

ITS IN AHMEDABAD

TRAFFIC IMPACT STUDY REPORT

TRAFFIC IMPACT STUDY
FOR
IMPLEMENTATION OF INTELLIGENT TRANSPORTATION SYSTEM
IN THE CITY OF AHMEDABAD, INDIA

June 2015

Prepared for:
Zero Sum Ltd., Japan

Prepared by:
Radix Project Management Pvt. Ltd.

Research Team:
Harsh Doshi
Yagnesh Dave
Mo. Wasim Sayyed

Table of Contents

1. Introduction	1
System Architecture	4
Deployment Plan for ITS System.....	8
Literature Review	8
2. Pre-Implementation Surveys.....	17
Existing Conditions.....	17
Route Choice Survey	18
User Perception Survey:.....	28
Travel Time and Speed Analysis	30
3 Knowledge Based Expert System.....	33
Knowledge acquisition:	33
Knowledge elucidation:	34
Knowledge representation:	35
Implementation:.....	37
4. Post Implementation Surveys	39
General.....	39
Route Choice & User Satisfaction Survey	39
User Satisfaction Survey:.....	44
Travel Time and Speed Analysis	45
4. Conclusions	48
Faster Data Collection, Analysis & Reporting	48
Higher Mobility.....	49
Higher Reliability	51
Cost Benefit Analysis	54
Road User Response to the System	63
Summary & Future Scope of Work.....	64

List of Tables

Table 1 Route Choice Survey Dates	19
Table 2 Route Choice Survey Sample Size	19
Table 3 Traffic Analysis Zones	20
Table 4 Route Choice Survey Pattern at EIB-1.....	23
Table 5 Route Choice Survey Result Summary at EIB-1	24
Table 6 Route Choice Survey Pattern at EIB-2.....	25
Table 7 Route Choice Survey Result Summary at EIB-2	25
Table 8 Route Choice Survey Pattern at EIB-3.....	26
Table 9 Route Choice Survey Result Summary at EIB-3	26
Table 10 Route Choice Survey Pattern at EIB-4	27
Table 11 Route Choice Survey Result Summary at EIB-4	27
Table 12 Summary of Frequency of Trips at All EIB Locations	28
Table 13 Summary of Purpose of Trips at All EIB Locations.....	29
Table 14 Summary of Willingness to Use Alternate Route Survey at All EIB Locations.....	29
Table 15 Summary of User Perception on Usefulness of ITS at All EIB Locations	29
Table 16 Summary of Preferred Medium of Display at All EIB Locations	30
Table 17 List of Routes for Travel Time and Speed Analysis.....	30
Table 18 Summary of Average Speed and Travel Times (Pre-Implementation)	31
Table 19 Knowledge Acquisition Duration	33
Table 20 Summary of Traffic Parameters at Different Camera Locations.....	34
Table 21 Governing Rules for Camera Sensors	36
Table 22 Applicable Camera List for Alternate Routes at Each EIB Location.....	37
Table 23 Route Choice Survey Dates (Post Implementation Stage)	40
Table 24 Route Choice Survey Sample Size (Post Implementation)	40
Table 25 Route Choice Survey Pattern at EIB-1 (Post Implementation).....	42
Table 26 Route Choice Survey Pattern at EIB-2 (Post Implementation).....	42
Table 27 Route Choice Survey Pattern at EIB-3 (Post Implementation).....	43
Table 28 Route Choice Survey Pattern at EIB-4 (Post Implementation).....	44
Table 29 Survey Result for Use of ATIS in taking Alternate Route	44
Table 30 Survey Result for Satisfaction with ATIS System	45
Table 31 List of Routes for Travel Time and Speed Analysis.....	45
Table 32 Summary of Average Speed and Travel Times (Post-Implementation).....	46
Table 33 Summary of Traffic Parameters at Different Camera Locations.....	48
Table 34 Comparison of Average Speed and Travel Times (Pre & Post Implementation Stages)	49
Table 35 User Perception Survey Results from Pre-Implementation Stage	63
Table 36 User Satisfaction Survey Results from Post-Implementation Stage	63
Table 37 Willingness to use Survey Results from Pre-Implementation Stage	64
Table 38 Use of ATIS to Select Alternate Route in Post Implementation Stage.....	64

List of Figures

Figure 1: ITS Implementation Area in the City of Ahmedabad	3
Figure 2: Zoning Map for Origin Destination and Route Choice Survey	22

1. Introduction

Intelligent Transportation Systems (ITS) improves transportation safety and mobility and enhances productivity through the use of advanced communications technologies. ITS technologies enable data collection, derive logical conclusions (“intelligence”) from the collected data and disseminate the information timely to traffic controllers and road-users. Typically ITS integrates:

- Information
- Vehicles; &
- Infrastructure

ITS can help in improving road safety, traffic operations, energy efficiency, environment and thus enhances economic productivity. Interest in ITS comes from the problems caused by traffic congestion, primarily on urban streets and arterials. With the availability of advanced data collection, simulation technologies as well as information processing and dissemination technologies, it became possible to optimize traffic operations without increasing the capacity of urban streets. Typically ITS is used to improve a performance measure without adding capacity to the transportation system.

ITS applications are divided into 16 types of technology based systems by the United States Department of Transportation. These are grouped in to two categories:

Categories	ITS Applications
Intelligent Infrastructure	<ul style="list-style-type: none"> ➤ Arterial Management ➤ Freeway Management ➤ Transit Management ➤ Incident Management ➤ Emergency Management ➤ Traveler Information ➤ Information Management

- Crash Prevention & Safety
- Electronic Payment & Pricing
- Roadway Operations & Maintenance
- Road Weather Management
- Commercial Vehicle Operations
- Intermodal Freