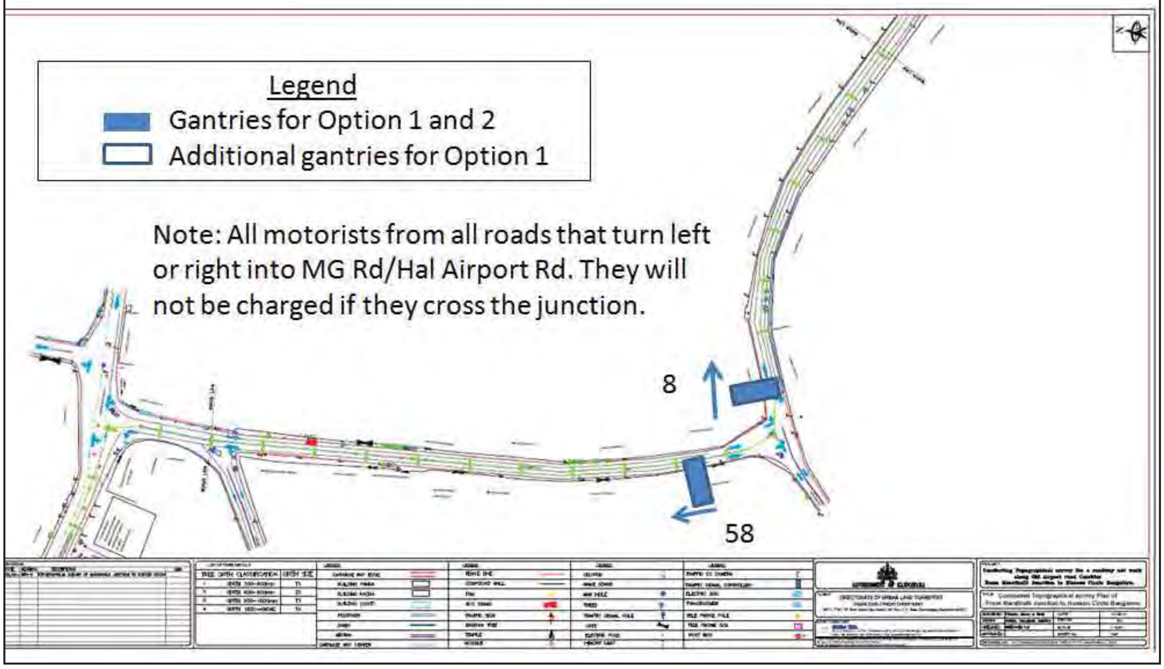


Location of gantries

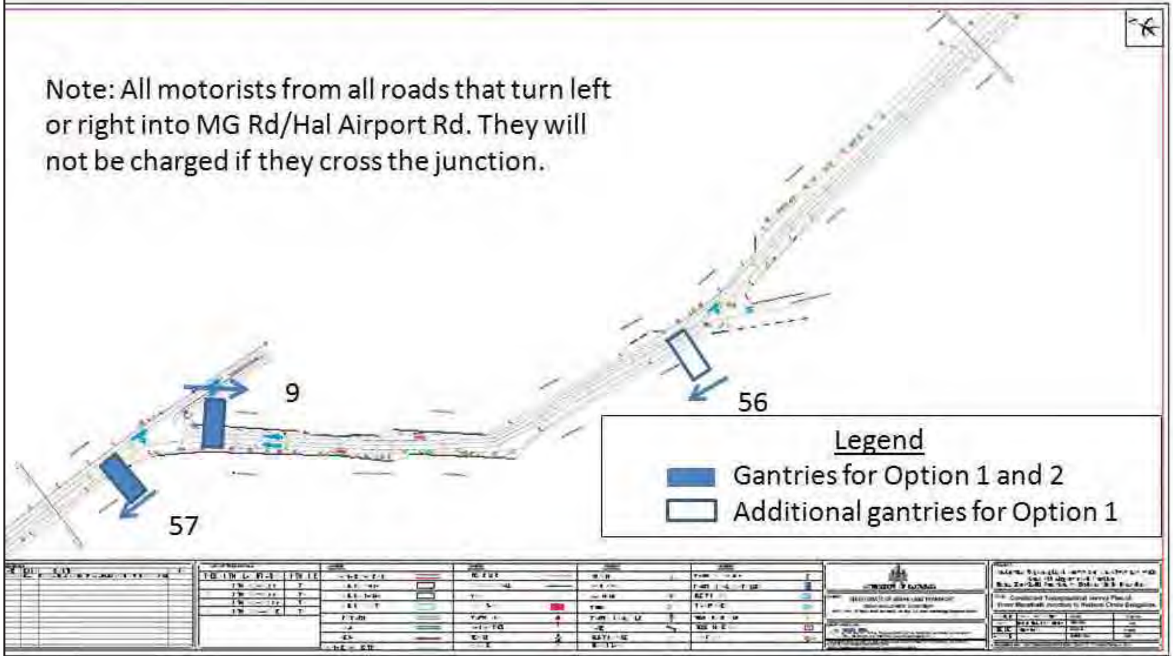


Note: All motorists from all roads that turn left or right into MG Rd/Hal Airport Rd. They will not be charged if they cross the junction.

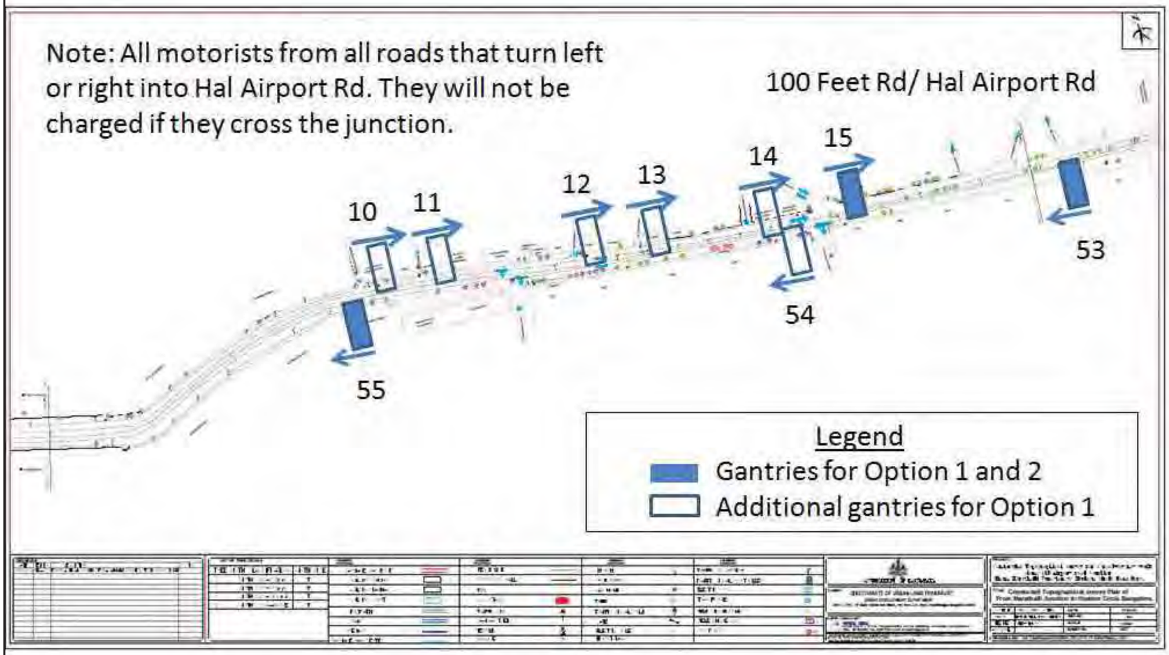
Location of gantries



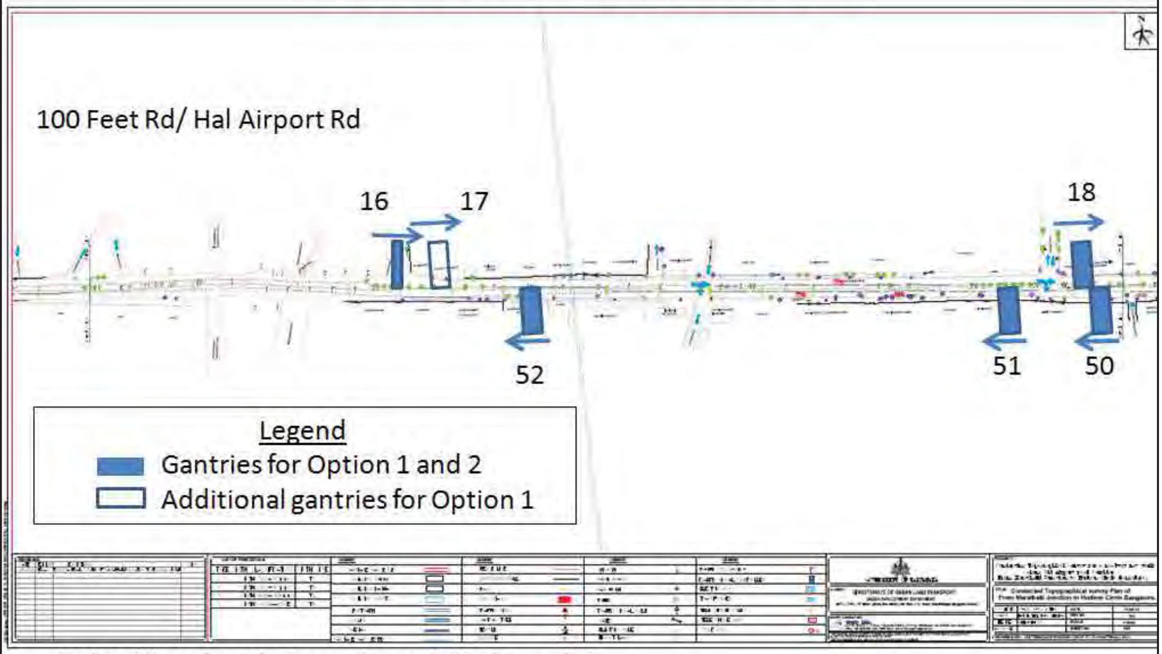
Location of gantries



Location of gantries

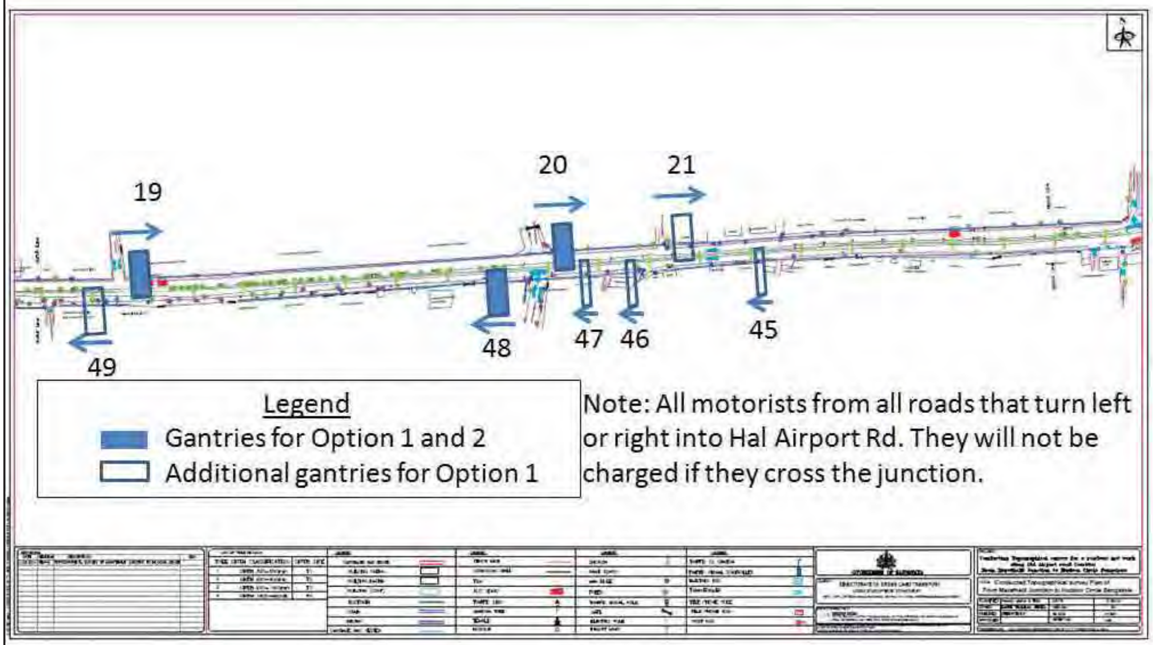


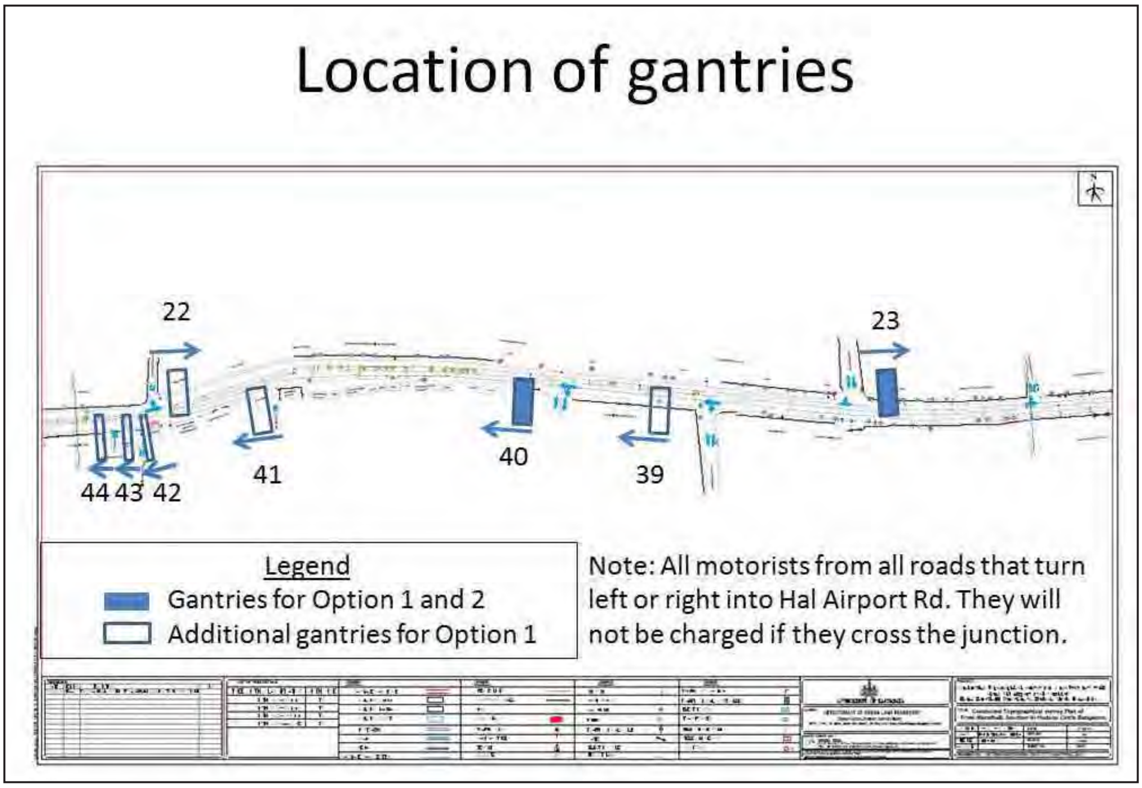
Location of gantries

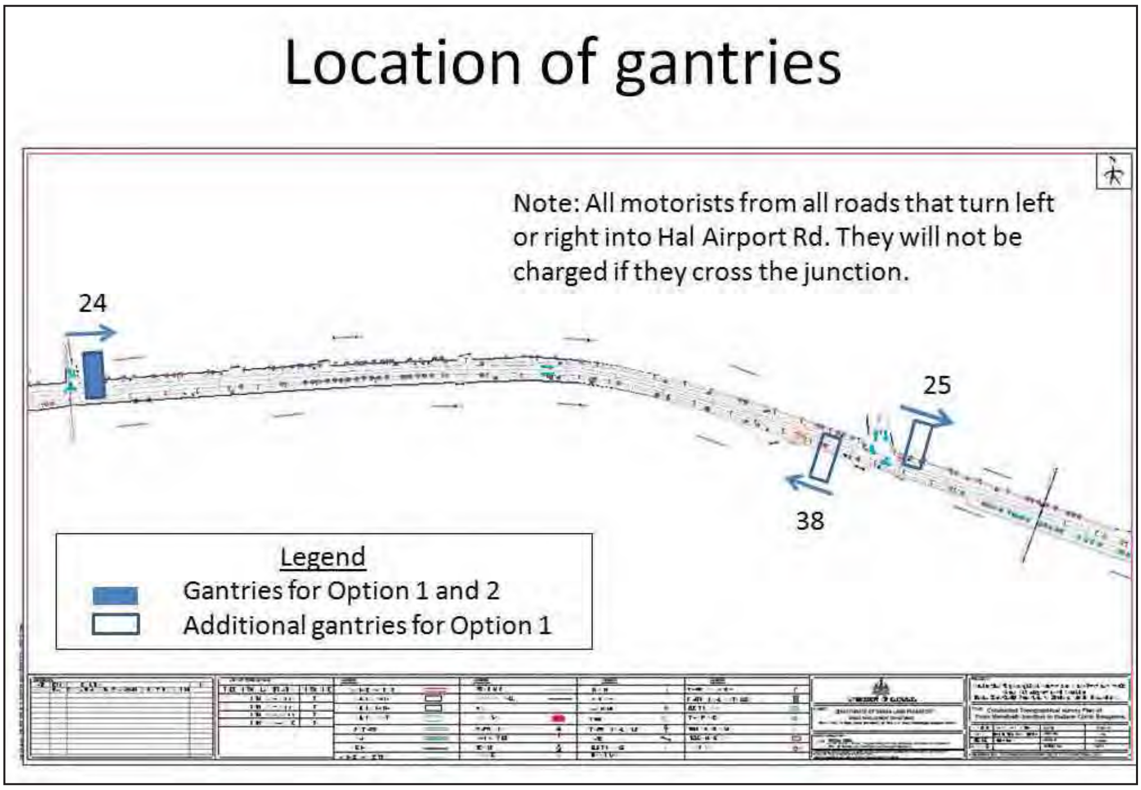


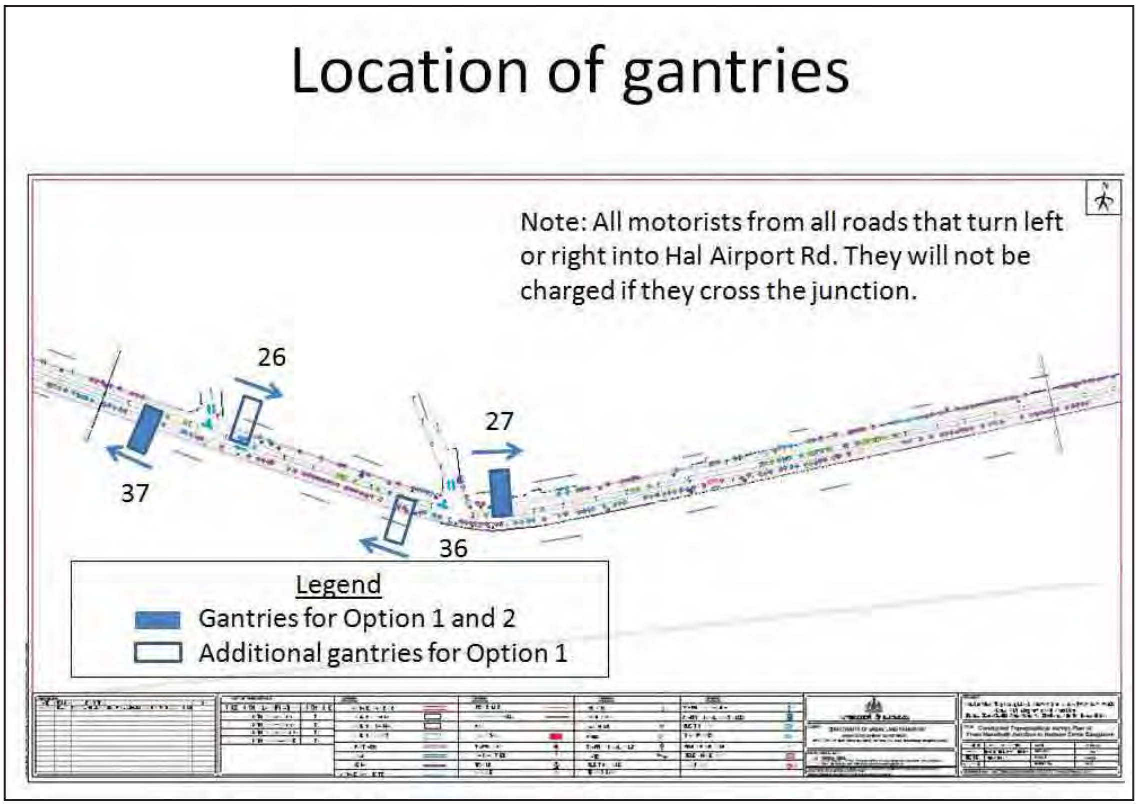
Note: All motorists from all roads that turn left or right into Hal Airport Rd. They will not be charged if they cross the junction.

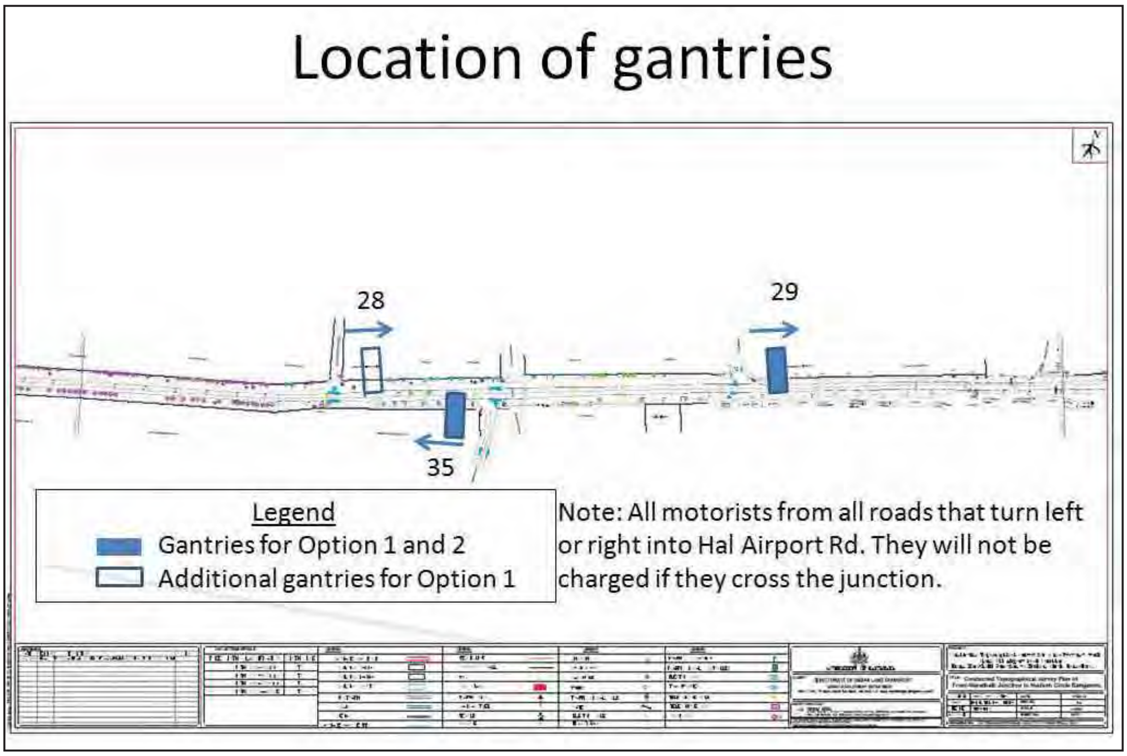
Location of gantries

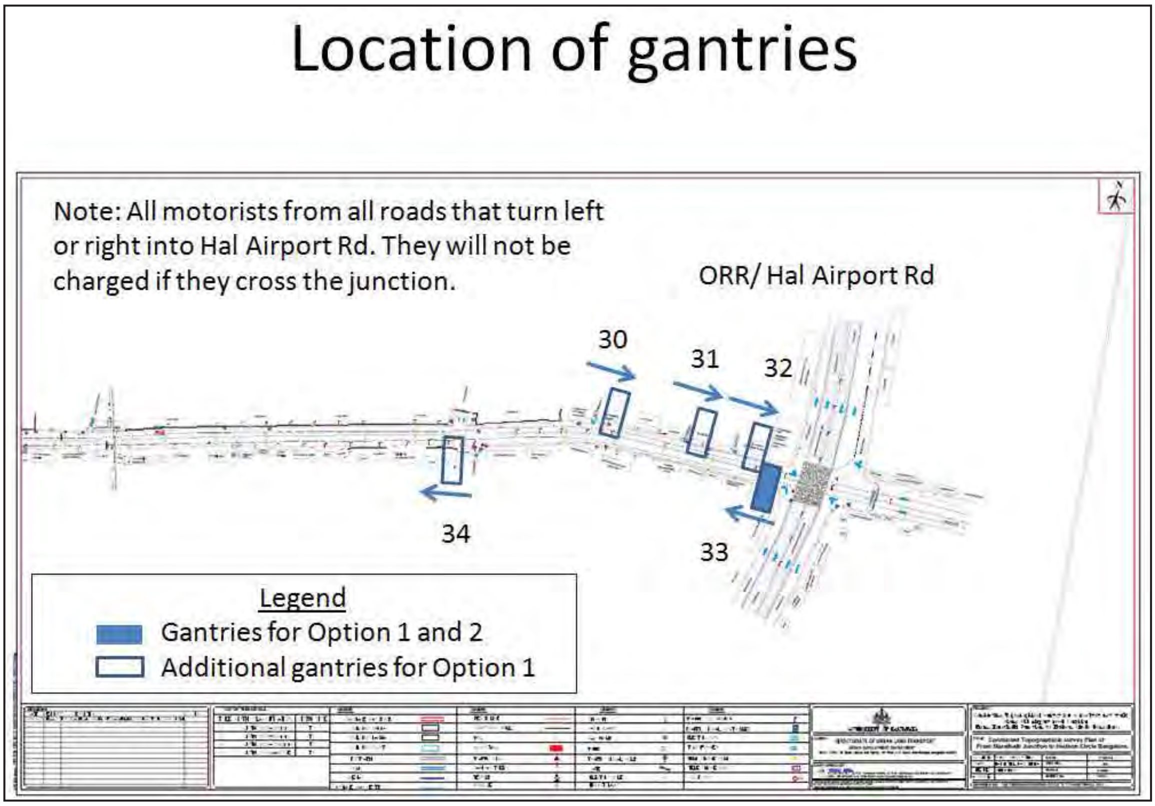



Location of gantries
22
23
44 43 42
41
40
39
Legend
Gantries for Option 1 and 2
Additional gantries for Option 1
Note: All motorists from all roads that turn left or right into Hal Airport Rd. They will not be charged if they cross the junction.


Location of gantries
Note: All motorists from all roads that turn left or right into Hal Airport Rd. They will not be charged if they cross the junction.
24
25
38
Legend
Gantries for Option 1 and 2
Additional gantries for Option 1

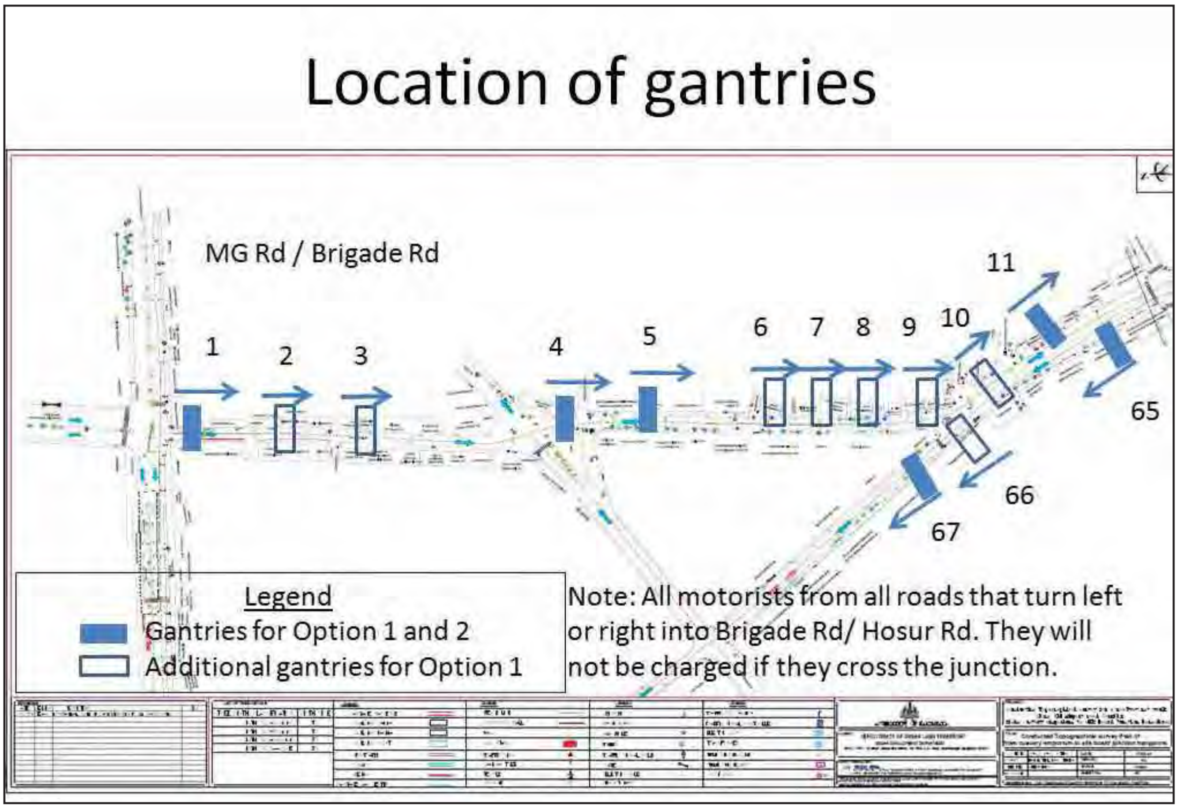

Location of gantries
Note: All motorists from all roads that turn left or right into Hal Airport Rd. They will not be charged if they cross the junction.
26
27
37
36
Legend
Gantries for Option 1 and 2
Additional gantries for Option 1

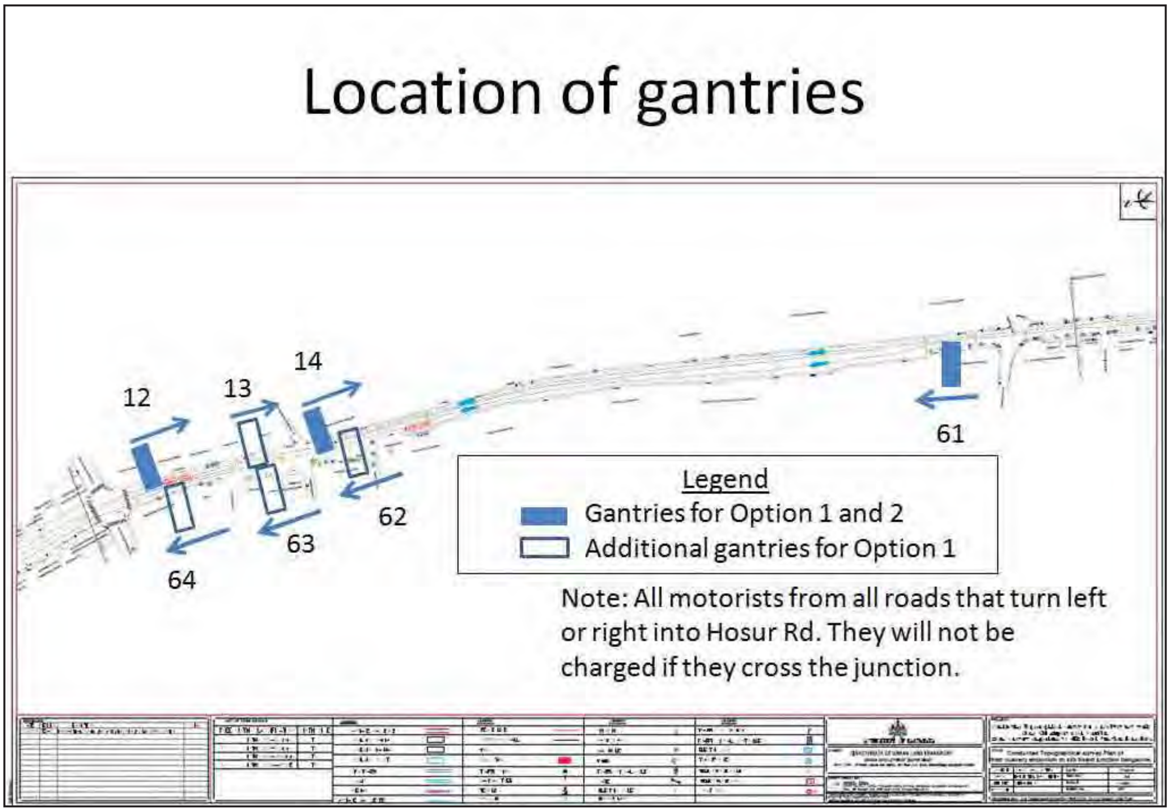

Location of gantries
28
29
35
Legend
Gantries for Option 1 and 2
Additional gantries for Option 1
Note: All motorists from all roads that turn left or right into Hal Airport Rd. They will not be charged if they cross the junction.


Location of gantries
Note: All motorists from all roads that turn left or right into Hal Airport Rd. They will not be charged if they cross the junction.
ORR/ Hal Airport Rd
30
31
32
33
34
Legend
Gantries for Option 1 and 2
Additional gantries for Option 1

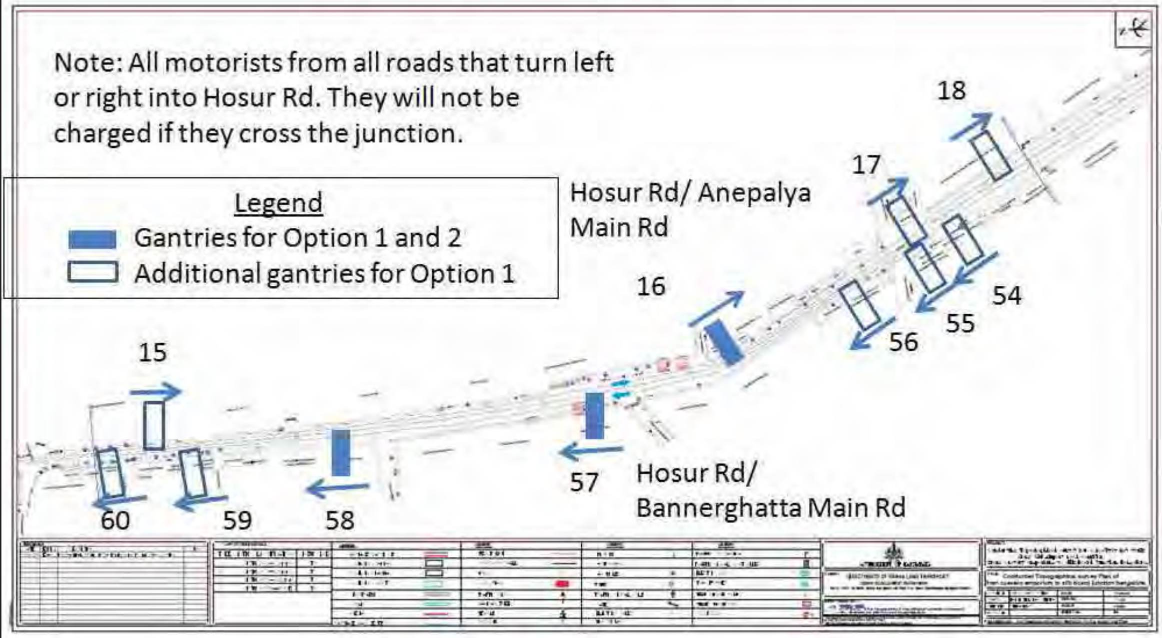
Appendix E

Hosur Rd

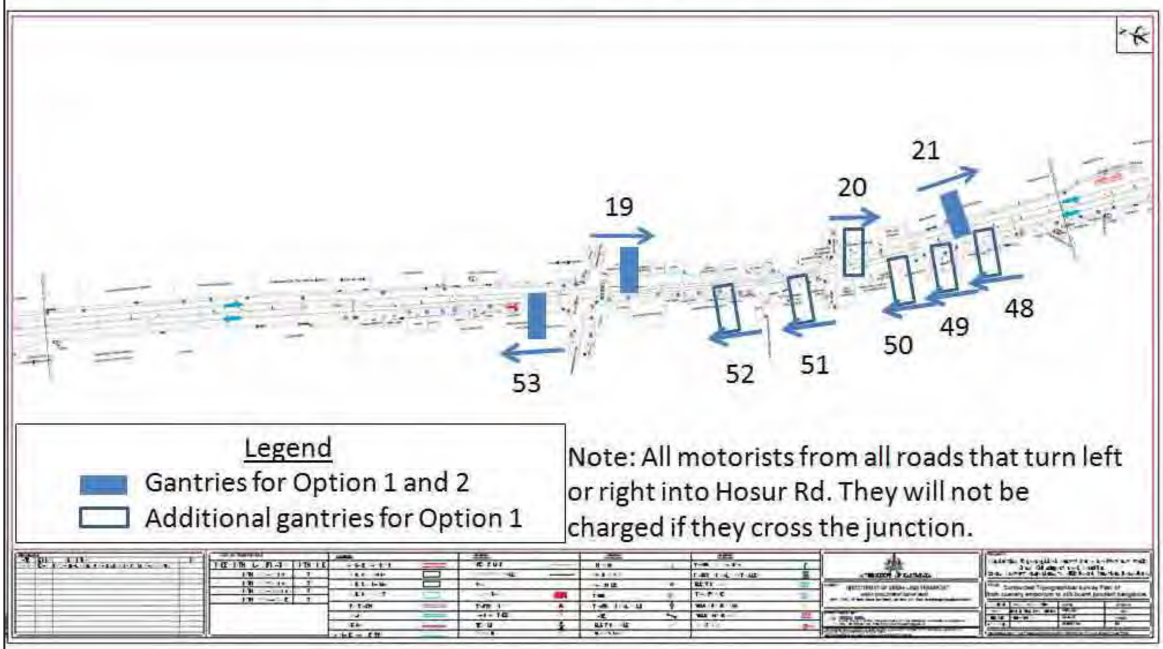




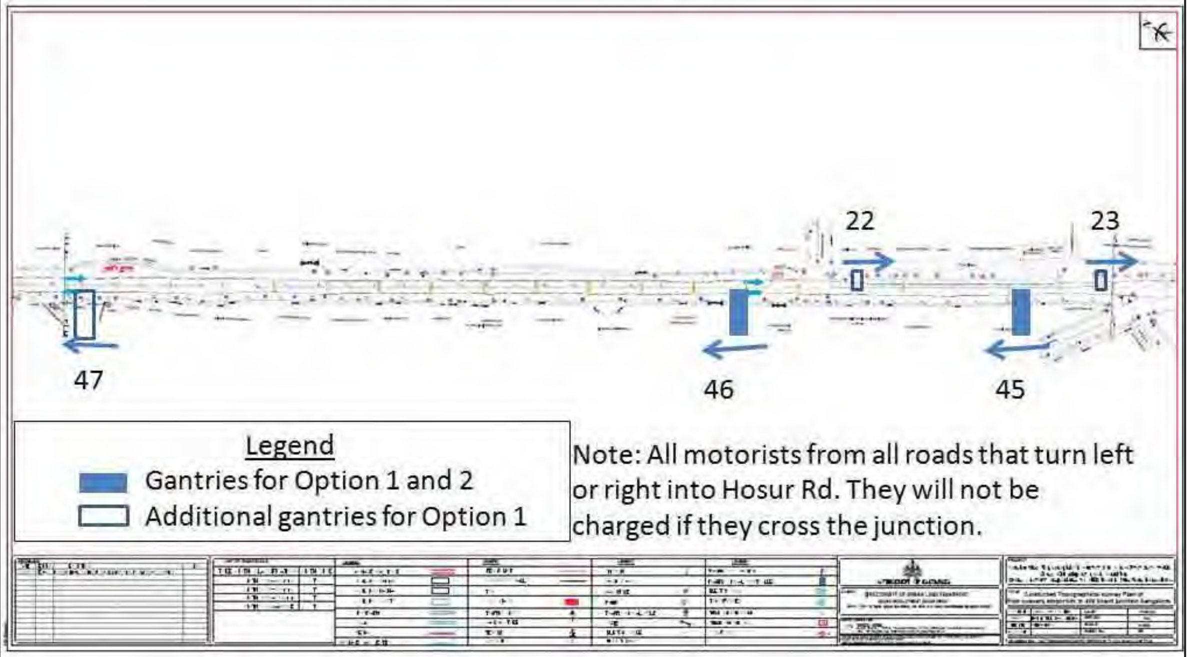
Location of gantries



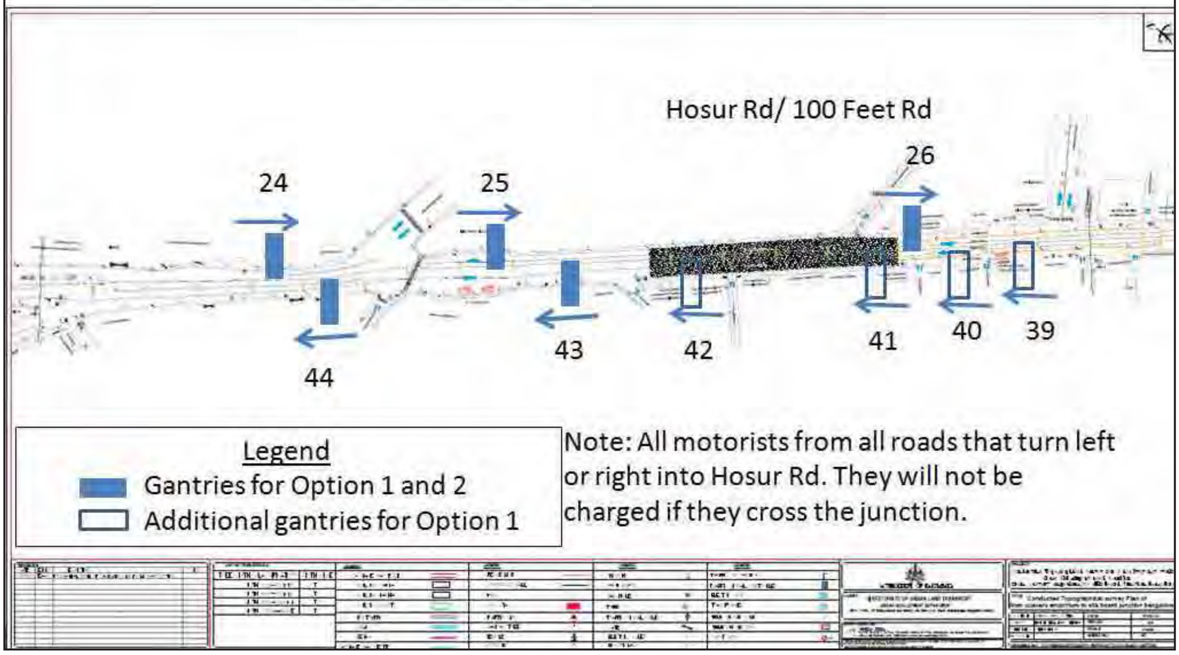
Location of gantries



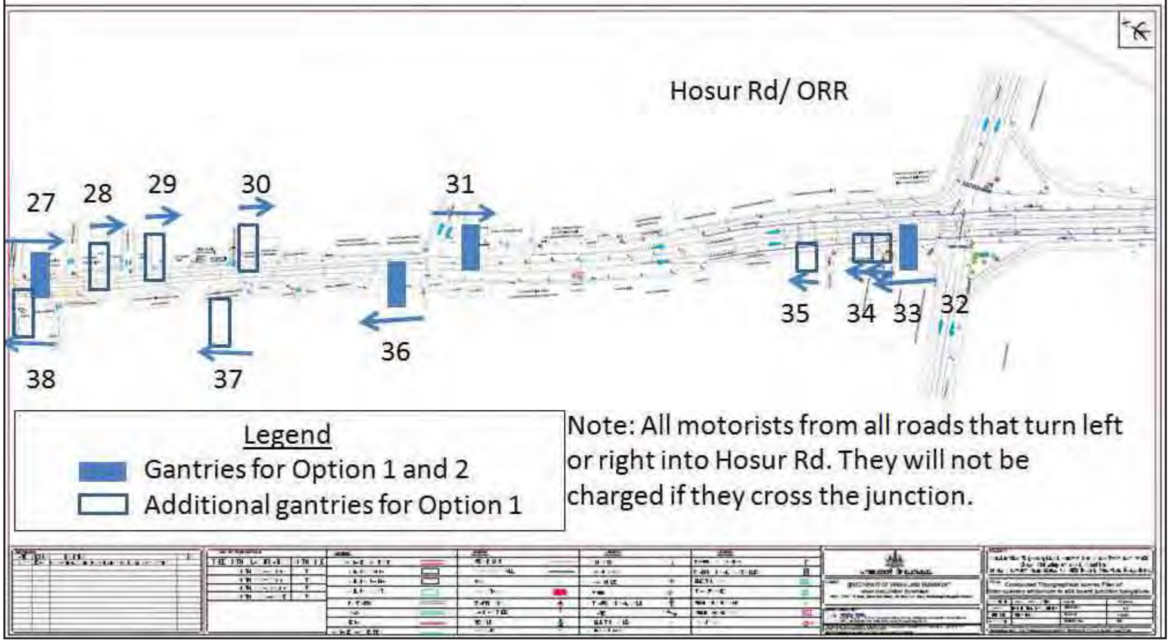
Location of gantries



Location of gantries

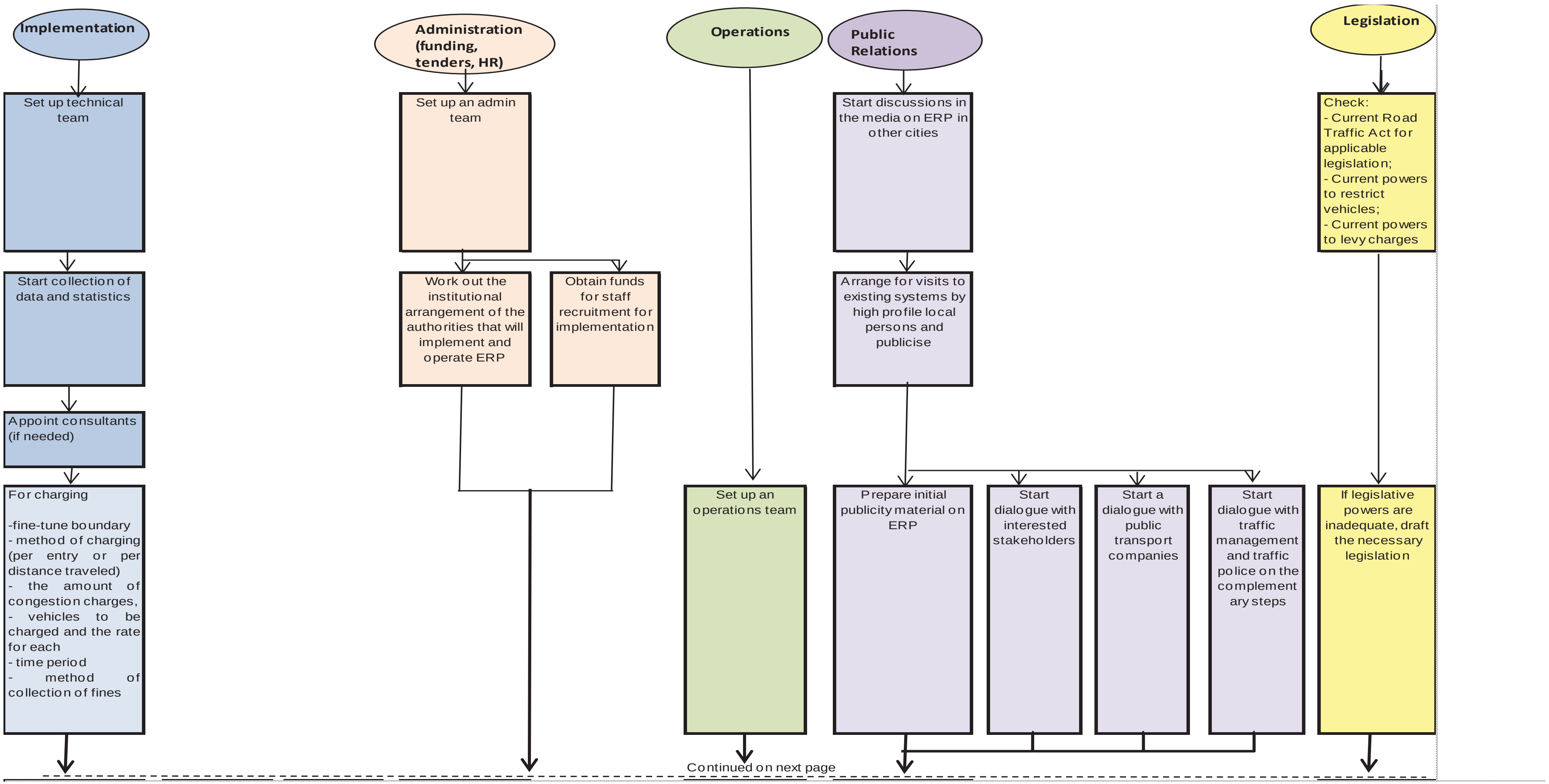


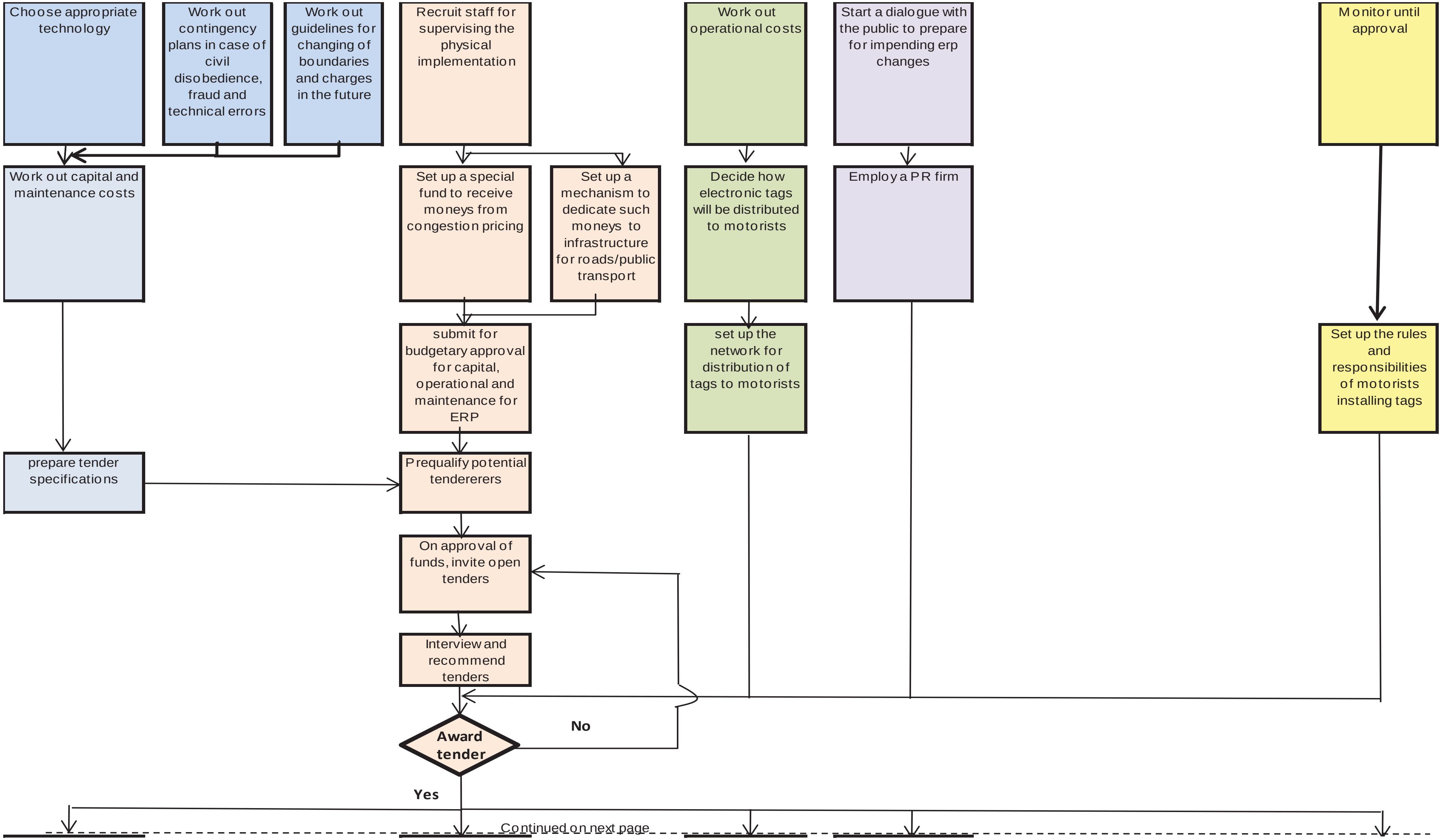
Location of gantries



Appendix F - Steps for implementation of congestion pricing

Set up a High Level Steering Committee (option 2 in Appendix F - Government with operations contracted out)





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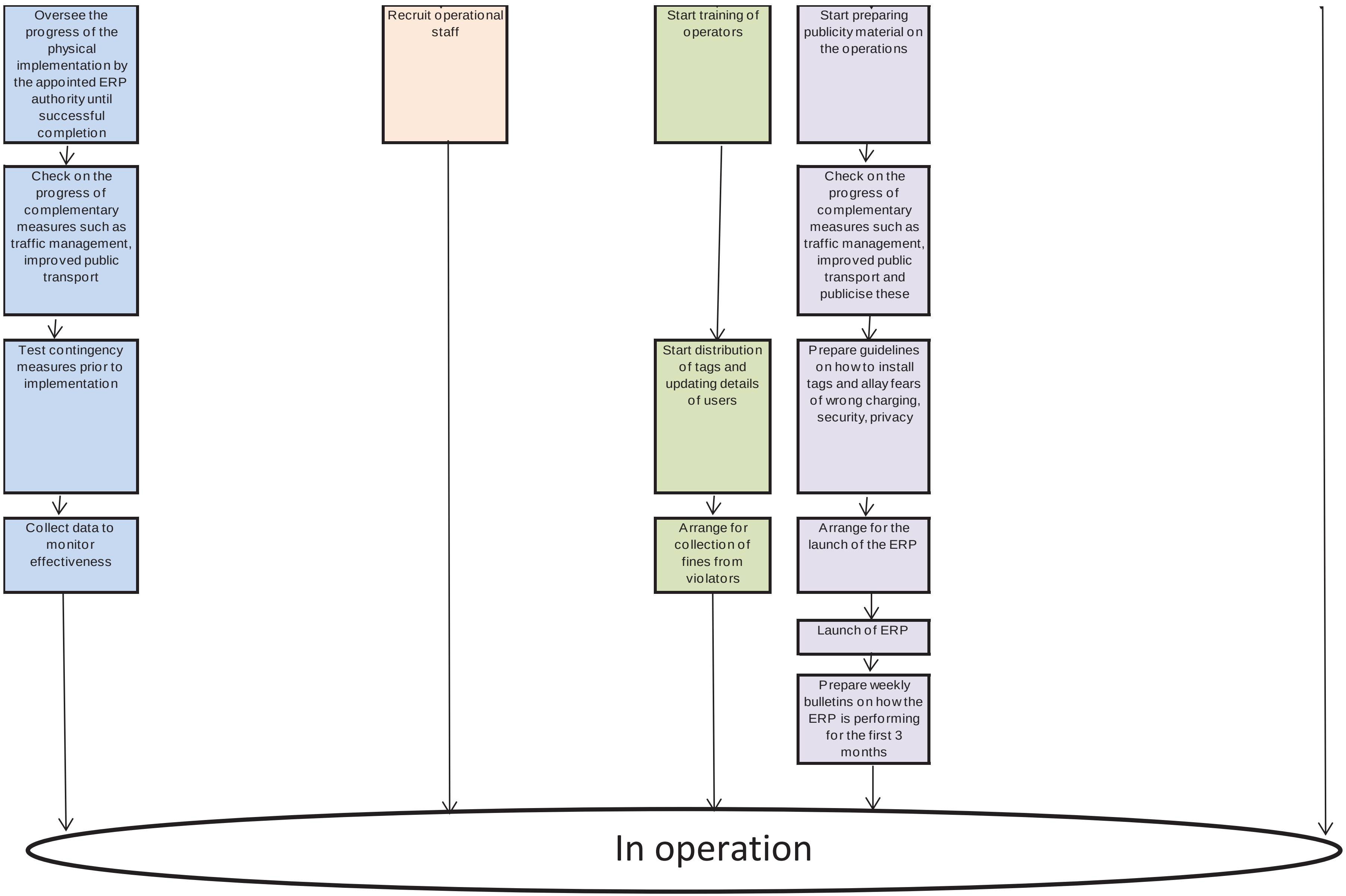
Oversee the progress of the physical implementation by the appointed ERP authority until successful completion
Check on the progress of complementary measures such as traffic management, improved public transport
Test contingency measures prior to implementation
Collect data to monitor effectiveness
Recruit operational staff
Start training of operators
Start distribution of tags and updating details of users
Arrange for collection of fines from violators
Start preparing publicity material on the operations
Check on the progress of complementary measures such as traffic management, improved public transport and publicise these
Prepare guidelines on how to install tags and allay fears of wrong charging, security, privacy
Arrange for the launch of the ERP
Launch of ERP
Prepare weekly bulletins on how the ERP is performing for the first 3 months
In operation

Appendix G

Feedback when congestion pricing was introduced in Singapore

1) In 1975 when the Manual System was implemented, which needed a paper area license to enter the CBD, the following issues surfaced from the public.

2) The opinions on the scheme:

a) The scheme is revenue-oriented
b) The better-off motorists will pay for the license and continue to drive into the CBD. The less-well-off will be the ones affected
c) Business in the CBD will be greatly affected
d) Will increase the cost of living
e) Traffic jams will shift elsewhere from CBD

3) The appeals were:

a) Request exemption from the licence fees (e.g doctors)
b) b) Exclude their area from the restrictions
c) c) Postpone the scheme until the bus services improve

4) The general responses that were given by the government were:

a) The scheme is to induce change in travel habits.
b) The license fee is not for revenue but to act as a disincentive to induce changes in travel habits
c) The scheme will have minimum disruption to businesses because of the careful selection of restricted hours
d) In fact businesses will benefit through less congestion and ease of parking at destinations
e) Accessibility to the CBD is assured at all times- only the mode of travel – the space-using under-utilized private vehicles are discouraged during the peak hours
f) All steps will be taken to improve bus services

5) When the ERP was introduced in 1998, there were still some grumbles about the need for congestion pricing, but the main feedback was on the reliability of the technology. The ERP required all vehicles who wanted to enter the CBD to have an on-board unit (similar to an electronic tag)

a)Will the motorist be penalised if the system failed and he was considered as a violator?

Violators will be penalised, but those with errors will only have to go for an inspection. The system will be able to distinguish between violations and errors

b) Are the radio frequency radiations from the ERP gantry harmful?

The radiated power from this antenna is very much less than what is allowable by the International Agencies on Radiation Protection.

c) Will vehicle movements be tracked?

Information on valid transactions and hence on the vehicles that passed under each gantry will be kept only as long as they are required to settle the claims. There are also strict controls on who would have access to such information. .

d) What would happen if the electronic tags (especially on motorbikes) are vandalised or stolen?

Stolen tags will be invalidated once a police report is made. . As for vandalism, this would be the responsibility of the motorist himself, as with any other part of his vehicle's equipment.

Appendix H

Options for congestion pricing implementation

	Option 1 Totally government	**Option 2** Government with operations contracted out	**Option 3** Private partner
Policy announcements	Government	Government	Government
Choice of partner	NA	NA	By negotiations from a series of potential companies
Construction financed by	Government	Government	Private company partner
Legislative framework by	Government	Government	Government
Design	Government staff + (consultants if needed)	Government staff + (consultants if needed)	Partner with government oversight
Choice of vendor	By tenders	By tenders	Partner appoints vendor with government approval
Completion by	Successful tenderer (appointed by government)	Successful tenderer (appointed by government)	Successful tenderer (appointed by partner)
Supervision of work by	Government staff + (consultants if needed)	Government staff + (consultants if needed)	Partner
Maintenance	Successful tenderer with government supervision (Government staff unable to maintain specialized systems)	Successful tenderer with government supervision	Partner may have own arrangements subject to government approval
Maintenance financed by	Government	Government	Partner
Public relations	Government	Government	Partner with key messages from Govt.
Operations	Government	Contracted out	Partner

	staff	with government oversight	
Operations financed by	Government	Government	Partner
Change of areas, times , rates	Decided by government	Decided by government	Decided by partner subject to approval by government
Imposition of fines for violations by and payment to	Government	Government	Partner
Method of payment by government	Staff salaries	Annual contract amount based on meeting contractual requirements of performance	None
Revenue from ERP to	Government	Government	Partner (sanctioned by government)
Revenue can be used by government for	Transport projects	Transport projects	Not available (or a small sum if government collects a license fee from partner)
Public complaints and feedback response by	Government	Government	Partner with guidance from government

The three possible ways by which the ERP project can be handled are shown in the table. First, a comparison is made between Options 1 (totally government) and Option 3 (private-public partnership)

Congestion pricing is a sensitive topic. Government has to take the lead and also the complaints on the subject as in Option 1. Most road users will see it as a ploy to collect revenue because it is applied to existing roads (as against toll roads which are new). So if it is given out as in Option3, it might be seen as the government letting the private sector makes profits from existing roads. Government will also have no access to the revenue from congestion pricing to improve other transport services. There may be no takers for Option 3 unless the private company expects to make some profits and this can only be done by way of the ERP charges. So if the revenue falls, there may be pressure from the private company to raise the ERP charges. ERP by its nature is trying to dissuade motorists from entering the city, which is diametrically opposite to what a private company wants.

In Option 3 is that government does not have to fork out any money. There will be less political interference, less bureaucracy and the project will be completed in a shorter time frame.The partner is likely to ensure that the project design takes into consideration, maintenance, operational and lifecycle costs making it more cost-effective. The private company will have more incentives to ensure payments, chase bad debts and collect fines because it affects their profitability-hence better effectiveness.

Option 2 is an in-between option. Government contracts out maintenance and operations for a fee. The performance indicators can be specified and some incentives and penalties on the fee imposed for better than expected service and worse than the expected service. The hire and fire of employees which is more onerous in government service can be overcome with the contracting out. Also high turnover of staff is better handled by the contracted party than by government. Government does not wash its hands on the project because there is a better oversight on all activities unlike in Option 3.

Option 2 is the recommended method for congestion pricing for Bengaluru CBD.

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(Centre for Transport Studies, Royal Institute of Technology, SE-100 44 Stockholm)

Appendix - 2

ITS Opinion Survey Report (Bengaluru)

The Master Plan Study on ITS in Bengaluru

ITS Opinion Survey Report

Submitted to

JICA Study Team

Submitted by

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Group of Educational Institutions

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UNIT 1

MOTORCYCLE USERS

PART I: GENERAL INFORMATION

A total of 150 motorcycle users were interviewed in the survey. An interview sheet was prepared in this regard. The surveyors randomly distributed interview sheet to motorcycle users at various locations in Bengaluru. Locations such as commercial areas, parking places, shopping malls, busy streets, residential and industrial areas were given prime focus where more motorcycle users were present. Some of the major locations where the motorcycle user survey carried out are listed below.

- Jayanagar
- Banashankari
- Marathahalli
- Madiwala
- Forum mall
- Cunningham Road
- Gopalan Mall, Mysore Road
- BTM Layout
- UB City, Vittal
- Shanthinagar
- M G road
- Garuda mall
- Mekri Circle
- Koramangala
- Commercial Street
- Mantri Square, Malleshwaram
- Hebbal
- Sivaji Nagar

Appendix-X：ITS Opinion Survey Questionnaire for motorcycle users should be referred for the details. The response of the users was collected on the spot. The following sections describe the results of motorcycle users survey.

MOTORCYCLE USERS PROFILE

A total of 150 motorcycle users were interviewed. Details of interviewee's sex, age, job and monthly salary are listed below.

Of the 150 motorcycle users interviewed, 66% were male and 34% were female. Majority of them were in the age group of 20-29 and 30-39. The job profile varied widely, most of them being professionals (27%) and engineers (23%). The monthly salary were mostly in the ranges of INR 10,000 – 19,999 to INR 30,000 to 49,999. The age details of motorcycle users are listed in table 1.

Table 1: Age Details of Motorcycle Users

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Male	1%	19%	31%	11%	4%	-	66%
Female	-	16%	16%	1%	1%	-	34%

The job profiles of the users are as follows: 23% engineers, 27% professionals, 19% administrative jobs, 17% service/sale jobs. Only a few of them were students (12%); another 2% were non working people (retired/housewife/jobless). The details are shown in figure 1.

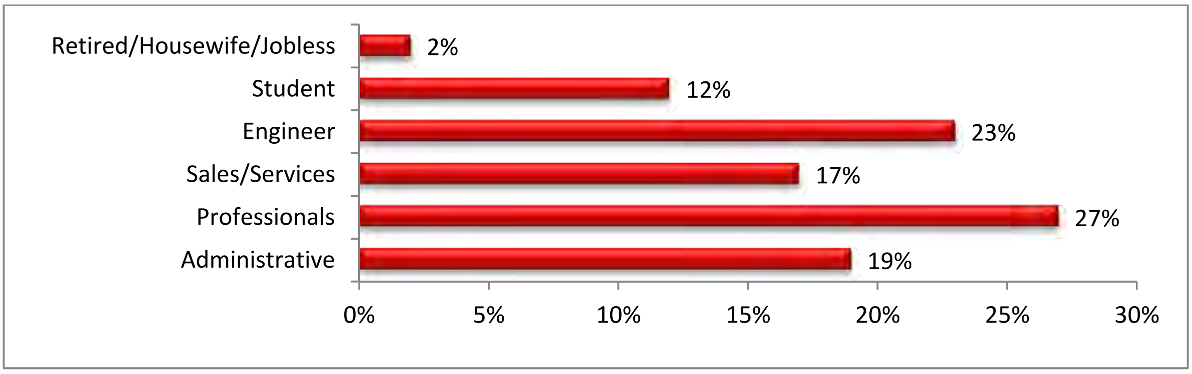


Figure 1: Job Profile

The monthly salaries of the users are listed in figure 2. The monthly income of motorcycle users were mostly in the medium ranges.

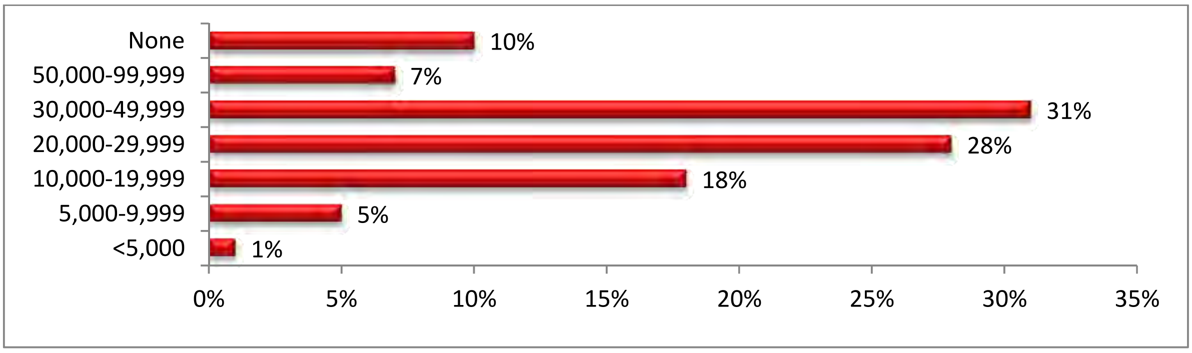


Figure 2: Monthly Salary Profile

FREQUENCY OF TRIPS

The motorcycle users were asked for number of trips made per week. Users responses are listed below.

- 87% travelling 5-7 days per week
- 2% travelling 3-4 days per week
- 1% travelling 1-2 days per week

PURPOSES OF THE TRIPS AND TRAVEL TIME

Users were asked about the purpose of their trip and the average travel time taken to reach destination. The analysis revealed that majority of them is regular commuters with an average travel time of 30-59 minutes.

Figure 3: Trip Purposes

It is observed that 89% of trips were regular trips, travelling to office and work places.

The average travel time of the motorcycle users is shown in figure 4. The majority traveled an average of 30-59 minutes to reach their destination. The percentage of users traveling both short duration (less than 15 minutes) and very long duration (>60 minutes) was observed to be less.

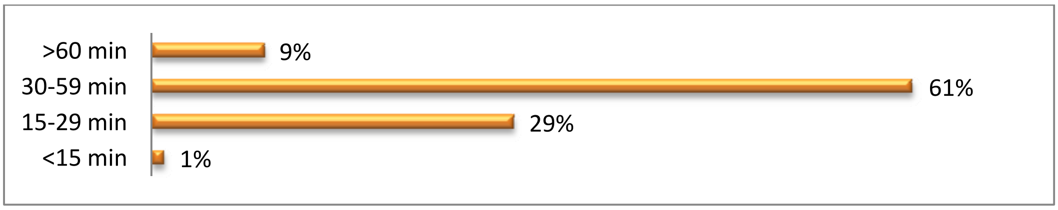


Figure 4: Average Travel Time Distribuition

REASONS FOR NOT OPTING FOR PUBLIC TRANSPORT

Users were asked for the reasons for not using public transport vehcicles. Two major reasons mentioned were inconvenience and long travel time.

57% responded that public transport system is not conveient for daily commuting and 42% responded that the travel time would be more in public transport compared to private vehciles.

Few of them, 1% responded that the public transport system is not clean. The results are shown in figure 5. This clealrly explains the need of improvement of public transport in Bengaluru.

Figure 5: Reasons for Not Using Public Transport

PARKING FACILITY AND WILLINGNESS TO PAY

Motorcycle users were asked about type of parking facilities used and the amount they paid as one time parking charges. The majority used the alloted parking lots available at offices/schools. Use of roadside parking and private off-road parking was less. The responses are shown in figure 6.

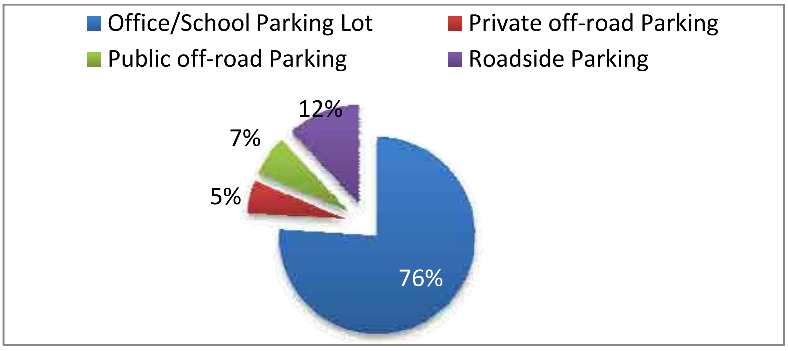


Figure 6: Responses of Motorcycle Users on Parking Facility

Most of the motorcycle users are paying INR 5 as parking charge for one time. Users response for parking charges are shown in figure 7.

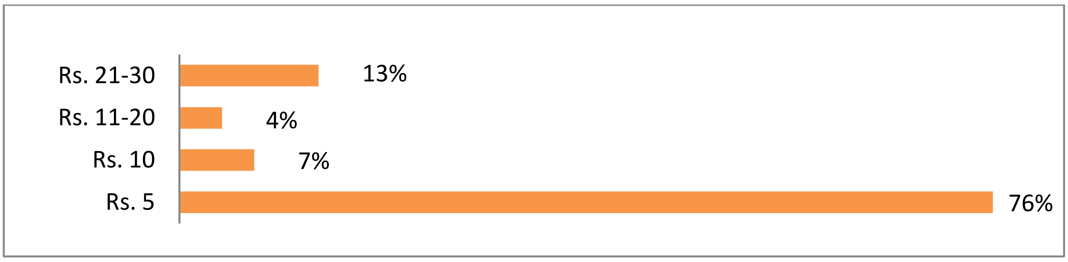


Figure 7: Responses of Motorcycle Users for One Time Parking Charge

TRANSFER TO/FROM OTHER MODES

This analysis was carried out to understand the mode shift from motorcycle to other transport modes. The results are shown in figure 8. Few users changed to other transport modes such as bus/metro to reach their destination.

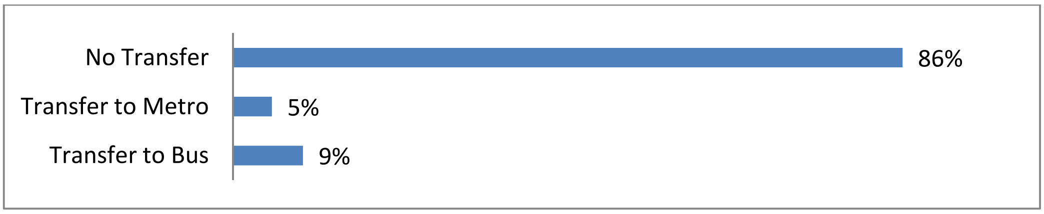


Figure 8: Responses of Motorcycle Users on Transfer to Other Modes

PART II: INTELLIGENT TRANSPORTATION SYSTEM

SOURCE OF CONGESTION INFORMATION AND CURRENT TRAFFIC INFORMATION FACILITY

This analysis is carried out to understand the current traffic congestion information facility in Bangalore.

65% responded that they are not receiving information on traffic congestion. 35% responded they are, and mentioned the following sources of congestion information.

- Radio – 25%
- Variable Message Sign Boards – 8%

- Mobile Phone – 1%
- Internet – 1%

The opinion of users on current traffic information facility is summarized in figure 9.

52% were unhappy and responded that it is not helpful. On the other hand, 17% responded as helpful. 31% expressed that they are not aware of such facility it and responded as don't know.

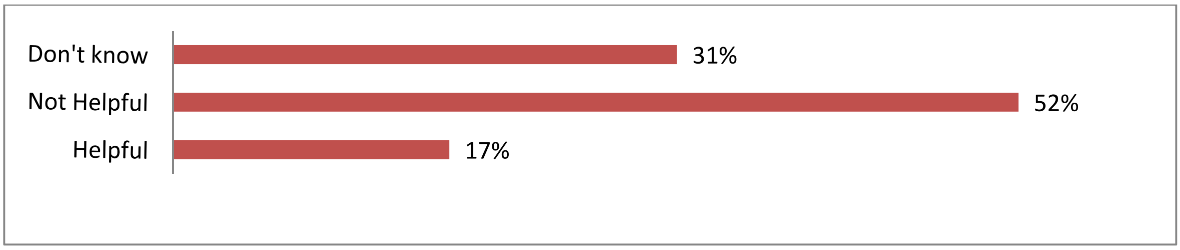


Figure 9: Opinion on Current Traffic Congestion Information Facility

TYPES OF TRAFFIC INFORMATION REQUIRED

Users were asked on required traffic information. Five types of traffic information were suggested and the response was collected for the following four categories:

- Very Helpful
- Helpful
- Not Helpful
- Don't Know

The responses of users for the required traffic information are listed in the following table.

Table 2: Response for Traffic Information Required

Type of Traffic Information Required	Very Helpful	Helpful	Not Helpful	Don't Know
Congested Location Information	37%	63%	-	-
Length of Congestion Information	8%	72%	15%	5%
Expected Travel Time Information to Reach Destination	17%	79%	3%	1%
Alternative Route Information	34%	65%	1%	-
Traffic Incident Information	15%	46%	37%	2%

Note: For analysis purposes, only the responses corresponding to 'very helpful' were considered. The percentage responses corresponding to 'very helpful' are shown in figure 10.

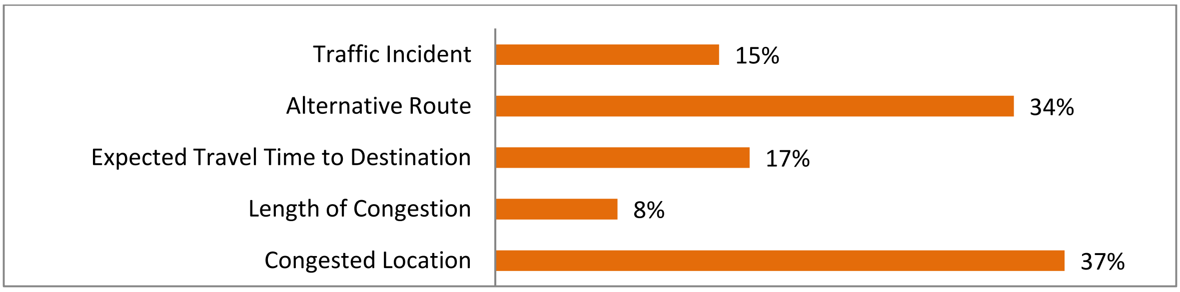


Figure 10: Responses on Required Traffic Information as Very Helpful

Users responded for two major types of information that would be very helpful: congested location and alternative route information. 37% responded for congested location and 34% for alternative route information. Information on traffic incident and expected travel time to reach destination are also supported by many users. Among all the suggested options, length of congestion information was preferred by very few users.

CHOICE ON MODE TO RECEIVE TRAFFIC INFORMATION

Users were asked on their choice of mode to receive the traffic information. The majority replied 'mobile phone' as the preferred mode to receive the traffic information. 44% users responded for mobile phone.

Few motorcycle users responded for combination of suggested modes. 'VMS and mobile phone', 'radio and mobile phone' and 'internet and mobile phone' are some of the choices that motorcycle users responded.

Users responses on their choice of mode to receive traffic information are shown in figure 11.

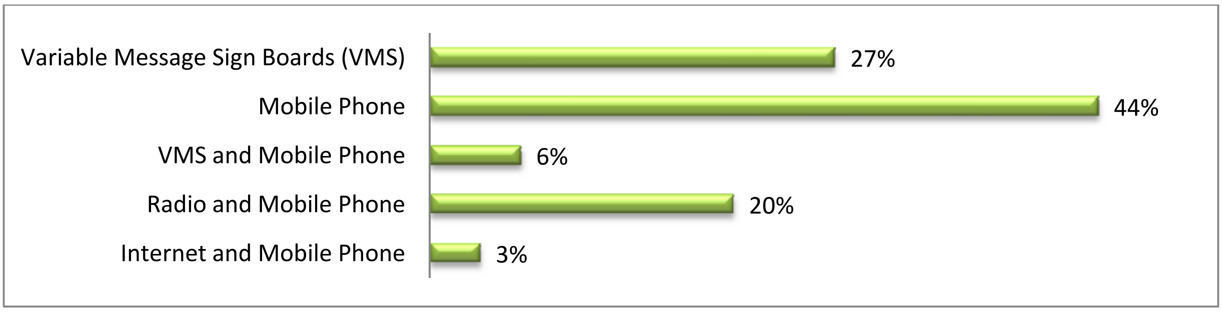


Figure 11: Responses on Choice of Mode to Receive Traffic Information

EXPRESSWAY – PROBLEMS AND IMPROVEMENTS NEEDED

Users were asked about expressway usage, the problems faced and the required solutions. The responses are summarized and listed below.

a) Responses on Use of Expressway:

- 58% of users used expressway
- 42% of users did not use expressway

b) Responses on Problems Faced on Expressway:

Queue at toll gate and lack of traffic information were two major problems that users responded. The responses are listed as follows:

- Queue at toll gate - 40%
- Lack of traffic information - 27%
- Traffic congestion -18%
- Traffic safety -15%

c) Responses on Improvements Needed for Expressway:

Realtime traffic information and common ETC for all toll gates are two major improvements that most of users wanted. Users responses are listed as follows:

- Realtime traffic information - 50%
- Common ETC for all toll gates - 38%
- ETC for motorcycle -12%

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS IN BENGALURU

REASONS FOR CONGESTION

Congestion is the most serious problem affecting all road users in Bengaluru. This section analyses the reasons for congestion and the required measures to be taken to reduce the congestion level.

10 different reasons for congestion were listed in the questionnaire. Users were asked to choose three major reasons among the 10 listed alternatives. Users responses are listed by reason priority in table 3.

Table 3: Responses of Three Major Reasons for Congestion in Bengaluru

Congestion reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	42%	22%	14%
• Too many vehicles	47%	35%	8%
• Inefficient traffic signals	-	1%	3%
• Bad pavement with potholes	3%	22%	23%
• Bump	-	-	2%
• On-street parking	-	1%	-
• Traffic accidents	-	3%	2%
• Bad driving manners	4%	13%	23%
• Too many one-way streets	2%	1%	8%
• Jaywalking pedestrians	2%	1%	2%

Note: Since multiple options were provided for users, the total response may not be 100%.

Increasing number of vehicles and insufficient capacity of roads are two major reasons pointed out by users. Bad pavement condition and driving manners are mentioned as other reasons for congestion.

Figure 12 shows the major congestion reasons along with its response percentage.

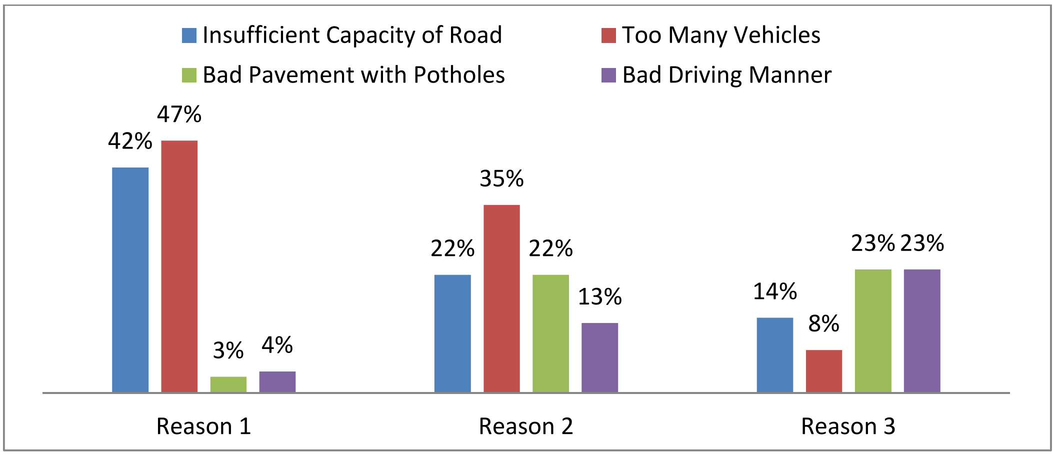


Figure 12: Responses for Congestion Reasons in Bengaluru

TRANSPORTATION SOLUTIONS FOR BENGALURU

Six different solutions for traffic and transportation improvement in Bengaluru were listed in the questionnaire. Users were asked to express their opinion on each of the solution as follows:

- Very Necessary
- Necessary
- May Be
- Not Necessary
- Don't Know

Users responses were analyzed and are listed in the following table.

Table 4: Response for Solutions in Bengaluru

Solutions	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	20%	61%	9%	9%	1%
• Provision of realtime traffic congestion information	8%	77%	15%	-	-
• Improvement of bus and metro service	25%	69%	4%	1%	1%
• Strict enforcement of traffic rules	47%	47%	3%	1%	2%
• Traffic signal improvement	9%	45%	13%	32%	1%
• Provision of traffic congestion information and route guidance	15%	71%	13%	1%	-

Here the analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From table 4, responses corresponding to 'very necessary' and 'not necessary' are selected and shown in the below figure.

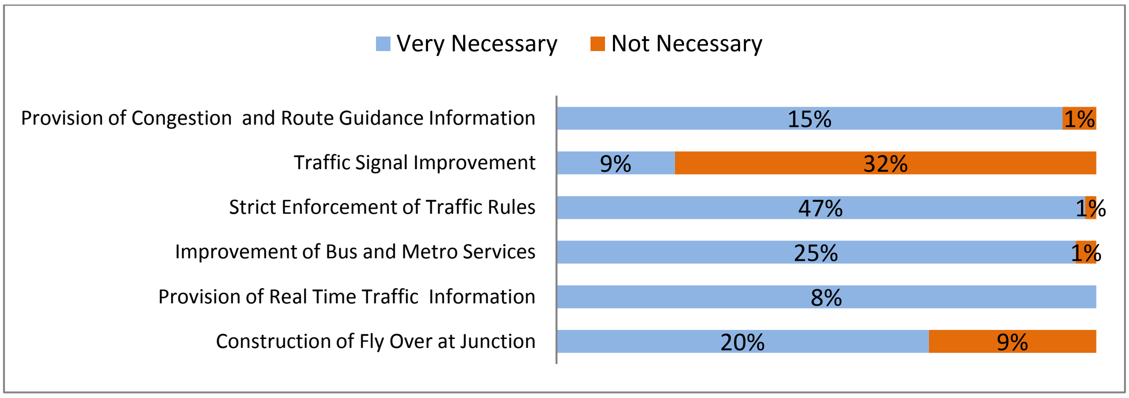


Figure 13: Responses for Solutions in Bengaluru

Strict enforcement of traffic rules was one major solution users wanted. 47% responded positively and 1% disagreed. This was followed by improvement of bus and metro services (25% agreed and 1% disagreed) and construction of flyover at junctions (20% agreed and 9% disagreed). We can't consider construction of flyover at junction as a major solution as it is disagreed by many users. The analysis also reveals users negative response for traffic signal improvement.

There is disparity between the traffic and transportation problems pointed out by users and their suggested improvements. The major traffic and transportation problems were identified as growth in number of vehicles and less capacity of roads. As a solution, users responded for strict enforcement of traffic rules. One cannot consider this a solution to the listed problems since this does not impact the user identified problems.

INTRODUCTION OF CONGESTION CHARGING FOR AN AREA

Users were asked their opinion on introduction of congestion pricing to Bengaluru. In addition to this, the survey also analysed users willingness to pay a congestion price. Random amounts, INR 5 – INR 20 and above were selected as amount of congestion pricing here. Please note that the amount listed here has not been arrived at from any study.

The response for introduction of congestion pricing in Bengaluru is shown in figure 14. Interestingly, the percentage of users that agreed and that disagreed was the same. Users who responded positively were familiar of congestion pricing practice in other countries.

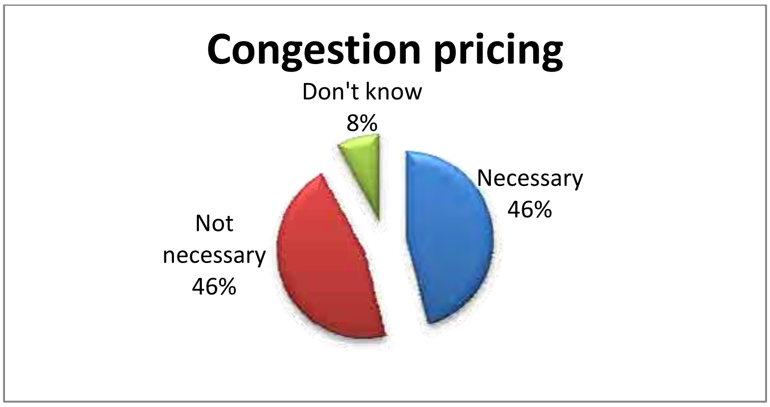


Figure 14: Responses for Congestion Pricing

The choice of amount of congestion price was collected from those users who responded positively for congestion pricing. The responses are shown in the chart below.

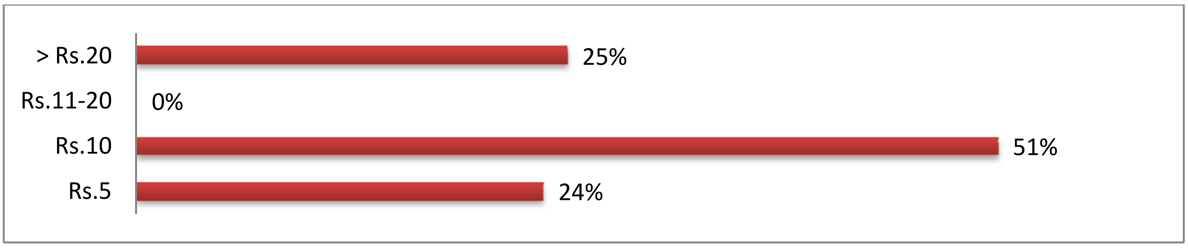


Figure 15: Responses for Choice of Amount of Congestion Price among those who accepted it

SUMMARY OF MOTORCYCLE USERS RESPONSES

Public transportation problems

- Public transport is not convenient

ITS facilities needed

- Congestion location information
- Alternative route guidance information
- Preferred mode to receive information - mobile phone

Bengaluru Traffic and Transportation Problems

- Severe congestion
- Increasing no. of vehicles

- Insufficient road capacity

Improvements Needed

- Strict enforcement of traffic rules
- Improvement of public transport system
- Realtime traffic information

Congestion pricing

- 46% are willing to accept

UNIT 2

CAR USERS

PART I: GENERAL INFORMATION

A total of 150 car users were covered in the survey from various locations in Bengaluru city. This includes commercial areas, parking places, shopping malls, busy streets, few residential locations and industrial areas. A few major survey locations are listed below.

- Jayanagar
- Banashankari
- Marathahalli
- Madiwala
- Forum mall
- Corporation
- Cunningham Road
- Gopalan Mall, Mysore Road
- BTM Layout
- UB City, Vittal
- Shanthinagar
- M G road
- Garuda mall
- Mekri Circle
- Koramangala
- Commercial Street
- Mantri Square, Malleshwaram
- Hebbal
- Sivaji Nagar
- KR Puram

Appendix-X : ITS Opinion Survey Questionnaire for car users should be referred for details. The response of the users was collected on the spot. The following sections describe the results of car users survey.

CAR USERS PROFILE

A total of 150 car users were interviewed. Details of interviewee's sex, age, job and monthly salary are listed below.

Among the 150 car users, 82% were male and 18% were female. The majority were in the age group of 30-39 and 40-49. The job profile of the users was wide with majority being admin., professionals and engineers and earning monthly salary of INR 50,000-99,999 range.

Table 5 shows the age details of car users.

Table 5: Age Details of Car Users

Age Group	20-29	30-39	40-49	50-59	>60	Total
Male	2%	35%	33%	10%	2%	82%
Female	1%	12%	3%	1%	1%	18%

Figures 16 and 17 show the job profile and the monthly salary profile of car users.

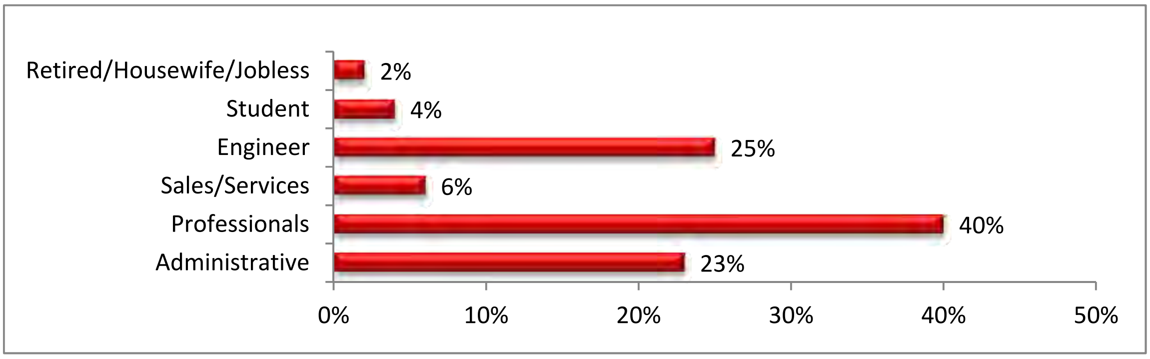


Figure 16: Job profile of Car Users

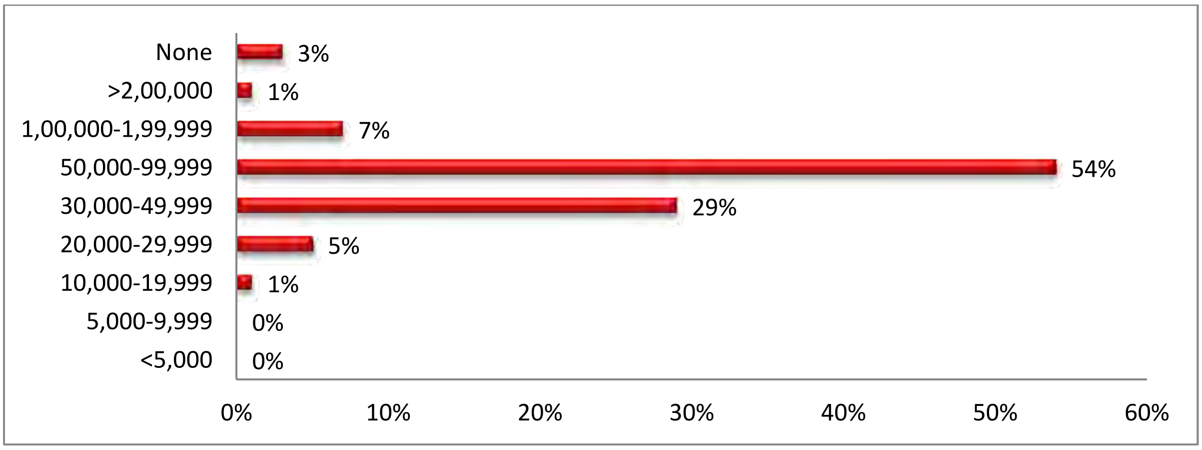


Figure 17: Monthly Salary of Car Users

FREQUENCY OF TRIPS

97% of car users were making 5-7 days per week. The responses of car users regarding their frequency of travel are as follows:

- 97% travelling 5-7 days per week
- 2% travelling 3-4 days per week

- 1% travelling 1-2 days per week

PURPOSES OF THE TRIPS AND TRAVEL TIME

The survey reveals that 93% of car users were regular commuters. Very few responded for other trip purposes such as business, shopping etc. The average travel time was observed to be 30-59 minutes.

Percentage response for trip purposes and the average travel time are shown in the following figures.

Figure 18: Responses of Car Users on Trip Purposes

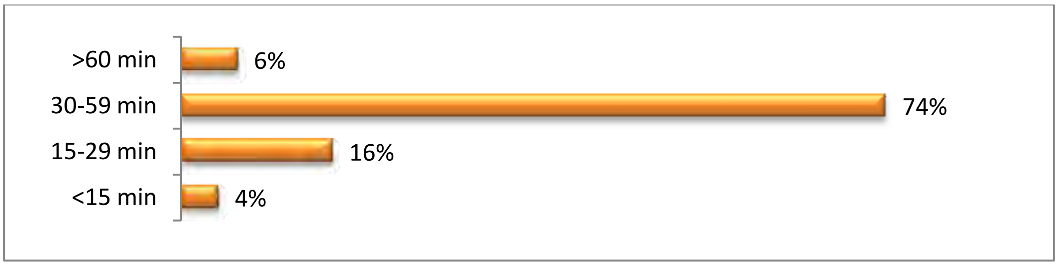


Figure 19: Responses of Average Travel Time of Car Users

REASONS FOR NOT OPTING FOR PUBLIC TRANSPORT

The majority reponded that public transport services are not convenient. The responses of car users is shown in figure 20.

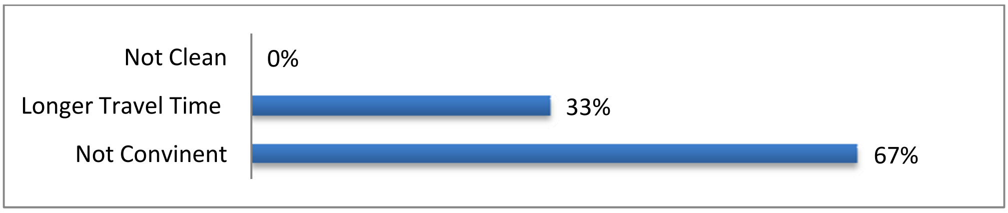


Figure 20: Responses of Car Users for Not Opting for Public Transport

PARKING FACILITY AND WILLINGNESS TO PAY

The majority car users parked at alloted parking lots available at offices/schools. Use of road side parking and private off-road parking was found to be less. The responses are shown in the figure below.

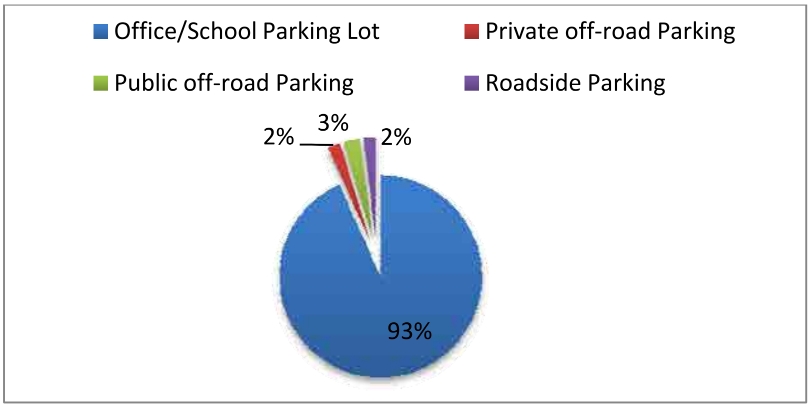


Figure 21: Responses of Car Users on Parking Facility

The parking charge for one time parking was varied fromm INR 5, INR 10 to INR 11-20. The percentage responses of car users is shown in the figure below.

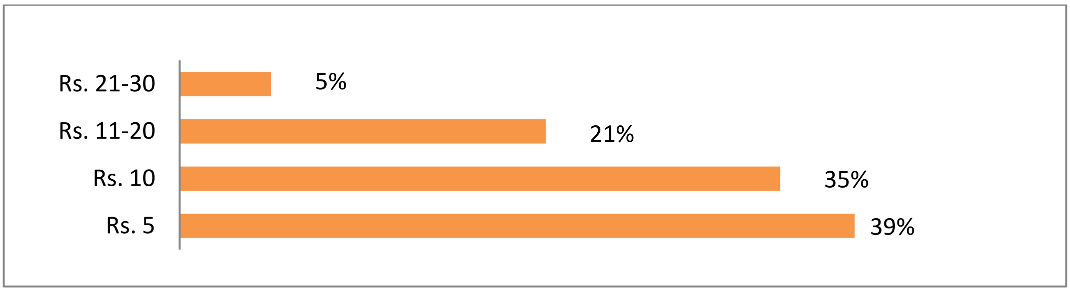


Figure 22: Responses of Car Users for One Time Parking Charge

TRANSFER TO/FROM OTHER MODES

This analysis was carried out to understand the mode shift from car to other transport modes. The results are shown in figure 23. 94% used only single mode (car) to reach the destination. Very few users changed from car to other transport modes such as bus/metro to reach their destination.

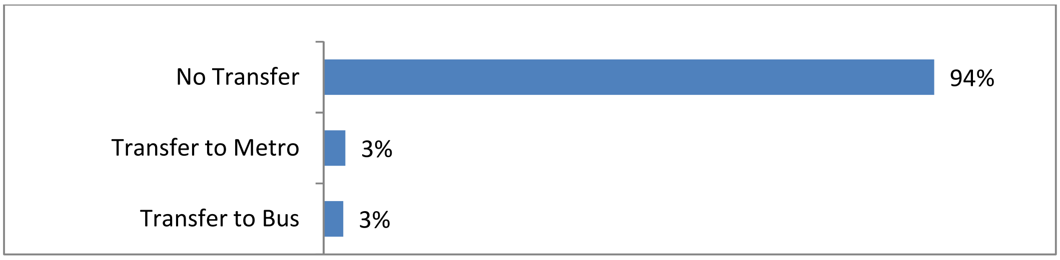


Figure 23: Responses of Car Users on Transfer to Other Modes

PART II: INTELLIGENT TRANSPORTATION SYSTEM

SOURCE OF CONGESTION INFORMATION AND CURRENT TRAFFIC INFORMATION FACILITY

75% responded that they are not receiving information on traffic congestion. 25% responded they are, and mentioned the following sources of congestion information.

- Radio – 17%
- Variable Message Sign Boards – 5%
- Mobile Phone – 2%

- Internet – 1%

The opinion of users on current traffic information facility is summarized in figure 24. 95% were unhappy and responded the existing traffic information system as 'not helpful'.

Figure 24: Opinion of Car Users on Current Traffic Congestion Information

TYPES OF TRAFFIC INFORMATION REQUIRED

The responses of users for the required traffic information are listed in the following table.

Table 6: Type of Traffic Information Required

Type of Traffic Information Required	Very helpful	Helpful	Not Helpful	Don't Know
Congested Location Information	71%	28%	1%	-
Length of Congestion Information	2%	89%	4%	5%
Expected Travel Time Information to Reach Destination	18%	78%	4%	-
Alternative Route Information	65%	34%	1%	-
Traffic Incident Information	5%	82%	8%	5%

Note: For analysis purposes, only the responses corresponding to 'very helpful' were considered. The percentage responses corresponding to 'very helpful' are shown in the below figure.

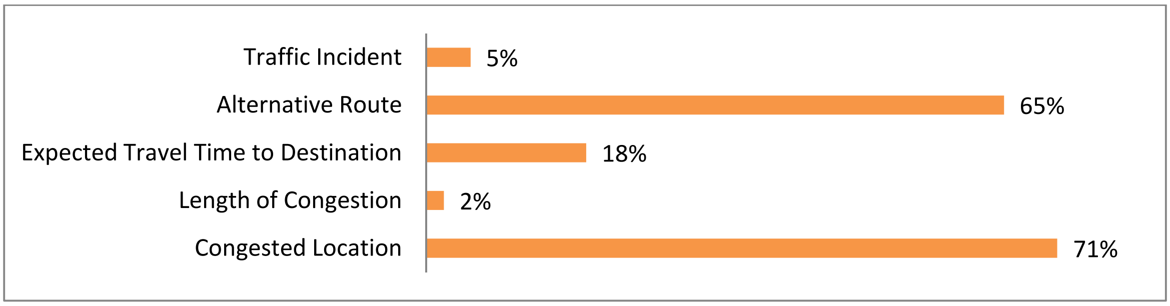


Figure 25: Responses on Required Traffic Information as Very Helpful

Congested location and alternative route guidance are the two types of information users responded would be very helpful. 71% and 65% responses received for these two choices respectively.

CHOICE ON MODE TO RECEIVE TRAFFIC INFORMATION

Unlike motorcycle users, car users responded 'Variable Message Sign Boards' (VMS) as best choice of mode to receive traffic information. 64% responded for VMS.

Car users responses are shown in the chart below.

Car navigation system and mobile phones are the other sources people preferred. Responses received for radio and internet was significantly less. Unlike motorcycle users, car users didn't respond for combination of information sources.

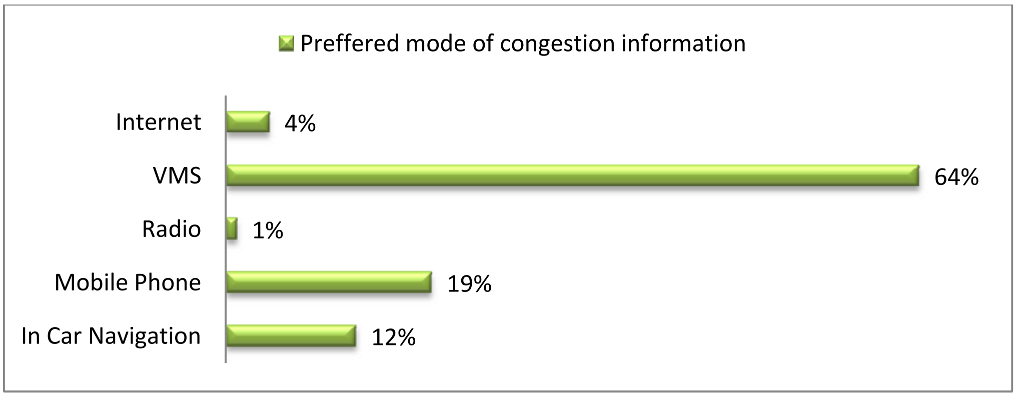


Figure 26: Responses on Preferred Mode of Congestion Information

EXPRESSWAY – PROBLEMS AND REQUIRED SOLUTIONS

Users response on expressway usage, the problems faced and the required solutions are summarized and listed below.

a) Responses on Use of Expressway:

- 84% of users used expressway
- 16% of users did not use expressway

The use of expressway was found to be more for car users than motorcycle users. Only 58% of motorcycle users responded they used expressway.

b) Responses on Problems Faced on Expressway:

For car users, the major problem was traffic congestion and queue at toll gates. The responses of users are listed below.

- Queue at toll gate - 21%
- Lack of traffic information - 12%
- Traffic congestion -59%
- Traffic safety -8%

c) Responses on Improvements Needed for Expressway:

More ETC toll gates was the major improvement users wanted. Users responses are listed as follows:

- Realtime traffic information - 7%
- Common ETC for all toll gates -33%
- More ETC toll gates -60%

Motorcycle and car users expressed difference in opinion for expressway problems and required improvements. Traffic congestion was the major problem faced by car users whereas queue at toll gates were motorcycles major problem. For the improvements required, motorcycle users responded more for realtime traffic information while car users for more ETC toll gates.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS

Car users responses on current traffic condition in Bengaluru were collected. 67% responded current traffic condition as ‘very bad’ and 33% as ‘bad’. Congestion was major problem suffered and the major reasons for congestion are analyzed in the next section.

REASONS FOR CONGESTION

Users were asked to choose three major reasons among the 10 listed alternatives. Users responses are listed by reason priority in table 7.

Table 7: Responses of Three Major Reasons for Congestion in Bengaluru

Congestion Reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	31%	42%	13%
• Too many vehicles	47%	19%	12%
• Inefficient traffic signals	1%	1%	1%
• Bad pavement with potholes	6%	18%	37%
• Bumps	-	1%	1%
• On-street parking	1%	-	1%
• Traffic accidents	1%	-	-
• Bad driving manners	8%	9%	18%
• Too many one-way streets	4%	6%	5%
• Jay walking pedestrians	1%	1%	1%

Note: Since multiple options were provided for users, the total response may not be 100%.

Increasing number of vehicles and insufficient capacity of road are two major reasons pointed out by car users. This was followed by bad pavement condition and driving manners. Figure 27 shows the major congestion reasons along with its response percentage.

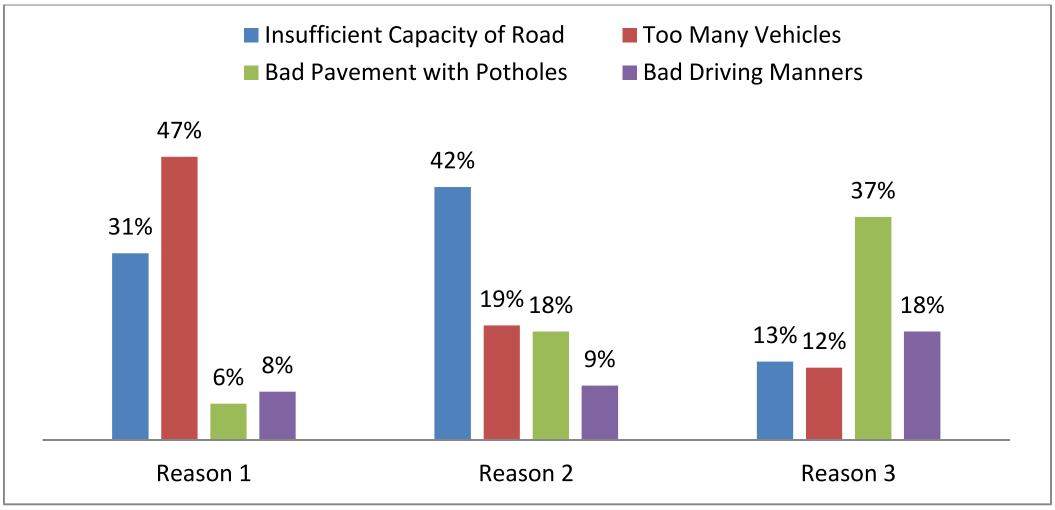


Figure 27: Response for Congestion Reasons in Bengaluru

Both motorcycle and car users mentioned similar reasons for congestion: increasing number of vehicles and insufficient capacity of roads.

TRANSPORTATION SOLUTIONS FOR BENGALURU

The solution for traffic and transportation problem is analyzed here. The following table shows the responses received from car users.

Table 8: Response of Car Users for Transportation Solutions in Bengaluru

Solutions	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	15%	77%	3%	5%	0%
• Provision of realtime traffic congestion information	2%	84%	12%	2%	0%
• Improvement of bus and metro service	23%	75%	2%	0%	0%
• Strict enforcement of traffic rules	53%	46%	1%	0%	0%
• Traffic signal improvement	4%	61%	10%	25%	0%
• Provision of traffic congestion information and route guidance	9%	75%	15%	1%	0%

The analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From the above table, responses corresponding to 'very necessary' and 'not necessary' are selected and shown in the figure below.

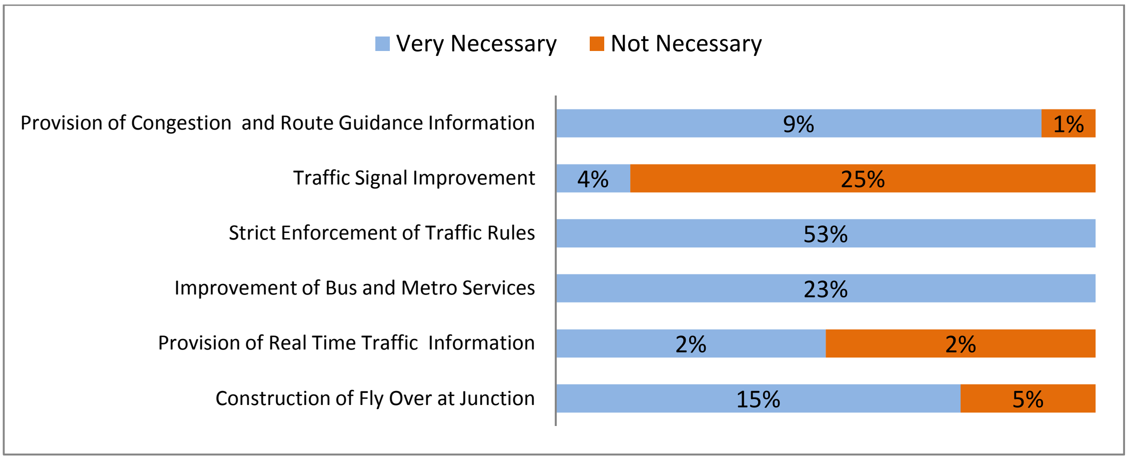


Figure 28: Responses for Solutions in Bengaluru

Like motorcycle users, car users also wanted strict enforcement of traffic rules as a major solution. 53% responded positively. This was followed by improvement of bus and metro services (23% agreed). The analysis also revealed users negative response for traffic signal improvement.

For traffic and transportation problems, the suggested improvements wanted by car users were similar to that of motorcycle users.

INTRODUCTION OF CONGESTION CHARGING FOR AN AREA

Like motorcycle users, car users also expressed mixed responses. Of the 150 car users, 46% agreed for congestion pricing and 49% disagreed. The responses are shown in the figure below.

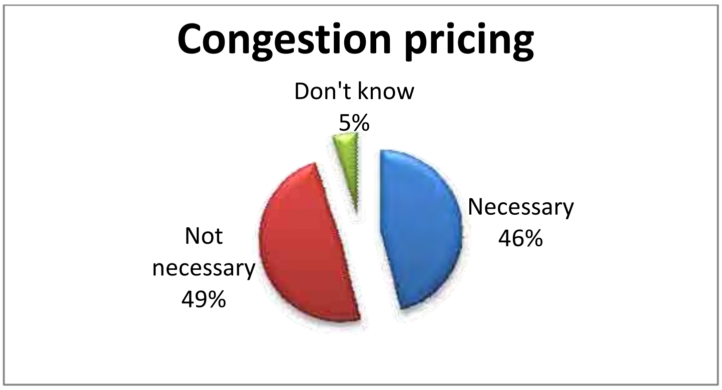


Figure 29: Responses for Congestion Pricing

The responses for congestion charge is shown in figure 30. The suggested congestion price amounts are random numbers and have not derived from any studies.

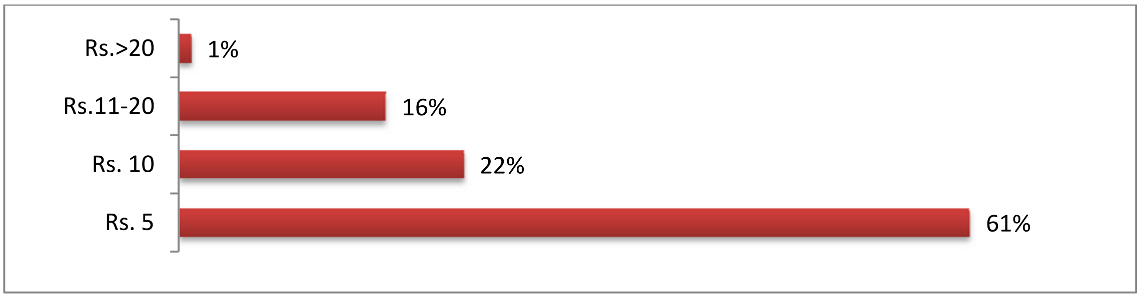


Figure 30: Responses of Car Users for Congestion Price among those who accepted it

SUMMARY OF CAR USERS RESPONSES

Public transportation problems

- Public transport is not convenient

ITS facilities needed

- Congestion location information
- Alternative route guidance information
- Preferred mode to receive information - VMS

Bengaluru Traffic and Transportation Problems

- Severe traffic congestion

- Insufficient road capacity
- Increasing no. of vehicles

Improvements Needed

- Strict enforcement of traffic rules
- Improvement of public transport

Congestion Pricing

- Mixed response (46% are willing to accept)

MODULE 3

BUS USERS

PART I: GENERAL INFORMATION

A total of 150 bus users were interviewed in the survey. The data was collected from various bus stops and bus terminals inside Bengaluru City. The details of survey locations are listed below.

- Santhi Nagar Bus Terminal
- Majestic Bus Terminal
- Jaynagar (Fourth Block) Bus stop
- BTM Layout Bus stop
- Yeshwanthpur Bus stop
- Hebbal Junction Bus stop
- Sivaji Nagar Bus stop
- Corporation Circle Bus stop
- Yelahanka Bus Terminal (old & new)
- KR Puram Bus stop

Appendix-X : ITS Opinion Survey Questionnaire for bus users should be referred to for details. The response of users was collected on the spot. The following sections describe the results of car users survey.

BUS USERS PROFILE

Of the 150 bus users covered in the survey, 52% were male and 48% were female. The majority of the bus users were in the age group of 20-29 and 30-39.

The age details of bus users are listed in table 9.

Table 9: Age Details of Bus Users

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Male	1%	40%	6%	-	-	5%	52%
Female	-	-	27%	17%	4%	-	48%

Most of the bus users were working people with majority of being administrative and professionals. The monthly salary of bus users was INR 50,000 and below. The details are given below.

Figures 31 and 32 show the bus users responses for their job profile and average monthly salary respectively.

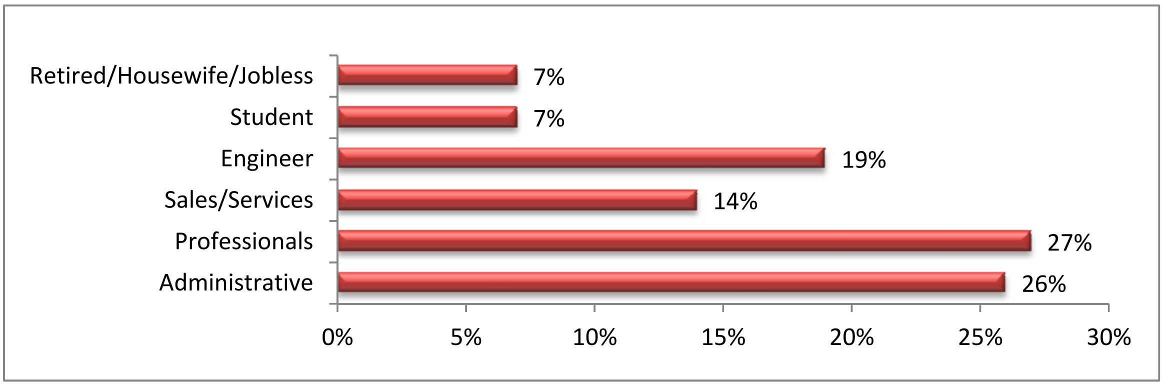


Figure 31: Job Profile of Bus Users

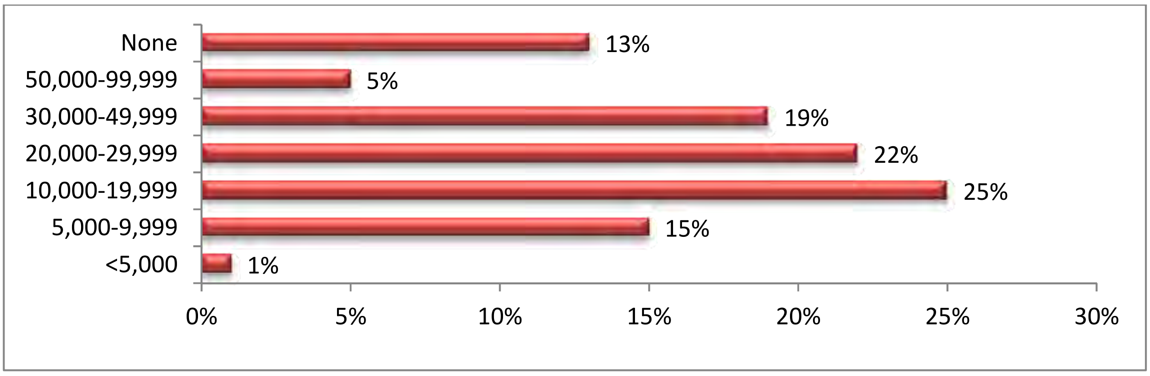


Figure 32: Average Monthly Salary of Bus Users

FREQUENCY OF BUS TRIPS

The majority of the bus users were regular commuters. The responses of bus users are as follows.

- 73% were travelling 5-7 days per week
- 12% were travelling 3-4 days per week
- 15% were travelling 1-2 days per week

MODE OF PAYMENT

There are two types of bus fare payment options available in Bangalore Metropolitan Transport Corporation (BMTC).

- Cash (Token)
- Bus Passes (Daily/Monthly/Yearly)

To promote the use of bus passes, BMTC has introduced several discount schemes for bus pass users.

In the survey, users were asked their mode of bus fare payment. The responses were collected and are summarized in the chart below.

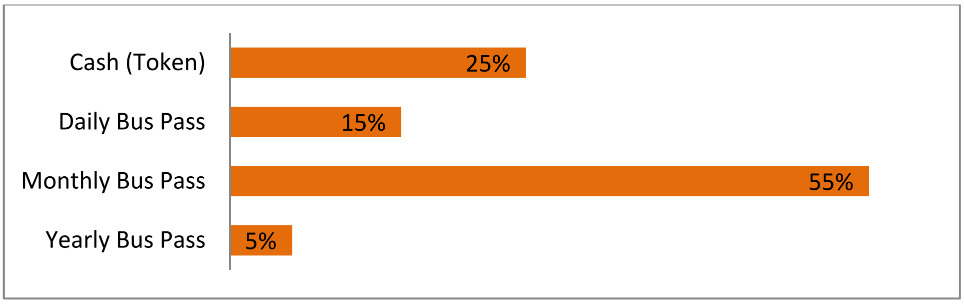


Figure 33: Responses for Mode of Bus Fare Payment

It is observed that the use of bus passes were more than the token system. Among the available bus passes, more users responded for monthly bus pass.

In the case of using bus token system, the survey analyzed the amount of bus fare paid for one way travel. The one way bus fare of majority was in the range of INR 11-20. The results are listed below.

- INR 5: Nil
- INR 6- 10: 16%
- INR 11-20: 79%
- INR >20: 5%

TRAVEL TIME DETAILS OF REGULAR COMMUTERS

Among 150 users, 85% were regular commuters and 15% were casual users. An analysis was carried out to understand the travel time of regular commuters. Towards this objective, the following questions were asked to regular commuters.

- Average travel time to reach destination
- Average time on board bus
- Average waiting time on bus stop

The casual bus users skipped the above questions. Only the responses of regular commuters were collected and are listed in the table below.

Table 10: Responses of Bus Commuters on Travel Time

Average Travel Time (minutes)				
	<15 min	15-29 min	30-59 min	>60 min
To reach destination	-	8%	51%	41%
On board bus	2%	20%	58%	20%
Average Waiting Time (minutes)				
	<10 min	10-19 min	20-29 min	>30 min
Waiting time on bus stop	50%	37%	11%	2%

The average travel time of regular commuters varies from 30 minutes to more than one hour. The majority spends 30- 59 minutes on board bus. The waiting time at bus stops was mentioned to be less than 10 minutes.

The responses of motorcycle and car users on public transport is noted here. The majority expressed their inconvenience as 'travel time in public transport'. This can be clearly seen in bus users responses of travel time to reach destination.

TRANSFER TO/FROM OTHER MODES

Users were asked about changing transport modes to reach the destination. The responses are shown in the chart below.

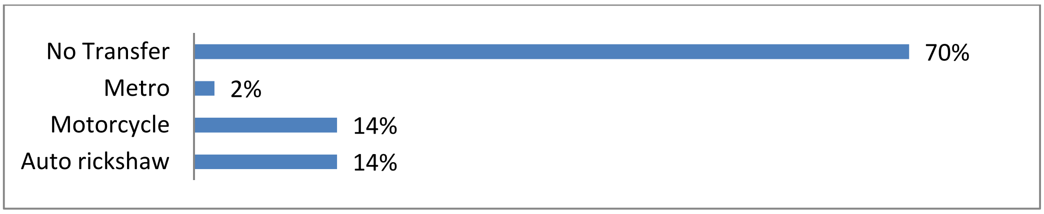


Figure 34: Responses for Transfer to/from Other Modes

It is observed that majority of bus users used bus as their primary transport mode to reach the destination. Change from bus to other transport mode was less.

Among 70% bus users, the number of changes in bus to reach the destination place was also analyzed. The responses are as follows: 25% used one bus, 35% used two buses and 10% used three buses.

PART II: PUBLIC TRANSPORTATION SERVICES

PASSENGER PROBLEMS WHILE USING PUBLIC TRANSPORTATION

Bus users were asked about major passenger problems while using public transportation. Nine problems were selected and listed in the questionnaire. Users were asked to select the three major problems.

The responses are listed in table 11.

Table 11: Response on Problems of Bus Passengers

Problems	Reason 1	Reason 2	Reason 3	Response
Long waiting time at bus stop	24%	8%	5%	37%
Long and uncertain riding time	11%	10%	5%	26%
Congested bus	26%	22%	10%	58%
Expensive fare	5%	10%	11%	26%
Complex bus system and route	-	3%	3%	6%
No route, time & fare information at bus stop	21%	11%	7%	39%
Inconvenient connection / transfer	4%	6%	6%	16%
Bad driving manners	3%	9%	15%	27%
Security on bus	-	1%	-	1%

Note: As the users has provided with multiple options, the total response may not be 100%.

From users responses, three major problems identified were:

- Congested bus
- Lack of route, time & fare information at bus stop
- Long waiting time at bus stop

Provision of passenger information system and passenger display facilities at bus stops can be a solution to the above problems.

RESPONSES ABOUT FACILITIES NEEDED TO IMPROVE PUBLIC TRANSPORTATION SERVICES

The responses of the users were analysed for the facilities needed to improve public transportation services in Bengaluru. Four major facilities were suggested to bus users in this regard. Users responses on suggested solutions were collected as follows – yes, no, and don’t know. The results are shown in the chart below.

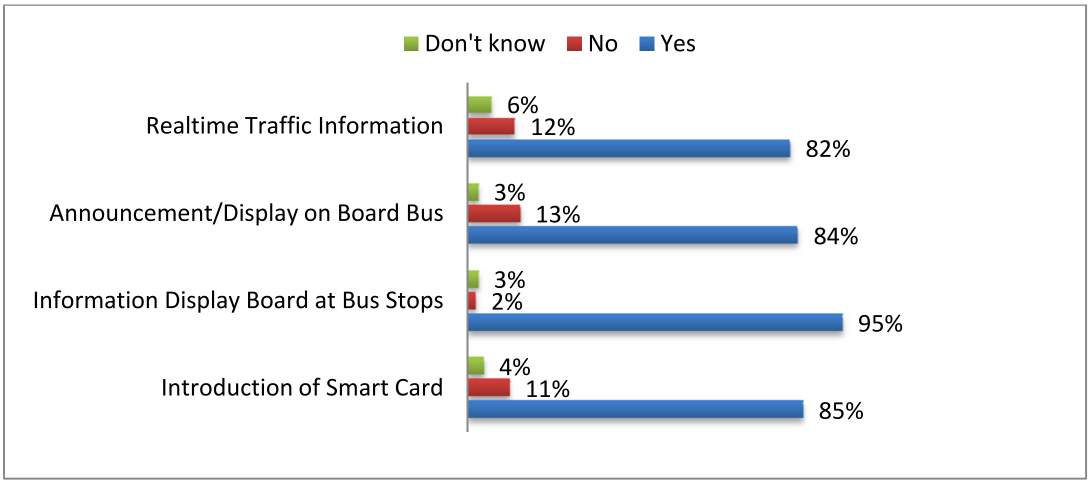


Figure 35: Responses of Bus Users for Facilities Needed to Improve Public Transport

Four of the suggested facilities received highly positive response from bus users. A major response (95%) was received for 'information display board at bus stops'. Lack of this facility was identified as a major significant problem.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS IN BENGALURU

The survey revealed that almost everyone considers the traffic situation in Bengaluru to be in bad condition, mainly due to congestion. Response of bus users on traffic condition in Bengaluru is as follows.

- 94% - responded as bad
- 5% - responded as so-so
- 1% - responded as good

The table below shows the reasons of the congestion mentioned by bus users.

Table 12: Responses of Bus Users for Reasons of Congestion

Congestion reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	33%	23%	8%
• Too many vehicles	49%	26%	13%
• Inefficient traffic signals	-	5%	2%
• Bad pavement with potholes	3%	14%	22%
• Bump	1%	1%	-
• On-street parking	-	2%	2%
• Traffic accidents	-	3%	2%
• Bad driving manners	9%	18%	13%
• Too many one-way streets	4%	6%	11%
• Jaywalking pedestrians	1%	1%	5%

Note: Since the users are provided with multiple options, the total response many not be equal to 100%

Increasing number of vehicles as well as insufficient capacity of roads are considered as major causes of congestion by the majority of users. A few responded too many one-way roads, bad pavement and traffic manners as other reasons.

Figure 36 shows the major congestion reasons along with its response percentage.

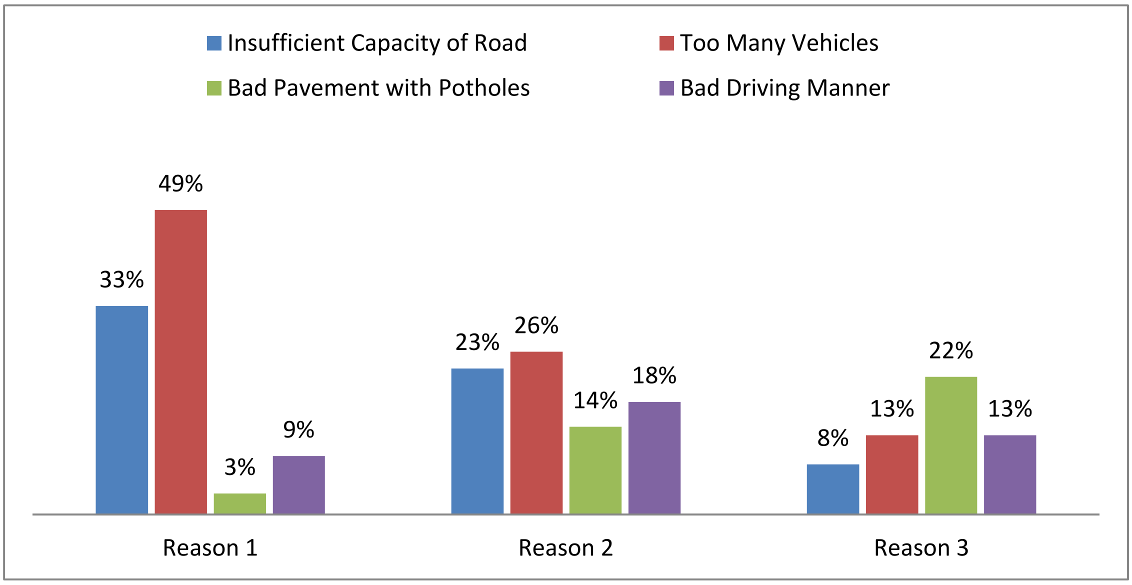


Figure 36: Major Reasons for Congestion in Bengaluru

SOLUTION FOR TRAFFIC AND TRANSPORTATION PROBLEMS

The responses of the users were analysed for the solutions for traffic and transportation in Bengaluru. Users responses on suggested solutions were collected as follows: very necessary, necessary, may be, and not necessary. Users responses were analyzed and are listed in the following table.

Table 13: Responses for Solutions in Bengaluru

Solutions	Very Necessary	Necessary	May be	Not Necessary	Don't know
• Construction of flyover at junction	-	71%	19%	9%	1%
• Provision of realtime traffic congestion information	-	76%	19%	3%	2%
• Improvement of bus and metro service	-	84%	12%	4%	-
• Strict enforcement of traffic rules	-	88%	6%	5%	1%
• Traffic signal improvement	-	49%	33%	17%	1%
• Provision of traffic congestion information and route guidance	-	-	-	-	-

The suggested solutions received positive response but none of them responded to it as 'very necessary'.

The analysis reports only the responses corresponding to necessary and not necessary. The results are shown in the chart below.

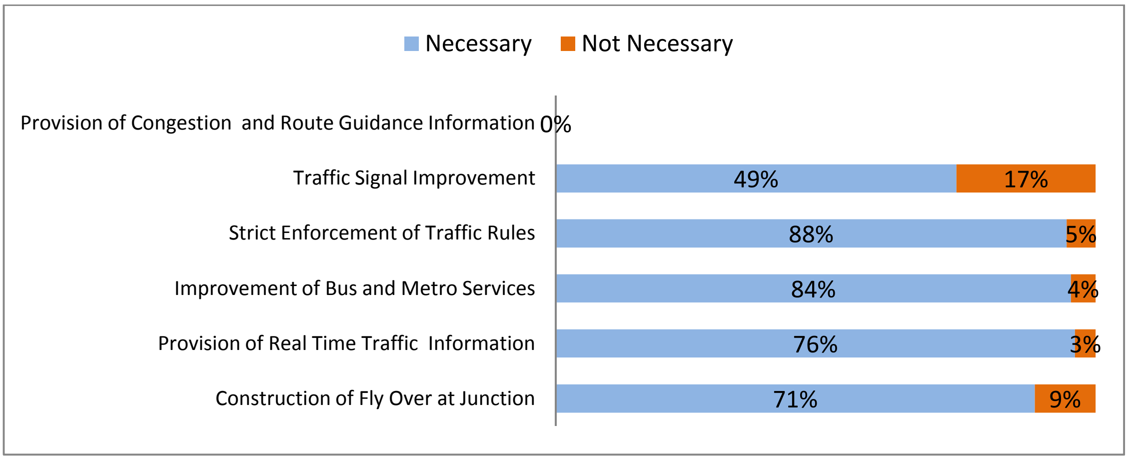


Figure 37: Bus Users Responses Corresponding to 'Necessary' and 'Not Necessary'

Strict enforcement of traffic rules and improvement of bus and metro services were major solutions users mentioned. This was followed by provision of realtime traffic information and construction of flyovers at junctions. Traffic signal improvement was supported by less users.

Similar to motorcycles and car users responses, bus users also mentioned enforcement of traffic rules.

OPINIONS ON CONGESTION PRICING

The opinions on congestion pricing were also asked. The survey revealed that many users regard congestion pricing positively. The response of users is shown in the chart below.

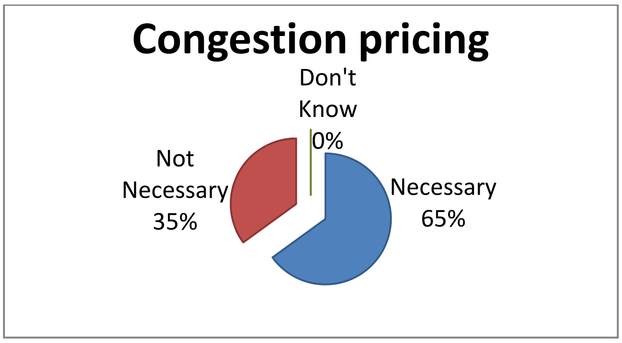


Figure 38: Responses of Bus Users for Congestion Pricing

The majority of public transport users responded that congestion pricing is required to reduce congestion. However, it should be noted that they responded on the condition that the charging be imposed on private vehicles.

OTHER SUGGESTIONS

Apart from the prepared questions in the questionnaire, users were given a chance to express about travel inconvenience in public transport. Some of the bus users responded and their responses are summarized below.

- Poor condition of buses, specially old buses
- Improper placement of bus stops
- Accessibility to public transport

SUMMARY OF BUS USERS RESPONSES

Public transportation problems

- Congested bus
- Long waiting time at bus stop
- Lack of route, time & fare information at bus stop

ITS facilities needed

- Introduction of smart card
- Information display boards at bus stops and on board bus
- Realtime traffic information

Bengaluru traffic and transportation problems

- Insufficient road capacity
- Increasing no. of vehicles

Improvementsd Needed

- Strict enforcement of traffic rules
- Improvement of public transport service

Congestion pricing

- Willing to accept congestion pricing (only for private vehicles)

MODULE 4

METRO USERS

PART I: GENERAL INFORMATION

Bengaluru metro network implementation consists of 3 phases: 42.3 km in Phase I, 72 km in Phase II, and 13 km in Phase III. Phase I is partially completed and commercial operation has started. The survey covered the following metro lines of Phase I:

- Line 1: MG Road station to Baiyappanahalli station
- Line 2: Peenya Industry to Mantri Square Sampige Road

Appendix-X : ITS Opinion Survey for Bengaluru should be referred to for details.

METRO USERS PROFILE

Details of interviewee's sex, age, job and monthly salary are listed below.

Of the 150 metro users interviewed, 54% were male and 46% were female. The majority of them were in the age group of 30-39. The age details of metro users are listed in table 14.

Table 14: Age Details of Metro Users

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Female	-	21%	18%	3%	2%	3%	46%
Male	-	12%	30%	8%	2%	3%	54%

Majority of users (86%) were working people with wide job profiles and a very few (14%) were students/housewife/retired people. Users job profile responses are shown in the chart below.

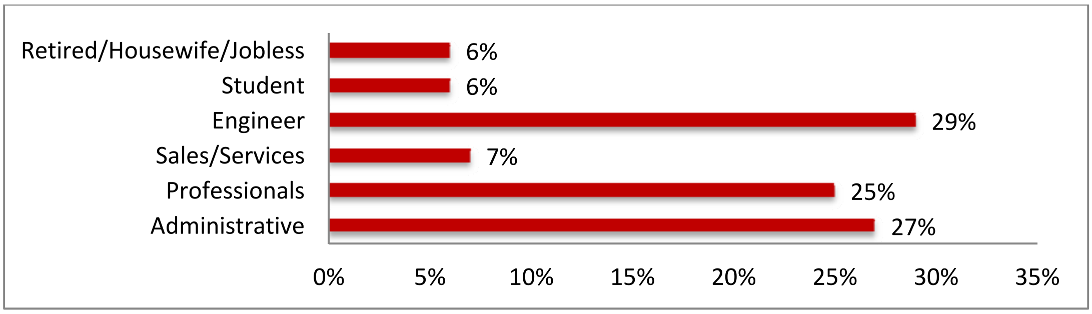


Figure 39: Metro Users Job Profile

The majority were in the salary range of INR 30,000-49,000. The users responses on their monthly salary are shown in the chart below.

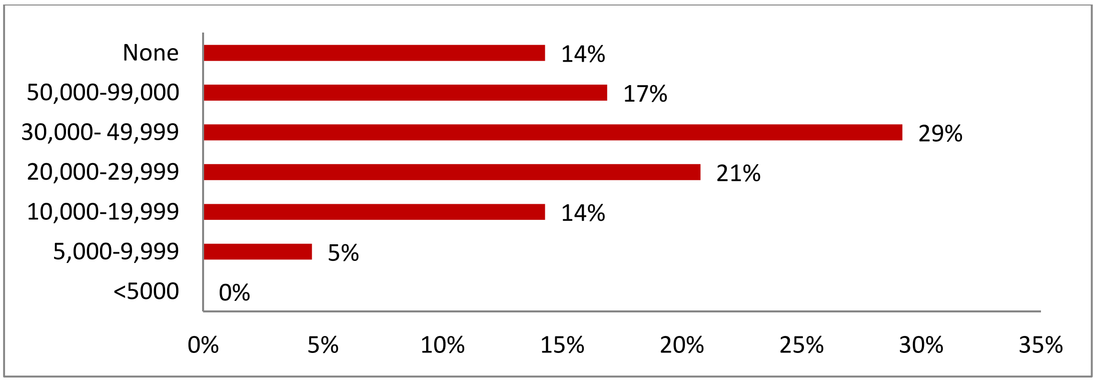


Figure 40: Monthly Salary profile of Metro Users

TRAVEL FREQUENCY OF METRO USERS

Of the 150 users, 70% were regular commuters and the remaining 30% were causal users. The responses of metro users are as follows:

- 54% travelling 5-7 days per week
- 16% travelling 3-4 days per week
- 30% travelling 1-2 days per week

It is inappropriate to comment on metro ridership, as the metro network is not fully implemented.

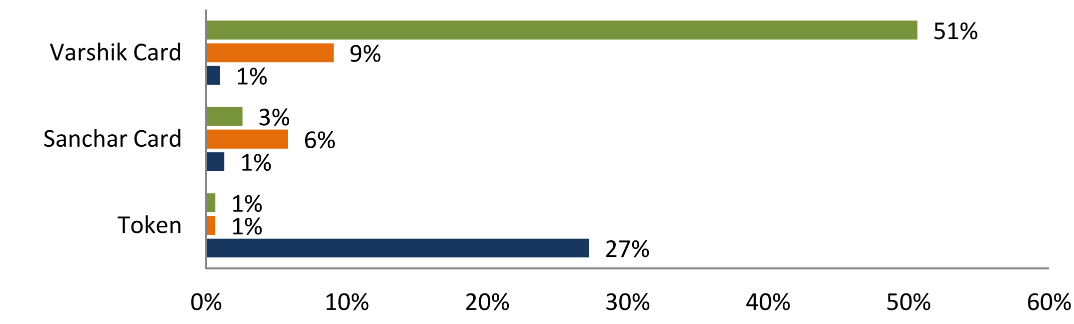
METRO FARE - MODE OF PAYMENT

Bengaluru metro adopts electronic fare payment system. Two types of tickets are issued by metro. They are:

- Smart Token
- Contactless Smartcards (named 'Varshik' and 'Sanchar')

29% were using smart tokens and 61% were using contactless smart cards for fare payment. Among the smartcards, use of 'varshik' card was found to be more than 'sanchar' card.

The response of users on type of fare payment was collected and the responses are shown in the chart below. The responses are categorized according to the frequency of trips made.



	Token	Sanchar Card	Varshik Card
five-seven trips	1%	3%	51%
three-four trips	1%	6%	9%
one-two trips	27%	1%	1%

Figure 41: Responses of Metro Users on Type of Fare Payment

Tokens were used by casual users who were making one-two trips per week. Sanchar and Varshik cards are used more by regular commuters.

AVERAGE TRAVEL TIME OF METRO USERS

The majority mentioned an average travel time of 30-59 minutes. The responses of users on average travel time to reach destination are shown in the chart below.

Figure 42: Responses of Metro Users on Average Travel Time

TRANSFER TO/FROM OTHER MODES

The metro commuters were transferring to/and from various modes. The responses are listed in the chart below.

Transfer to/from bus, motorcycle, auto rickshaw etc. was mentioned by many users.

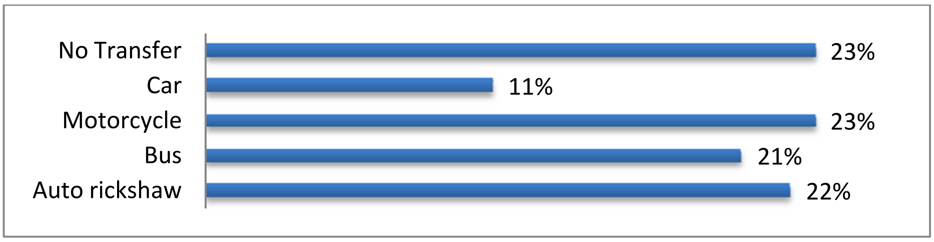


Figure 43: Responses of Metro Users on Transfer to/from to Other Modes

PART II: NAMMA METRO SERVICE

IMPROVEMENT FOR METRO SERVICE

Users were asked about improvements required for three major facilities. They are:

- Introduction of common prepaid card to BMTC and metro
- Transfer facilities between Metro and bus/auto rickshaw
- Park and ride facility (car and motorcycle parking at metro stations)

The responses were collected for categories as follows: very necessary, necessary, may be, not necessary, don't know. The responses are summarized and listed below.

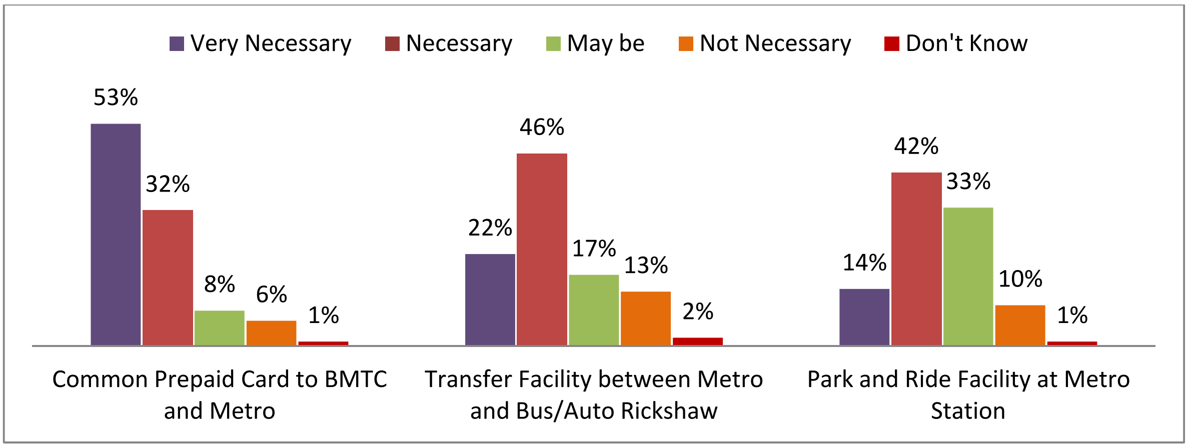


Figure 44: Responses of Metro Users on Improvements Needed

Among the three suggested facilities, introduction of common prepaid card to bus and metro got good response. 53% responded it as very necessary. The need of transfer facilities and park & ride facilities were also supported by users.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS IN BENGALURU

REASONS FOR CONGESTION

The majority evaluated Bengaluru traffic condition as 'very bad' because of sever congestion. The reasons for congestion are analyzed and listed in the table below.

Table 15: Responses on Three Major Reasons for Congestion in Bengaluru

Congestion reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	39%	23%	11%
• Too many vehicles	32%	23%	14%
• Inefficient traffic signals	2%		1%
• Bad pavement with potholes	5%	16%	18%
• Bump	-	-	-
• On-street parking	-	-	1%
• Traffic accidents	-	1%	1%
• Bad driving manners	7%	16%	29%
• Too many one-way streets	12%	18%	18%
• Jaywalking pedestrians	2%	4%	5%

Note: Since multiple options were provided for users, the total response may not be 100%.

Increasing number of vehicles and insufficient capacity of road are two major reasons pointed out by users. Too many one-way streets are also mentioned as another reason for congestion.

TRANSPORTATION SOLUTIONS FOR BENGALURU

Users responses for traffic and transportation solutions are listed in the table below.

Table 16: Responses for Solutions in Bengaluru

Solutions	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	3%	46%	36%	15%	-
• Provision of realtime traffic congestion information	17%	69%	12%	1%	1%
• Improvement of bus and metro service	53%	33%	12%	2%	-
• Strict enforcement of traffic rules	69%	21%	7%	2%	1%
• Traffic signal improvement	18%	31%	26%	24%	1%
• Provision of traffic congestion information and route guidance	-	-	-	-	-

Users responded about two major solutions. They are: strict enforcement of traffic rules and improvements of bus and metro services.

OPINIONS ON CONGESTION PRICING

The metro users gave mixed response for congestion charging. 79% agreed 37% disagreed for congestion pricing. However, it should be noted that they responded on the condition that the charging be imposed on the private vehicles.

Metro users responses are listed in the chart below.

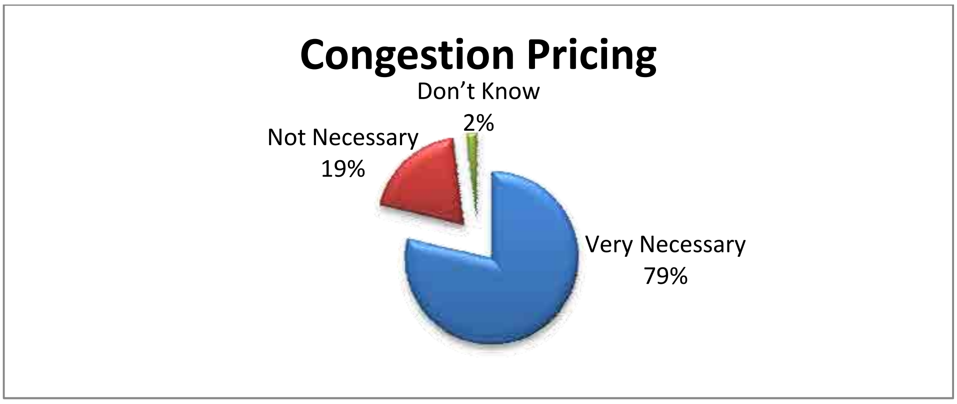


Figure 45: Metro Users Responses on Congestion Pricing

SUMMARY OF METRO USERS RESPONSES

Required Improvements for Metro services

- Common prepaid card to bus and metro

Bengaluru Traffic and Transportation Problems

- Insufficient road capacity
- Increasing no. of vehicles

Improvements Needed

- Strict enforcement of traffic rules
- Improvement of public transport service

Congestion Pricing

- Willing to accept congestion pricing (only for private vehicles)

MODULE 5

TRUCK DRIVERS

PART I: GENERAL INFORMATION

A total of 150 truck drivers were interviewed in the survey. An interview sheet was prepared in this regard. The surveyors randomly distributed interview sheet to truck drivers at various locations in Bengaluru. Locations such as truck terminals, parking places on highways, industrial areas were given prime focus where more trucks were present.

Appendix-X : ITS Opinion Survey Questionnaire for truck drivers should be referred to for details. The response of users was collected on the spot. The following sections describe the results of truck driver's survey.

DRIVER PROFILE

The majority of the drivers were in the age group of 30-39. The age details of truck drivers are listed in the table below.

Table 17: Age Details of Truck Drivers

Age group	15-20	20-29	30-39	40-49	50-59	>60	Total
Response	-	7%	56%	30%	7%	-	100%

The monthly income of the drivers was lower. The majority mentioned a monthly salary of INR. 10,000-19,999. Truck drivers responses on their monthly salary is shown in the chart below.

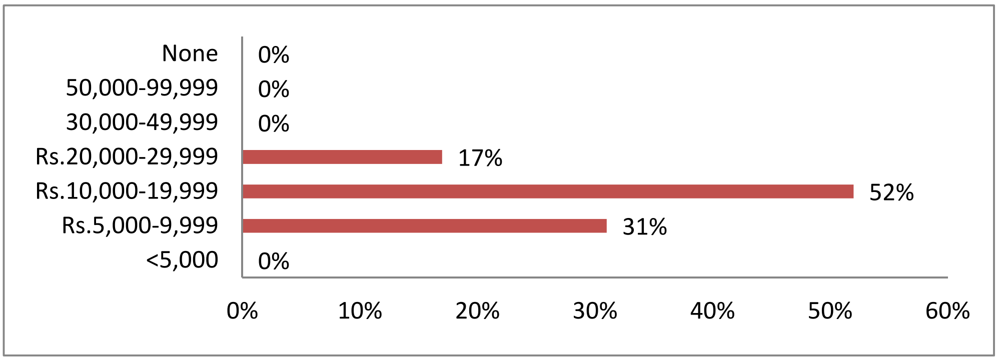


Figure 46: Truck Drivers Responses on Monthly Salary

TYPE OF VEHICLES AND FREQUENCY OF TRIPS

Three categories of vehicles were covered in the survey. They are light commercial vehicle (LCV), heavy commercial vehicle (HCV) and medium commercial vehicle (MCV). The percentage of each of the vehicle is listed below.

- Light commercial vehicle: 59%
- Heavy commercial vehicle: 34%
- Medium commercial vehicle: 7%

The majority were light commercial vehicles followed by heavy commercial vehicles.

Regarding, frequency of trips, the majority were making trips regularly. The responses are listed as follows:

- 73% making 5-7 days per week
- 25% making 3-4 days per week
- 2% making 1-2 days per week

ALTERNATIVE ROUTES TO AVOID CONGESTED LOCATION

It is understood that the truck drivers take alternative routes to avoid traffic congestion. Truck drivers were asked on this and their responses are listed in the table below.

Table 18: Truck Drivers Responses for use of Alternative Routes

Type of Vehicle	Use of Alternative Routes			
	Always	Often	Sometimes	None
HCV	5%	25%	3%	1%
LCV	14%	31%	13%	2%
MCV	-	5%	-	1%

It is clear from the responses that the use of alternative route is frequent among truck drivers.

PART II: ITS APPLICATION

SOURCE OF CONGESTION INFORMATION AND OPINION ON CURRENT TRAFFIC INFORMATION

Truck drivers responded that they are not aware of any congestion information sources.

TYPE OF TRAFFIC INFORMATION REQUIRED

Truck drivers were asked on required traffic information. Five types of traffic information were suggested and the responses collected as: very helpful, helpful, not helpful and don't know.

The responses for the required traffic information are listed in the following table.

Table 19: Truck Drivers Responses for Traffic Information Required

Type of Traffic Information Required	Very Helpful	Helpful	Not Helpful	Don't Know
Congested Location Information	47%	33%	20%	-
Length of Congestion Information	25%	51%	24%	-
Expected Travel Time Information to Reach Destination	21%	79%	-	-
Alternative Route Information	55%	45%	-	-
Traffic Incident Information	59%	41%	-	-

Note: For analysis purposes, only the responses corresponding to 'very helpful' were considered. The percentage responses corresponding to 'very helpful' are shown in the below figure.

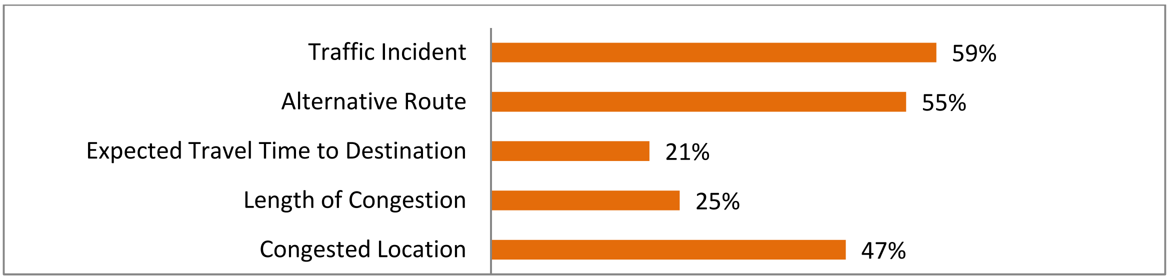


Figure 47: Truck Drivers Responses on Required Traffic Information

Truck drivers mentioned two major types of information they want: traffic incident and alternative route information. This was followed by congested location information.

CHOICE ON MODE TO RECEIVE TRAFFIC INFORMATION

Only one mode was mentioned by all truck drivers to receive the traffic information: in car navigation system. Zero responses were received for other information modes.

EXPRESSWAY – PROBLEMS AND IMPROVEMENTS NEEDED

Users were asked about expressway usage, the problems faced and the required solutions. The response are summarized and listed below.

a) Responses on Use of Expressway:

- 81% of users used expressway
- 19% of users do not use expressway

b) Responses on Problems Faced on Expressway:

Queue at toll gate was the major problem mentioned by truck drivers. The responses are listed as follows:

- Queue at toll gate - 72%
- Lack of traffic information - 0%
- Traffic congestion -14%
- Traffic safety -14%

c) Responses on Improvement Needed in Expressway:

Only few responses were received for solutions of expressway problems; only 20% only responded to the question. All of them responded for one solution: more ETC toll gates.

Vehicle queue was a major problem mentioned by truck drivers. From truck drivers opinions, provision of more ETC toll gates may solve the traffic queue at toll gates.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS

REASONS FOR CONGESTION

Majority of truck drivers analyzed Bengaluru current traffic condition as 'very bad'. Congestion is the most serious problem for truck drivers.

This section analyses the reasons for congestion and the required measures to be taken to reduce the congestion level.

Table 20: Truck drivers Responses on Three Major Reasons for Congestion in Bengaluru

Congestion Reasons	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	33%	40%	15%
• Too many vehicles	31%	13%	18%
• Inefficient traffic signals	1%	2%	3%
• Bad pavement with potholes	8%	15%	25%
• Bumps	-	2%	3%
• On-street parking	2%	-	2%
• Traffic accidents	-	-	-
• Bad driving manners	19%	15%	20%
• Too many oneway streets	6%	11%	10%
• Jay walking pedestrians	-	1%	1%

Note: Since multiple options were provided for users, the total response may not be 100%.

Increasing number of vehicles and insufficient capacity of road are two major reasons pointed out by users. Bad driving manners and pavement condition are also mentioned as other reasons for congestion.

Figure 45 shows the major congestion reasons along with its response percentage.

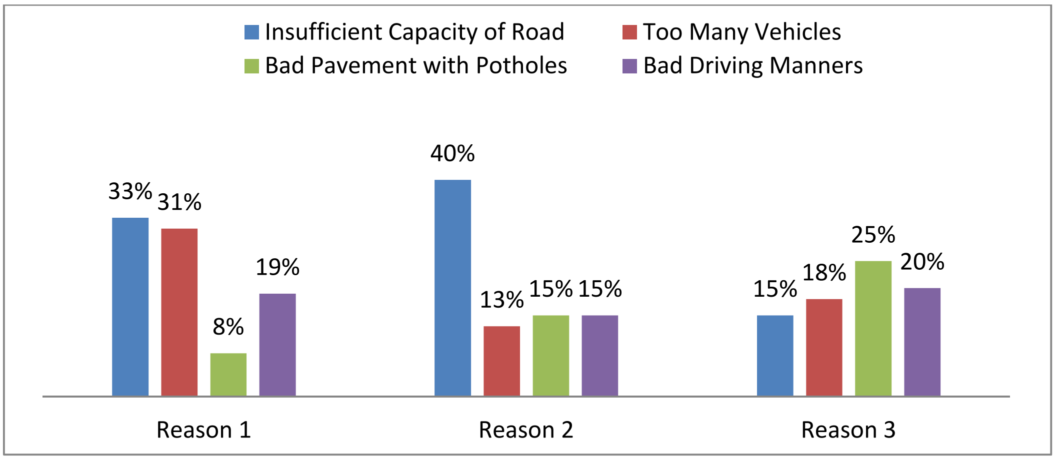


Figure 48: Responses for Congestion Reasons in Bengaluru

TRANSPORTATION SOLUTIONS FOR BENGALURU

The solution for traffic and transportation problem has been analyzed. Truck drivers responses are listed in the table below.

Table 21: Truck Drivers Responses for Transportation Solutions

Solution for traffic & transportation problem	Very Necessary	Necessary	May be	Not Necessary	Don't know
• Construction of flyover at junction	27%	61%	5%	7%	-
• Provision of realtime traffic congestion information	2%	72%	22%	4%	-
• Improvement of bus and metro service	45%	53%	2%	-	-
• Strict enforcement of traffic rules	56%	44%	-	-	-
• Traffic signal improvement	9%	2%	3%	86%	-
• Provision of traffic congestion information and route guidance	2%	41%	13%	37%	7%

Here the analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From above table, responses corresponding to 'very necessary' and 'not necessary' were selected and are shown separately in the below figure.

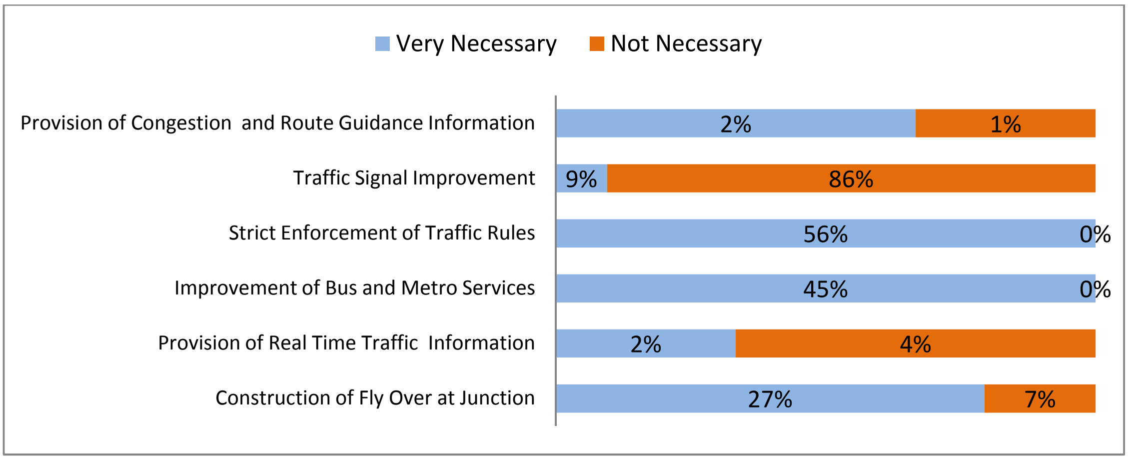


Figure 49: Truck Drivers Responses for Transportation Solutions

Truck drivers mentioned two major solutions: strict enforcement of traffic rules and improvement of bus and metro services. 56% and 45% responded these two improvements as ‘very necessary’. Traffic signal improvement was not accepted by the majority and mentioned as ‘not necessary’.

INTRODUCTION OF CONGESTION CHARGING FOR AN AREA

99% truck drivers highly disagreed with congestion pricing in Bengaluru. The remaining 1% favored congestion pricing.

SUMMARY OF TRUCK DRIVERS RESPONSES

Current Traffic Information System

- 100% dissatisfaction

Required Traffic Information

- Traffic incident
- Alternative route guidance

Choice of Mode to Receive Traffic Information

- In–car navigation system

Bengaluru Traffic and Transportation Problems

- Insufficient road capacity
- More no. of vehicles

improvements Required

- Strict enforcement of traffic rules
- Improvement of public transportation

Congestion Pricing

- 99% disagreed
- 1% agreed

MODULE 6

AMBULANCE DRIVERS

PART I: GENERAL INFORMATION

A total of 50 ambulance drivers were covered in the survey. The survey was conducted at six major hospitals in Bengaluru. The names of the hospitals are listed below.

- St. John's Hospital
- Narayana Hrudhayalaya Hospital
- Jeydeva Hospital
- NIMHANS Hospital
- Manipal Hospital
- Sanjeevini Hospital

DRIVER PROFILE

Of the 50 ambulance drivers covered in the survey, 28% were in the age group 30-39 and remaining 72% were 40-49. The details are listed below.

Table 22: Age Details of Ambulance Drivers

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Male	-	-	28%	72%	-	-	100%
Female	-	-	-	-	-	-	-

The majority (52%) earned INR 10,000-19,999 per month, 30% earned INR 5,000-9,999 and remaining 18% earned INR 20,000-29,999 per month. The salary profile is shown in the chart below.

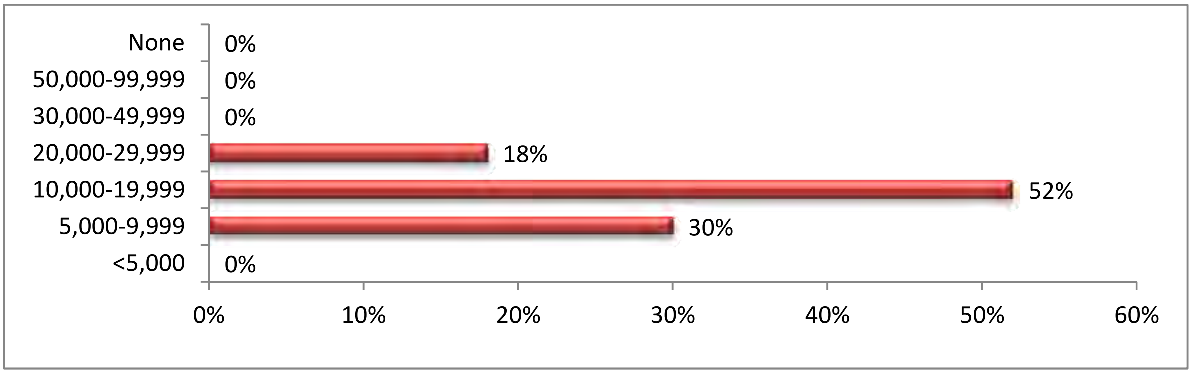


Figure 50: Average Monthly Salary of Ambulance Drivers

TRIP INFORMATION

To understand the trip details of ambulance drivers, the following questions were asked

- Number of emergency calls attended per day
- Average travel time to bring victim to hospital
- Source of emergency information

Drivers responses for the above questions were collected and are summarized below.

Table 23: Responses of Ambulance Drivers on Trip Information

Frequency of emergency call		Avg. Travel Time (minutes)		Source of information
No. of calls/day	Response	To reach victim	Bring victim to hospital	
1-2 calls	40%	40-45	40-50	• Call from hospital • Call from citizens
3-4 calls	36%	40-45	40-50	
5 calls	24%	20-25	20-25	• 108 facility • call from hospital

Note: 108 is a free telephone number for emergency services in India, currently operational in 17 states including Karnataka.

The majority of drivers responded that they attended 1-2 or 3-4 emergency cases per day. A few of them even attend 5 emergency cases per days. It is to be noted that drivers attending 5 calls per day was taking emergency cases on nearby locations. The average travel time for one way travel was 40 -50 minutes. In most of the cases the major sources were calls from citizens, hospitals and 108 call facilities.

CURRENT TRAFFIC INFORMATION SYSTEM

100% drivers expressed their dissatisfaction on current traffic information system.

AMBULANCE ACTIVITIES – PROBLEMS AND REQUIRED SOLUTION

Ambulance drivers were asked about the three major traffic problems faced while attending emergency cases. The responses are shown in the chart below.

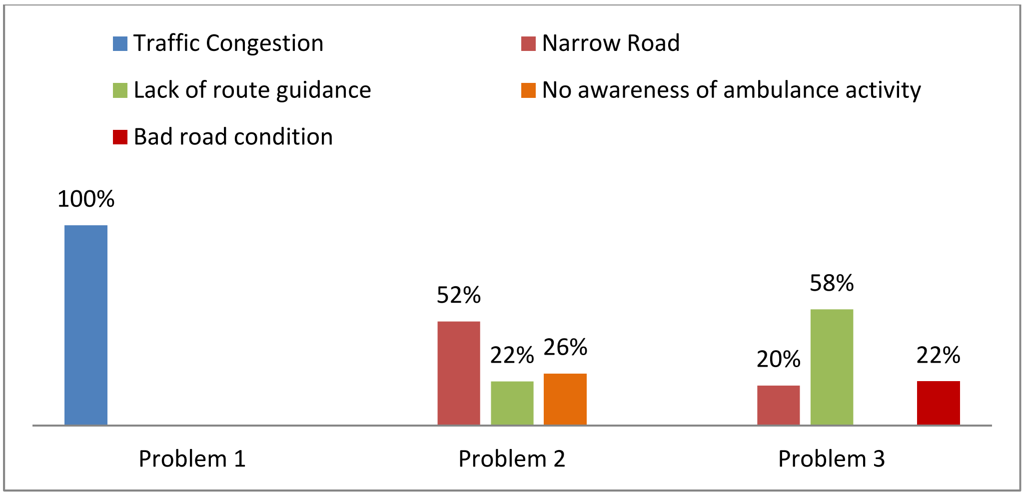


Figure 51: Driver's Response for Problems for Ambulance activities

The three major problems identified were: traffic congestion, narrow roads and lack of route guidance information.

The ambulance drivers gave solutions to tackle the above problems. Their responses are shown in the chart below.

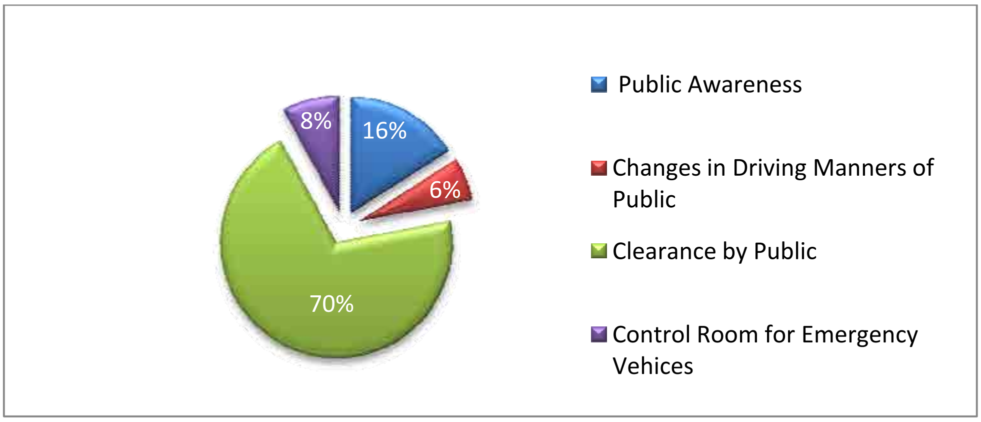


Figure 52: Responses for Improvements Required

Clearance by public was the major requirement ambulance drivers mentioned. Change in driving manners of public and more awareness to public was suggested by a few of the drivers.

PART II: INTELLIGENT TRANSPORT SYSTEM

CURRENT TRAFFIC INFORMATION AVAILABLE

All the drivers expressed current traffic information as ‘not helpful’.

TYPE OF TRAFFIC INFORMATION REQUIRED

The following traffic information was mentioned as ‘very helpful’ by ambulance drivers:

- Congested location information
- Alternative route information
- Expected travel time to destination information
- Length of traffic congestion information
- Traffic incident information

100% of drivers responded in-car navigation system as their choice to receive the traffic information.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS IN BENGALURU:

100% of ambulance drivers evaluated current Bengaluru traffic as very bad condition. Congestion was the major problem identified and the reasons were asked to the drivers. The responses received for different options are listed in table 24.

Table 24: Reasons for Congestion

Congestion Reason	Reason 1	Reason 2	Reason 3
• Insufficient road capacity	26%	56%	18%
• Too many vehicles	72%	22%	6%
• Inefficient traffic signals	-	-	-
• Bad pavement with potholes	-	2%	12%
• Bump	-	-	-
• On-street parking	-	-	-
• Traffic accidents	-	-	-
• Bad Driving Manners	2%	16%	54%
• Too many one-way streets	-	4%	8%
• Jaywalking pedestrians	-	-	-

Note: Since multiple options were provided for users, the total response may not be 100%.

The majority responded about increasing number of vehicles as primary cause for congestion. Insufficient road capacity and bad driving manners are also mentioned as other reasons for congestion.

TRAFFIC AND TRANSPORTATION SOLUTIONS

Six transport solutions were suggested to ambulance drivers. 100% positive response was received for each solution. The responses are shown in the table below.

Table 25: Driver's Response for Solution

Solutions	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	100%	-	-	-	-
• Provision of realtime traffic congestion information	100%	-	-	-	-
• Improvement of bus and metro service	-	100%	-	-	-
• Strict enforcement of traffic rules	100%	-	-	-	-
• Traffic signal improvement	-	100%	-	-	-
• Provision of traffic congestion information and route guidance	100%	-	-	-	-

OPINIONS ON CONGESTION PRICING

Ambulance drivers agreed for introduction of congestion pricing in Bengaluru. It was responded as 'very necessary' by all the drivers, especially for private vehicles, mainly motorcycles and cars. Ambulance drivers strongly believe that congestion pricing may reduce the number of vehicles on roads.

SUMMARY OF AMBULENCE DRIVERS RESPONSES

Current Traffic Information System

- 100% dissatisfaction

Improvements Required

- Public awareness
- Changes in driving manners of public
- Control room for emergency vehicles

ITS Solutions

- 100% positive response
- Congested location information
- Alternative route guidance information
- Expected travel time information
- In-car navigation system

Congestion Pricing

- 100% agreed (for private vehicles)

MODULE 7

SUMMARY

MAJOR FINDINGS

The major findings of the opinion survey conducted on various transport modes are summarized in the sections below.

MODE OF CHOICE BY MONTHLY SALARY

The analysis was made to understand the choice of transport mode by monthly salary. The following trends were observed.

Bus and Motorcycle are generally preferred by people who earn less than INR. 30,000. As the salary profile increases to INR. 30,000, the usage tends to shift to metro and private cars. As the salary profile becomes more than INR. 1, 00,000, the majority prefer private car.

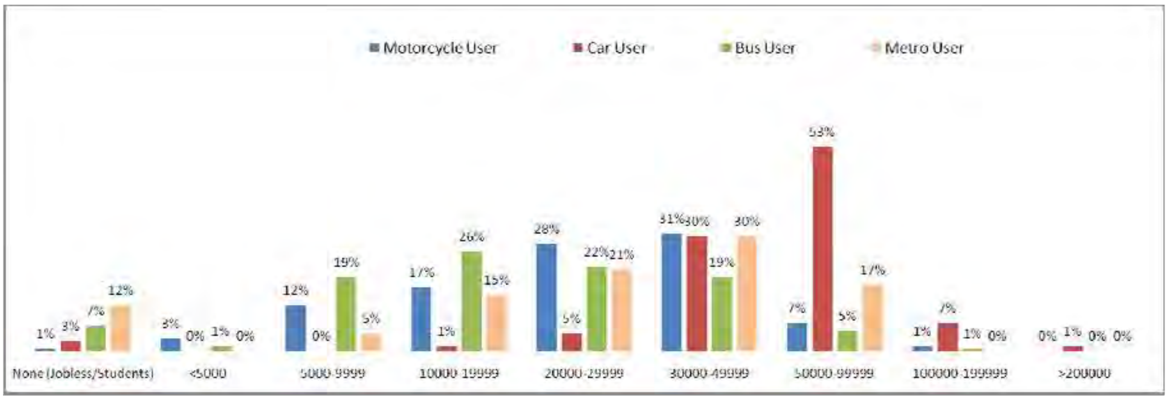


Figure 53: Choice of Transport Mode by Monthly salary

AVERAGE TRAVEL TIME BY TRANSPORT MODE

The travel time from origin (home) to destination (schools, work place) by transport mode was compared and the results are shown in the chart below. One major observation is that the majority average travel time lies in the range of 30 - 59 minutes, regardless of transport mode except bus. The majority of bus users responded with the travel time of more than 60 minutes. This implies that additional time such as waiting at bus stop, walking from/to bus stop to arrive their destinations is required. It is noted that the result of metro users may not be significant because the metro line was only partially in operation at time of the survey.

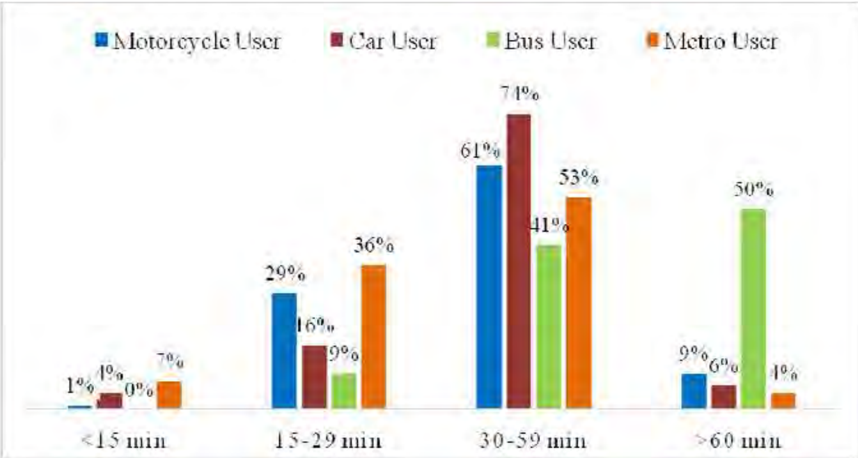


Figure 54: Average Travel Time by Transport Mode

FACILITIES NEEDED IN DIFFERENT MODES

Each transport mode covered in the survey has responded for the improvements needed in their respective modes. The type of the facilities required varied according to the transport mode.

PUBLIC TRANSPORT

The chart below shows the facilities and information desired by bus and metro users. Both users, bus and metro, responded that the smartcard would be useful. Lack of information and display boards at bus stops was mentioned by the majority of the bus users. Lack of transfer facilities is a major concern of metro users. Realtime traffic information is desired even by the public transport users as they wish to plan their journeys in advance.

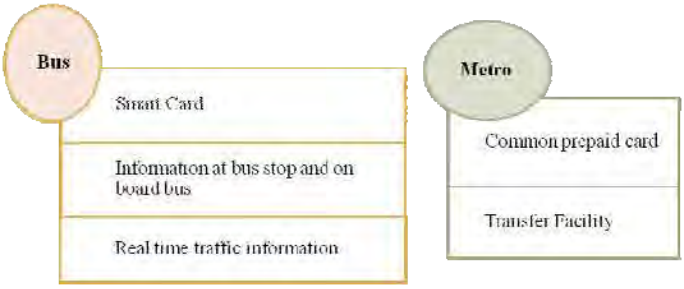


Figure 55: Desired Facilities and Information of Public Transport Users

PRIVATE TRANSPORT (MOTORCYCLE AND CAR)

The results of private transport users are completely different from those of public transport users. The private transport users prefer ITS facilities for their convenience. The responses of motorcycle and car users are more or less similar. Both users, motorcycle and car, responded that they needed two major kinds of information: information on congested locations and route guidance.

The results of Motorcycle and Car users are shown in the chart below.

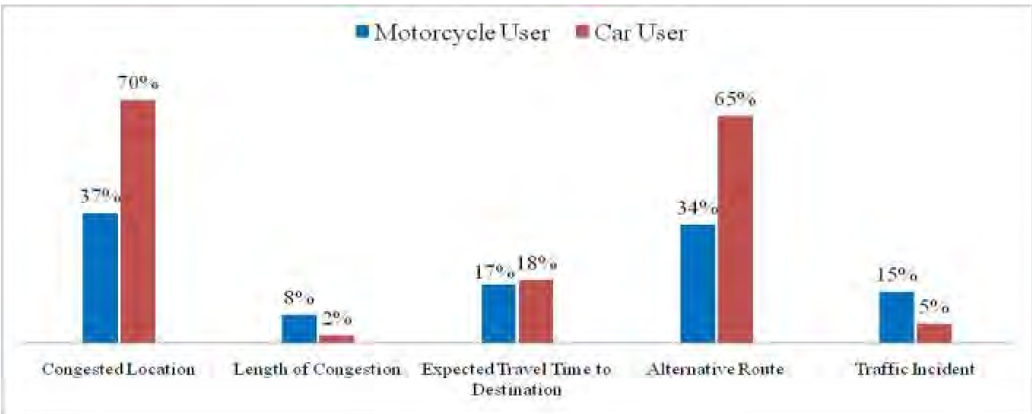


Figure 56: Required Information by Private Mode Users

COMMERCIAL AND EMERGENCY VEHICLES

The facilities desired by truck and ambulance drivers to enhance their service are summarised and shown in the chart below.

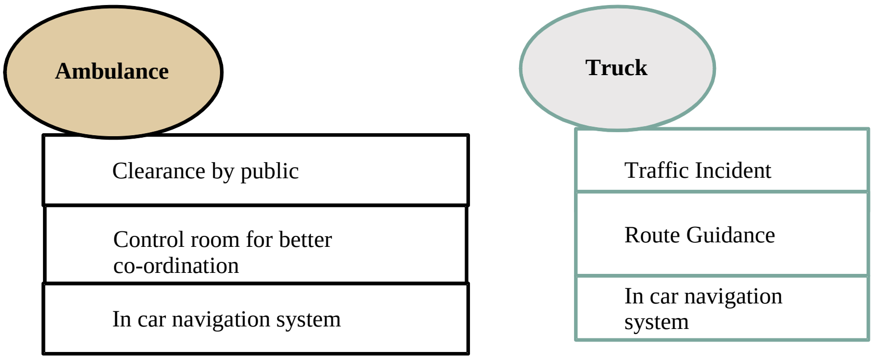
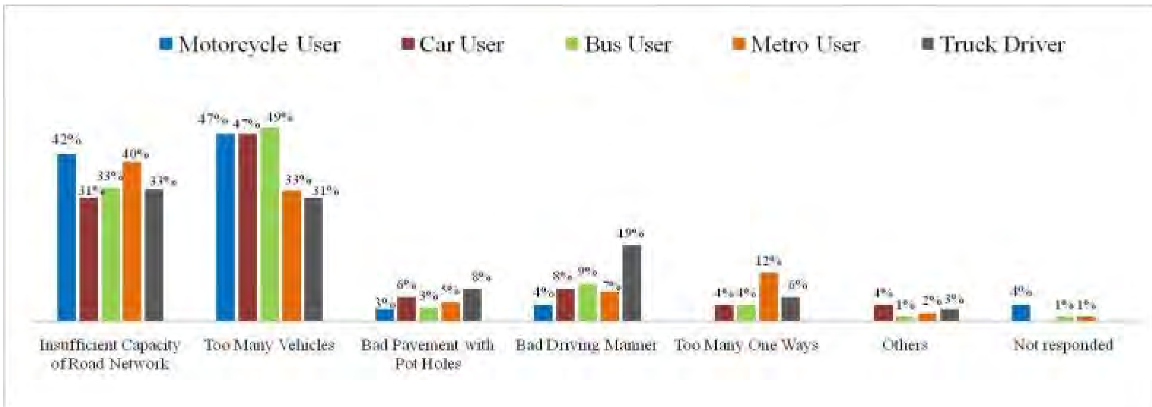


Figure 57: Improvements Desired for Truck and Ambulance Vehicles

TRAFFIC AND TRANSPORTATION BENGALURU

CONGESTION REASONS

The survey revealed that almost everyone considers the traffic situation in Bengaluru bad condition, mainly due to congestion. The chart below shows the reasons of the congestion responded by users of different transport modes. Increasing number of vehicles as well as insufficient capacity of roads are considered as major causes of congestion by the majority of users. A few responded too many one way roads, bad pavement and traffic manners as other reasons.



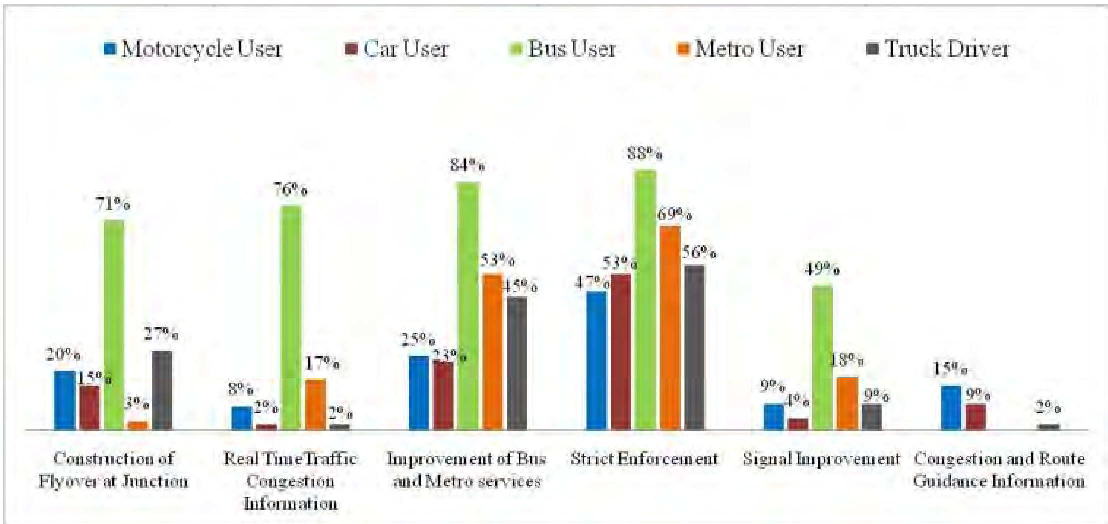
Others: Bumps, Traffic Accidents, Jaywalking Pedestrains and Roadside Parking.

Figure 58: Reasons Mentioned for Bengaluru Congestion

SOLUTIONS FOR BENGALURU CITY

The responses of the users were analysed for the solutions for traffic and transportation in Bengaluru. Users response on suggested solutions were collected as follows: very necessary, necessary, may be, and not necessary. The analysis reports, only the responses corresponding to very necessary. The results are shown in the chart below.

The majority responded that strict enforcement of traffic rules and improvement of public transport services are important.



Note: Since multiple options were provided for users, the total response may not be 100%.

Figure 59: Solution for Bengaluru City

CHOICE FOR CONGESTION PRICING

The opinions on congestion pricing were also asked. The survey unexpectedly revealed that many users regard congestion pricing positively.

The majority of public transport users responded that it is required to reduce congestion. However, it should be noted that they responded on the condition that the charging be imposed on the private vehicles. Interestingly, nearly half the users of private transport, motorcycle and car, responded that congestion charging is required. This implies that people regard the congestion in the city as a very serious problem.

Table 26: Responses on Congestion Pricing

Mode	Yes	No	Don't Know
Bus	100% (Private Vehicles)	0%	0%
Metro	79% (Private Vehicles)	19%	2%
Motorcycle	46%	46%	8%
Car	46%	49%	5%
Truck	1%	99%	0%

APPENDIX: X

QUESTIONNAIRE FOR MOTORCYCLE USERS

Sample ID:	______________________	Date:	______________________
Location:	______________________ (location name/road name/landmark)	Terminal name:	______________________

Part I. General Information

Sex	1) Male 2) Female	**Age**	1) 15-20 4) 40-49	2) 20-29 5) 50-59	3) 30-39 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of bike usage: How often do you use two wheeler?

1) 5-7 days/week 2) 3-4 days/week 3) 1-2 days/week 4) 1-2 days/month

Main purpose of use

1) Commuting 2) School 3) Business 4) Shopping 5) Others

If your answer to 0 is not 1) or 2), skip next question and proceed to 0
Average travel time to destination

1) Less than 15 minutes 2) 15 to 29 minutes 3) 30 – 59 minutes 4) 60 minutes or more

Why you do not use public transport (bus)?

1) Not convenient 2) Take more time 3) Not clean 4) Others(Specify)
( )

At destination, where do you park your two wheeler?

1) Office/school parking	2) private off-road parking	3) public off-road parking	4) Roadside	4) Others (specify) ( )

If you use pay parking, how much do you pay for parking at a time

1) Rs. 5	2) Rs. 10	3) Rs. 11 - 20	4) Rs. 21-30	5) Rs. 31 or more

Do you transfer to/from other mode? If yes, type of transport?

1) Rickshaw	2) Metro	3) Bus	4) Car	5) Train

Part II. Intelligent Transport System

How you get congestion information?

1) Radio	2) Internet	3) Mobile phone	4) Variable message sign	5) Others ( )	6) None

Do you think traffic information currently available sufficient?

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Type of information you need
Congested location?

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Length of traffic congestion

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Expected travel time to destination

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Alternative route

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

How do you want the information above to be provided?

1) Radio	2 Variable Message Sign	3) Internet	4) Mobile phone	5) In-car navigation system	6) Others ( )

Have you ever use Expressway (Nice Road or Bangalore Elevated Tollway)

1- Yes. 2- No

If your answer is "yes", please answer 0 and 0.
What are the problems you encounter on these expressways?

1) Queue at toll gate	2) Traffic congestion	3) Lack of traffic information	4) Traffic safety	5) Others (specify) ( )

What improvement do you want for existing expressway systems?

1) ETC system for two wheeler	2) ETC system common to all toll roads	3) Real time traffic information	4- Others (specify) ( )

Part II. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad	2) Bad	3) So-so	4) Good	5) Very good

What are causes of traffic congestion? Please select three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Lack of traffic information	12) Others (specify) ( )

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Provision of real time traffic congestion information

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Enhancement of bus and metro service.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Strict enforcement of traffic rules.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Traffic signal improvement.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Provision of traffic congestion information and route guidance.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Introduction of congestion charging for congested area

1) Very necessary	2) Necessary	3) Not necessary	4) Don't know

If you answer is “yes”, please to go to 0, otherwise skip to 0.
How much do you pay for congestion charge (amount to pay to enter restricted area/road)

1) Rs. 5   2) Rs. 10   3) Rs. 20   4) More than Rs. 20

If you have any other suggestion, please write.

____

Thank you for your cooperation!

QUESIONNAIRE FOR CAR USERS

Sample ID:		Date:	
Location:	(location name/road name/landmark)	Terminal name:	

Part I. General Information

Sex	1) Male 2) Female	**Age**	1) 15-20 4) 40-49	2) 20-29 5) 50-59	3) 30-39 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of bike usage: How often do you use two wheeler?

1) 5-7 days/week	2) 3-4 days/week	3) 1-2 days/week	4) 1-2 days/month

Main purpose of use

1) Commuting	2) School	3) Business	4) Shopping	5) Others

If your answer to 0 is not 1) or 2), skip next question and proceed to 0
Average travel time to destination

1) Less than 15 minutes	2) 15 to 29 minutes	3) 30 – 59 minutes	4) 60 minutes or more

Why you do not use public transport (bus)?

1) Not convenient	2) Take more time	3) Not clean	4) Others(Specify) ( )

At destination, where do you park your two wheeler?

1) Office/school parking	2) private off-road parking	3) public off-road parking	4) Roadside	4) Others (specify) ( )

If you use pay parking, how much do you pay for parking at a time

1) Rs. 5　2) Rs. 10　3) Rs. 11 - 20　4) Rs. 21-30　5) Rs. 31 or more

Do you transfer to/from other mode? If yes, type of transport?

1) Rickshaw　2) Metro　3) Bus　4) Car　5) Train

Part II. Intelligent Transport System

How you get congestion information?

1) Radio　2) Internet　3) Mobile phone　4) Variable message sign　5) Others (　　　)　6) None

Do you think traffic information currently available sufficient?

1) Very helpful　2) Helpful　3) Not helpful　4) Don't know:

Type of information you need

Congested location?

1) Very helpful　2) Helpful　3) Not helpful　4) Don't know:

Length of traffic congestion

1) Very helpful　2) Helpful　3) Not helpful　4) Don't know:

Expected travel time to destination

1) Very helpful　2) Helpful　3) Not helpful　4) Don't know:

Alternative route

1) Very helpful　2) Helpful　3) Not helpful　4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful　2) Helpful　3) Not helpful　4) Don't know:

How do you want the information above to be provided?

1) Radio　2 Variable Message Sign　3) Internet　4) Mobile phone　5) In-car navigation system　6) Others (　　　)

Have you ever use Expressway (Nice Road or Bangalore Elevated Tollway)

1- Yes.　2- No

If your answer is "yes", please answer 0 and 0.

What are the problems you encounter on these expressways?

1) Queue at toll gate　2) Traffic congestion　3) Lack of traffic information　4) Traffic safety　5) Others (specify) (　　　)

What improvement do you want for existing expressway systems?

1) ETC system for two wheeler	2) ETC system common to all toll roads	3) Real time traffic information	4- Others (specify) ( )

Part II. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad   2) Bad   3) So-so   4) Good   5) Very good

What are causes of traffic congestion? Please select three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Lack of traffic information	12) Others (specify) ( )

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary   2) Necessary   3) Maybe   4) Not necessary   5) Don't know

Provision of real time traffic congestion information

1) Very necessary   2) Necessary   3) Maybe   4) Not necessary   5) Don't know

Enhancement of bus and metro service.

1) Very necessary   2) Necessary   3) Maybe   4) Not necessary   5) Don't know

Strict enforcement of traffic rules.

1) Very necessary   2) Necessary   3) Maybe   4) Not necessary   5) Don't know

Traffic signal improvement.

1) Very necessary   2) Necessary   3) Maybe   4) Not necessary   5) Don't know

Provision of traffic congestion information and route guidance.

1) Very necessary   2) Necessary   3) Maybe   4) Not necessary   5) Don't know

Introduction of congestion charging for congested area

1) Very necessary   2) Necessary   3) Not necessary   4) Don't know

If you answer is "yes", please to go to 0, otherwise skip to 0.
How much do you pay for congestion charge (amount to pay to enter restricted area/road)

1) Rs. 5   2) Rs. 10   3) Rs. 20   4) More than Rs. 20

If you have any other suggestion, please write.

Thank you for your cooperation!

QUESTIONNAIRE FOR BUS USERS

Sample ID:	______________________	Date:	______________________
Location:	______________________ (location name/road name/landmark)	Terminal name:	______________________

Part I. General Information

Sex	1) Male 2) Female	**Age**	1) 15-20 4) 40-49	2) 20-29 5) 50-59	3) 30-39 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of using public transportation (bus)

1) 5-7 times/week 2) 3-4 times/week 3) 1-2 times/week 4) 1-2 times/month

How do you pay fare for bus?

1) Monthly pass 2) Daily pass 2) Cash 3) Others (specify)

If you pay bus fare in cash, how much do you pay for a one-way ride?

1) Rs. 5 2) Rs. 6 - 10 3) Rs. 11 – 20 4) More than Rs.

Are you a commuter?

1- Yes. 2- No

If you answer above is "yes", please continue to answer to 0 – 0, otherwise skip to Part II.

Average travel time to destination?

1) Less than 15 minutes 2) 15 to 29 minutes 3) 30 – 59 minutes 4) 60 minutes or more

Average time on board bus?

1) Less than 15 minutes 2) 15 to 29 minutes 3) 30 – 59 minutes 4) 60 minutes or more

Average waiting time at a bus stop?

1)10 minutes or less	2) 10 to 19 minutes	3) 20 – 29 minutes	4) 30 minutes or more

Number of transfers (bus to bus)?

1) None	2) 1 time	3) 2 times	4) 3 times or more

Do you transfer to/from other transport mode?

1) Rickshaw	2) Metro	3) Two wheeler	4) Car	5) Train

Part II. Public Transportation Services

As a passenger, what are the problems you encounter while using public transportation (bus)? Please select three (3) most significant problems.

1) Long waiting time at bus stop	2) Long and uncertain riding time	3) Congested bus	4) Expensive fare
5) Complex bus system and route	6) No route, time and fare information at bus stop	7) Inconvenient connection / transfer	8) Bad driving manner
9) Security on bus			

Are there any others problems (please specify).

____

To improve public transportation services (bus), what improvement should be done?
BMTC is planning to introduce prepaid smart card. Do you want to use it?

1) Yes.	2) No	3) Don't know

Do you want an information board at bus stop that shows expected waiting time until next bus?

1) Yes.	2) No	3) Don't know

Do you want an announce/display system that guide next bus stop on board bus?

1) Yes.	2) No	3) Don't know

Do you want to get real-time bus information through your smart phone?

1) Yes.	2) No	3) Don't know

If you have other suggestion, please write.

____

Part III. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad	2) Bad	3) So-so	4) Good	5) Very good

What are causes of traffic congestion? Please specify three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Others (specify) (	)

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Q25. Provision of real time traffic congestion information

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Enhancement of bus and metro service.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Strict enforcement of traffic rules.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Traffic Signal Improvement.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Introduction of congestion charging for congested area

1) Very necessary	2) Necessary	3) Not necessary	4) Don't know

If you have any other suggestion, please write.

Thank you for your cooperation!

QUESTIONNAIRE FOR METRO USERS

Sample ID:	______________	Date:	______________
Location:	______________ (location name/road name/landmark)	Terminal name:	______________

Part I. General Information

Sex	1) Male	**Age**	1) 15-20	2) 20-29	3) 30-39
	2) Female		4) 40-49	5) 50-59	6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of Metro use

1) 5-7 times/week	2) 3-4 times/week	3) 1-2 times/week	4) 1-2 times/month

How do you pay Metro fare?

1) Stored value (Varshik)	2) Trip ticket (Sanchar)	2) Metro-Bus ticket day pass	3) Token (cash)

If you pay in cash, what is the reason for not using Varshik or Sanchar cards?

1) Casual user	2) High initial cost	3) Discount (15%) not attractive	4) Don't know about card	5) Others (specify) ( )

Are you a commuter?

1- Yes.	2- No

If you answer above is "yes", please continue to answer to 0 – 0, otherwise skip and proceed to Part II.
Average travel time to destination?

1) Less than 15 minutes	2) 15 to 29 minutes	3) 30 – 59 minutes	4) 60 minutes or more

Do you transfer from/to other transport mode?

1) Rickshaw	2) Bus	3) Motorcycle	4) Car	5) Others

Part II. Namma Metro Service

What improvement do you expect for Metro.

Prepaid card common to Metro and BMTC buses.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Transfer facilities between Metro and bus/auto rickshaw

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Park and ride facility (car parking/two wheeler parking at Metro station)

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Part III. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad	2) Bad	3) So-so	4) Good	5) Very good

What are causes of traffic congestion? Please specify three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Others (specify) (	)

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Q25. Provision of real time traffic congestion information

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Enhancement of bus and metro service.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Strict enforcement of traffic rules.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Traffic Signal Improvement.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area

1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you have any other suggestion, please write.

____

Thank you for your cooperation!

QUESTIONNAIRE FOR TRUCK DRIVERS

Sample ID:		Date:	
Location:	(location name/road name/landmark)	Terminal name:	

Part I. General Information

Sex	1) Male 2) Female	**Age**	1) 15-20 4) 40-49	2) 20-29 5) 50-59	3) 30-39 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Type of truck

1) Light commercial vehicle	2) Medium commercial vehicle	3) Heavy commercial vehicle	4) Others (specify) ( )

Frequency of use. How many days you drive your truck?

1) 5-7 days/week	2) 3-4 days/week	3) 1-2 days/week	4) 1-2 days/month

Do you take alternative route to avoid congested location?

1) Always	2) Often	3) sometimes	4) None

Part II. Intelligent Transport System

How you get congestion information?

1) Radio	2) Internet	3) Mobile phone	4) Variable message sign	5) Others ( )	6) None

Do you think traffic information currently available sufficient?

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Type of information you need

Congested location?

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Length of traffic congestion

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Expected travel time to destination

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Alternative route

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

How do you want the information above to be provided?

1) Radio 2 Variable Message Sign 3) Internet 4) Mobile phone 5) In-car navigation system 6) Others ( )

Have you ever use Expressway (Nice Road or Bangalore Elevated Tollway)

1- Yes. 2- No

If your answer is "yes", please answer 0 and 0.

What are the problems you encounter on these expressways?

1) Queue at toll gate 2) Traffic congestion 3) Lack of traffic information 4) Traffic safety 5) Others (specify) ( )

What improvement do you want for existing expressway systems?

1) More ETC toll gates 2) ETC system common to all toll roads 3) Real time traffic information 4- Others (specify) ( )

Part III. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad 2) Bad 3) So-so 4) Good 5) Very good

What are causes of traffic congestion? Please specify three (3) most significant causes.

1) Insufficient capacity of road network 2) Too many vehicles 3) Inefficient traffic signal 4) Bad pavement with pot holes

5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Others (specify) (	)

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Q25. Provision of real time traffic congestion information

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Enhancement of bus and metro service.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Strict enforcement of traffic rules.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Traffic Signal Improvement.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of traffic congestion information and alternative route.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area

1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you answer is "yes", please to go to 0, otherwise skip to 0.
How much do you pay for congestion charge (amount to pay to enter restricted area/road)

1) Rs. 5 2) Rs. 10 3) Rs. 20 4) More than Rs. 20

If you have any other suggestion, please write.

Thank you for your cooperation!

QUESTIONNAIRE FOR AMBULANCE DRIVERS

Sample ID:	____________________	Date:	____________________
Location:	____________________ (location name/road name/landmark)	Terminal name:	____________________

Part I. General Information

Sex 1) Male 2) Female

Age 1) 15-20 2) 20-29 3) 30-39 4) 40-49 5) 50-59 6) >60

Occupation

1) Ambulance driver 2) Others

Monthly Income level

1) None 2) Under 5,000 3) 5,000-9,999 4) 10,000 - 19,999
5) 20,000 - 29,999 6) 30,000 -49,999 7) 50,000-99,999 8) 100,000-199,999
9) 200,000 and above

Frequency of emergency call you receive for dispatching ambulance car a day

1) 1 -2call/a day 2) 3-4 call/a day 3) more than 5 call/a day 4) Others

What is the problem you are facing for your ambulance activity: Please pick 3

1) Traffic Congestion 2) Narrow road 3) Lack of route guidance
4) No awareness of ambulance activity 5) Bad road condition 6) Others

How much time takes to reach victim (average)

1) -10 2) 10-15 3) 15-20 4) 20-25 5) 25-30
6) 30-35 7) 35-40 8) 40-

How much time takes you to bring victim to hospital (average)

1) -10 2) 10-15 3) 15-20 4) 20-25 5) 25-30
6) 30-35 7) 35-40 8) 40-

What is the information source which you receive regarding initiation of ambulance activities a day

1) Ambulance No.108 2) Call from citizens 3) contact from police
4) contact from hospital 5) Others

Do you get the traffic information before starting the ambulance car

1) Yes 2) No

If your answer is "yes", how you get these information

1) Emergency support 2) Internet 3) SMS 4) Radio 5) Police
6) Hospital 7) Others 6) None

Please give us any your idea which enable to solve the problem for ambulance activities?

Part II. Intelligent Transport System

Do you think traffic information currently available sufficient?

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Type of information you need
Congested location?

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Length of traffic congestion

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Expected travel time to destination

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Alternative route

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

How do you want the information above to be provided?

1) Radio 2 Variable Message Sign 3) Internet 4) Mobile phone 5) In-car navigation system 6) Others ( )

Part III. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad 2) Bad 3) So-so 4) Good 5) Very good

What are causes of traffic congestion? Please select three (3) most significant causes.

1) Insufficient capacity of road network 2) Too many vehicles 3) Inefficient traffic signal 4) Bad pavement with pot holes

5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Lack of traffic information	12) Others (specify) ( )

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of real time traffic congestion information

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Enhancement of bus and metro service.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Strict enforcement of traffic rules.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Traffic signal improvement.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of traffic congestion information and alternative route.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area

1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you answer is "1) or 2)", please to go to Q30, otherwise skip.
Q30 How much do you pay for congestion charge (amount to pay to enter restricted area/road)

1) Rs. 5 2) Rs. 10 3) Rs. 20 4) More than Rs. 20

Q31 If you have any other suggestion, please write.

____

Thank you for your cooperation!

Appendix - 3

ITS Opinion Survey Report (Mysore)

The Master Plan Study on ITS in Mysore

Opinion Survey Report

Submitted to

JICA Study Team

Submitted by

REVA Group of Educational Institutions

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MODULE 1

MOTORCYCLE USERS

PART I: GENERAL INFORMATION

A total of 50 motorcycle users were interviewed in the survey. An interview sheet was prepared in this regard. The surveyors randomly distributed interview sheet to motorcycle users at various locations in Mysore. Locations such as commercial areas, parking places, shopping malls, busy streets, residential and industrial areas were given prime focus where more number of motorcycle users were present. Some of the major locations where the motorcycle user survey carried out are listed below.

- Mall of Mysore
- Hunsur Road
- Kuvempu Nagar
- Kalidasa Road
- Sayyaji rao Road Irwin Road
- Mandi Mohalla Road
- Mysore City Corporation
- Devaraj RS road
- Saraswathipuram Road
- Mysore Medical College
- Mysore City Bus Stand
- Mysore University

Appendix-X : ITS Opinion Survey Questionnaire for motorcycle users should be referred to for the details. The responses of the users was collected on the spot. The following sections describe the results of motorcycle users survey.

MOTORCYCLE USER PROFILE

Of the 50 motorcycle users covered in the survey, 82% were male and remaining 18% were female. The majority were in the age group of 30-39. The job profile varied widely, most of them being administrative jobs (26%) and professionals (22%). The monthly salary was in the range of INR 20,000 – 29,999.

The age details of motorcycle users are listed in table 1.

Table 1: Age Details of Motorcycle Users

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Male	-	12%	28%	26%	8%	8%	82%
Female	-	8%	10%	-	-		18%

The job profile of motorcycle users are shown in the table below.

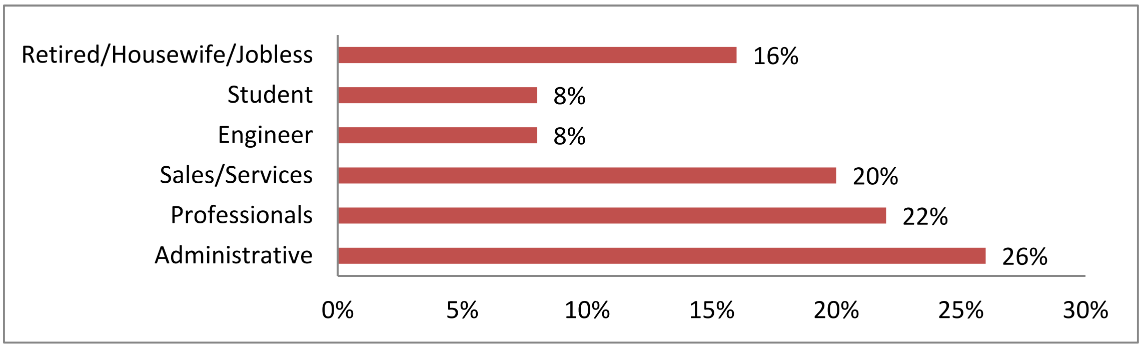

Figure 1: Job Profile of Motorcycle Users

Figure 2 shows the average monthly salary of motorcycle users.

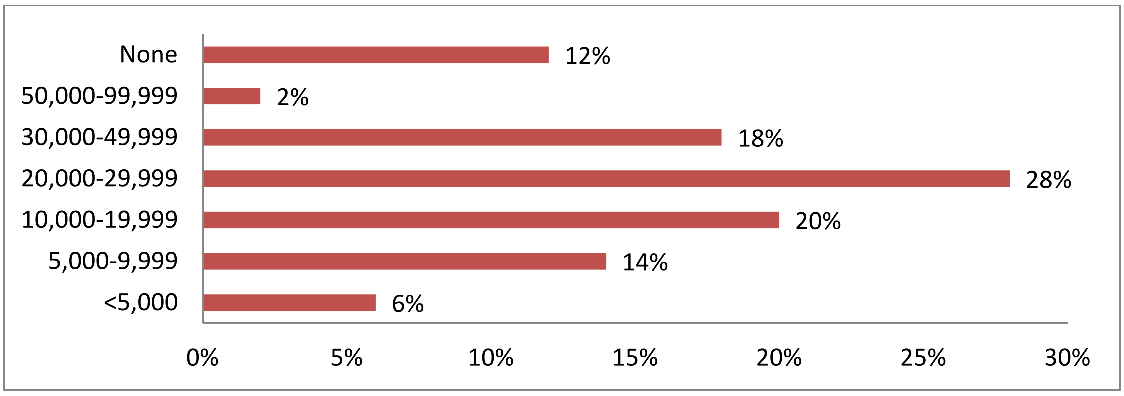

Figure 2: Motorcycle Users Responses for Monthly Income

FREQUENCY OF TRIPS

The majority of motorcycle users were making regular trips. Users responses on frequency of trips are listed as follows.

- 86% responded 5-7 days per week
- 8% responded 3-4 days per week
- 6% responded 1-2 days per week

PURPOSE OF TRIP AND TRAVEL TIME

Users were asked on the purpose of the trip and the average travel time to complete the trip. The majority were regular commuters travelling to work places. The average travel time responded was 15-29 minutes.

Users responses on purpose of trip are shown in the chart below.

Figure 3: Motorcycle Responses on Purpose of Trip

Responses on average travel time of motorcycle users are shown in figure 4.

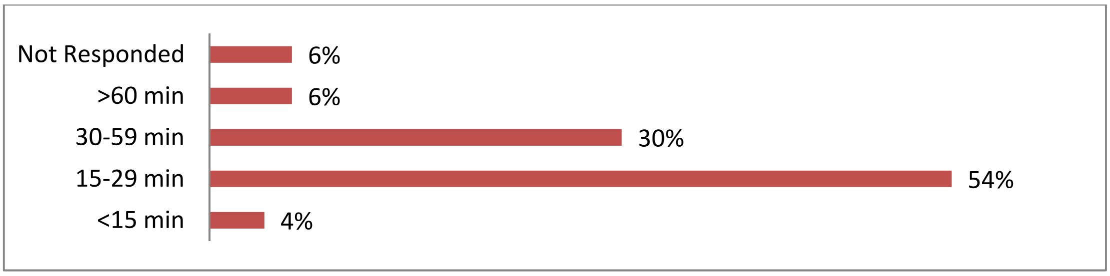

Figure 4: Average Travel Time of Motorcycle Users

REASONS FOR NOT OPTING PUBLIC TRANSPORT

Inconveience of public transport was one major reasons responded by the majority of motorcyclists. The responses are listed as follows:

- 74% - not conveient
- 26% - travel time is more

PARKING FACILITY AND WILLINGNESS TO PAY

The majority used the alloted parking lots available at offices. Use of roadside parking was also mentioned by motocyclists. The responses are shown in the figure below.

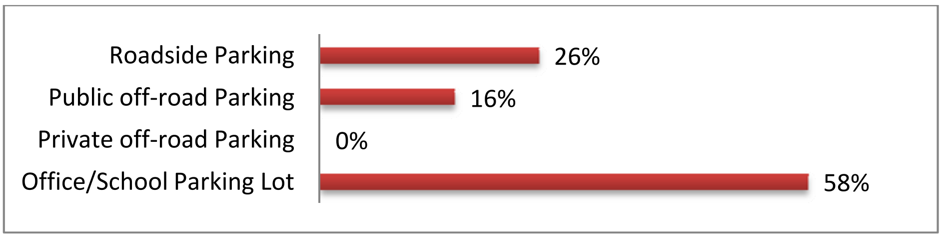

Figure 5: Responses on Parking Place

Most of the motorcycle users were paying INR 5 as parking charge for one time. Users responses for parking charges are listed below.

- INR 5: 58%
- INR 10: 42%
- INR 11-20: 0%

- INR 21-30: 0%

TRANSFER TO/FROM OTHER MODES

Transfer to other transport modes was found to be less among motorcycle users. Users responses on transfer to/from other transport modes are listed as follows:

- No transfer: 94%
- Transfer to/from auto: 2%
- Transfer to/from bus: 4%
- Transfer to/from car: 0%

PART II: INTELLIGENT TRANSPORTATION SYSTEM

SOURCE OF CONGESTION INFORMATION AND CURRENT TRAFFIC INFORMATION FACILITY

98% responded that they are not receiving traffic congestion information. 2% responded positively, mentioned 'radio' as the major source of congestion information.

Users responses on sources to receive congestion information are listed below:

- Radio – 2%
- Variable Message Sign Boards – 0%
- Mobile Phone – 0%
- Internet – 0%

The opinions of users on current traffic information facility was collected and are summarized in the figure below. 94% were unhappy and responded that it is not helpful. On the other hand, 6% responded as helpful.

Figure 6: Opinions on Current Traffic Congestion Information

TYPE OF TRAFFIC INFORMATION REQUIRED

Users were asked on required traffic information. Five types of traffic information were suggested and the responses is collected as follows:

- Very Helpful
- Helpful
- Not Helpful
- Don't Know

The responses of users for the required traffic information are listed in the following table. The response of users in percentage are shown in the table.

Table 2: Response for Traffic Information Required

Type of Traffic Information Required	Very Helpful	Helpful	Not Helpful	Don't Know
Congested Location Information	0%	22%	78%	0%
Length of Congestion Information	0%	4%	96%	0%
Expected Travel Time Information to Reach Destination	0%	4%	96%	0%
Alternative Route Information	0%	16%	84%	0%
Traffic Incident Information	0%	10%	90%	0%

The suggested traffic information mentioned 'not helpful' by the majority of motorcyclists.

CHOICE ON MODE TO RECEIVE TRAFFIC INFORMATION

Less responses were received for this survey question. Only 30% motorcyclists responded here. Users responses on their choice of mode to receive traffic information are shown in the figure below.

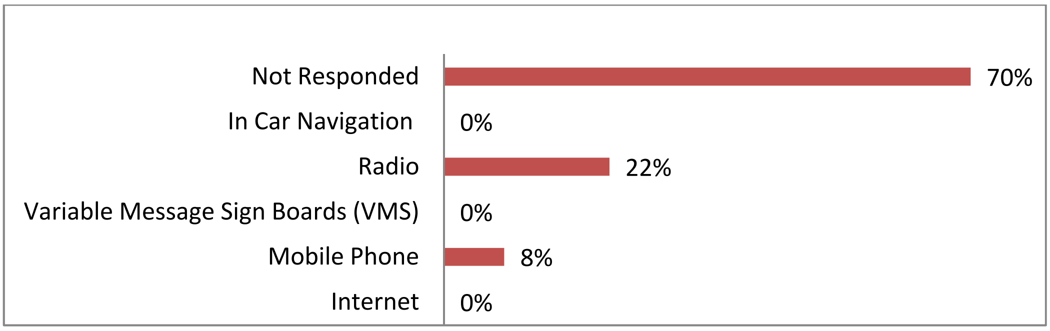

Figure 7: Responses on Choice of Mode to Receive Traffic Information

Among the responses received, 22% responded for 'radio' and 8% for 'mobile phone'.

EXPRESSWAY – PROBLEMS AND SOLUTIONS

Of the 50 motorcycle users covered in the survey, none of the users responded for expressway use. Hence the questions regarding expressway problems and solutions were not included.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS

MYSORE CITY TRAFFIC

Regarding Mysore traffic, the majority gave positive response. 66% responded Mysore traffic condition as 'good'. User's responses are listed below.

- Very Good: 0%
- Good: 66%
- So-So: 28%
- Bad: 6%

Compared to Bengaluru traffic, the majority of motorcyclists were happy with current Mysore traffic condition.

Although many gave positive response, everyone agreed with the fact that Mysore is starting to face traffic congestion problems. The reasons for traffic congestion were asked in this regard.

10 different reasons for congestion were listed in the questionnaire. Users were asked to choose three major reasons among the 10 listed options. Users responses are listed by reason priority in table 3.

Table 3: Response on Three Major Reasons for Congestion in Mysore

Congestion reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	20%	4%	2%
• Too many vehicles	58%	22%	
• Inefficient traffic signals	-	-	-
• Bad pavement with potholes	-	-	2%
• Bump	-	-	-
• On-street parking	-	-	-
• Traffic accidents	-	-	-
• Bad driving manners	2%	6%	8%
• Too many one-way streets	-	-	-
• Jaywalking pedestrians	-	-	-

Note: Since multiple options were provided for users, the total response may not be 100%.

Increasing number of vehicles was the major reason responded by the majority of motorcyclists. Insufficient capacity of road and bad driving manners are also mentioned as other reasons for congestion.

TRANSPORTATION SOLUTIONS FOR MYSORE

Six different solutions for traffic and transportation improvement in Mysore were listed in the questionnaire. Users were asked to express their opinion on each of the solution as follows:

- Very Necessary
- Necessary
- May Be
- Not Necessary
- Don’t Know

Users responses are analyzed and listed in the following table.

Table 4: Response for Solutions in Mysore

Solutions	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	-	34%	20%	46%	-
• Provision of realtime traffic congestion information	-	6%	10%	84%	-
• Improvement of bus and metro service	-	42%	36%	22%	-
• Strict enforcement of traffic rules	-	72%	12%	16%	-
• Traffic signal improvement	-	4%	4%	92%	-
• Provision of traffic congestion information and route guidance	-	2%	8%	90%	-

Here the analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From the table, responses corresponding to 'necessary' and 'not necessary' are selected and shown in the figure below.

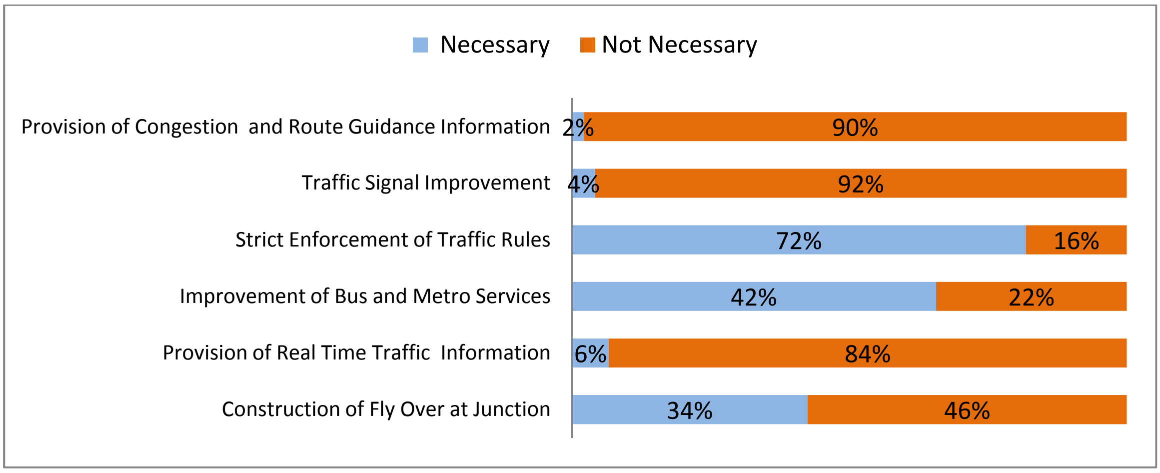

Figure 8: Responses for Solutions in Mysore

Strict enforcement of traffic rules was one major solution users mentioned. 72% responded positively. This was followed by improvement of bus and metro services and construction of flyover at junctions.

The analysis also reveals users negative response for traffic signal improvement and provision of realtime traffic information.

INTRODUCTION OF CONGESTION CHARGING FOR AN AREA

Users were asked their opinion on introduction of congestion pricing in Mysore. In addition to this, the survey also analyses user's willingness to pay for congest price. Random amounts, INR 5 – INR 20 and above were selected as amount of congestion price here. Please note that the amount listed here has not arrived from any studies.

The majority disagreed for congestion pricing in Mysore. The responses are shown in the following figure.

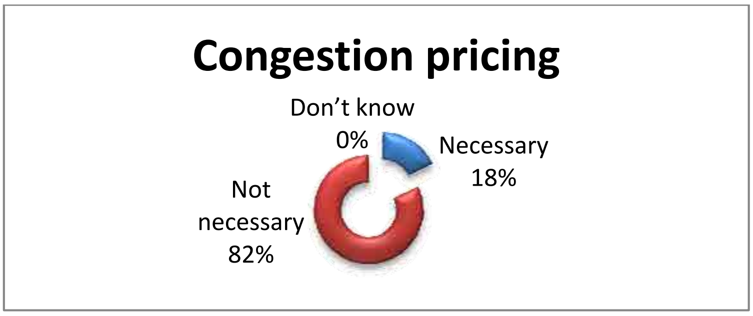

Figure 9: Responses for Congestion Pricing

18% responded that congestion pricing is required to reduce congestion in Mysore. However, it should be noted that they responded on the condition that the charging be imposed on tourist vehicles. In their opinion, it is the tourist vehicles that create traffic congestion in Mysore.

The response for amount for congestion charge is listed in the following figure. The responses were collected from only those users who gave positive responses for congestion pricing.

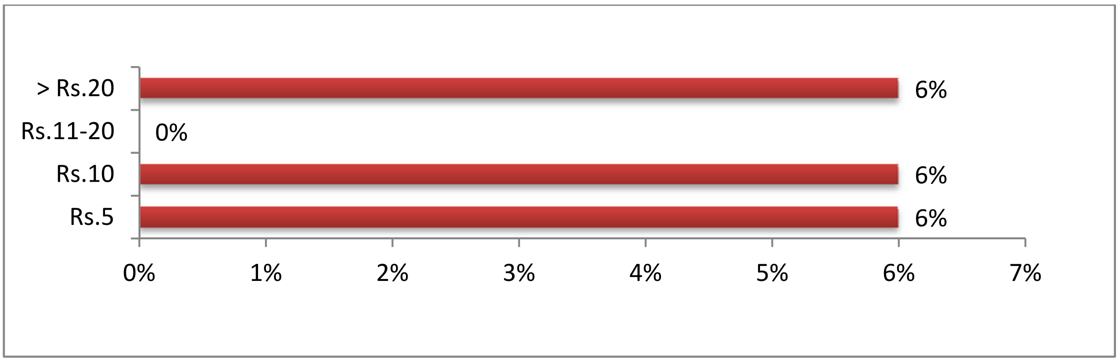

Figure 10: Responses for Amount of Congestion Price

OTHER SUGGESTIONS

The following are some suggestions responded by motorcyclists apart from the survey questions.

- Need of introducing policies to control tourist vehicles
- Need of improved traffic management especially at festival times.

SUMMARY OF MOTORCYCLE USERS RESPONSES

Problems

- Public transport is not convenient

ITS facilities needed

- Congestion location information
- Alternative route guidance information

- Preferred mode to receive information -Radio

Mysore Traffic and Transportation Problems

- Traffic congestion – emerging issue
- Increasing no. of vehicles – major reason

Improvements Needed

- Strict enforcement of traffic rules
- Improvement of public transport system

Congestion pricing

- Not willing to pay for congestion pricing

MODULE 2

CAR USERS - MYSORE

PART I: GENERAL INFORMATION

A total of 50 car users were covered in the survey from various locations in Mysore. This includes commercial areas, parking places, shopping malls, busy streets, a few residential locations and industrial areas. A few major survey locations are listed below.

- Mall of Mysore
- Hunsur Road
- Kuvempu Nagar
- Kalidasa Road
- Sayyaji rao Road
- Irwin Road
- Mandi Mohalla Road
- Mysore City Corporation
- Devaraj RS Road
- Mysore Medical College
- Mysore City Bus Stand
- Mysore University

Appendix-X : ITS opinion survey questionnaire for car users should be referred to for the details. The following sections describe the results of car users survey.

CAR USER PROFILE

Of the 50 motorcycle users covered in the survey, 92% were male and remaining 8% were female. The majority were in the age group of 30-39. The job profile varied widely, most of the being professionals and administrative jobs. The monthly salary was in the range of INR 30,000 – 49,999.

The age details of car users are listed in table 5.

Table 5: Age Details of Car Users

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Male	-	2%	56%	24%	8%	2%	92%
Female	-	2%	2%	2%	2%	-	8%

Figure 11 and 12 shows the job profile and the monthly salary profile of car users.

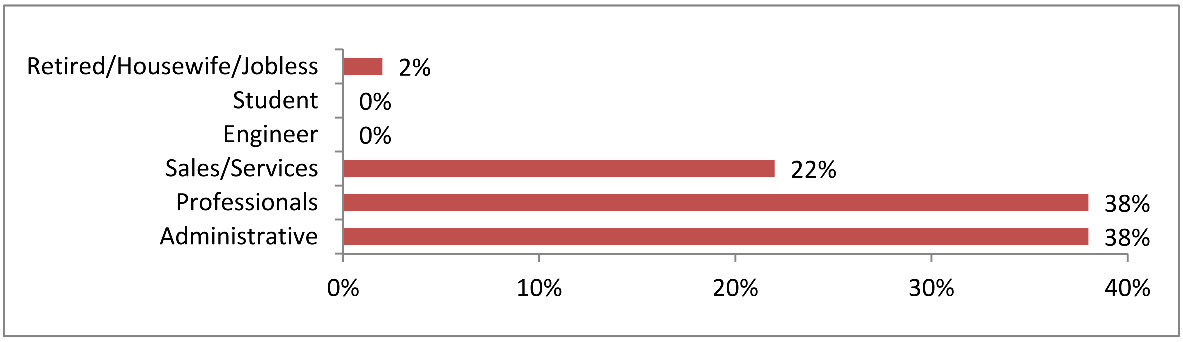

Figure 11: Job Profile of Car Users

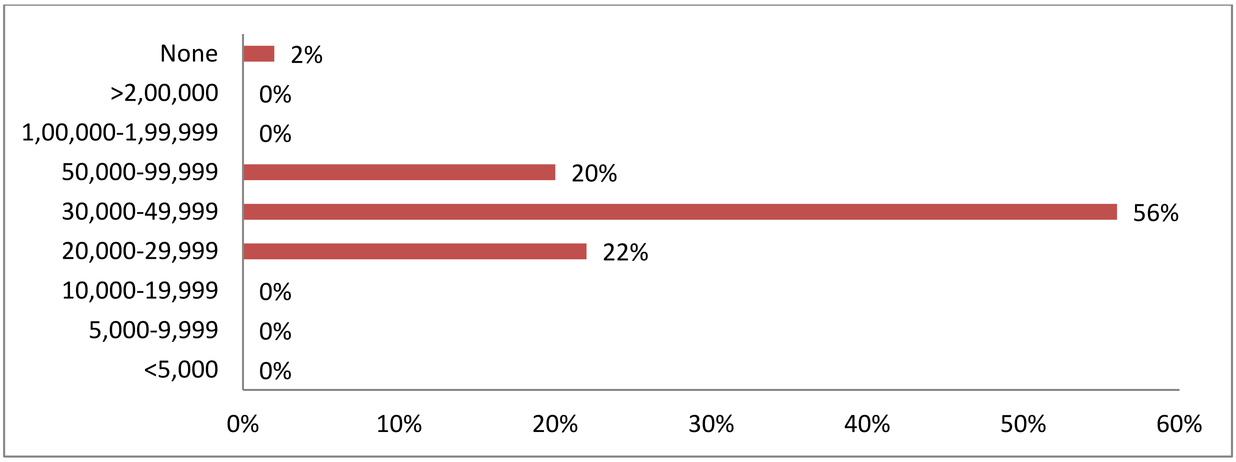

Figure 12: Monthly Salary of Car Users

FREQUENCY OF TRIPS

84% car users were making trips 5-7 days per week. The responses of car users regarding their frequency of travel are as follows:

- 84% travelling 5-7 days per week
- 10% travelling 3-4 days per week
- 6% travelling 1-2 days per week

PURPOSE OF TRIP AND TRAVEL TIME

The survey reveals that 94% of car users are regular commuters. The average travel time was observed to be 15-29 minutes.

Percentage responses for trip purpose and the average travel time are shown in the following figures.

Figure 13: Responses of Car Users on Trip Purpose

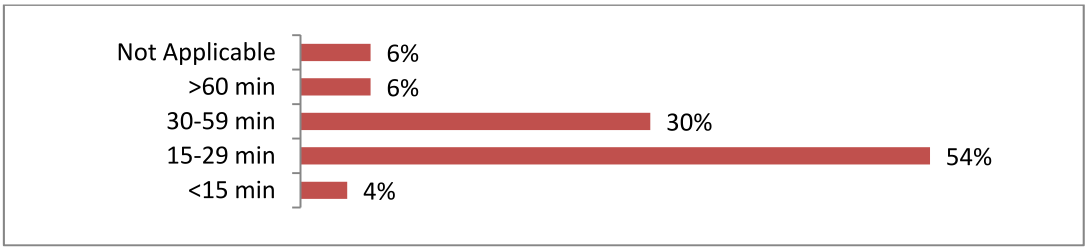

Figure 14: Responses of Average Travel Time of Car Users

REASONS FOR NOT OPTING PUBLIC TRANSPORT

Inconvenience of public transport was one of the major reasons responded by the majority of car users. Users responses are listed as follows:

- 84% - not convenient
- 16% - travel time is more

PARKING FACILITY AND WILLINGNESS TO PAY

The majority car users parked at alloted parking lots available at offices/schools. Use of roadside parking and private off-road parking was found to be less. The responses are shown in the figure below.

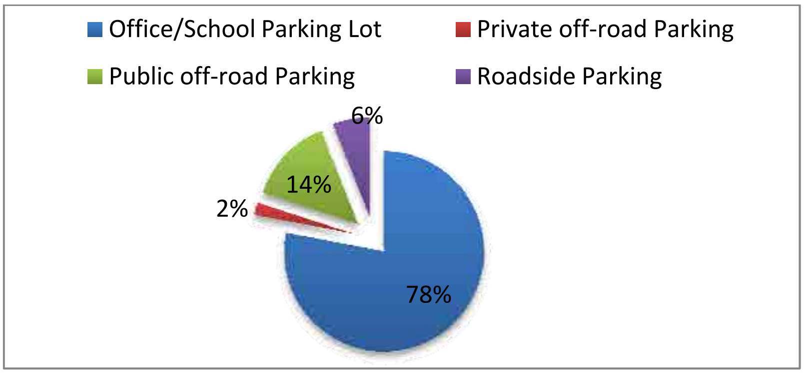

Figure 15: Responses of Car Users for Parking Facility

The parking charge for one time parking was varied from INR 5, INR 10 to INR 11-20. The percentage responses of car users are listed below.

- INR 5: 54%
- INR 10: 46%
- INR 11-20: 0%
- INR 21-30: 0%

TRANSFER TO/FROM OTHER MODES

Transfer to other transport modes was zero by all car users. The reponses are listed below.

- No transfer: 100%
- Transfer to/from auto: 0%
- Transfer to/from bus: 0%
- Transfer to/from car: 0%

PART II: INTELLIGENT TRANSPORTATION SYSTEM

SOURCE OF CONGESTION INFORMATION AND CURRENT TRAFFIC INFORMATION FACILITY

100% car users responded that they are not receiving any congestion information.

The opinions of users on current traffic information facility was collected and are summarized in figure 16. 100% were unhappy and responded the existing traffic information system as ‘not helpful’.

Figure 16: Opinions of Car Users on Current Traffic Congestion Information

TYPE OF INFORMATION NEEDED

The responses of users for the required traffic information are listed in the following table.

Table 6: Type of Traffic Information Required

Type of Traffic Information Required	Very helpful	Helpful	Not Helpful	Don’t Know
Congested Location Information	-	12%	88%	-
Length of Congestion Information	-	2%	98%	-
Expected Travel Time Information to Reach Destination	-	4%	96%	-
Alternative Route Information	-	8%	92%	-
Traffic Incident Information	-	2%	98%	-

The suggested traffic information was responded as ‘not helpful’ by the majority of car users.

CHOICE ON MODE OF INFORMATION

Less response was received for this survey question. Only 12% responded here. User’s responses on their choice of mode to receive traffic information are shown in the figure below.

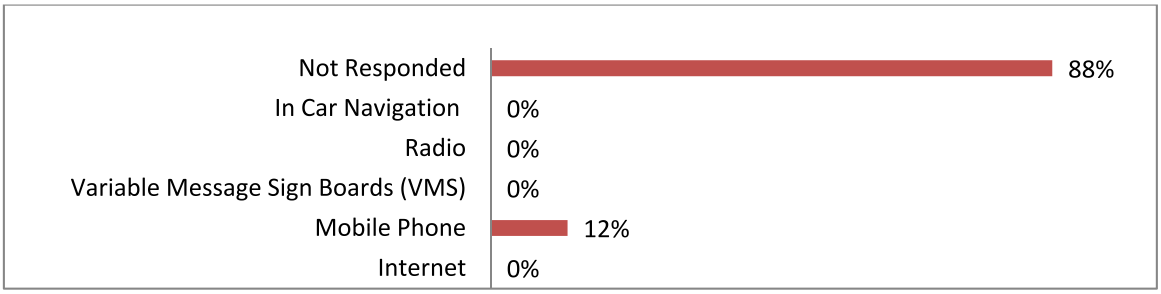

Figure 17: Responses on Choice of Mode to Receive Traffic Information

Among the responses received, 12% responded ‘mobile phone’ as major choice to receive traffic information.

EXPRESSWAY – PROBLEMS AND SOLUTIONS

Users response on expressway usage, the problem faced and the required solutions are summarized and listed below.

a) Responses on Use of Expressway:

- 20% of users used expressway
- 80% of users have not experienced expressway

The use of expressway was found to be more in car users than motorcycle users.

b) Responses on Problems Faced for Expressways:

For car users, the major problem was queue at toll gates. The responses of users are listed below.

- Queue at toll gate - 70%
- Lack of traffic information - 10%
- Traffic congestion -10%
- Traffic safety -10%

c) Responses on Improvements Needed in Expressway:

More ETC toll gates was one of the major improvements mentioned. Users responses are listed as follows:

- Realtime traffic information - 0%
- Common ETC for all toll gates -0%
- More ETC toll gates -100%

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS

MYSORE TRAFFIC

Regarding Mysore traffic, the majority gave positive response. 60% responded current Mysore traffic condition is good. User’s responses are listed below.

- Very Good: 0%
- Good: 60%
- So-So:28%
- Bad: 12%

Although many were happy with existing Mysore traffic, everyone agreed that ‘traffic congestion’ is an emerging issue in Mysore.

The major reasons for congestion were asked and the responses received are summarized in the table below.

Table 7: Responses on Three major Reasons for Congestion in Mysore

Congestion reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	32%	2%	2%
• Too many vehicles	42%	42%	
• Inefficient traffic signals	-	-	-
• Bad pavement with potholes	-	-	2%
• Bumps	-	-	-
• On-street parking	-	-	-
• Traffic accidents	-	-	-
• Bad driving manners	12%	18%	-
• Too many one-way streets	-	-	-
• Jay walking pedestrians	-	-	-

Note: Since multiple options were provided for users, the total response may not be 100%.

The majority responded for one major reason –increasing number of vehicles. 82% responded for this reason. Insufficient road capacity and bad driving manners were pointed as other reasons for congestion.

TRANSPORTATION SOLUTIONS FOR MYSORE

Six different solutions for traffic and transportation improvement in Mysore were listed in the questionnaire. The responses are listed in the table below.

Table 8: Responses for Transportation Solutions

Solutions	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	-	22%	26%	52%	-
• Provision of realtime traffic congestion information	-	-	22%	78%	-
• Improvement of bus and metro service	4%	58%	28%	10%	-
• Strict enforcement of traffic rules	46%	30%	14%	10%	-
• Traffic Signal Improvement	-	-	10%	90%	-
• Provision of traffic congestion information and route guidance	-	-	22%	78%	-

The analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From the above table, responses corresponding to 'very necessary' and 'not necessary' are selected and shown in the figure below.

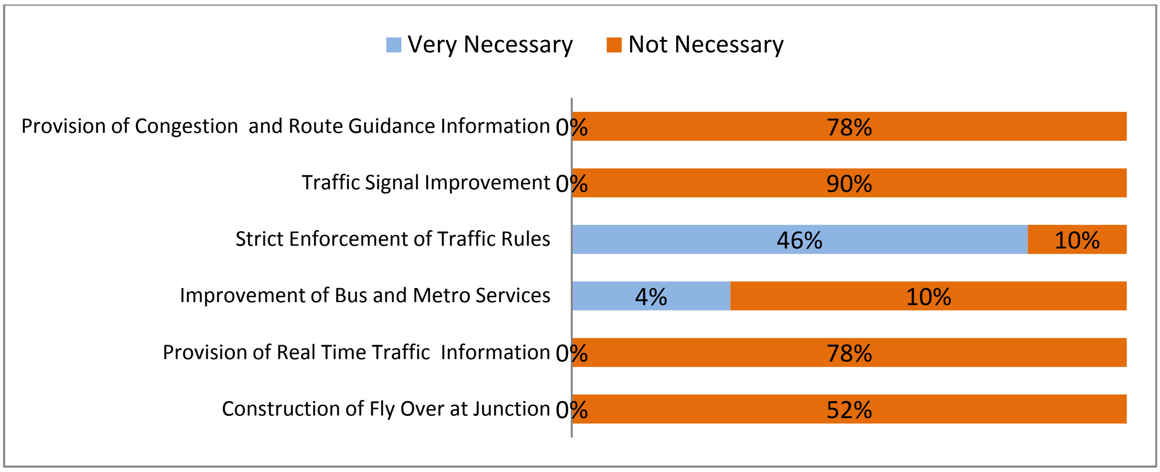

Figure 18: Responses for Solutions in Mysore

Like motorcycle users, car users also responded for strict enforcement of traffic rules as major solution. 46% responded positively. This was followed by improvement of bus and metro services (4% agreed). The analysis also reveals users negative response for traffic signal improvement.

The traffic and transportation problems and its suggested improvements responded by car users were similar to that of motorcycle users.

- INTRODUCTION OF CONGESTION CHARGING FOR AN AREA

The majority disagreed for congestion pricing in Mysore. The responses are shown in the following figure.

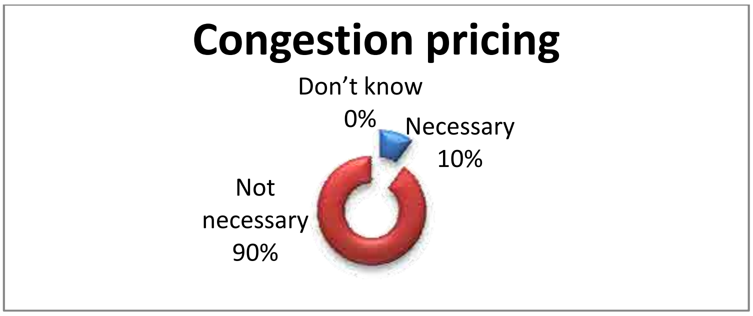

Figure 19: Response for Congestion Pricing

10% responded that congestion pricing is required to reduce congestion in Mysore. However, it should be noted that they responded on the condition that the charging be imposed on tourist vehicles. In their opinion, it is the tourist vehicles that create traffic congestion in Mysore.

The responses for amount for congestion charge is listed in the following figure. The responses werte collected from only those users who gave positive response for congestion pricing.

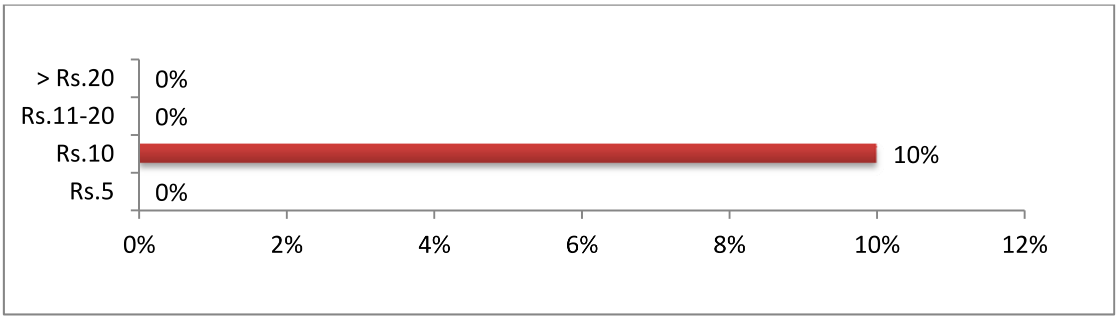

Figure 20: Responses for Amount of Congestion Price

OTHER SUGGESTIONS

The following are some suggestions mentioned by car users apart from the survey questions.

- Need of introducing policies to control tourist vehicles
- Need of improved traffic management especially at festival times.

SUMMARY OF CAR USERS RESPONSES

Problems

- Public transport is not convenient

ITS facilities needed

- Congestion location information
- Alternative route guidance information
- Preferred mode to receive information –Mobile Phone

Mysore Traffic and Transportation Problems

- Traffic congestion – emerging issue
- Increasing no. of vehicles – major reason

Improvements Needed

- Strict enforcement of traffic rules
- Improvement of public transport system

Congestion pricing

- Not willing to pay for congestion pricing

MODULE 3

BUS USERS

PART I: GENERAL INFORMATION

A total of 50 bus users responses were collected in the present investigation. The data was collected from various locations inside Mysore City. The major source of the data was the City bus station. The details of the selected location are listed below.

- Mysore City Bus Stand
- Railway Station
- Bus Stops Near to Railway Station
- Mysore City Corporation
- Mysore Medical College
- Hunsur Road
- Kuvempu Nagar
- Kalidasa Road
- Mysore University

Appendix-X : ITS Opinion Survey Questionnaire for bus users should be referred to for details. The response of users was collected on the spot. The following sections describe the results of bus users survey.

USER PROFILE

Of the 50 bus users covered in the survey, 26% were male and 74% female. The majority were in the age group of 30-39. The age details of bus users are listed in table 9.

Table 9: Age Details of Bus Users

Age Group	15-20	20-29	30-39	40-49	50-59	>60	Total
Male		8%	18%	-	-	-	26%
Female	2%	30%	24%	10%	6%	2%	74%

Bus was equally preferred by both working and non working people such as students, retired people and housewife. The job profile of bus users are shown in the figure below.

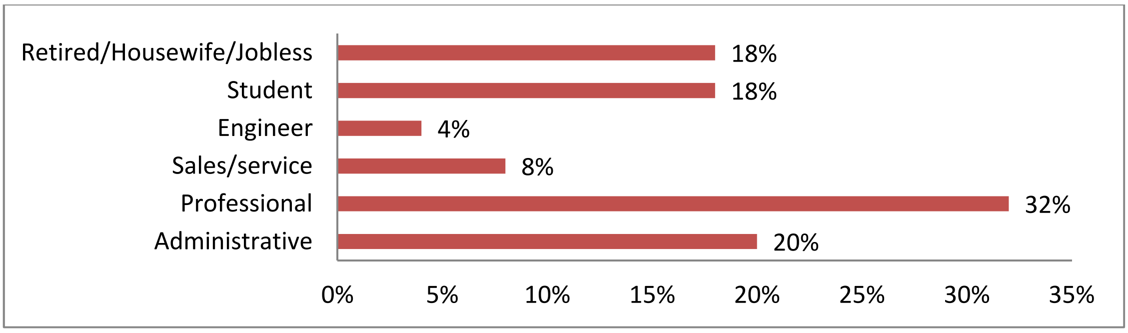

Figure 21: Job Profile of Bus Users

The salary profile of the bus users is shown in figure 22.

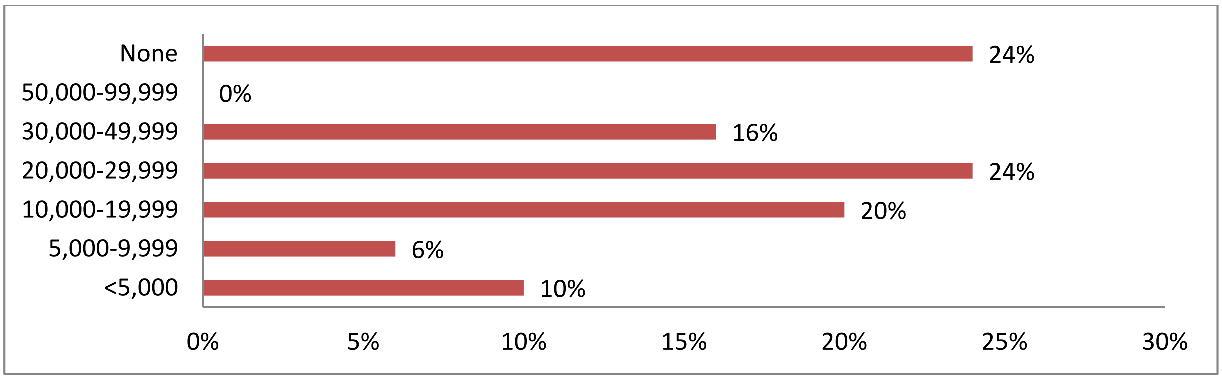

Figure 22: Monthly Salary Profile of Bus Users

FREQUENCY OF TRIP

The majority of the bus users were regular commuters. The responses of bus users are as follows.

- 86% were travelling 5-7 days per week
- 6% were travelling 3-4 days per week
- 8% were travelling 1-2 days per week

MODE OF FARE PAYMENT

There are two types of bus fare payment options available for users:

- Cash (Token)
- Bus Passes (Daily/Monthly/Yearly)

In the survey, users were asked their mode of bus fare payment. The responses were collected and are summarized in the chart below.

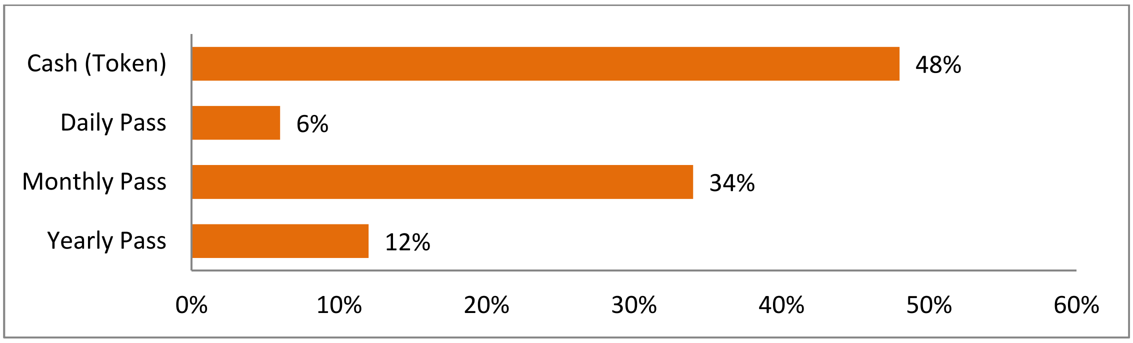

Figure 23: Responses for Mode of Bus Fare Payment

The use of bus passes were more than the token system. Among the available bus passes, more users mentioned monthly pass.

In the case of bus users using bus token system, the survey analyzed the amount of bus fare paid for their one-way travel. The one-way bus fare of the majority of them was in the range of INR 11-20. The results are listed below.

- INR 5: 4%
- INR 6- 10: 29%

- INR 11-20: 54%
- INR >20: 13%

TRIP PURPOSE: COMMUTERS

Among 50 users, 92% were regular commuters and 8% were casual users. An analysis was carried out to understand the travel time of regular commuters. Towards this objective, the following questions were asked to regular commuters.

- Average travel time to reach destination
- Average time on board bus
- Average waiting time at bus stop

Casual bus users were not asked the above questions. Only the responses of regular commuters were collected and are listed in the table below.

Table 10: Response of Bus Commuters on Travel Time

Average Travel Time (minutes)				
	<15 min	15-29 min	30-59 min	>60 min
To reach destination	-	17%	48%	35%
On board bus	-	22%	65%	13%
Average Waiting Time (minutes)				
	<10 min	10-19 min	20-29 min	>30 min
Waiting time at bus stop	52%	33%	13%	2%

The average travel time of regular commuters varies from 30 to 60 minutes and more. The majority spend 30- 59 minutes time on board bus. The waiting time at bus stops was observed to be less than 10 minutes.

TRANSFER TO/FROM OTHER MODES

Users were asked about change to transport modes to reach the destination. The responses are listed below.

- No transfer: 94%
- Transfer to/from auto: 4%
- Transfer to/from motorcycle: 2%
- Transfer to/from car: 0%

It is observed that the majority of bus users used ‘bus’ as their primary transport mode to reach destination. Change from bus to other transport modes was less.

Among 94% bus users, the response of number of changes of bus to reach the destination place was also analyzed. The responses are as follows: 33% used one bus, 37% used two buses and 24% used three buses.

PASSENGER PROBLEMS WHILE USING PUBLIC TRANSPORTATION

Bus users were asked on major passenger problems while using public transportation. Nine problems were selected and listed in the questionnaire. Users were asked to select the three major problems.

The responses are listed in table 11.

Table 11: Responses on Problems of Bus Passengers

Problems	Reason 1	Reason 2	Reason 3	Response
Long waiting time at bus stop	20%	20%	2%	42%
Long and uncertain riding time	6%	-	2%	8%
Congested bus	28%	26%	4%	58%
Expensive fare	2%	4%	2%	8%
Complex bus system and route	2%	2%	-	4%
No route, time & fare information at bus stop	20%	8%	2%	30%
Inconvenient connection / transfer	2%	-	4%	6%
Bad driving manner	6%	6%	4%	16%
Security on bus	-	-	2%	2%

Note: As the users has provided with multiple options, the total response may not be 100%.

Bus transportation service in Mysore is well developed with ITS facilities such as buses with probe devices, passenger information system and information display boards at bus terminals and few bus stops. Hence less responses were received for this survey question.

From the responses received, one major problem identified - congested bus.

FACILITIES NEEDED TO IMPROVE PUBLIC TRANSPORTATION SERVICES

.Four major facilities were suggested to bus users. Users response on suggested solutions were collected as follows: yes, no, and don’t know. The results are shown in the chart below.

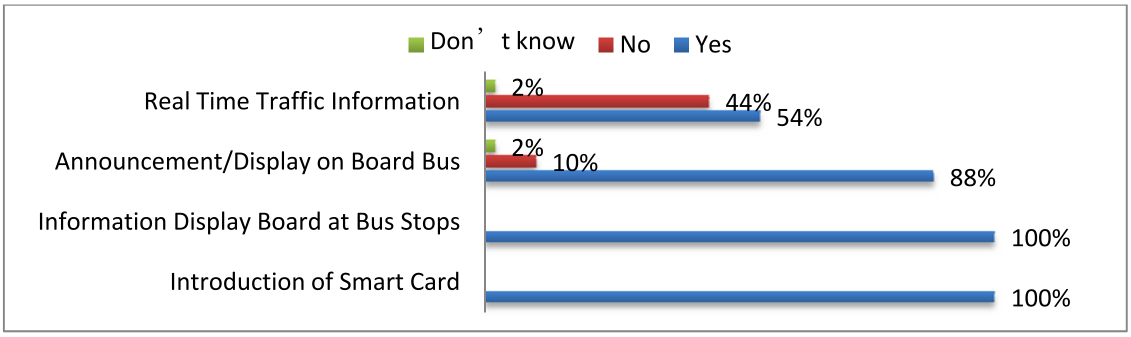

Figure 24: Responses of Bus Users for Facilities Needed to Improve Public Transport

100% positive response received for introduction of smart card and information board at bus stops.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS

MYSORE TRAFFIC

Regarding Mysore traffic, the majority gave positive response. 64% responded Mysore traffic condition as ‘good’. Users responses are listed below.

- Very Good: 0%
- Good: 64%
- So-So: 28%
- Bad: 8%

Congestion was mentioned as one of the emerging issue by most of the bus users. Major reasons for congestion were analyzed and are listed in the following table.

Table 12: Responses for Congestion Reasons

Congestion reason	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	12%	28%	8%
• Too many vehicles	66%	14%	
• Inefficient traffic signals	-	-	-
• Bad pavement with potholes	-	2%	-
• Bump	-	-	-
• On-street parking	-	-	-
• Traffic accidents	-	-	-
• Bad driving manners	2%	18%	4%
• Too many one-way streets	2%	-	-
• Jaywalking pedestrians	-	4%	2%

Note: Since the users are provided with multiple options, the total response many not be equal to 100%

The majority responded for one major reason –increasing number of vehicles. Insufficient road capacity and bad driving manners were pointed out as other reasons for congestion.

SOLUTION FOR TRAFFIC AND TRANSPORTATION PROBLEMS

The responses of the users were analysed for the solutions for traffic and transportation in Mysore. Users responses were analyzed and are listed in the following table.

Table 13: Responses for Transportation Solutions

Solution	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	4%	10%	14%	72%	-
• Provision of realtime traffic congestion information	-	-	4%	96%	-
• Improvement of bus and metro service	2%	84%	8%	6%	-
• Strict enforcement of traffic rules	56%	26%	6%	12%	-
• Traffic Signal Improvement	2%	2%	2%	94%	-
• Provision of traffic congestion information and route guidance	-	-	-	-	-

The analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From the above table, responses corresponding to 'very necessary' and 'not necessary' are selected and shown in the figure below.

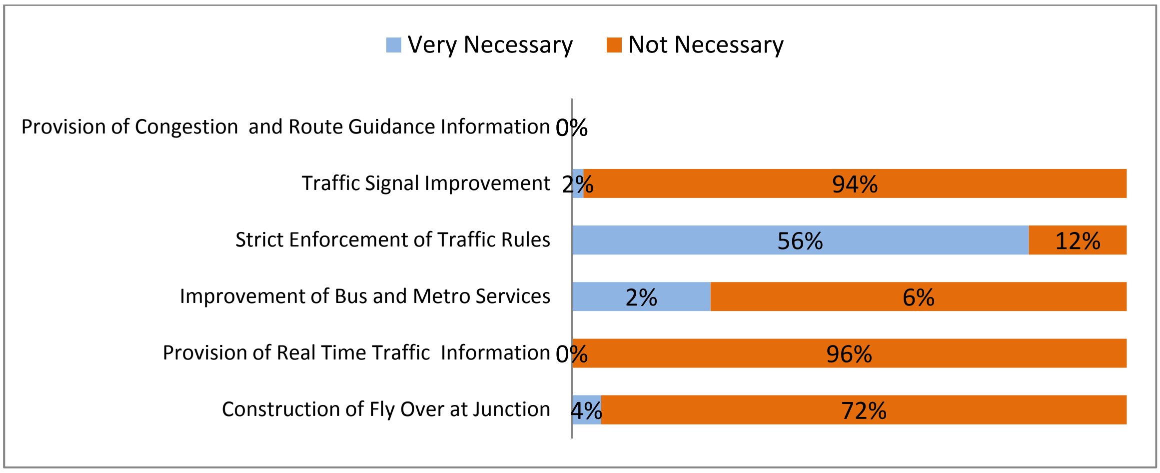

Figure 25: Responses for Solutions in Mysore

Like motorcycle and car users, bus users also responded strict enforcement of traffic rules as major solution. 56% responded positively.

Traffic signal improvement, realtime traffic congestion information, and provision of congestion and route guidance information were not appreciated by bus users.

INTRODUCTION OF CONGESTION CHARGING FOR AN AREA

The majority disagreed for congestion pricing in Mysore. The responses are shown in the figure below.

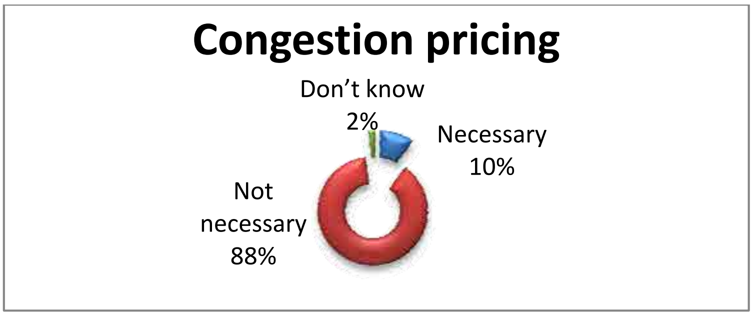

Figure 26: Responses for Congestion Pricing

10% responded that congestion pricing is required to reduce congestion in Mysore. However, it should be noted that they responded on the condition that the charging be imposed on tourist vehicles.

SUMMARY OF BUS USERS RESPONSES

Bus users Problems

- Congested bus

Facilities Required

- Introduction of smart card facility
- Information display board at bus stops

Mysore Traffic Condition

- Good
- Congestion is an emerging issue

Congestion Reasons for Mysore

- Increasing number of vehicles

Improvement Needed

- Strict enforcement of traffic rules

Congestion Pricing

- Not willing to pay for congestion pricing

MODULE 4

TRUCK DRIVERS - MYSORE

PART I: GENERAL INFORMATION

A total of 50 truck drivers responses were collected. Details of survey locations are listed below. Locations such as truck terminals, parking places on highways, industrial areas were given prime focus where more trucks were present.

Appendix-X : ITS Opinion Survey Questionnaire for truck drivers should be referred to for details. The response of users was collected on the spot. The following sections describe the results of truck drivers survey.

DRIVER PROFILE

The majority of the drivers were in the age group of 30-39. The age details of truck drivers are listed in the table below.

Table 14: Age Details of Truck Drivers

Age group	15-20	20-29	30-39	40-49	50-59	>60	Total
Response	-	10%	66%	18%	6%	-	100%

The monthly income of truck drivers observed was lower. The majority mentioned a monthly salary of INR. 10,000-19,999. Truck drivers responses on their monthly salary are shown in the chart below.

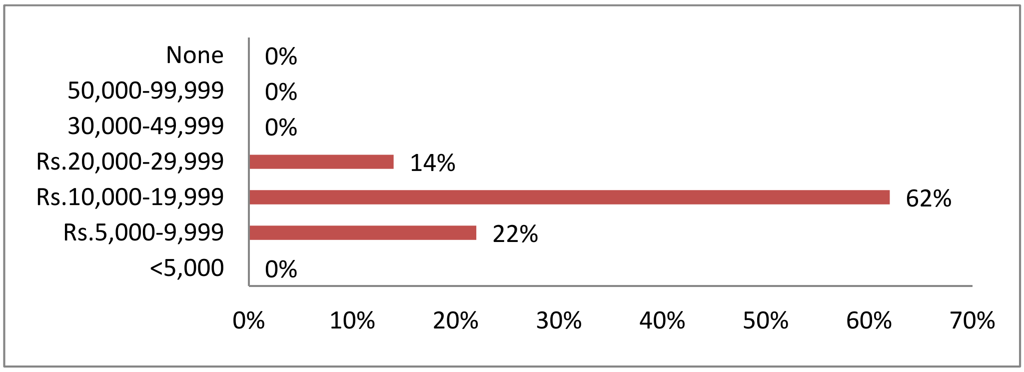

Figure 27: Salary Profile of Truck Drivers

TYPE OF VEHICLE AND TRIP FREQUENCY

Two categories of vehicles were covered in the survey. They are light commercial vehicle (LCV) and heavy commercial vehicle (HCV). The percentage of each of the vehicles is listed below.

- Light commercial vehicle: 36%
- Heavy commercial vehicle: 67%

Regarding, frequency of trips, the majority were making trips regularly. The responses are listed as follows:

- 84% responded 5-7 days per week
- 16% responded 3-4 days per week
- 0% responded 1-2 days per week

ALTERNATIVE ROUTE TO AVOID CONGESTED LOCATION

It is understood that truck drivers use alternative routes to avoid traffic congestion. Truck drivers were asked about this and the responses are listed in the table below.

Table 15: Truck Drivers Responses for use of Alternative Route

Type of Vehicle	Use of Alternative Route			
	Always	Often	Sometimes	None
HCV	14%	34%	16%	-
LCV	10%	16%	6%	4%

It is clear from the response that the use of alternative route is frequent among truck drivers.

PART II: ITS APPLICATION

SOURCE OF CONGESTION INFORMATION AND OPINION ON CURRENT TRAFFIC INFORMATION

Truck drivers responded that they are not aware of any congestion information sources.

TYPE OF INFORMATION NEEDED

The responses for the required traffic information are listed in the following table.

Table 16: Truck Drivers Responses for Traffic Information Required

Type of Traffic Information Required	Very Helpful	Helpful	Not Helpful	Don't Know
Congested Location Information	-	12%	88%	-
Length of Congestion Information	-	2%	98%	-
Expected Travel Time Information to Reach Destination	-	-	100%	-
Alternative Route Information	-	4%	96%	-
Traffic Incident Information	-	6%	94%	-

The majority of truck drivers gave negative response for suggested facilities.

MODE OF INFORMATION TO BE PROVIDED

86% didn't respond for this survey question. A very few, who responded positively for realtime traffic information, opted for two major modes: radio and mobile phone.

EXPRESSWAY – PROBLEMS AND SOLUTIONS

a) Responses on Use of Expressway:

- 67% of users used expressway
- 33% of users did not use expressway

b) Responses on Problem Faced Expressway:

Traffic safety was major problem mentioned by truck drivers. The responses are listed as follows:

- Queue at toll gate - 24%
- Lack of traffic information - 9%
- Traffic congestion -15%
- Traffic safety -32%
- Not responded -20%

c) Responses on Improvements Needed in Expressway:

Only a few responses received for solutions of expressway problems. 30% only responded to the question. All of them responded for one solution: more ETC toll gates.

PART III: TRAFFIC AND TRANSPORTATION PROBLEMS

MYSORE TRAFFIC

Truck drivers responses on Mysore traffic condition are as follows.

- Very Good: 0%
- Good:80%
- So-So: 18%
- Bad: 2%

The majority pointed out traffic congestion as an emerging issue in Mysore. This section analyses the reasons for congestion and the required measures to be taken to reduce congestion level.

Increasing number of vehicles was major reason pointed out by truck drivers. The responses on major reasons for congestion are listed in the table below.

Table 17: Truck drivers Responses on Three Major Reasons for Congestion in Mysore

Congestion Reasons	Reason 1	Reason 2	Reason 3
• Insufficient capacity of road	8%	-	-
• Too many vehicles	22%	-	-
• Inefficient traffic signals	-	-	-
• Bad pavement with potholes	1%	-	-
• Bumps	-	-	-
• On-street parking	2%	-	-
• Traffic accidents	-	-	-
• Bad driving manners	-	-	-
• Too many one-way streets	-	-	-
• Jay walking pedestrians	-	-	-

Note: Since multiple options were provided for users, the total response may not be 100%.

TRANSPORTATION SOLUTIONS

The solution for traffic and transportation problem is analyzed here. Truck drivers responses are listed in the table below.

Table 18: Responses on Transportation Solutions

Solution for traffic & transportation	Very Necessary	Necessary	May be	Not necessary	Don't know
• Construction of flyover at junction	12%	16%	-	72%	-
• Provision of realtime traffic congestion information	-	-	-	100%	-
• Improvement of bus and metro service	8%	2%	-	80%	10%
• Strict enforcement of traffic rules	30%	36%	4%	28%	2%
• Traffic signal improvement	8%	4%	2%	86%	-
• Provision of traffic congestion information and route guidance	2%	4%	-	86%	8%

Here the analysis focuses mainly on responses corresponding to 'very necessary' and 'not necessary'. From the above table, responses corresponding to 'very necessary' and 'not necessary' are selected and shown in the figure below.

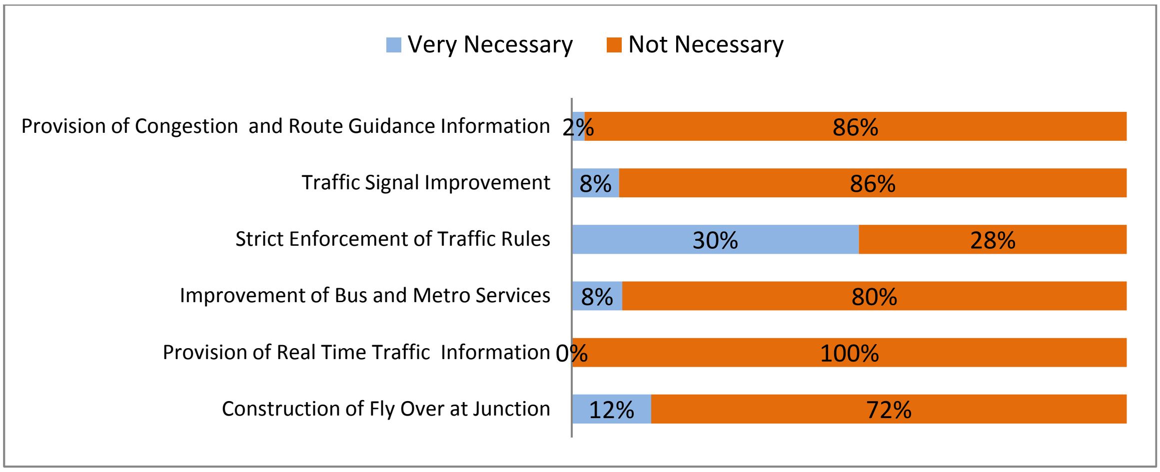

Figure 28: Truck Drivers Responses for Transportation Solutions

Truck drivers responded for one major solution: strict enforcement of traffic rules. Other suggested transport solutions were 'not necessary' by the majority of drivers.

INTRODUCTION OF CONGESTION PRICING TO AN AREA

The majority disagreed for congestion pricing in Mysore. The responses are shown in the following figure.

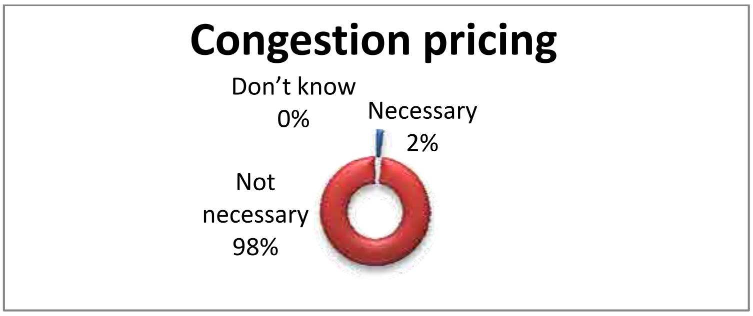

Figure 29: Responses for Congestion Pricing

SUMMARY FOR TRUCK RIVERS RESPONSES

Current Traffic Information System

- 100% dissatisfaction

Required Traffic Information

- Traffic incident
- Alternative route guidance

Traffic and Transportation Problems

- Increasing no. of vehicles

Improvements Needed

- Strict enforcement of traffic rules

Congestion Pricing

- Not willing to pay for congestion pricing

MODULE 5

MAJOR FINDINGS

The major findings are summarised as follows.

- CHOICE OF TRANSPORT MODE BY MONTHLY SALARY

Analysis was made to understand the choice of transport mode by monthly salary. The following trends were observed.

Bus and motorcycle are generally preferred by people irrespective of their salary. As the salary profile increases to INR 20,000 and above, thee usage tends to shift more into private cars.

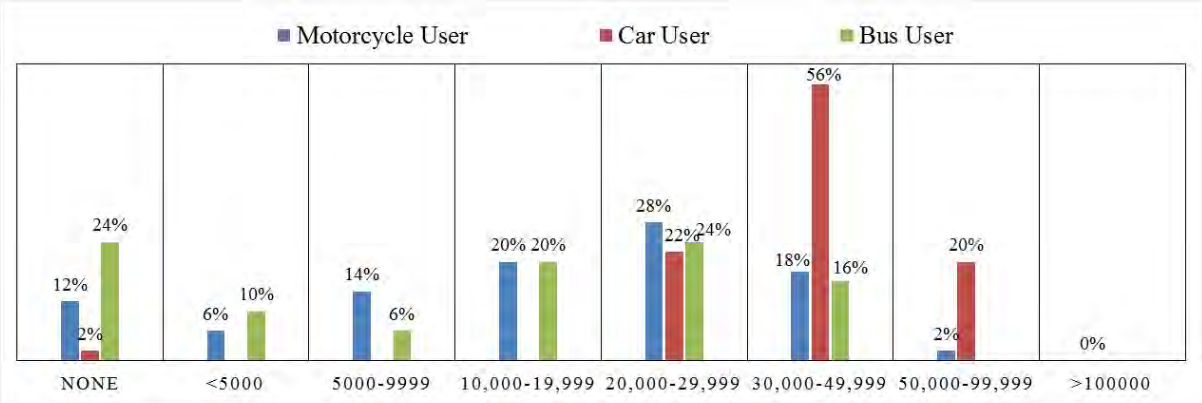

Figure 30: Choice of Transport Mode by Monthly Salary (in INR)

Note: “None” includes category of students, non-working people, housewife, retired people

- AVERAGE TRAVEL TIME BY TRANSPORT MODE

The travel time from origin (home) to destination (schools, work place) by transport mode was compared and the results are shown in the chart below. One major observation is the change in the travel time by the transport mode used. The majority of the motorcycle and car users responded for 15-29 minutes whereas the bus users responded 30-59 minutes. This implies that additional time such as waiting at bus stop, walking from/to bus stop to arrive their destinations is required.

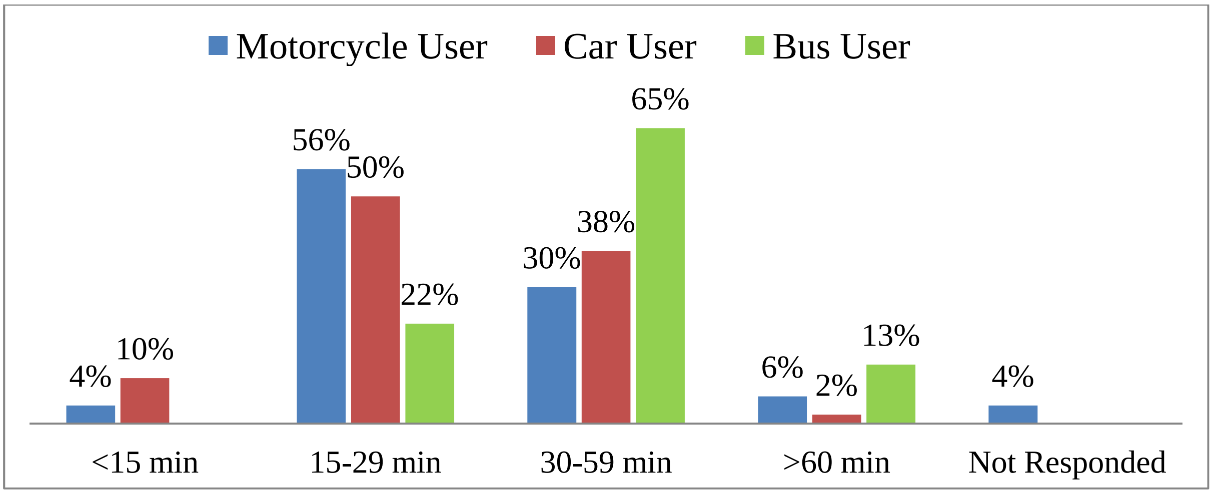

Figure 31: Average Travel Time by Transport Mode

REQUIRED FACILITIES AND INFORMATION BY TRANSPORT MODE

The required facilities and information by transport mode were analysed.

Bus Users

Three major issues were mentioned by bus users. They are: congested buses, long waiting time at bus stops and lack of fare information display boards at bus stops. Bus users responded that the smartcard would be useful. Information display boards at bus stops were also mentioned by many bus users.

The chart below shows the issues and facilities required by bus users.

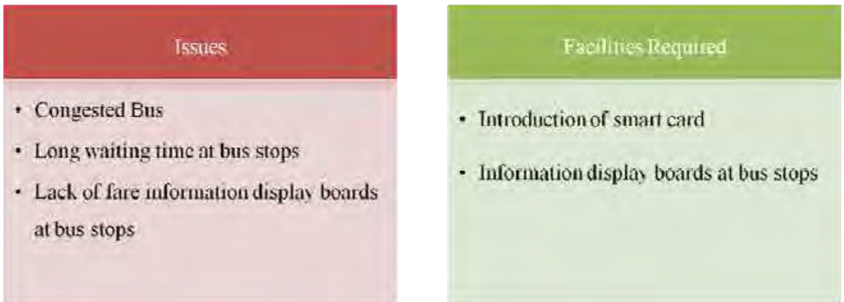

Figure 32 Issues and Desired Facilities Mentioned by Bus Users

Motorcycle and Car Users

The motorcycle and car users prefer ITS facilities for their convenience. The responses of motorcycle and car users are more or less similar. Both users, motorcycle and car, responded that they needed three major kinds of information: congested location information, alternative route guidance information and traffic incident information. The results of motorcycle and car users are shown in the chart below.

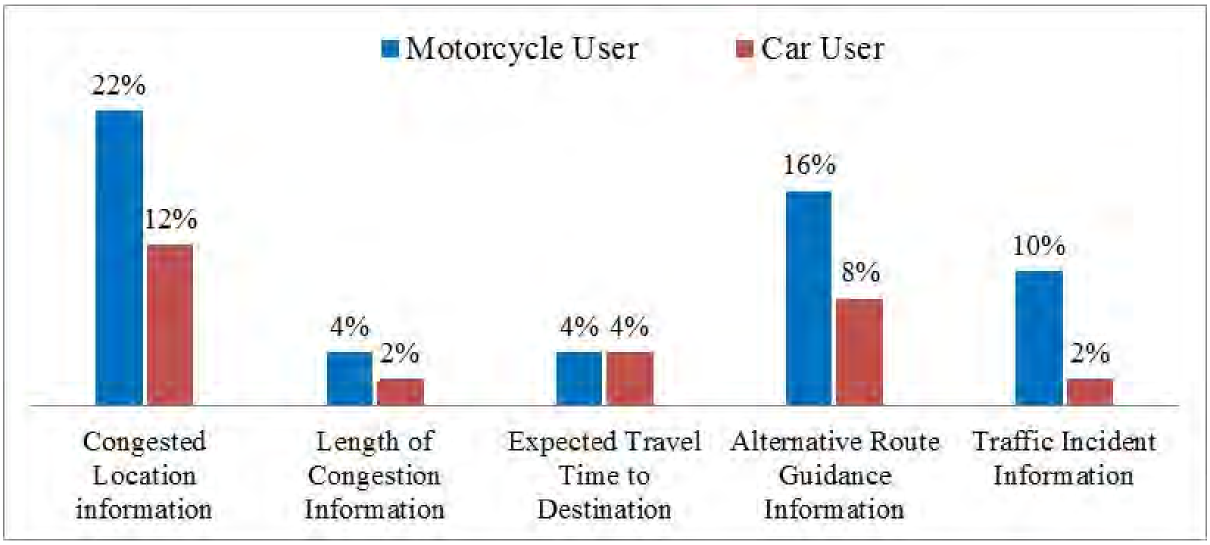

Figure 33: Required Information by Motorcycle and Car Users

Truck Drivers

The facilities desired by the truck drivers to enhance their service are summarised and shown in the chart below. Truck drivers prefer ITS facilities for smooth journey.

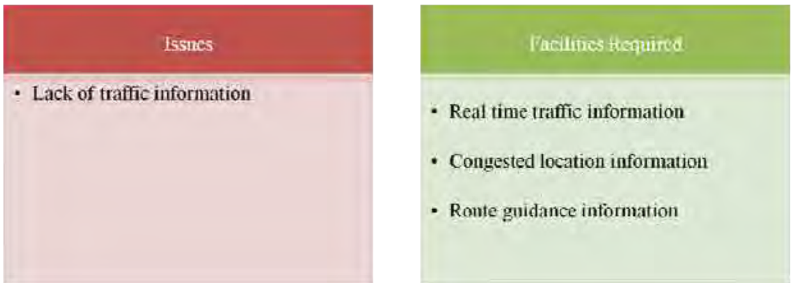

Figure 34: Issues and Facilities Mentioned by Truck Drivers

- TRAFFIC AND TRANSPORTATION MYSORE

Reasons of Congestion

The survey revealed that almost all interviewers regard the traffic situation in Mysore as in good condition when compared to the case of Bangalore. However many of them responded that congestion is an emerging issue in Mysore.

The chart below shows the reasons of the congestion mentioned during the interviews. Increasing number of vehicles and insufficient capacity of the roads are considered as major causes of congestion. A few responded that bad driving manners is another reason.

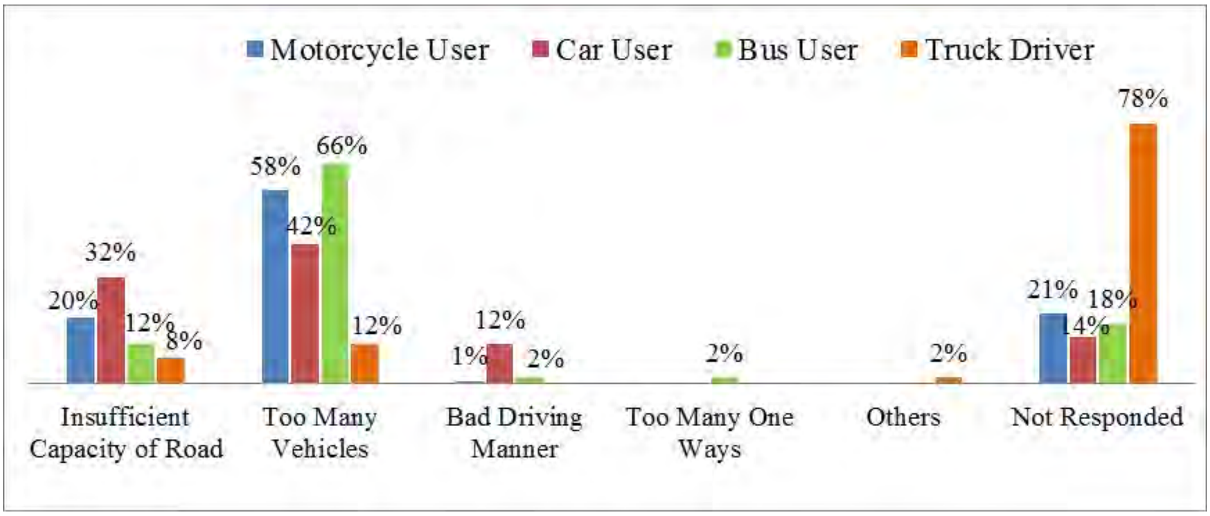

Figure 35: Reasons of Mysore Congestion

SOLUTIONS FOR MYSORE CITY

The responses of the users were analysed for the solutions for traffic and transportation in Mysore. The results are shown in the chart below. The majority responded that strict enforcement of traffic rules and improvement of public transport services are required.

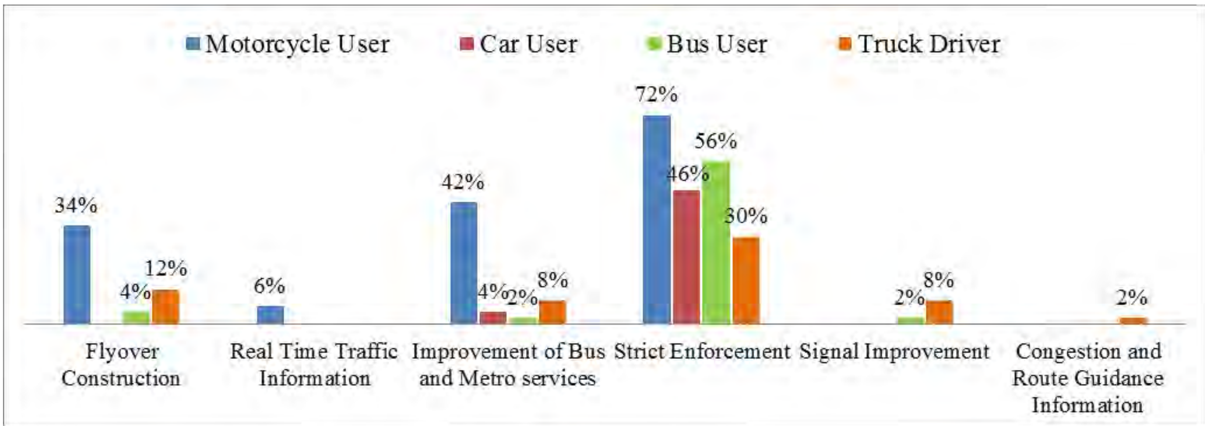

Figure 36: Solutions for Mysore City

OPINIONS ON CONGESTION PRICING

The opinions on congestion pricing were also asked to get people's response. Since the congestion in Mysore is not severe, most of the interviewers provided negative response for the congestion pricing.

A few users responded that it is required to reduce congestion. It, however, should be noted that they responded on the condition that the charging be imposed on the tourist vehicles. Being a heritage city, Mysore attracts lot of tourists into the city and in their view these tourist vehicles cause congestion.

Table 19 : Opinions on Congestion Pricing

Vehicle Category	Requirement of Implementing Congestion Pricing		
	Required	Not Required	Don’t Know
Bus Users	10% (Tourist Vehicles)	88%	2%
Motorcycle users	18% (Tourist Vehicles)	82%	
Car Users	10% (Tourist Vehicles)	90%	
Truck Drivers	2%	98%	-

APPENDIX: X

QUESTIONNAIRE FOR MOTORCYCLE USERS

Sample ID:	______________________	Date:	______________
Location:	______________________ (location name/road name/landmark)	Terminal name:	______________

Part I. General Information

Sex	1) Male 2) Female	**Age**	1) 15-20 4) 40-49	2) 20-29 5) 50-59	3) 30-39 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of bike usage: How often do you use two wheeler?

1) 5-7 days/week 2) 3-4 days/week 3) 1-2 days/week 4) 1-2 days/month

Main purpose of use

1) Commuting 2) School 3) Business 4) Shopping 5) Others

If your answer to 0 is not 1) or 2), skip next question and proceed to 0

Average travel time to destination

1) Less than 15 minutes 2) 15 to 29 minutes 3) 30 – 59 minutes 4) 60 minutes or more

Why you do not use public transport (bus)?

1) Not convenient 2) Take more time 3) Not clean 4) Others(Specify) (   )

At destination, where do you park your two wheeler?

1) Office/school parking 2) private off-road parking 3) public off-road parking 4) Roadside 4) Others (specify) (   )

If you use pay parking, how much do you pay for parking at a time

1) Rs. 5 2) Rs. 10 3) Rs. 11 - 20 4) Rs. 21-30 5) Rs. 31 or more

Do you transfer to/from other mode? If yes, type of transport?

1) Rickshaw 2) Metro 3) Bus 4) Car 5) Train

Part II. Intelligent Transport System

How you get congestion information?

1) Radio | 2) Internet | 3) Mobile phone | 4) Variable message sign | 5) Others ( ) | 6) None

Do you think traffic information currently available sufficient?

1) Very helpful | 2) Helpful | 3) Not helpful | 4) Don't know:

Type of information you need

Congested location?

1) Very helpful | 2) Helpful | 3) Not helpful | 4) Don't know:

Length of traffic congestion

1) Very helpful | 2) Helpful | 3) Not helpful | 4) Don't know:

Expected travel time to destination

1) Very helpful | 2) Helpful | 3) Not helpful | 4) Don't know:

Alternative route

1) Very helpful | 2) Helpful | 3) Not helpful | 4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful | 2) Helpful | 3) Not helpful | 4) Don't know:

How do you want the information above to be provided?

1) Radio | 2 Variable Message Sign | 3) Internet | 4) Mobile phone | 5) In-car navigation system | 6) Others ( )

Have you ever use Expressway (Nice Road or Bangalore Elevated Tollway)

1- Yes. | 2- No

If your answer is "yes", please answer 0 and 0.

What are the problems you encounter on these expressways?

1) Queue at toll gate | 2) Traffic congestion | 3) Lack of traffic information | 4) Traffic safety | 5) Others (specify) ( )

What improvement do you want for existing expressway systems?

1) ETC system for two wheeler | 2) ETC system common to all toll roads | 3) Real time traffic information | 4- Others (specify) ( )

Part II. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad | 2) Bad | 3) So-so | 4) Good | 5) Very good

What are causes of traffic congestion? Please select three (3) most significant causes.

1) Insufficient capacity of road network | 2) Too many vehicles | 3) Inefficient traffic signal | 4) Bad pavement with pot holes

5) Hump | 6) unscrupulous roadside parking | 7) Traffic accident | 8) Bad driving manner

9) Too many one-way streets	10) Jaywalking pedestrians	11) Lack of traffic information	12) Others (specify) ( )

How do you access the solution for the traffic and transportation problems?

Construction of flyover at junction.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of real time traffic congestion information

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Enhancement of bus and metro service.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Strict enforcement of traffic rules.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Traffic signal improvement.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of traffic congestion information and route guidance.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area

1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you answer is "yes", please to go to 0, otherwise skip to 0.

How much do you pay for congestion charge (amount to pay to enter restricted area/road)

1) Rs. 5 2) Rs. 10 3) Rs. 20 4) More than Rs. 20

If you have any other suggestion, please write.

Thank you for your cooperation!

QUESTIONNAIRE FOR CAR USERS

Sample ID:	______________________	Date:	______________________
Location:	______________________ (location name/road name/landmark)	Terminal name:	______________________

Part I. General Information

Sex 1) Male 2) Female

Age 1) 15-20 2) 20-29 3) 30-39 4) 40-49 5) 50-59 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of bike usage: How often do you use two wheeler?

1) 5-7 days/week 2) 3-4 days/week 3) 1-2 days/week 4) 1-2 days/month

Main purpose of use

1) Commuting 2) School 3) Business 4) Shopping 5) Others

If your answer to 0 is not 1) or 2), skip next question and proceed to 0

Average travel time to destination

1) Less than 15 minutes 2) 15 to 29 minutes 3) 30 – 59 minutes 4) 60 minutes or more

Why you do not use public transport (bus)?

1) Not convenient 2) Take more time 3) Not clean 4) Others(Specify) (   )

At destination, where do you park your two wheeler?

1) Office/school parking 2) private off-road parking 3) public off-road parking 4) Roadside 4) Others (specify) (   )

If you use pay parking, how much do you pay for parking at a time

1) Rs. 5 2) Rs. 10 3) Rs. 11 - 20 4) Rs. 21-30 5) Rs. 31 or more

Do you transfer to/from other mode? If yes, type of transport?

1) Rickshaw 2) Metro 3) Bus 4) Car 5) Train

Part II. Intelligent Transport System

How you get congestion information?

1) Radio	2) Internet	3) Mobile phone	4) Variable message sign	5) Others ( )	6) None

Do you think traffic information currently available sufficient?

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Type of information you need
Congested location?

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Length of traffic congestion

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Expected travel time to destination

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Alternative route

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

How do you want the information above to be provided?

1) Radio	2 Variable Message Sign	3) Internet	4) Mobile phone	5) In-car navigation system	6) Others ( )

Have you ever use Expressway (Nice Road or Bangalore Elevated Tollway)

1- Yes.	2- No

If your answer is "yes", please answer 0 and 0.
What are the problems you encounter on these expressways?

1) Queue at toll gate	2) Traffic congestion	3) Lack of traffic information	4) Traffic safety	5) Others (specify) ( )

What improvement do you want for existing expressway systems?

1) ETC system for two wheeler	2) ETC system common to all toll roads	3) Real time traffic information	4- Others (specify) ( )

Part II. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad	2) Bad	3) So-so	4) Good	5) Very good

What are causes of traffic congestion? Please select three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Lack of traffic information	12) Others (specify) ( )

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.
1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of real time traffic congestion information
1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Enhancement of bus and metro service.
1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Strict enforcement of traffic rules.
1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Traffic signal improvement.
1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of traffic congestion information and route guidance.
1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area
1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you answer is "yes", please to go to 0, otherwise skip to 0.
How much do you pay for congestion charge (amount to pay to enter restricted area/road)
1) Rs. 5 2) Rs. 10 3) Rs. 20 4) More than Rs. 20

If you have any other suggestion, please write.

Thank you for your cooperation!

QUESTIONNAIRE FOR BUS USERS

Sample ID:	______________________	Date:	______________
Location:	______________________ (location name/road name/landmark)	Terminal name:	______________

Part I. General Information

Sex	1) Male	**Age**	1) 15-20	2) 20-29	3) 30-39
	2) Female		4) 40-49	5) 50-59	6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Frequency of using public transportation (bus)

1) 5-7 times/week	2) 3-4 times/week	3) 1-2 times/week	4) 1-2 times/month

How do you pay fare for bus?

1) Monthly pass	2) Daily pass	2) Cash	3) Others (specify)

If you pay bus fare in cash, how much do you pay for a one-way ride?

1) Rs. 5	2) Rs. 6 - 10	3) Rs. 11 – 20	4) More than Rs.

Are you a commuter?

1- Yes.	2- No

If you answer above is “yes”, please continue to answer to 0 – 0, otherwise skip to Part II.

Average travel time to destination?

1) Less than 15 minutes	2) 15 to 29 minutes	3) 30 – 59 minutes	4) 60 minutes or more

Average time on board bus?

1) Less than 15 minutes	2) 15 to 29 minutes	3) 30 – 59 minutes	4) 60 minutes or more

Average waiting time at a bus stop?

1)10 minutes or less	2) 10 to 19 minutes	3) 20 – 29 minutes	4) 30 minutes or more

Number of transfers (bus to bus)?

1) None	2) 1 time	3) 2 times	4) 3 times or more

Do you transfer to/from other transport mode?

1) Rickshaw	2) Metro	3) Two wheeler	4) Car	5) Train

Part II. Public Transportation Services

As a passenger, what are the problems you encounter while using public transportation (bus)? Please select three (3) most significant problems.

1) Long waiting time at bus stop	2) Long and uncertain riding time	3) Congested bus	4) Expensive fare
5) Complex bus system and route	6) No route, time and fare information at bus stop	7) Inconvenient connection / transfer	8) Bad driving manner
9) Security on bus			

Are there any others problems (please specify).

To improve public transportation services (bus), what improvement should be done?
BMTC is planning to introduce prepaid smart card. Do you want to use it?

1) Yes. 2) No 3) Don't know

Do you want an information board at bus stop that shows expected waiting time until next bus?

1) Yes. 2) No 3) Don't know

Do you want an announce/display system that guide next bus stop on board bus?

1) Yes. 2) No 3) Don't know

Do you want to get real-time bus information through your smart phone?

1) Yes. 2) No 3) Don't know

If you have other suggestion, please write.

Part III. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad 2) Bad 3) So-so 4) Good 5) Very good

What are causes of traffic congestion? Please specify three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Others (specify) ( )	

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Q25. Provision of real time traffic congestion information

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Enhancement of bus and metro service.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Strict enforcement of traffic rules.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Traffic Signal Improvement.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area

1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you have any other suggestion, please write.

Thank you for your cooperation!

QUESTIONNAIRE FOR TRUCK DRIVERS

Sample ID:	______________________	Date:	______________
Location:	______________________ (location name/road name/landmark)	Terminal name:	______________

Part I. General Information

Sex 1) Male 2) Female

Age 1) 15-20 2) 20-29 3) 30-39 4) 40-49 5) 50-59 6) >60

Occupation

1) Admin.	2) Professional*	3)Engineer	4) Sale/Services
5) Farmer/fisherman	6) Unskilled	7) Student	8) House wife
9) Retired	10)- Jobless	11) Other (specify):	

Professional: e.g. lawyer, doctor, professor,

Monthly Income level

1) None	2) Under 5,000	3) 5,000-9,999	4) 10,000 - 19,999
5) 20,000 - 29,999	6) 30,000 -49,999	7) 50,000-99,999	8) 100,000-199,999
9) 200,000 and above			

Type of truck

1) Light commercial vehicle 2) Medium commercial vehicle 3) Heavy commercial vehicle 4) Others (specify) (   )

Frequency of use. How many days you drive your truck?

1) 5-7 days/week 2) 3-4 days/week 3) 1-2 days/week 4) 1-2 days/month

Do you take alternative route to avoid congested location?

1) Always 2) Often 3) sometimes 4) None

Part II. Intelligent Transport System

How you get congestion information?

1) Radio 2) Internet 3) Mobile phone 4) Variable message sign 5) Others (   ) 6) None

Do you think traffic information currently available sufficient?

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Type of information you need

Congested location?

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Length of traffic congestion

1) Very helpful 2) Helpful 3) Not helpful 4) Don't know:

Expected travel time to destination

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Alternative route

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

Traffic incident (accident, road work, event, temporary traffic restriction, etc.)

1) Very helpful	2) Helpful	3) Not helpful	4) Don't know:

How do you want the information above to be provided?

1) Radio	2 Variable Message Sign	3) Internet	4) Mobile phone	5) In-car navigation system	6) Others ( )

Have you ever use Expressway (Nice Road or Bangalore Elevated Tollway)

1- Yes.	2- No

If your answer is "yes", please answer 0 and 0.
What are the problems you encounter on these expressways?

1) Queue at toll gate	2) Traffic congestion	3) Lack of traffic information	4) Traffic safety	5) Others (specify) ( )

What improvement do you want for existing expressway systems?

1) More ETC toll gates	2) ETC system common to all toll roads	3) Real time traffic information	4- Others (specify) ( )

Part III. Traffic and Transportation Problems

How do you evaluate traffic condition in Bengaluru?

1) Very bad	2) Bad	3) So-so	4) Good	5) Very good

What are causes of traffic congestion? Please specify three (3) most significant causes.

1) Insufficient capacity of road network	2) Too many vehicles	3) Inefficient traffic signal	4) Bad pavement with pot holes
5) Hump	6) unscrupulous roadside parking	7) Traffic accident	8) Bad driving manner
9) Too many one-way streets	10) Jaywalking pedestrians	11) Others (specify) ( )	

How do you access the solution for the traffic and transportation problems?
Construction of flyover at junction.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Q25. Provision of real time traffic congestion information

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Enhancement of bus and metro service.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Strict enforcement of traffic rules.

1) Very necessary	2) Necessary	3) Maybe	4) Not necessary	5) Don't know

Traffic Signal Improvement.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Provision of traffic congestion information and alternative route.

1) Very necessary 2) Necessary 3) Maybe 4) Not necessary 5) Don't know

Introduction of congestion charging for congested area

1) Very necessary 2) Necessary 3) Not necessary 4) Don't know

If you answer is "yes", please to go to 0, otherwise skip to 0.
How much do you pay for congestion charge (amount to pay to enter restricted area/road)

1) Rs. 5 2) Rs. 10 3) Rs. 20 4) More than Rs. 20

If you have any other suggestion, please write.

Thank you for your cooperation!

Appendix - 4

ITS Opinion Survey Report (Mysore: Tourist)

The Master Plan Study on ITS in Mysore

ITS Opinion Survey Report (Tourist)

Submitted to

JICA Study Team

Prepared by

Miss. Reashma P. S.

December 2014

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ITS OPINION SURVEY (TOURIST)

1. Outline of Study

ITS Opinion Survey in Mysore city was carried out for the purpose of identifying potential needs of tourists who visit Mysore city. Both domestic and international tourists were considered in the study. A questionnaire was prepared in this regard. The interviews were conducted only with prior approval from the respondents to participate in the study. The field work was conducted from 20^{th} to 23^{rd} November 2014.

2. Survey Locations

The study was conducted at the following tourist places in and around Mysore city.

- Mysore palace
- Chamundi Hills
- Brindavan Gardens
- Mysore Zoo
- Mysore Silk factory
- Karanji Lake
- KRS Dam
- Tippu Palace, Srirangapatana
- Somnatpur Temple
- Mysore City Market

3. Target Interviewees

A total of 104 tourists were interviewed.

Table 01: Types of Interviewed Tourists

Category	No. of Interviewed Tourist
Domestic Tourists	70
International Tourists	34
Total	104

4. State of Origin

a) Domestic Tourist

The majority of domestic tourists came from south Indian states (53% from Kerala and Tamilnadu, 28% from Karnataka) and 19% from other north Indian states. All of them were visiting Mysore for the first time.

Table 02: Number of Domestic Tourists by Region

States	No. of Visitors
Karnataka	20
Tamilnadu and Kerala State	37
Other States	13
Total	70

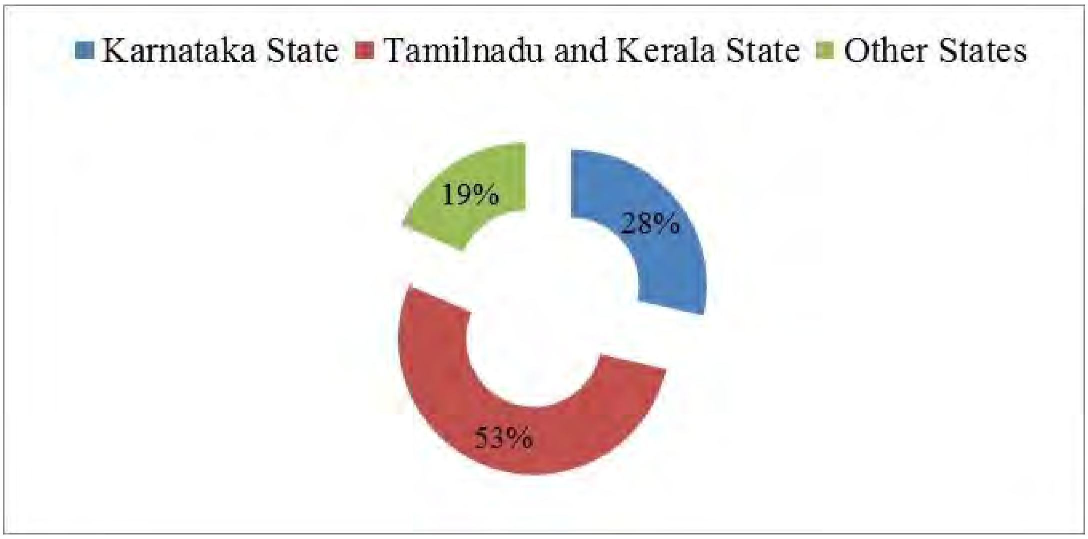


Figure 1: Percentage of Domestic Tourists by Region

b) International Tourists

The largest number of international tourists came from Europe. Most of them were visiting India for the first time, except two.

Table 03: Number of International Tourists by Country

Country	No. of Tourists
Poland	6
Netherlands	6
England	6
Switzerland	5
Germany	4
New Zealand	2
Hong Kong	2
China	2
France	1
Total	34

5. Accompanying Travel Preference

a) Domestic Tourists

It was found that all domestic tourists visited Mysore with a group. The largest number of domestic tourists came with family, others visited with community group, friends and relatives as shown below.

Table 04: Group Accompanying Domestic Tourists

Category	No.
Family	38
Community Group	17
Friends	8
Relatives	7
Total	70

b) International Tourists

In case of international tourists, most of them were accompanied by travel agencies. The travel agencies arranged accommodation, places to visit, transport, etc. Some of the international tourists were with family and friends as shown below.

Table 05: Group Accompanying International Tourists

Category	No.
Travel Agency	22
Friends	10
Family	2
Total	34

6. Travel Route

The travel routes to come to Mysore were surveyed

a) Domestic Tourists

It was observed that 40% of domestic tourists travelled to Mysore via Bengaluru and 60% took other routes.

Table 06: Route to Travel to Mysore (Domestic Tourists)

Route	Karnataka State	Tamilnadu and Kerala State	Other States	Total
via Bengaluru	15	7	6	28
Other Routes	5	30	7	42

b) International Tourists

In case of international tourists, 20% of international tourist travelled to Mysore via Bengaluru and 80% took other routes. Those who responded via other routes came from other south Indian states.

Table 07: Route to Travel to Mysore (International Tourists)

Route	No.
Other Routes	27
via Bengaluru	7
Total	34

7. Transport Mode

The transport modes for travelling to Mysore and for sightseeing in Mysore were surveyed.

a) Domestic Tourists

The transport modes used by domestic tourists to travel to Mysore are summarised below.

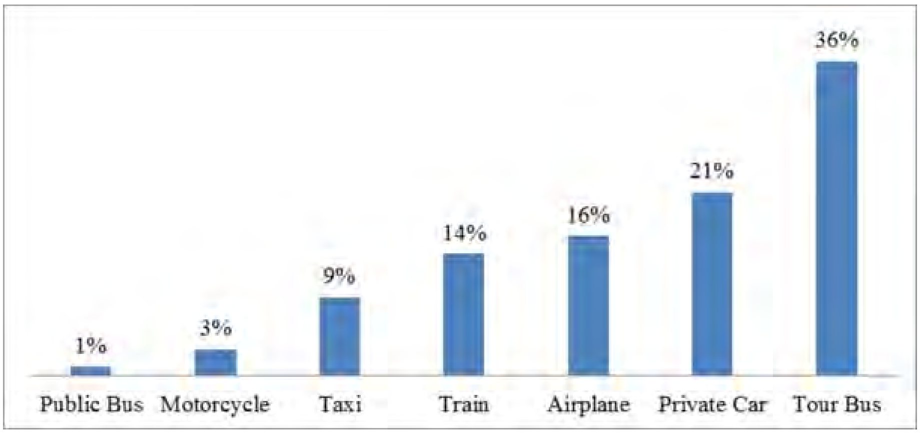


Figure 02: Transport Mode for Travelling to Mysore Used by Domestic Tourists

- Tour bus was the most widely used transport mode, followed by private car. The tour bus was mostly preferred by the tourists travelling as community group.
- The survey revealed that the use of airplane was 16%. It is noted that the tourists who fall into this category arrived via Bengaluru airport from other places in India at first and then traveled to Mysore by such transport as taxi, car, bus etc. It is inferred that a lack of transport service of Mysore airport would be one of the factors, thus a certain proportion of domestic tourists use flights to Bengaluru to travel to Mysore
- It was found that the use of public bus was much less than other transport modes.

The table below shows the usage of transport mode for travelling to Mysore and Sightseeing in Mysore.

Table 8: Transport Mode for Travelling to Mysore and Sightseeing in Mysore

Transport Mode	For Travelling to Mysore	For Sightseeing in Mysore
Tour Bus	36%	36%
Private Car	21%	36%
Airplane	16%	N/A
Train	14%	N/A
Taxi	9%	24%
Two Wheeler	3%	3%
Public Bus	1%	0%
Auto–Rickshaw	N/A	1%

It was observed that the tourists who travelled to Mysore by train, public transport and airplane used such transport as taxi, private car and auto–rickshaw for sightseeing in Mysore.

It was also found that 36% of domestic tourists used private car and 24% used taxi for sightseeing.

b) International Tourists

All international tourists used taxis for sightseeing in Mysore.

The figure below shows the transport mode used for sightseeing in Mysore by international and domestic tourists.

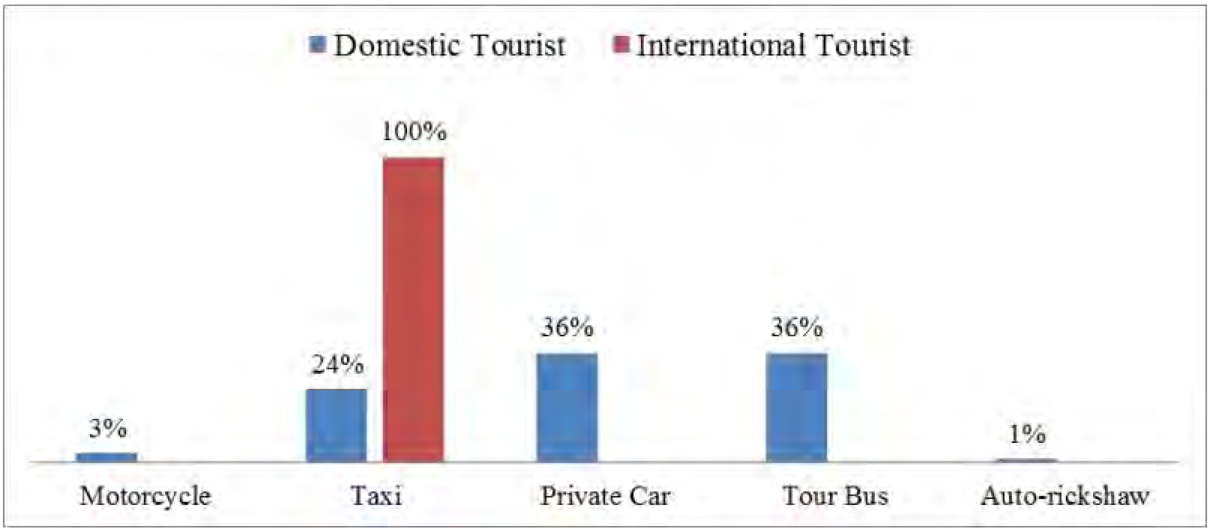


Figure 03: Transport mode Used for Sightseeing in Mysore

Due to absence of mass transit in Mysore, means of travelling in Mysore is heavily dependent on road transport.

8. Usage and Opinions on Local Transport in Mysore

There are following local transport in Mysore.

- Auto-Rickshaw
- Taxi
- City Bus
- Tonga

The local transport experienced by tourists and their opinions were surveyed. In addition to the above listed transport, the opinions of walking in Mysore were asked in interviews. The results and observations are summarized below.

Table 9: Local Transport Experience and Opinions of Tourists

<table>
<tr><th rowspan="3">Transport Mode</th><th colspan="3">Domestic Tourists</th><th colspan="3">International Tourists</th></tr>
<tr><th colspan="2">Used</th><th rowspan="2">Opinion</th><th colspan="2">Used</th><th rowspan="2">Opinion</th></tr>
<tr><th>Yes</th><th>No</th><th>Yes</th><th>No</th></tr>
<tr><td>Public Bus</td><td>0%</td><td>100%</td><td>N/A</td><td>0%</td><td>100%</td><td>N/A</td></tr>
<tr><td>Taxi</td><td>24%</td><td>76%</td><td>• Reliable and safe</td><td>5%</td><td>95%</td><td>• Reliable and safe</td></tr>
<tr><td>Walking</td><td>0%</td><td>100%</td><td>N/A</td><td>10%</td><td>90%</td><td>• Lack of proper pedestrian footpath
• Lack of route guidance information</td></tr>
<tr><td>Auto-Rickshaw</td><td>1%</td><td>99%</td><td>• Easy access</td><td>16%</td><td>84%</td><td>• Necessity of more strict enforcement of fare meter use and printed receipt
• Necessity of improvement of service for safety and security
• Necessity of displaying fare information in vehicle</td></tr>
<tr><td>Tonga</td><td>54%</td><td>46%</td><td>• Necessity of conserving traditional tonga service
• Necessity of establishing fare policy for tonga use
• Necessity of upgrading tonga design with modern feature</td><td>0%</td><td>100%</td><td>N/A</td></tr>
</table>

The observations can be summarized as follows:

- None of tourists (domestic and international) used city bus to travel in Mysore.
- Taxis were mostly preferred transport mode by domestic and international tourists.

- Necessity of improving pedestrian facilities was pointed out by many international tourists.
- Auto-rickshaws were used more by international tourists than domestic tourists. However necessity of improvement of auto-rickshaw services were stressed.
- None of international tourists used Tonga. Many domestic tourists regard Tonga as local traditional service and wish to preserve it. Some suggested to modernize and have more reliable fare policy.

9. Traffic Problems Encountered

Domestic and international tourists were asked about the traffic problems encountered on their way to Mysore. Six traffic issues were asked and tourist responded with multiple reasons on questioned items. The total response on each item is listed in the table below.

Table 10: Traffic Problems Encountered

Category	Response Received		Total Response
	Domestic Tourists	International Tourists	
Traffic congestion	21	-	21
Accident	-	-	
Lack of route guidance information	43	20	63
Bad road condition	27	25	52
Delay in public transport	-	-	
Lack of pedestrian infrastructure	-	30	30

Note: Each tourist provided multiple answers.

For domestic tourists, the major traffic problems are lack of route guidance information, bad road condition and traffic congestion. They responded: 61% for lack of route guidance information, 30% for traffic congestion and 39% for bad road condition respectively.

The issues encountered by international tourists were different from domestic tourists. The major issues are lack of basic infrastructure such as footpath, pedestrian crossings. They responded: 88% for necessity of improving basic pedestrian infrastructure, 74% for bad road condition and 59% for lack of route guidance information.

10. Information Source and Opinions on Facilities

The following questions were asked to both domestic and international tourists.

- Pre-trip information source for tourism in Mysore.
- Information source to find out tourism spot in Mysore.
- Opinions on current parking facilities.
- Opinions on current ticketing system in tourism spot

The results are summarized in the following table.

Table 11: Information Source and Opinions on Facilities

Items	Domestic Tourists		International Tourists	
Pre-trip information source	Website	Other sources	Website	Other sources
	66%	34%	10%	90%
Information source to find out tourism spot	Map	Asking people	Map	Asking people
	-	100%	-	100%
Difficulty in finding parking place near tourist spot	Yes	No	Yes	No
	33%	67%	15%	85%
Difficulty in purchasing ticket in tourist spot	Yes	No	Yes	No
	57%	43%	70%	30%

The observations are summarised as follows:

- Tourism websites were a major source of pre-trip information for domestic tourists. It was used less by international tourists.
- All tourists depended on local people in Mysore to find out the locations of tourism spots. Lack of road sign board which guides to the tourism spot was pointed out by many tourists. Necessity of availability of Mysore city map at convenient places such as hotel, KIOSK etc. was stressed by many international tourists.
- As for parking facilities, relatively small number of tourists responded that it was difficult to find the parking places. However, it is noted that this survey was carried out on weekdays and the result may vary on weekends and holidays when the number of tourist increases.
- As for ticketing system, the majority of tourists expressed difficulty in purchasing tickets because they were required to stand and wait in a queue for a long time. Many wished that the ticketing system be improved to e-ticketing to avoid standing in a queue.

11. Opinion on Condition of Traffic and Environment in Mysore

The opinions on traffic condition in Mysore were asked and the result is summarised below:

The domestic tourists responded as ‘Good’ and international tourists as ‘Acceptable’.

Table 12: Opinions on Traffic Condition in Mysore

Traffic Condition	Domestic Tourists	International Tourists
Very Good	0%	0%
Good	100%	0%
Acceptable	0%	100%
Bad	0%	0%
Very Bad	0%	0%

The opinions on necessity of improvement in environment and public facility were asked and the result is summarized below. Public toilet was asked as public facility because it is assumed that the public toilet is an important facility for tourists.

Necessity of improvement in cleanliness and hygiene was stressed by many international tourists.

Necessity of improvement in other items was also pointed out by domestic tourists.

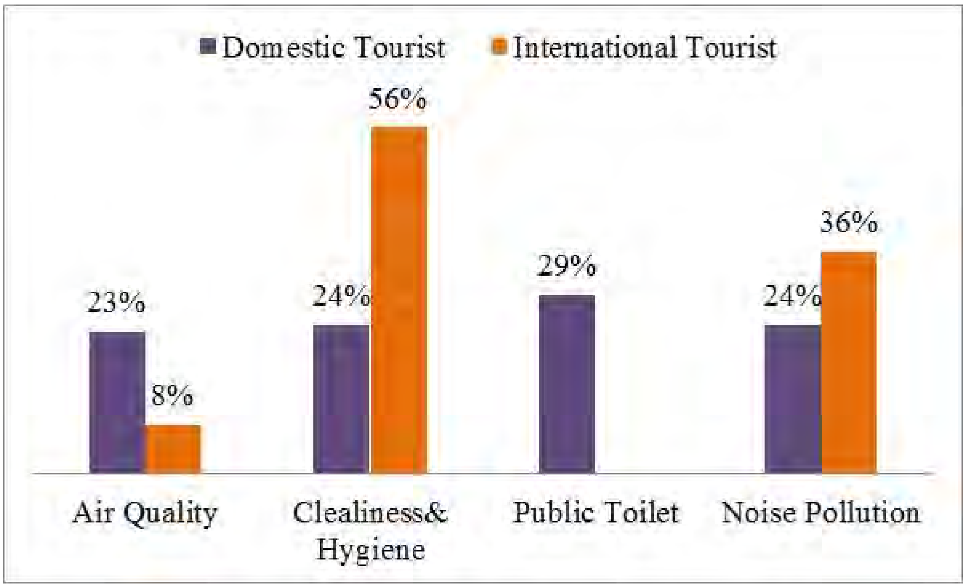


Fig 04: Opinions on Necessity of Improvement of Environment and Public Facility

12. Inconvenience faced by Tourists in Mysore

Inconveniences faced by tourists were asked and the result is summarized below.

Table 13: Inconvenience Faced by Tourist

Items	Domestic Tourists	International Tourists
Mysore tourism information	0%	60%
Language communication problem	22%	0%
Lack of tourist spot guidance information	64%	0%
Attitude of sales people in shops	0%	30%
No issues	14%	10%

The inconvenience faced by domestic and international tourists were different.

- Lack of tourist spot guidance information - Domestic people faced problems to reach tour spots. Tourists depend on Mysore local people for route guidance.

- Language communication problem - Tourist's from different states, especially from north Indian states faced difficulty to communicate with Mysore local people.
- Mysore tourism information - Most of the international tourist expressed the difficulty they faced due to lack of tourism information.
- Public attitude (Shopping) - Few of international tourists expressed the inconvenience due to inappropriate public attitude.

13. Required Improvements in Mysore

The following items were asked and the result is summarised below.

Table 14: Required Improvement in Mysore

Items needed in Mysore	Domestic Tourists	International Tourists
Dynamic traffic information	0%	0%
Site visit information	50%	58%
Park&Ride facilities & information	13%	0%
Introduction of eco-friendly vehicle	37%	42%
Connection information between Bangalore & Mysore	0%	0%
Others	0%	0%

- Improvement of site visit information was responded by the largest number of tourist.
- Introduction of eco-friendly vehicles such as electric vehicle, bicycle sharing and etc. was responded by the second largest number of tourist.
- Introduction of park & ride facilities and information was responded by domestic tourists.

14. Suggestions for Mysore Provided by Tourists

Other suggestions provided by domestic and international tourists are listed below.

- Introduction of Smart Tourism*
- Preparation of tourist information centre or call centre
- Improvement in maintenance of tourist spots
- Reinforcement of environment protection
- Modernisation of Tonga
- Introduction of eco-friendly vehicle
- Improvement of basic pedestrian infrastructure

*Smart Tourism: The use and application of technology in the tourism sector is called Smart tourism

Appendix - 5

Meeting Record

Meeting Record

Topic	Meeting with Bangalore Metro Transport Corporation (BMTC)
Date	30th Jan 2014
Time	12:00 to 13:30 Hrs
Venue	BMTC Office
Attendees	Representative from BMTC: 1. Mr. Kumar Pushkar, IFS - Director, IT, BMTC Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr.Narayan

Meeting Record

JICA Study Team informed the start of the study for ITS master Plan for Bangalore and Mysore. The team explained the purpose and outlines of the study.

Summary of the meeting

The items discussed as below:

- JICA study team provided the questionnaire BMTC that can be filled and sent back to the JICA study tem
- JICA study team explained the content and necessity of the questionnaire
- BMTC showed BMTC website – www.mybmtc.com where all the details like organization structure, bus routes, bus fares etc are available.
- Current status of proposed Common Card for BMTC and Metro
    - The vendor is finalised – Axis Bank
    - The Central Procurement Department of Karnataka is meeting shortly to finalise the release of Work order
    - Project duration 8 months from the date of release of Work order
- ITS Project of BMTC (Vehicle tracking and Passenger Information System)
    - Work order is issued – vendor is TRIMAX
    - Initially a pilot project for one depot will be carried out and then the total project will be carried out.
    - GPS will be installed on all 6,500 buses of Bangalore
    - At depots and bus terminals – LED display will be arranged with bus arrival / departure

information (200 LED display units)

- Command Control centre (CCC) will be at BMTC, Shanthinagar Bus Stop.
- Video wall in the CCC is 3X2 (each 55 inch LCDs)
- Data centre is established at the State Government Information Centre, Bangalore
- The contract is awarded for 5 years including the O&M of 4 years

- Parking Management System
  - BMTC is currently managing 10 Traffic and Transit Management Centres (TTMC)
- BRTS – It is informed that DULT is responsible

Meeting Record

Topic	Meeting with Traffic Police
Date	30th Jan 2014
Time	17:00 hrs to 18:00 hrs
Venue	BETL Office
Attendees	Representative from Traffic Police: 1. Mr. Dayanand , IPS 2. Mr. Diwaker, Sub -Inspector 3. Mr. Sanjeev (consultant of Traffic Police) Representative from DULT: 1. Mr. Sivasubramaniam (Transport Planner) Representatives from JICA Team: 1. Mr. Totani 2. Mr. Matsuoka 3. Mr. Kondo 4. Mr. Oikawa 5. Mr. Narayan

Meeting Record

Outline and purpose of the meeting:

New team members of the JICA Study team were introduced to the Traffic Police.

JICA Study team informed Traffic Police about the commencement of the study for ITS master Plan for Bangalore and Mysore.

JICA Study team provided the questionnaire to the Traffic Police. The Traffic Police requested to provide the soft copy of the questionnaire and the answers will be mailed to the DULT.

Below are discussed items:

- The JICA Study visited the Traffic Control Centre (BTRAC)
  - The BTRAC is covering about 40 corridors. Each corridor has about 5 cameras
  - Total cameras installed are 179
  - The traffic signals are installed by vendor, BEL (Bharat Electronics Ltd), an Indian government agency. There are 360 Traffic signals in total in Bangalore.
  - 20 VMS are installed in Bangalore.
  - The messages currently displayed on VMS are by the traffic police operators based on CCTV observation and information collected from traffic constables in the field.
  - The video wall is a projector type.
  - The Cameras are supplied by Schneider Electric.
  - The BTRAC system maintenance is performed by the vendor - CMS systems
  - The traffic control center is operated by traffic police
  - The traffic signal lights, CCTV and VMS are all connected to the control center through a 4 MBPS OFC.

o The OFC service provider is BSNL (Bharat Sanchar Nigam Ltd), a central government communication provider.

Meeting Record

Topic	Meeting with Bangalore Development Authority (BDA)
Date	31st Jan 2014
Time	15:00
Venue	BDA Office
Attendees	Representative from BDA: 1. Mr. P.N.Nayak. (BE(Civil) MIE Engineer Member) 2. Mr. Anbu Thomas Samuel (*STUP Consultants Pvt. Ltd*) 4. Mr. T.V.Rajeev (*STUP Consultants Pvt. Ltd*) 5. Mr. SRIVATSA B.K (*STUP Consultants Pvt. Ltd*) Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr.Narayan

Meeting Record

JICA Study Team informed the start of the study for ITS master Plan for Bangalore and Mysore. The team explained the purpose and outlines of the study.

Summary of the meeting

- The cross section designs were changed as per the suggestion of JICA team and the latest DPR was sent to JICA.
- DPR will be finalized after the cross sections are finalized
- Land acquisition notices were sent to all the land owners after incorporating the new law by government of India. The acquisition is expected to be completed within next few months.
- Toll plaza provision is available at all the intersections.
- Traffic study results are part of DPR.
- The soft copy of the DPR will be provided to JICA study team. It will be sent to DULT.
- The BDA consultant requested JICA Study team to provide the place/width required for the ITS Equipment at the intersections.
- The fare to be collected on PRR is yet to be finalized as the BDA is still discussing on it.

Meeting Record

Topic	Meeting with Bangalore Elevated Tollway Limited (BETL)
Date	1st Feb 2014
Time	14:15 hrs
Venue	BETL Office
Attendees	Representative from BETL: 1.Mr.Ranjith Representative from DULT: 1. Mr. Sivasubramaniam (Transport Planner) Representatives from JICA Team: Mr. Totani, Mr. Matsuoka, Mr. Kondo, Mr. Oikawa, Mr. Narayan, Mr. Madan

Meeting Record

Outline and purpose of the meeting:

To gather information about the existing ITS systems available in the Bangalore elevated toll way limited.

Organization Outline

- Bangalore Elevated Toll way limited (BETL) is located between Silk board junction and Electronic city Junction. It consists of 4 toll plazas for 26 km length
- It is a consortium with the members of - NCC, SOMA, IL&FS
- The project is implemented as a BOT project for 20 years under NHAI
- The service was commenced three and half years ago.

Below are discussed items:

<HTMS: Highway Traffic Management System>

- It contains CCTV surveillance , Automatic Traffic Counters and Classifiers (ATCC), Variable Message Sign (VMS) and Emergency Call Boxes (ECB)
- HTMS was supplied and installed by FCON as system integrator
- It includes highway patrol, ambulance and towing services
- HTMS control room functions for 24x7
- Emergency call boxes (ECB) are installed at every 2km on both sides
- 5 VMS
- Fiber optic cables laid by BETL

<TMS: Toll Collection System>

- Manual, Touch & Go and Automatic Toll Collection

- TMS was supplied and installed by EFKON as system integrator
- Touch & Go: for 2 wheelers, 3000 smart cards have been sold.
- Automatic Toll Collection:
  - For 4 wheelers,
  - One piece OBU, microwave type (maybe passive DSRC)
  - 20,000 OBUs have been sold. Approx. 25% of 4 wheelers per day
  - OBU costs 1,000 INR. But it has been provided to the users at 150 INR to encourage usage.
- Planned RFID Toll Collection System
  - It is planned to replace the above system by RFID based toll collection because of frequent malfunctions of the current system.
  - The replacement of the current system has been initiated by BETL because of the above problem, not instructed nor mandated by NHAI.
  - It is under process of selection of supplier.
  - Approx. 1 crore INR for replacement

< Recharging>

- OBU recharging and smart card for touch and go recharging.
- The charging center are available only at Toll plazas
- The following discount is applicable to OBU and smart card:
  - o Recharge amount 3,000 INR – 5 % discount
  - o Recharge amount 6,000 INR – 10 % discount
- One month pass (which allows unlimited trips during these periods) is available for OBS and Smart Card users.

<Other Equipment>

- Cameras installed for about 26 km with a camera at every 2 km
- Automatic Traffic Counters are installed at toll plazas to count and classify the vehicles.
- The AVCC are loop coiled based and sensors.
- The system classifies vehicles as small and large vehicles.
- The sensors record the axel length of the vehicle.Based on axel length, the vehicles are further classified manually as car, truck, lorry etc.
- 5 VMS were installed for the provision of safety messages to road users

Meeting Record

Topic	Meeting with Bangalore Department of Transport
Date	1st Feb 2014
Time	15:00
Venue	Department of Transport Office
Attendees	Representative from Department of Transport: 1. Mr. Hemanth 2. Mr. Sambrani 3. Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr.Narayan

Meeting Record

JICA Study Team informed the start of the study for ITS master Plan for Bangalore and Mysore. The team explained the purpose and outlines of the study.

Summary of the meeting

<General>

1. JICA Study team explained the purpose and the content of the questionnaire.
2. The questionnaire was discussed in the meeting and the Department of Transport provided below information
   - Total number of Administrative staff is 2482 (Currently 1931 are available and remaining 551 are vacant)
   - Total number of technical staff are 587 (Currently 340 are available and remaining 247 are vacant)
   - Current revenue of the Department of Transport is for the earlier financial year is 416 crore INR.
   - The report published by the department of Transport about the information revenue, expenditure, process and other aspects was provided to the JICA Study team by the Department of Transport.

<Standard Number Plate>

- The standard number plate registration process is still under hold because of legal aspects, currently under the Supreme Court of India. Because tenderer who lost tender went to the court since selected contractor will be monopoly.
- Does not know how much time it may take for the legal process to complete.
- 7 Indian states have already implemented the standard number plate registration process.
- Standardization of Number Plate is seems impossible since guideline which central government issued had not stipulated font of letter.

<Digitization of Vehicle Registration Data>

- The digitization of the vehicle registration in the Karnataka state is completed 70%.
- All the vehicles registered after the year 2009 are already in the database.
- The vehicles registered before the year 2009 are yet to be fully completed
- There are 58 Transport offices available in Karnataka state where vehicle registration can be made.
- All new vehicle registration are issued as smart cards

<Identification of New Owner of Vehicle>

- If a vehicle is sold to a second owner and the vehicle is brought for registration by second owner, the new owner can be identified. This is possible because on the vehicle registration card, ownership number is published as 1, 2 etc. 1 means the first owner, 2 means 2nd owner (that means 1st owner sold it and the second owner bought it)
- There is no process currently available to identify a discarded vehicle.

<Vehicle Registration Database integration with other Agency>

- Vehicle registration database is currently connected to traffic police.
- The traffic police can search and know the vehicle owner in real time from their control center
- The vehicle database connected to the traffic police is updated with the latest data for each hour

<Driver License Information digitization>

- The digitization of the driver license information in the Karnataka state is completed 70%.
- All the driver licenses issued after the year 2009 are already in the database.
- The driver licenses issued before the year 2009 are yet to be fully completed
- All new driver licenses are issued as smart cards

Meeting Record

Topic	Meeting with Bangalore Mahanagar Palika (BBMP)
Date	1st Feb 2014
Time	15:00
Venue	Bangalore Mahanagar Palika (BBMP)
Attendees	Representative from Department of Transport: 1. Mr. Somashekhara (Chief Engineer) 2. Mr. Kabadia (Executive Engineer) Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr. Iseki 6. Mr.Narayan

Meeting Record

JICA Study Team informed the start of the study for ITS master Plan for Bangalore and Mysore. The team explained the purpose and outlines of the study.

JICA Study team explained the purpose and the content of the questionnaire.

Summary of the meeting

<General>

- The geographical area of Bangalore municipality is 830 Sq Km
- Total length of the road is 13,000 km
- The arterial and sub-arterial roads of length 2,000 km carries the major traffic

<Organization Structure – Technical operation>

- BBMP is structured as below for technical operation purpose:
  - Divided into 198 wards (it is a small administrative zone)
  - The technical person responsible in each ward is Junior Assistant Engineer
  - 2 to 3 wards combined together to form a Sub-division
  - Each Sub-division will have technical in charge as Assistant Executive Engineer
  - 2 to 3 sub-division are combined to form a Division
  - 2 to 3 Divisions combined to form a zone
  - There are 8 zones in BBMP

< Organization Structure – Administrative operation>

- BBMP is structured as below for Administrative operation purpose:
  - Divided in to 5 wings
  - Each wing is headed by Chief Engineer
    - Wing 1: Road & Infrastructure
    - Wing 2 : Storm Water Management

  - Wing 3: Lake Development
  - Wing 4: Waste Water Management
  - Wing 5: Project Management (??)

<Budget & Revenue>

- Annual Budget for the financial year 2013-2014 is 9,000 crore INR
- Annual Budget for the financial year 2014-2015 is under preparation
- Source of Revenue is from the collection of Building Tax, Advertisement Tax, Money collected from Road cutting permissions provided to various agencies, Building construction licenses, Government funding etc.
- Expenditure is mainly for the operation and maintenance of the road (civil works)

<Current condition – Road projects>

- Total Intersections & Junctions in the city – 4000
- 600 junctions are signalized junctions
- All signals are Installed, operated and maintained by Traffic Police
- Proposal was submitted to the Central government under JNNURM scheme – for improvement of major 162 junctions (Improvement means not major modifications, but small changes like widening, road laying etc)
- For Installation of signals at junctions /modifications, no coordination is currently happening between traffic police and BBMP
- Old Airport belongs to the Hindustan Aeronautics Ltd (HAL), a central government agency. The HAL is an Indian airfare R&D organization.

<ERP>

- It is policy matter to be decide by the Karnataka state government
- It is still under discussion stage

<Skywalks >

- 100 skywalks are proposed
- Around 10 are approved and under proposal preparation stage
- One skywalk is already available Kempe Gowda road and it is a 20-metre skywalk.
- It was constructed on DBOOT (Design, Build, Own, Operate and Transfer) basis by Rajdeep Buildcon Pvt. Ltd, Bangalore

<Traffic Data Collection>

- No traffic survey was conducted for entire Bangalore city
- Traffic surveys/count are prepared at 16 junctions around 2 years back. This shall be provided to DULT by BBMP

<Rad Inventory>

- RITES prepared a road inventory in 2006 for major sections in the city
- 2 to 3 years back, some Mumbai consultant prepared road inventory covering the entire Bangalore Metropolitan road network. BBMP shall provide that information.

<Parking>

- Only few multi storied parking structures are available in the city
- Road side parking is currently free
- There is no automatic parking system in the city.

- Tenders were published for automatic parking systems at 3 city locations. But the tenders are not yet finalized
- Currently parking plan discussion are in progress as per the parking policy of DULT

<Parking Information System>

- Currently discussion is progress to call for global tenders to create on the road parking information system
- This system is proposed to be based on revenue sharing between government and the contractor

<Action Items>

- DPR of the 162 junction improved proposal prepared and submitted under JNNURM – DULT collects from BBMP
- Road inventory data prepared by a Mumbai consultant for BMMP – DULT collects from BBMP (IT Section)
- Traffic survey/count prepared at 16 grade separate junctions and 4 of them were approved to improve – DULT collects from BBMP

Meeting Record

Topic	Project Kick-off Meeting – Master Plan Study for Bengaluru and Mysore
Date	4th Feb 2014
Time	14:30
Venue	Board Room - DULT
Attendees	Meeting Chaired by: Ms. Manjula IAS (Commissioner DULT) Meeting Attendees from Indian side: 1. Mr. Somashekara (Chief Engineer BBMP) 2. Mr. Kabadia (Executive Engineer BBMP) 3. Mr. Shivananda (Deputy Chief Engineer, BMRL) 4. Mr. Mr. K N Ingalagi (Head, IT Division, BMTC) 5. Mr. Ravi (BMTC) 6. Mr. B C Kanaka Kumar (Bangalore Traffic Police) Representative from DULT: 1. Mr. Shamanth.P.K – Head TETC (Traffic Engineering Transportation cell) 2. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Study Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr. Iseki 6. Mr. Yamada 7. Mr. Sampath 8. Mr.Narayan 9. Ms. Priya

Meeting Record

The meeting was conducted by DULT to kick-off the project “ITS Master Plan Study for Bengaluru and Mysore”

The meeting was chaired by Commissioner, DULT and attended by representatives of stakeholder, DULT team and JICA Study team members.

Summary of the meeting

<Introduction – By Commissioner>

- Introduced the JICA Study team to stakeholder agencies
- Highlighted below items:
  - The Bangalore city is fast growing and traffic congestion has become a regular issue
  - Individual agencies such Traffic police, BMTC and etc are having ITS components prepared by themselves
  - Co-ordination between various city agencies is currently not existing
  - Metro Phase I work is currently in progress
  - Some proposal for Mono rail are made and mono may be considered in future

  - PRR has few installations of ITS
  - It is being considered congestion pricing such as ERP in the city to discourage the traffic to move towards the congested sections
  - The need is to integrate all the systems and prepare a central system.
  - All the systems that are developed in future shall be integrated under the central system
- Mentioned about the mandate of the ITS Master Plan as below
  - consider the coordination between various agencies
  - consider the integration of various existing ITS systems under central ITS system
  - consider the development all new ITS systems as part of the central ITS system
  - consider the multipurpose smart card introduction that can be used for Metro, Bus, Parking, Taxi etc
- Mentioned that the ITS will be introduced in a phased manner
  - Short term including the integration of all the existing ITS systems under the central ITS system
  - Long term to introduce new ITS initiatives
- JCC(Joint Coordination Committee) will be formed
  - Purpose of JCC is to establish proper coordination between JICA Study team and the stakeholder and making decisions
  - Members of the JCC will be DULT, BDA, BBMP, JICA India Office and JICA Study team
- TAG (Technical Advisory Group)
  - Purpose is to exchange information with JICA Study team
  - Representatives from all stakeholders
  - Each agency was asked to identify a person with functional knowledge
  - The person identified by each agency shall be able to spend substantial time in DULT to coordinate with JICA Study team

<Presentation by JICA Study Team>

JICA made presentation about the below mentioned items:

1. Study Background
2. Expected Goals of Study
   - Traffic congestion reduction by improving traffic flow on the road network including PRR realized by ITS
   - Usage of Public Transport will grow
   - Proper planning and implementation of road infrastructure development and traffic management will be realized by utilization of quantitative data on traffic
3. Study Outputs
   - ITS Master Plan for Bangaluru Metropolitan Area
   - ITS Master Plan for Mysore
   - Basic Design concept of prioritized ITS items for Bangaluru
   - Capacity Building
4. Major ITS Components for consideration for study

- ITS in the City
- ITS for PRR
- Electronic Road Pricing (ERP)
- Common Card

5. Overall work schedule – study period (Jan 2014 to June 2015)
6. Introduced team members
7. Report submission schedules mentioned
8. Major Issues to be considered for the City
    - Increase in traffic and inadequate road transport
    - Ineffective use of Data necessary for proper road and traffic management
    - Lack of Comprehensive approach for ITS planning
    - Speed of implementation of ITS
    - Many Stakeholder
9. Explained the Study Policy
    - Policy 1:Effectivs use of Road and Traffic data for appropriate road traffic management
    - Policy 2:Traffic Control using ITS
    - Policy 3:Integration of ITS
    - Policy 4:Phased ITS Implementation
10. Explained major work items
11. Explained the study methodologies
    - Review of related conditions
    - Review of ITS conditions
    - ITS opinion survey
    - Traffic survey and demand forecast
    - Basic policy for ITS Master Plan
    - Identifying required functions and ITS services
    - ITS study tour
    - ITS Master Plan formulation (Bengaluru)
    - ITS Master Plan formulation (Mysore) – this is based on Master Plan of Bengaluru
    - Design concept for prioritized ITS services for Bengaluru
12. JICA Study team highlighted the undertakings required from the counterpart in detail
    - Commissioner promised full cooperation from all the stakeholders
13. JICA Study team provided the list of information/items required from all the stakeholders immediately for the study.
    - All the stakeholders promised to provide the information/items within a weeks' time

<Comments from Stakeholders>

<Traffic Police>

- Appreciated the study approach presented by the JICA Study team
- Observed that the scope and contents of study are well planned
- Mentioned that the idea of taking opinion of various agencies and road users is

appreciable

- Suggested to provide a long term step by step approach for introduction of ITS in the city

<Metro Rail>

- Suggested to include the BRT also as part of the study
- Consider the connectivity of the feeder bus service facility at Metro stations based on metro train schedule and availability

<DULT>

- Will be sending the inception report prepared by JICA study team and requested the stakeholders to provide their requirements in terms of ITS implementation

<Kondo san presentation>

- Explained about the integration of Common Card
- Information on Integration – Traffic Control by Big data
- ITS solution (physical connectivity)

<Conclusion>

- Requested all agencies to identify a member who can spend substantial time with JICA study team in DULT
- Requested the stakeholder to provide all the document/data within the timelines mentioned

<Action Items>

- All stakeholders agreed to identify a person and inform DULT within a week
- All stakeholders shall send the document/data requested by JICA Study team within a week
- Mr. Siva Subramaniam is identified by DULT for coordination between JICA study team and stakeholders/agencies

Meeting Record

Topic	Meeting with Bangalore Mysore Infrastructure Corridor Area Planning Authority (BMICAPA)
Date	5th Feb 2014
Time	11:30 hrs
Venue	Bangalore Mahanagar Palika (BBMP)
Attendees	Representative from BMICAPA: 1. Dr. Mahendra (Additional Director) Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr. Iseki 6. Mr. Yamada 7. Mr. Wakatsuki 8. Mr. Matsumoto 9. Mr.Narayan

Meeting Record

DULT informed the study for ITS master Plan for Bangalore and Mysore. The team explained the purpose and outlines of the study.

JICA Study team explained the purpose and the content of the questionnaire.

Summary of the meeting

<FORMULATION – BMICAPA>

- BMICAPA was constituted under section 4C (1) of KTCP Act by the Government of Karnataka vide G.O. No. Na aa ee/377/MIB/98 dt. 5-10-99 , 21-05-2003 , 23-04-05 and 24-06-06 respectively
- BMICAPA was constituted to have an efficient infrastructure corridor between two cities - Bangalore and Mysore.
- It is a planning agency only
- It is also to plan for the development of population through growth centers (around the corridor), which will acts as counter-magnets to the cities growth

<NICE AGENCY>

- The express way is constructed, operated and maintained by NICE (Nandini Infrastructure Corridor Enforcement), a private agency.
- Concession period for toll road is 40 years including 10 years of construction period
- The agreement between NICE and Karnataka State Government was signed in 1995
- Not sure whether NICE will accept to integrate their ITS systems under the central ITS center.

- BMICAPA suggested the JICA Study team to meet the NICE authorities for getting information on the existing systems and other details

<CTTS>

- CTTS (Comprehensive Traffic and Transportation Study) was performed in June 2010 for the BDA
- CTTS is still with government of Karnataka for final approval
- BMICAPA sent the CTTS report to DULT

<ACTIONS>

- DULT shall provide copy of CTTS to JICA Study team.

Meeting Record

Topic	Meeting with Karnataka State Road Transport Corporation (KSRTC)
Date	6th Feb 2014
Time	11:30 hrs
Venue	KSRTC
Attendees	Representatives from KSRTC: 1. Mr. Manjunath Prasad IAS (Managing Director) 2. Mr. Mallikarjun (KSRTC) 3. Mr. Dipankar Das (CMC Ltd) 4. Mr. Gobi R (IBI) Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Noboru Kondo 2. Mr. Hiroya Totani 3. Mr. Matsuoka 4. Mr. Oikawa 5. Mr. Iseki 6. Mr. Yamada 7. Mr. Wakatsuki 8. Mr. Matsumoto 9. Mr.Narayan

Meeting Record

DULT informed about the start of the master plan study on the introduction of Intelligent Transport Systems (ITS) in Bengaluru and Mysore. The JICA study team explained the purpose and outlines of the study.

JICA study team explained the content of the questionnaire.

KSRTC presented about the ITS initiatives in the Organization.

Summary of the meeting

<MYSORE - ITS>

- Population of Mysore is about 1 million
- KSRTC operating 480 buses within the Mysore city
- ITS Mysore bus project components are:
    - Real time passenger information system
    - In-vehicle display system
    - Automated voice announcement system
    - Central control system
    - Automatic vehicle location system
    - Enterprise management system
    - MIS reports

- ITS Mysore vendor is CMC Ltd (A Tata Group Company)
- Project management consultants : IBI Group, Canada
- The ITS Mysore is a successfully implemented system
- ITS components – in bus equipment
  - Vehicle mounted unit
  - In-Bus display unit
  - Audio unit
  - Batter backup unit
- ITS component - central control centre
  - Data centre
  - Video wall
- ITS Component – data centre
  - Database server
  - Application server
  - Communication server
  - GIS server
  - IVRS server
  - Display server
  - SMS server
- ITS Component – passenger information system
  - Display at bus terminals and bus shelters
  - In-bus display
  - Using mobile SMS
  - Using IVR
  - Using web portal

<KSRTC – BANGALURU>

- KSRTC mainly operates intra-state (buses from Bengaluru to other places in the Karnataka state) and Inter-state (from Bengaluru to other states like Chennai, Hyderabad etc.)
- Total buses operated are 8350

<KSRTC – ITS project for BANGALURU>

- Proposal to implement ITS solution for 4000 buses (out of 8350 buses) is finalized
- This project is including 200 buses operating between Bengaluru and Mysore
- Other 3800 buses of this project are those from Bengaluru to other places in the Karnataka state (intra-state buses) and buses from Bangalore to other states such as Hyderabad and Chennai (inter-state)

- The project is finalized
- Vendor is CMC – Installation, Operation and Maintenance
- Project Management Consultancy – IBI, Canada

<Proposals in consideration >

<Electronic Ticketing System>

<Current Status>

- Buses are installed with Electronic Ticket vending machines.
- The bus driver/conductor issues ticket using the Electronic Vending machine
- At the end of the day, data from the Electronic Vending machine is copied to the server in the KSRTC Data Centre

<Proposal under Consideration>

- To integrate the Electronic Vending machine with the Central Control Centre
- It helps in knowing the availability of seats in the bus in real time
- The seat availability can be provided to the bus users waiting to board the bus at next stops
- It helps in knowing the daily revenue collection in real time

<KSRTC – OPINION>

<Common Card>

- KSRTC expressed their willingness to cooperate with other agencies if common card system is finalized and implemented
- KSRTC would like to understand the revenue sharing in case of usage of common card
- Suggested that DULT need to take the initiative

<Integration with Traffic Management>

- KSRTC feels that if the bus location data collected by KSRTC is used in integration with traffic police, it will be helpful to reduce road congestion and also useful to the road users
- KSRTC expressed willingness to provide their bus location data to other agencies

Meeting Record

Topic	Meeting with Bharath Electronics Limited (BEL)
Date	19 February, 2014
Time	15:00 – 16:00
Venue	DULT Office
Attendees	Representative from BEL: 1. Mr. Rakeshranjan (Manager) 2. Mr. Ravikumar (Deputy General Manager) 3. Mr. Arun (Senior Engineer) 4. Mr. Suresh (Senior Engineer) Representative from DULT: 1. Mr. Siva Subramaniam J.(Transport Planner) Representative from JICA Team: 1. Mr. Matsuoka 2. Mr. Madhan

Meeting Record

Discussed Items:

1. JICA Study team informed BEL about the outline of the study for ITS master Plan for Bangalore and Mysore
2. JICA Study team provided BEL with the questionnaire that can be filled and sent back to the JICA study team.
3. JICA Study team explained the content and necessity of the questionnaire.

Summary of the meeting

List and location of traffic signals:

- 352 traffic signals installed in Bangalore
- Out of 352 traffic signals, 11 have been removed and 8 signals are installed but not in use because of road works
- Location map of existing signals:
- Mapping is done more than 300 junctions
- The detailed of the mapping is provided by TMC (Traffic Management Centre) at Website http://www.bangaloretrafficpolice.gov.in/

System and function

- More than 270 Signals are connected with the TMC.
- The TMC receives the real time monitoring data from the controller and the same shall be witnessed on a monitor.

- The signal control plans generated in the TMC can be sent to the local controller for implementation.
- Signals are equipped with time-of-day control function so that different signal timing is applied according to time of day.
- Most of the signals are operated manually by police
- The programmes can also be changed depending on the need. All the signals are programmed to work from 7am to 12pm
- From 12pm to 7am all the signals in the city are in a blinking mode and show amber blinking

Communication system

- BSNL line is leased to connect traffic signal at intersection with the server in Traffic Management Centre.
- Communication protocol is original to BEL using TCP/IP. There are no communication standards for traffic signal in India.
- All these signals are connected by BSNL cables to a controlling server and each signal is fed with a programme for a day. There are three types of signal controls - fixed time signals, vehicle activated control and synchronised control.
- Lease fee of communication line for signal and CCTV camera is borne by BDP.

Upgrading of signal

- Vehicle Actuation, linking to TMC, optimization of timing and pattern, and LED signal lantern

Maintenance

- BEL is responsible for maintenance of the signals they installed. One year defect liability period and two year maintenance are included in the contract. After expiry of initial contract, three year maintenance contract was made that covers maintenance until 2015.
- Maintenance is on a 24x7 hours working time basis with three shifts
- Recovery time from the notification of failure until fixing of detect is specified in the maintenance contract.
- Power fluctuation and damage by third party are main cause of trouble.
- No MTBF (mean time between failures) data is available for signal controller.

Actuated signal

- Actuated signal using inductive loop vehicle detector was once installed at MG Road. But it was removed later.
- Another actuated signal based on video vehicle detector is installed at an intersection near BEL factory. It will be completed soon. Site visit can be arranged in April, 2014.

Traffic Controller Supplier in India

- There are three manufacturers of signal controller in India, namely CMS Computers Ltd. (India), Nucleonics Traffic Solutions Pvt. Ltd. and BEL.

<u>Meeting Record</u>

<table>
<tr><td>Topic</td><td>Meeting with Centre for infrastructure Sustainable Transportation and Urban Planning(CiSTUP)</td></tr>
<tr><td>Date</td><td>21st March 2014</td></tr>
<tr><td>Time</td><td>11:30 hrs</td></tr>
<tr><td>Venue</td><td>Indian Institute Of Science (IISc)</td></tr>
<tr><td>Attendees</td><td><u>Representative from CiSTUP</u>:
1. Mr. Lokesh Hebbani (Transportation Program Manager)

<u>Representative from DULT</u>:
1. Mr. Siva Subramaniam J.(Transport Planner)

<u>Representative from JICA Team</u>:
1. Mr. Noboru Kondo
2. Mr. Hiroya Totani
3. Mr.Narayan
4. Mr.Madhan</td></tr>
<tr><td colspan="2">Meeting Record</td></tr>
</table>

DULT explained the study for ITS master Plan for Bangalore and Mysore.

<u>Summary of the meeting</u>

<General>

- CiSTUP was established in the year 2009 by government of Karnataka with grant of 30 crore INR.
- CiSTUP is mainly focused on sustainable urban transport in terms of infrastructure and urban planning
- CiSTUP is providing consulting support to Bangalore Traffic Police and BBMP
- It also undertakes consultancy projects for other agencies.
- Recently CiSTUP conducted a project “Road Safety Action Plan” for Bihar state under World Bank scheme.

Points mentioned by CiSTUP:

<No Central Database of Registered Vehicles at National Level >

1. No central database is currently available for registered vehicles at national level. So it is difficult to identify a vehicle that was registered in other states. When such vehicles involved in accidents in other states, it is difficult to identify the owner.
2. Central database is important for strict enforcement of violations such as drunken driving, over speeding.
3. It is important to introduce policy and strict enforcement for cancellation of registration, based on number of violations recorded for a registered vehicle.

<Central Database of Accidents and Black spots>

1. It is important to maintain a central database of accidents at city level and state level. This database must be available to agencies such as Traffic Police, BBMP, BDA and Transport Department.
2. It is important to maintain central database of black spots and make it available to other agencies.
3. These databases can be utilized by government and private agencies to educate the people and students about the occurrence of accidents and safety measures to be considered.

<Pedestrian Facility Maintenance>

1. Pedestrians do not have proper footpaths, under passes and FOBs to cross roads. Because of this, most of the time pedestrians cross the roads. This results in accidents and deaths.
2. The footpaths, underpasses and FOBS that are available currently are not maintained properly and most of these are not used by pedestrians.
3. Most of the footpaths are either occupied by small vendors or not constructed/maintained properly and thus making them unusable.
4. Strict enforcement is required to make the pedestrian facilities usable.

<Over Loaded Vehicular Movement >

1. Over Loaded vehicular movement is not restricted on the city roads. Because of this, the city roads are wearied quickly.
2. Even if, over loaded vehicles are checked at some places, the vehicles are allowed after paying penalty without off-loading. This results in the damage of the existing road.

<Coordination Between Agencies >

1. There is no coordination between various city agencies
2. It is important to have coordination between traffic police, road management, public transport agencies.
3. The agencies do not follow standards while developing facilities. It is required to follow national standards like IRC (Indian Road Congress).

<Central Agency Required>

1. It is important that a central agency is established at city level to collect, aggregate and provide the below data/information.
    a. Real-time Traffic data
    b. Real-Time congestion information
    c. Road Inventory – classification of roads, road capacity etc
    d. Accident and Black spot data
2. Central agency is required to coordinate between agencies as below:
    a. During times of events such as meetings/rallies by political parties and trade unions in the city, the city roads are choked in the areas, where the event is happening. People are not aware of such situation and travelling into the congested sections of the road network.
    b. This kind of situation is resulting in wastage of fuel consumption and high pollution levels. It is important to calculate the impact of such situation on economy, energy consumption levels, and pollution levels. These data should be used to take appropriate legal measures to make the organizers of the events accountable and to discourage such events.
    c. It is important to provide road closure/congested information to people in advance

and guide to take alternate routes.

d. This is possible by collection, analysis and provision of data/information by a central agency with full participation from all stakeholders such as traffic police, transport agencies, road management agencies and others.

e. Currently, traffic police control the traffic signal green time at junctions based on traffic situation at each junction. But, traffic control based on area based traffic control mechanism is required to efficiently manage the traffic condition. Traffic police currently are not equipped with such data/information. Central agency as described in above points can be able to generate and provide such information to the Traffic Police.

f. It is important that the a central agency collects the data from various road side equipment such as sensors, CCTV and probe data.

g. It is required to maintain road clearing patrol vehicles in the city to clear vehicles stopped on the roads and other obstructions on 24X7 bases.

h. It is important to highlight the “mobility of people” and not “mobility of vehicles” to promote and encourage public transport use and provide road users with information for a seamless transport.

i. It is recommended to provide a common three digit Telephone number where people can call for any kind of emergency.

Meeting Record

Topic	1st Technical Advisory Group (TAG) Meeting
Date	28th March 2014
Time	14:30
Venue	DULT, Bangalore
Attendees	Chaired By: Ms. Manjula I.A.S, Commissioner, DULT Attendees: DULT Members: 1. Mr. Shamanth 2. Mr. Siva Subramanyam TAG members : As attached in the Annexure JICA Study Team: 3. Mr. Noboru Kondo 4. Mr. Hiroya Totani 5. Mr. Oikawa 6. Mr.Narayan 7. Mr.Madhan

Meeting Record

Summary of the meeting

<General>

- Commissioner explained how the ITS Master Plan study for Bangalore and Mysore was initiated.
- Commissioner explained the purpose of the forming TAG as to provide technical suggestions and comments to the study team on regular basis.
- Commissioner mentioned that the TAG meetings will be held once in month and it is expected that the same nodal officers from each agency attend this meeting regularly
- Commissioner explained that currently Bangalore city has few ITS components developed by individual agencies and these are operating in solo. She mentioned that there is need to bring all individual systems under a central agency.

< Discussed items>

<Presentation on Inception Report>

- JICA Study Team made presentation about the study objective, purpose, study contents and proposed outcomes of the study

<Presentation on Identification of Current Traffic Conditions and Issues>

- JICA Study Team made presentation on current traffic conditions and issues such as transportation issues, infrastructure conditions, urban growth, outcome of the field survey about the congestion related issues in various parts of the city etc
- The attendees expressed that city bus route information need to be considered along with Metro information for preparation of forecast for future transport needs

- Commissioner requested Study team to include Metro Phase 3 also to represent the future traffic related demand in the city
- CDAC mentioned that on road parking need to be considered while the current road congestion issues in the city are identified
- Commissioner mentioned that the current study will identify only ITS related aspects. She mentioned that infrastructure development proposals like road related are not within the scope of the project
- Study team mentioned that one of the items of the study is the electronic parking system
- BMRCL members suggested to include expected shift to Public transport from the private transport after the completion of the Metro. BMRCL mentioned that the detail study made by them in this regard (such as future demand forecast for Metro) will be provided to the JICA study team
- Traffic Police mentioned that they have collected accidents/black spot data in the city and agreed to provide that information to the study team in a weeks' time
- Commissioner mentioned that Dr. Gururaj of Nimhans Hospitals undertook detailed study about the accidents on the Bangalore city roads. She suggested study team to meet him.
- Commissioner mentioned that the accident data need to be analyzed to identify the cause of the accident in terms of road condition, safety measures, traffic manners etc
- CDAC mentioned that it is necessary to manage accident database at the city/regional level

<Presentation on proposed ITS functions for Bangalore>

- Study team made presentation on the currently identified issues in the city, needs in terms of soft and hard measures and possible ITS related measures those can be implemented.
- Study team made presentation with details about the proposed data exchange mechanism between existing ITS components of various agencies (B-TRAC of Traffic Police, Probe of BMTC, KSRTC, KSTDC and Metro) and proposed ITS components such as City ITS, PRR ITS Centre, ERP Centre, Electronic Parking Centre etc.
- The presentation also made on the proposed central ITS agency with its purpose and functions.
- Commissioner mentioned about the importance of probe data from various sources such as BMTC buses, KSRTC buses, Taxi and other
- TAG members discussed on the provision of road/lane closure data by BBMP to the central ITS agency. It was expressed by BBMP that it may be appropriate to collect such data from various facility agencies such as electricity agency, water works agency, Public Works Department (PWD).Commissioner mentioned that this issue need to be discussed further before taking a decision
- Commissioner asked BBMP to provide all the proposals of planned road related infrastructure project information to the study team. BBMP agreed to provide the data within a week
- CiSTUP suggested to provide classification of the city roads
- It was suggested to study toll collection methods on National Highways while considering PRR ITS

- All the Team members were asked by the Commissioner to send their comments (about the discussed items in the meeting/presentation) within a weeks' time.

Annexure

Attendees for the 1st TAG Meeting

Venue : DULT, Bangalore

Date: 28th March 2014
Time: 14:30

SNO	NAME	DEPARTMENT	DESIGNATION
1	S Povaiah	MUDA (Mysore Urban Development Authority)	The Commissioner
2	M C Shashi Kumar	MUDA	Joint Director of Town Planning
3	A V Rangesh	BDA (Bangalore Development Authority)	TPM (Town Planning Member)
4	H S Prasanna Kumar	DDUTTL (Directorate of Devaraj Urs Truck Terminals Ltd)	Executive engineer
5	Hemanth Kumar	DDUTTL	MD (The Managing Director)
4	H G Kumar	Transport department, Bangalore	Additional Commissioner
5	Jaya Dhindaw	CISTUP (Center for Infrastructure, Sustainable Transportation and Urban Planning), Bangalore	Urban Planner
6	P Ravi Kumar	CDAC (Center of Development of Advance Computing), Trivandrum	Joint Director
7	Basavaraj R Kabade	BBMP (Bruhat Bengaluru Mahanagara Palike)	Executive engineer
8	Shivananda	BMRC (Bangalore Metro Rail Corporation)	Deputy Chief engineer
9	H B Prakash	BDA	AEE (Assistant

			Executive Engineer), PRR Sub division
10	Nagendra	BMTC (Bangalore Metropolitan Transport Corporation)	DTO (Divisional Traffic Officer)
11	B C Kanaka kumar	Traffic planning, Bangalore city	ACP (Assistant Commissioner of Police)
12	K N Lingaraj	BMTC	CSM (Chief System Manager)
13	S Rajesh	KSRTC (Karnataka State Road Transport corporation, Bangalore)	DTO (Divisional Traffic Officer)
14	Manjunatha A N	KSRTC	Assistant Traffic Manager
15	R G Premananda Kumar	MCC (Mysore City Corporation, Mysore)	AEE (Assistant Executive Engineer)

Meeting Record

Topic	2nd Technical Advisory Group (TAG) Meeting – Meeting on Electronic Road Pricing with the JICA ERP experts.
Date	23rd April 2014
Time	11;00
Venue	DULT, Bangalore
Attendees	Chaired By: Ms. Manjula I.A.S, Commissioner, DULT Attendees: DULT Members: 1. Mr. Shamanth 2. Mr. Siva Subramanyam TAG members : As attached in the Annexure JICA Study Team: 1. Mr. Hiroya Totani 2. Mr. Matsuoka 3. Mr. Gopinath Menon 4. Mr. Ho Kum Fatt 5. Mr.Lim Tao Heng 6. Mr.Narayan 7. Mr.Madhan

Meeting Record

Summary of the meeting

<General>

- Commissioner explained the agenda of the meeting is to discuss on the possibility of congestion pricing for Bangalore
- She introduced the Singapore members of the JICA study team who are studying the feasibility of congestion pricing for Bangalore. The team is to submit their proposal for the congestion pricing scheme.
- Commissioner mentioned that recently Ministry of Urban Development (MOUD), Government of India has directed all the city governments to evaluate the congestion pricing schemes
- She mentioned Bangalore is the first city in India that undertook the study for congestion price scheme

<Singapore Team Presentation – **Congestion Pricing in Singapore**>

The presentation includes the below items:

<Part I – ERP in Singapore>

- Singapore Concept Plan (SCP) project (1968-72)
- First Land use Transport Concept plan 1971
- Transportation strategy 1975

- Road pricing first scheme in 1975 - Manual
- Automatic Road pricing scheme – 1998
  - The ERP gantry
  - Payment by Cash card and OBU(On Board Unit)
  - ERP Rate variations
  - Types of charges
  - ERP charges for foreign vehicles
  - Impact –violations and Errors
  - Administration
  - Results of Road pricing in Singapore
  - Effects of ERP on driving behavior
  - Lessons from Road pricing in Singapore
  - Other Road pricing schemes such as in London and Stockholm

<Part II – ERP for Bangalore>

- Current situation in Bangalore
- Bangalore Congestion pricing – Discussion
  - Traffic problems
  - Demand Management – Measures for the city (Non-fiscal and fiscal)
  - Possible strategy
  - Possible Charging Methods
  - Selection of Area or Road to be charged
  - Determine boundaries of controlled area
  - Type of vehicles to be charged
  - Times of operation
  - Deciding on initial charge
  - Variation of charges
  - Types of system (Gadget in vehicle)
  - Enforcement of violations
  - Legislations
  - Costs
  - Administration
  - Alternatives
  - Public Relations
  - Monitoring
  - Contingency

< Discussed items>

- BMTC said that initiation of congestion price scheme in Bangalore city is very much required. It was mentioned that improvement of public transport is required so as to encourage the road users to shift to public transport
- It was suggested that the city may look into possibility of increasing the tax on cars to discourage the car sales
- Traffic police mentioned that congestion pricing is required for Bangalore city and it can be introduced on a stretch as pilot initially
- It was generally agreed that on-road parking is one of the main issues of congestion in the city. But it is mentioned that major roads of the city that do not have on-road parking are also congested during peak hours. So it is important to look into the options of discouraging road users entering into critical roads during peak hours.
- Singapore Team explained about the initial hitches faced by Singapore for the introduction of congestion pricing. Singapore started initially by explaining to the public that the initiative is not for the collection of money, but there is a huge impact on city economy and environment with the congestion on major roads.
- Singapore Team mentioned that the road pricing is adjusted once in 3 months based on the average vehicle speed on the congestion pricing roads.
- BMTC mentioned that currently toll prices paid by the agency on toll roads is passed to the bus users as part of the ticket price. Bus ticket rates are adjusted based on the toll payments made by BMTC. So in future even the congestion price payments by BMTC buses can be adjusted into the bus ticket price. It was mentioned that price increase will be minimal.
- It was mentioned that the auto rickshaw rates need also to be adjusted for the auto rickshaw operating on the congestion roads.
- It was agreed by all participating agencies that congestion pricing must be for peak hours travels
- Singapore Team explained that introduction of the first time price for congestion price will be a challenging task. They mentioned that it needs to be calculated based on the multiple times (in Singapore it is 3 times) of the average cost of price for travel during peak hours on the congestion priced routes.
- It was suggested that Road Transport Authority (RTA) must collect yearly tax on vehicles rather than the current method of life tax that is once in a life time of the vehicle.
- RTA mentioned that there exists an association for Car owners and agreed to provide the details to DULT.
- It was also mentioned that there are 15 auto rickshaw owners’ associations.
- It was generally felt that enforcement of the “failure to pay” will be a major challenge and it needs to be carefully planned.

Annexure

Attendees for the 2nd TAG Meeting

Venue : DULT, Bangalore

Date: 23rd April 2014
Time: 11:00

SNO	NAME	DEPARTMENT	DESIGNATION
1	Dayananda	Police	Additional Commissioner
2	Kumar Pushkar	BMTC (Bangalore Metropolitan Transport Corporation)	Director, IT
3	B C Kanaka Kumar	Traffic Police	ACP (Assistant Commissioner of Police) Traffic Planner
4	Hemantha Kumar	DDUTTL (Directorate of Devaraj Urs Truck Terminals Ltd)	MD (The Managing Director)
5	R Muniveera Gowda	Transport	Additional Transport Commissioner
6	P N Nayak	BDA (Bangalore Development Authority)	Engineer
7	Sannappaiah H V	BDA	Deputy Director Town Planning
8	H C Ramendra	BDA	Engineer
9	H B Manamohan Prakash	BDA	AEE (Assistant Executive Engineer), PRR Sub division
10	B Nagendra	BDA	Executive Engineer

Meeting Record

Topic	2nd Technical Advisory Group (TAG) Meeting
Date	8th May 2014
Time	11:00
Venue	DULT, Bangalore
Attendees	Chaired By: Ms. Manjual I.A.S, Commissioner, DULT Attendees: (As attached in the annexure) TAG members DULT Members JICA Study Team: 1. Mr. Hiroya Totani 2. Mr.Matsuoka 3. Mr. Oikawa 4. Mr.Narayan

Meeting Record

Summary of the meeting

JICA Study Team made presentation on the below:

1. Opinion Survey conducted in Bangalore city – presented by the consultant who was engaged by JICA study team to conduct the opinion survey
2. Supplementary Traffic Survey – Current traffic conditions and Issues
3. Proposed ITS for PRR
4. Proposed traffic Signal System for Bangalore city
5. Smart card – Current status in Bangalore and examples from Hong Kong, Singapore and Japan

< Suggestion / Observations>

<Opinion Survey>

- It was suggested to take larger sample size for such surveys as the current sample size of 150 is smaller.
- It was suggested to consult public transport agencies before such surveys so that they can provide some suggestions on the questionnaires.
- All the participants felt that the survey was conducted with simple and direct questions. Although the sample size is small, the outcome of the survey provided important aspects.
- Members suggested that it would have been better if the questionnaire recorded the respondents' answers in terms of time of the day.
- Members also pointed out that although 2-wheelers never face any congestion at the toll plazas, the survey shows that the 2-wheeler riders mentioned it as major issue. It was felt that 2-wheeler riders might have not understood the questions correctly.
- Members opined that a separate and bigger sample survey is required covering the 2-wheeler and 4-wheelers.

Annexure

Attendees for the 2nd TAG Meeting

Venue : DULT, Bangalore

Date: 8th May 2014
Time: 11:00

SNO	NAME	DEPARTMENT	DESIGNATION
1	P Ravikumar	CDAC (Center of Development of Advance Computing), Trivandrum	J D (Joint Director)
2	B C Kanaka Kumar	Traffic Police	ACP (Assistant Commissioner of Police) Traffic Planner
3	Hemanth Kumar L	DDUTTL (Directorate of Devaraj Urs Truck Terminals Ltd)	MD (The Managing Director)
4	Shivananda	BMRCL (Bangalore Metro Rail Corporation Ltd)	Deputy Chief engineer
5	Lokesh Hebbani	CISTUP (Center for Infrastructure, Sustainable Transportation and Urban Planning)	Transportation Program Manager
6	Shamenth Kuelangi	DULT (Directorate of Urban land Transport)	Head of Traffic Engineering and Transport Planning
7	K N Patil	KSTDC (Karnataka State Tourism Development Corporation)	General Manager
8	Rajesh S	KSRTC (Karnataka State Road Transport corporation, Bangalore)	DTO (Divisional Traffic Officer)
9	K N Ingalagi	BMTC (Bangalore Metropolitan Transport Corporation)	CSM (Chief System Manager)

10	B Nagendra	BDA (Bangalore Development Authority)	Executive Engineer
11	Basavaraj R Kabade	BBMP (Bruhat Bengaluru Mahanagara Palike)	Executive Engineer
12	H B Manamohana Prakash	BDA	AEE (Assistant Executive Engineer), PRR Sub division
13	A V Rangesh	BDA	TPM (Town Planning Member)
14	Sivasubramaniam J	DULT	Transport Planner
15	Ritumoni Sonawal	DULT	Transport Planner

Meeting Record

Topic	Meeting with Traffic Police
Date	13th May 2014
Time	11:00
Venue	BETL Office
Attendees	Representative from Traffic Police: Mr. Dayanand , IPS Mr. B C Kanaka Kumar Mr. Sanjeev (consultant of Traffic Police) Representative from DULT: 1. Mr. Sivasubramaniam (Transport Planner) Representatives from JICA Team: Mr. Matsuoka, Mr. Oikawa, Mr. Narayan

Meeting Record

Outline and purpose of the meeting:

To explain the observations about current Signal System of Bangalore by the JICA Study team to Traffic Police and take the suggestions/clarifications.

Below are discussed items:

- It was informed that the total signals are 353 and out of that 204 are connected to Traffic Control Centre.
- Traffic Police told that it is wrong to think that the current system is designed by non-traffic engineers. They engaged a consultant firm which has traffic engineers and qualified design engineers.
- Traffic Police informed that the non-functioning of about 30% CCTV is mainly because of connectivity problem from the service provider BSNL. It was told that even other service providers are also do not have good capability to improve the connectivity performance. So Traffic Police are coordinating with BSNL to improve the performance of the connectivity.
- Traffic Police informed that the traffic signal and CCTV use the same connectivity(OFC cable) to connect to traffic control centre. Thus traffic signal also face the same situation of non-function of 30% on an average.
- Traffic police told that the traffic signal timing is continuously reviewed based on the feedback from field constables and other data collected by traffic police. So they feel that the current traffic signal timings is managed scientifically
- Traffic police told that area traffic control system for the signal system may be completed by next year. BEL is currently working on this. But the consultant of the Traffic Police mentioned that although BEL has been working on this system for over 2 years, they did not see any outcome of it.

- Traffic police is going to hire system integrator for the next phase of B-TRAC who is responsible for entire system. Earlier B-TRAC hired vendors for each component of the system because of which traffic police say that they are facing many issues in the O&M of the system
- Traffic police told that they would like the JICA study team to propose a method to upgrade the current B-TRAC system and not to replace the existing system with a new one.
- Traffic police told that the lane marking is the responsibility of BBMP and traffic police mark the pedestrian markings only.
- JICA study team requested the traffic police to provide the SLAs (Service Level Agreement) defined in their current tenders for study purpose. Traffic Police mentioned that they need to check whether it can be shared or not.

Meeting Record

Topic	4^{th} Technical Advisory Group (TAG) Meeting
Date	30^{th} JULY 2014
Time	14:00 pm
Venue	DULT, Bangalore
Attendees	Chaired By: Ms. Manjula I.A.S, Commissioner, DULT Attendees: TAG members : As attached in the Annexure DULT Members: 1. Mr. Shamanth 2. Mr. Siva Subramaniam J JICA India Members: 3. Mr. Sanjeev 4. Mr. Chiba NK India Members: 5. Mr. Sampath JICA Study Team: 6. Mr. Hiroya Totani 7. Mr. Noboru Kondo 8. Mr. Narayan 9. Ms. Reashma 10. Mr. Madhan

Meeting Record

Summary of the meeting

JICA Study Team made presentation on the topics below:

1. Activities carried out by JICA Study Team
2. Proposed Bengaluru Traffic Information (B-TIC)
3. Proposed ITS for PRR
4. Proposed Traffic Signal
5. Proposed Common Card

< Discussed items>

<Presentation on activities carried out by JICA Study Team >

- JICA study team briefed about the activities carried out by the study team such as meetings with stakeholders, information collected through interviews, TAG meeting reviews and supplementary traffic surveys conducted by the study team.

<Presentation on Bengaluru Traffic Information (B-TIC)>

- JICA study team explained B-TIC functions as
  - Data collection (Probe data from BMTC buses, road side equipments such as ATCC, CCTV etc.) and
  - Traffic information provision to road users (through VMS, website etc.)

- BMTC confirmed that probe data will be provided to B-TIC as per the format and frequency required.
  - Commissioner requested JICA study team to provide the required data format to BMTC for transmission of probe data between B-TIC and BMTC.
  - JICA study team replied that they will consider it appropriately.
- JICA study team requested BMTC to provide information on the frequency of BMTC buses on arterial roads. BMTC replied that all information is available on the website.
  - JICA study team explained that they are facing difficulties in identifying it from the information on the website of BMTC.
  - Commissioner requested BMTC to share the information on the route and frequency of BMTC buses to JICA study team.
- Commissioner requested JICA study team to consider planning installation of ATCC outside PRR.
  - JICA study team replied that they will consider it appropriately.

<Presentation on Proposed ITS for PRR>

- JICA Study team explained ITS components of PRR which are as follows:
  - Toll Management System (TMS) and
  - Highway Traffic Management System (HTMS).
- Regarding TMS, JICA study team explained three toll collection methods: ETC, Touch and Go and manual toll collection.
  - Commissioner commented that it would be better to mandate the use of OBU on large-sized vehicles, namely buses and trucks. Commissioner mentioned that it is a policy decision and shall be taken under Govt. consideration.
    - In regard of above, Commissioner requested JICA study team to highlight the necessity of policy development in the Master Plan.
    - JICA study team replied that they will consider and highlight it in the Master Plan.
- JICA study team explained HTMS components such as ATCC, CCTV equipment for data collection.
  - CDAC enquired the purpose of deploying both ATCC and CCTV on PRR.
  - DULT enquired the locations selected for installing ATCC and CCTV and the use of the database. Commissioner requested JICA study team to mention criteria in Master Plan to identify locations where the devices shall be installed.
  - JICA study team replied that they will consider it appropriately.

<Presentation on Proposed Traffic signal>

- JICA study team explained existing traffic signal system and listed the following issues
  - No vehicle detector is used and signal timing is only adjusted by time of day.

- Communication line is not reliable. As a result, many signals are not connected to TMC.

- JICA study team explained proposed adaptive signal system which adjusts signal timing according to traffic condition.
    - JICA study team explained that it would be better to plan a pilot project to demonstrate the adaptive signal system.
    - JICA study team explained that Yelahanka is the location considered for the pilot project and listed eight locations selected in Yelahanka.
    - Regarding the locations selected for the pilot project in Yelahanka, BBMP mentioned that location No.1 and No.3 are identified for development of underpass in Yelahanka.
    - In regard of above, Commissioner requested JICA study team to avoid those two locations and consider two other locations.

<Presentation on Proposed Common Card>

- JICA study team explained about two different business models proposed for the common card.
    - Scheme A is proposed in consideration of establishing a state level clearing house
    - Scheme B is proposed based on current situation of smart card introduction by transport operators which are BMRCL and BMTC.

<Other Discussed Items>

- The TAG members commented that the purposes of the proposed equipments shall be clearly explained in the Master Plan.
- Commissioner highlighted that the prime focus of B-TIC shall be data collection and information provision and not on management.

Annexure

Attendees for the 4th TAG Meeting

Venue : DULT, Bangalore

Date: 30th July 2014
Time: 14:00

No.	DEPARTMENT	NAME	DESIGNATION
1	BDA (Bangalore Development Authority)	A V Rangesh	Town Planning Member
		Rajagopala Reddy	Asst. Executive Engineer
2	DDUTTL (Directorate of Devaraj Urs Truck Terminals Ltd)	Hemanth Kumar	MD (Managing Director)
		H S Prasanna Kumar	Executive engineer
3	Transport Department, Bangalore	H G Kumar	Additional Commissioner
4	CISTUP (Center for Infrastructure, Sustainable Transportation and Urban Planning), Bangalore	Lokesh Hebbani	Transportation Program Manager
		Jaya Dhindaw	Urban Planner
5	CDAC (Center of Development of Advance Computing), Trivandrum	P Ravi Kumar	Joint Director
6	BBMP (Bruhat Bengaluru Mahanagara Palike)	Basavaraj R Kabade	Executive engineer
7	Traffic planning, Bangalore city	B C Kanaka kumar	Assistant Commissioner of Police
8	BMTC	K N Ingalagi	CSM (Chief System Manager)
9	KSRTC (Karnataka State Road Transport corporation, Bangalore)	S Rajesh	DTO (Divisional Traffic Officer)
		K.N. Patil	GM (F)

Meeting Record

Topic	Presentation: Coordination Between Civil and ITS for PRR & Outline of TMS for PRR
Date	25th April 2015
Time	14:00
Venue	DULT, Bangalore
Attendees	Chaired By: Ms. Manjual I.A.S, Commissioner, DULT Attendees: Member form DULT Members from BDA Consultant of BDA (STUP) JICA Study Team: 1. Mr. Kondo 2. Mr.Narayan
Used Material	Power Point Slide for Concept of Toll Management System and Required Coordination Between Civil and ITS for PRR

Meeting Record

< Discussion Topic >

JICA Study Team made presentation on:

1. Required Coordination between Civil Team and ITS Team for PRR Construction.
2. Outline of Toll Management System (TMS) for PRR

< Summary of the Meeting>

- DULT and BDA understood the close coordination between civil team and ITS team is indispensable. For example, the cable duct and junction box will be constructed by civil contractor. The installation of optical fibre cable (OFC) and power cable for ITS equipment is under the scope of ITS contractor. In this case, if the cable duct and junction box are not properly constructed, the reconstruction will be required.
- DULT and BDA suggested that all government vehicles are exempted from toll collection and included in the 'exemption list of toll collection', same as traffic police car, patrol car, and etc.
- DULT enquired whether Automatic Vehicle Classification (AVC) and Camera are required to install at both entry and exit toll gates. JICA Study Team explained that AVC is required at both gates. The reasons are (i) a distance base toll fare will be applied to PRR. The toll fare differs by vehicle type. Thus the vehicle type needs to be correctly identified at both entry and exit gates (This is for manual, T&G and ETC), and (ii) For manual toll collection, the vehicle type is to be

checked by both toll collector and AVC. The toll collector may make mistake. The accuracy of AVC is not always 100%. If there are any discrepancies between the judgement made by the toll collector and result measured by AVC, a confirmation is made by the staff at centre by looking at CCTV image. The measures of (i) and (ii) are intended to minimise error and fraud act by checking at both entry and exist gates.

- JICA Study Team explained about increase in usage of ETC in Japan from commencement of ETC service to now. All attendants understood that the applying discount for ETC user was a major reason that almost 90% of usage of ETC has been achieved.
- JICA Study Team explained the estimated usage ratio of smartcard and ETC for PRR from 2010 to 2025 as presented PPT. DULT pointed out that it should be higher than the presented estimation. JICA Study Team explained that considering the price of OBU which is approx. USD 40, the usage of ETC may not significantly increase unless such measures as discount service exclusively for ETC users, and etc. are provided. DULT understood the view of JICA Study Team. The following ideas were agreed to handle increasing ETC users in the future:
  - ✓ Unifying the width of all toll lanes
  - ✓ Unifying the length of all toll lanes

    These arrangements make it possible that the toll lanes initially used for manual and T&G will be used for ETC in the future as required by installing associated equipment for ETC on the toll lanes with minimum re-constructions.
- The participants of Indian side mentioned that the toll fare shall be collected at entrance gate due to concern that there are drivers who do not carry enough money. JICA Study Team raised importance that the toll fare is collected at exit gate, otherwise the queue occurs at the entrance gate. All participants agreed that this issue is left pending (to be further considered by Indian side).

Appendix - 6

Meeting Handout

THE MASTER PLAN STUDY ON THE INTRODUCTION OF INTELLIGENT TRANSPORT SYSTEM (ITS) IN BENGALURU AND MYSORE

- Identification of current traffic situation and Issues -



JICA Study Team
Ryuichi OIKAWA (M.A., P.E.)

 (Source: JICA Study Team)

Contents

 (Source: JICA Study Team)

1. Challenges of Urban Land Transportation in Bangalore

Bangalore Metropolitan

- Global Mega City with 10 million population
- Major Hub for IT industry – The Silicon Valley of India
- Capital of Economic and Socio-Culture in the state of Karnataka
- Main hub for strategizing and merchandising in South India

Major Challenges in ULT

- Efficient and comfortable transport
- Safe and secure transport
- Clean and CO2- emission reduced transport

Basic Ideas for achievement

- Promotion of shifting to public transportation
- Maximum utilization of road infrastructure
- Intelligent use of comprehensive transport systems

The challenges of urban land transportation must be achieved for sustainable economic growth and socio-cultural development.

Intelligent Transport Systems is the Key System

(Source: JICA Study Team)

2. Identification of Current Traffic situation and Issues

2-1. Observed Issues in Transportation Sector in Bangalore

- ✓ Rapid growth of urban population and vehicles
- ✓ High proportion of motorcycle and heterogeneous traffic composition, heavy traffic volume, chronic traffic congestion.
- ✓ Many one way roads which cause complexity for road users
- ✓ Insufficient connectivity between different transport mode
- ✓ Large proportion of road transport mode usage
- ✓ Many level-crossing of railway / Lack of public transport information
- ✓ Improper location of bus stops / High number of road traffic accidents
- ✓ Lack of road infrastructure to accommodate the traffic demand
- ✓ Improper design of junctions/intersections / No sufficient maintenance of road and systems
- ✓ Absence of data base for planning / traffic such as road inventory
- ✓ Insufficient coordination for traffic management / Lack of engineering experience
- ✓ Absence of standard No. plate and vehicle database
- ✓ Lack of facilities for vulnerable / Lack of traffic discipline

 (Source: JICA Study Team)

2. Identification of Current Traffic situation and Issues

2-2. Traffic Characteristic and Road Network Issues

Highlight Points;

✓Traffic Volume;

- Traffic concentration within area of core ring road and on specific corridors, especially that connects to major industrial area such as NH4-Thumkur Rd. to Peenya Industrial area, NH4-Old Madras Rd. to White Filed, NH7-Hosur Rd. to Electronic city.
- Over V/C=2.0 in peak hour on the road in center city.
- Chronic Congestion in daytime (8:00-20:00).

✓Travel speed and Main observed bottlenecks;

- Congestion at the intersection. Traffic jam length of over 2km
- Average travel speed : 15km/h (In of ORR), 30km/h (Out of ORR)
- Decreased function of the major arterial road

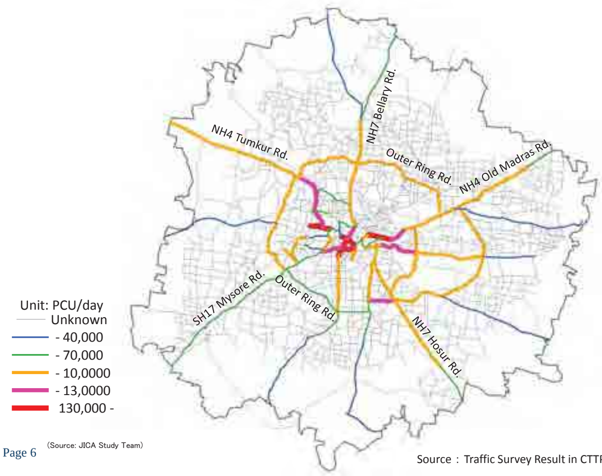
One key point of Planning;

✓ The performance up of main arterial roads is the pressing issues

 (Source: JICA Study Team)

2. Identification of Current Traffic situation and Issues

2-3. Daily Traffic Volume (24hr)

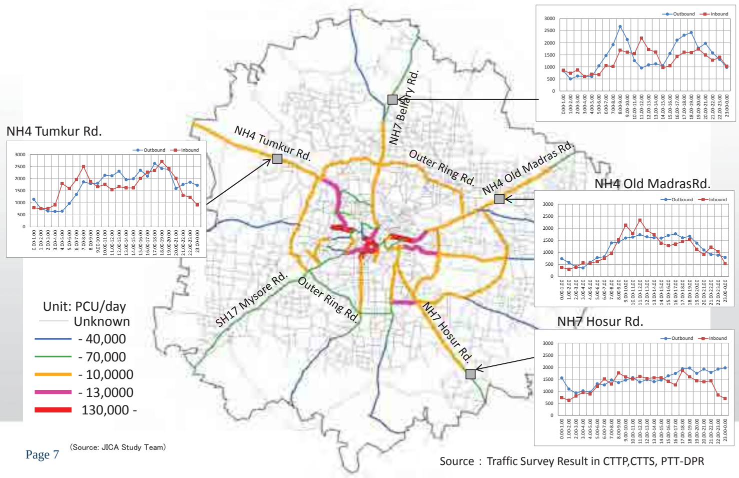


Source：Traffic Survey Result in CTTP,CTTS, PTT-DPR

 (Source: JICA Study Team)

2. Identification of Current Traffic situation and Issues

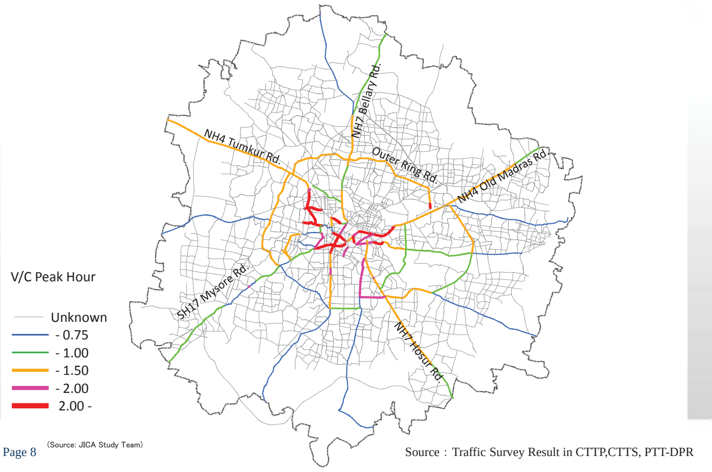
2-3. Daily Traffic Volume (24hr)



Source : Traffic Survey Result in CTTP,CTTS, PTT-DPR

2. Identification of Current Traffic situation and Issues

2-4. V/C in Peak Hour

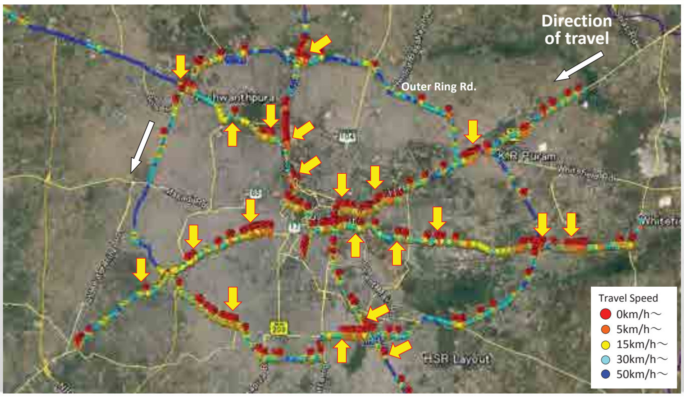


Source : Traffic Survey Result in CTTP,CTTS, PTT-DPR

2. Identification of Current Traffic situation and Issues

2-5. Travel Speed and Major Bottleneck on Main Corridors

➢ **Overall result of travel speed survey; Peak hour, Inbound-**



2. Identification of Current Traffic situation and Issues

2-6. Travel Speed and Major Bottleneck on Main Corridors

➢ **NH4 Old Madras Road -Morning Peak Hour, Inbound-**

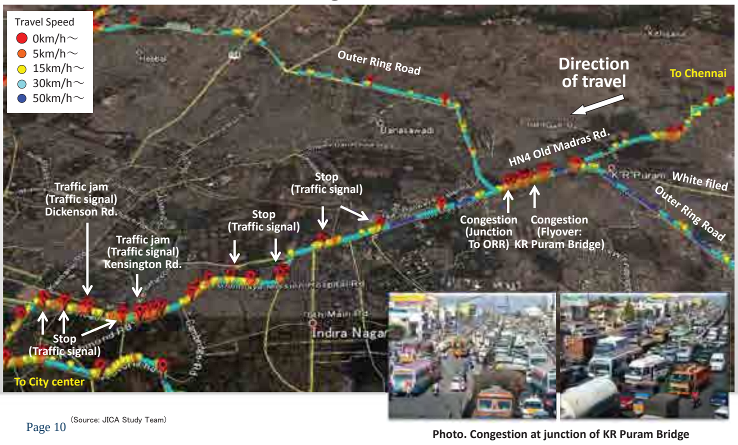
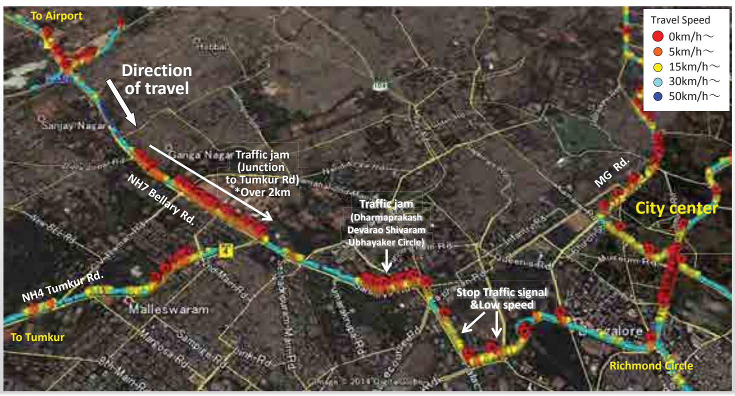


Photo. Congestion at junction of KR Puram Bridge

2. Identification of Current Traffic situation and Issues

2-7. Travel Speed and Major Bottleneck on Main Corridors

➢ **NH7 Bellary Road -Morning Peak Hour, Inbound-**



2. Identification of Current Traffic situation and Issues

2-2. Traffic Characteristic and Road Network Issues

Highlight Points;

✓Traffic Volume;

- ➢ Traffic concentration within area of core ring road and on specific corridors, especially that connects to major industrial area such as NH4-Thumkur Rd. to Peenya Industrial area, NH4-Old Madras Rd. to White Filed, NH7-Hosur Rd. to Electronic city.
- ➢ Over V/C=2.0 in peak hour on the road in center city.
- ➢ Chronic Congestion in daytime (8:00-20:00). No clear directionality.

✓Travel speed and Main observed bottlenecks;

- ➢ Congestion at the intersection of the major road: Traffic jam length of over 2km
- ➢ Average travel speed : 15km/h (In of ORR), 30km/h (Out of ORR)
- ➢ Decreased function of the major radial road

✓Issues;

- ➢ Traffic demand and capacity, Urban structure and road network, Road structure, Traffic management, Traffic signal, Road capacity・・・.

One key point of Planning;

✓ The performance up of main radial roads is the pressing issues

3. Future Perspective of Transportation in Bangalore

3-1. Exponential urbanization and motorization

Highlight Points;

✓ Rapid Expanding of urbanization and urban sprawl.

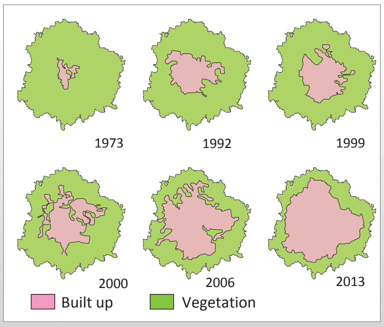


Fig . Progression of Urbanization and Sprawl

Fig . Land Use Plan (Bangalore Master Plan 2015)

 (Source: JICA Study Team)

3. Future Perspective of Transportation in Bangalore

3-2. Exponential urbanization and motorization

Highlight Points;

✓ Exponential population growth including with the social increase from other state and overseas.

✓ Rapid growth of registration vehicle in 4 times for the population growth.

✓ Clear growth of travel demand

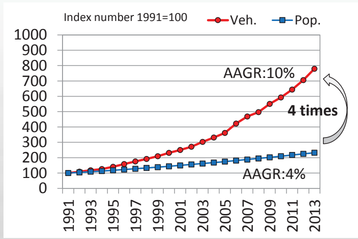


Fig. Growth of Population and Number of Vehicle

*Wheelers included

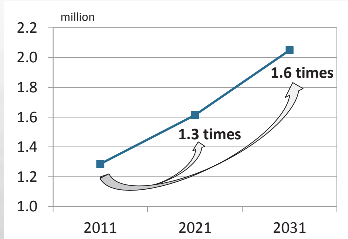
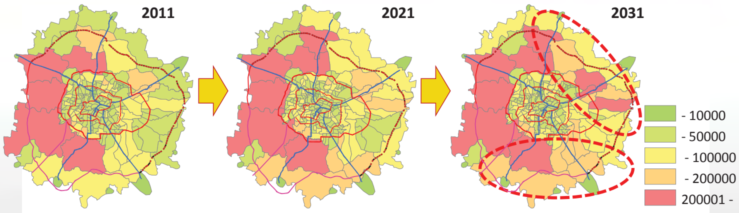


Fig. Growth of travel demand

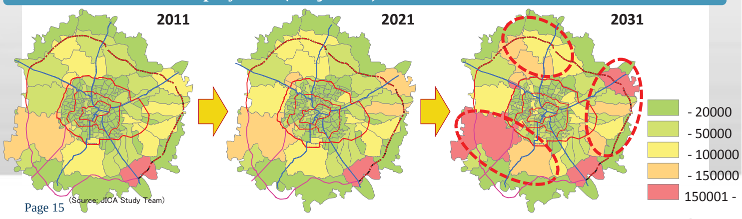
 (Source: JICA Study Team)

3. Future Perspective of Transportation in Bangalore

3-3. Distribution of Population (Projection)



3-3. Distribution of Employment (Projection)

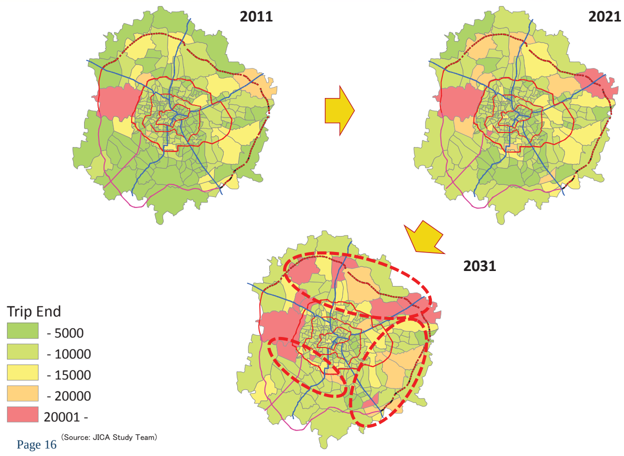


 (Source: JICA Study Team)

Source：JICA Study team

3. Future Perspective of Transportation in Bangalore

3-4. Generation / Attraction Trip Demand (Projection)

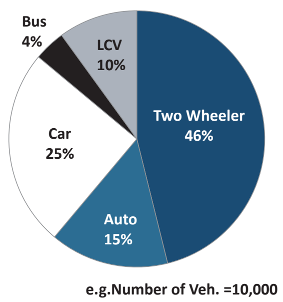


 (Source: JICA Study Team)

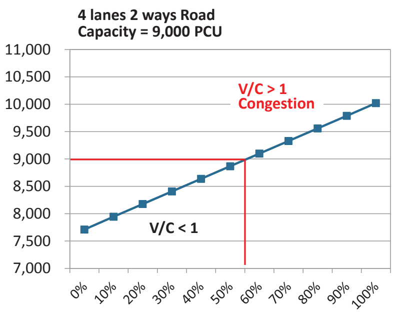
Source：JICA Study team

3. Future Perspective of Transportation in Bangalore

3-4. Sift from 2 Wheelr to Car and PCU: Passenger Car Unit



Mode share in Typical Road Section



Sift Ratio from 2 Wheeler to Car and PCU

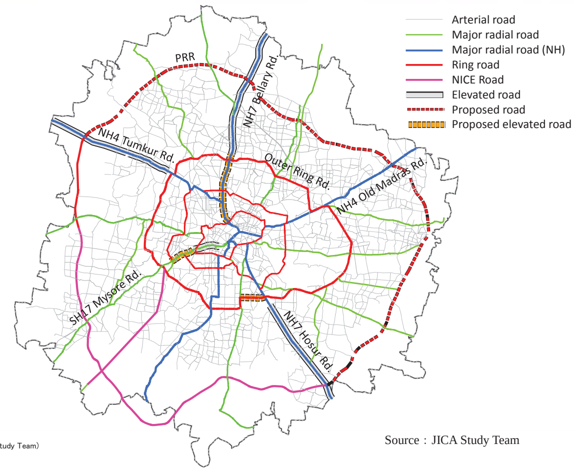
*Car=1.0 pcu, Two Wheelr=0.5pcu

 (Source: JICA Study Team)

Source：JICA Study team

3. Future Perspective of Transportation in Bangalore

3-5. Existing and Future Road Network (2020)

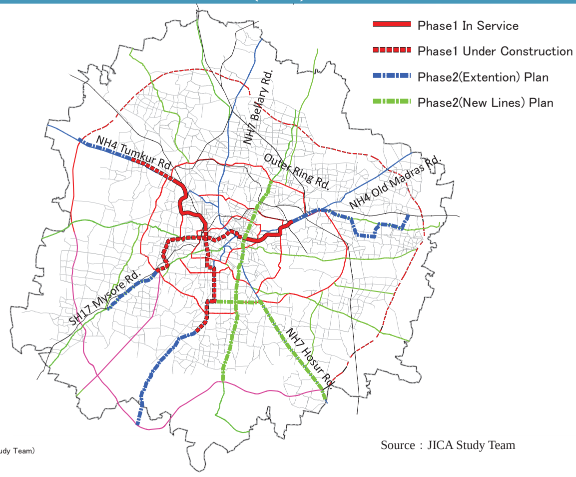


 (Source: JICA Study Team)

Source：JICA Study Team

3. Future Perspective of Transportation in Bangalore

3-6. Existing and Future Metro Network (2020)



Source : JICA Study Team

4. Requirements to ITS

Issues of Demand

•Decreased performance of the major radial road and traffic concentration to city center
•Clear Rapid expanding of urbanization (Land Use, Population, Business…) and Traffic growth
•Demand increasing along the major radial road, suburban area

Issues of Supply : Infrastructure development

•PRR project and some elevated road project in city center
•Difficulty of development road in central city
•Metro project in development stage

Basic Ideas for measures

1. Promotion of shifting to public transportation
2. Maximum utilization of road infrastructure
3. Intelligent use of comprehensive transport systems

Requirements to ITS

- Information providing
- Demand management
- Traffic Control
- Seamless mode
- Collection data for proper planning &monitoring

Next Step

- Analysis of current road traffic and Issues
- Traffic demand fore cast. Target year 2020
- Impact analysis by ITS implementation

Elaboration of ITS Master Plan

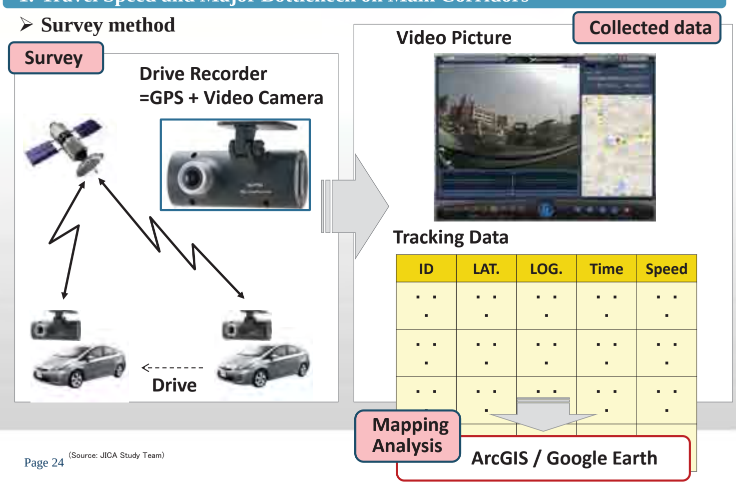
- Strategy / Basic ideas
- ITS Menu and component
- Priority area or road

Appendix

Identification of Current Traffic situation and Issues

1. Travel Speed and Major Bottleneck on Main Corridors

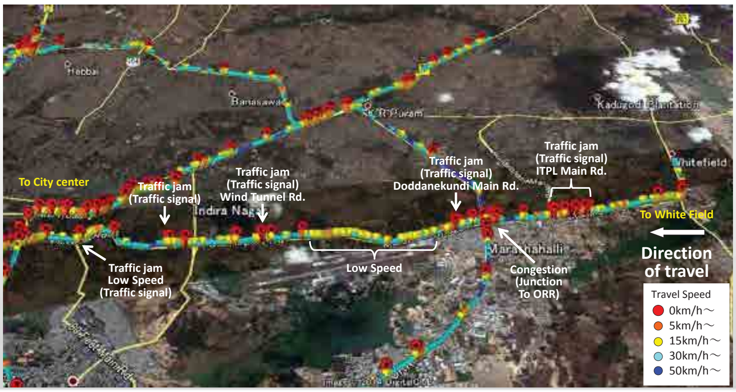
➢ Survey method



Identification of Current Traffic situation and Issues

1. Travel Speed and Major Bottleneck on Main Corridors

➢ Old Airport Road -Morning Peak Hour, Inbound-

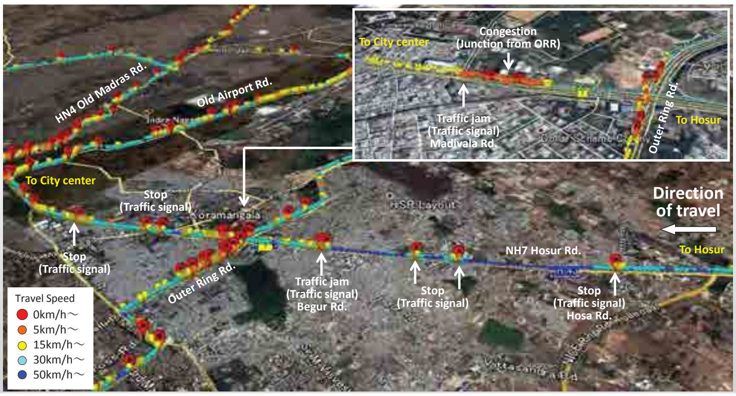


 (Source: JICA Study Team)

Identification of Current Traffic situation and Issues

1. Travel Speed and Major Bottleneck on Main Corridors

➢ NH7 Hosur Road -Morning Peak Hour, Inbound-

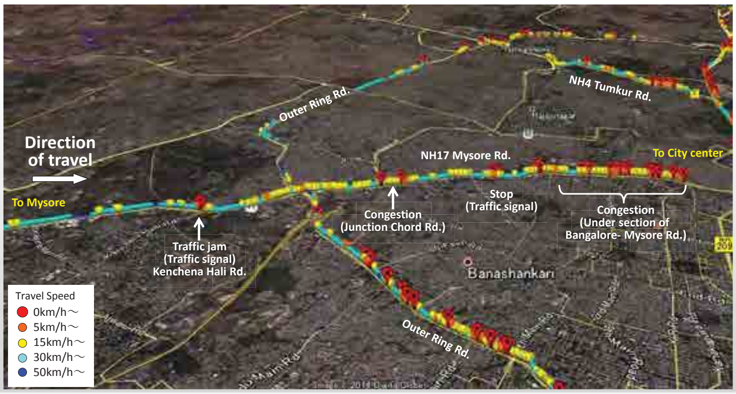


 (Source: JICA Study Team)

Identification of Current Traffic situation and Issues

1. Travel Speed and Major Bottleneck on Main Corridors

➢ NH17 Mysore Road -Morning Peak Hour, Inbound-



 (Source: JICA Study Team)

Identification of Current Traffic situation and Issues

1. Travel Speed and Major Bottleneck on Main Corridors

➢ NH4 Tumkur Road -Morning Peak Hour, Inbound-

 (Source: JICA Study Team)

Identification of Current Traffic situation and Issues

1. Travel Speed and Major Bottleneck on Main Corridors

➢ NH17 Bellary Road -Morning Peak Hour, Inbound-

 (Source: JICA Study Team)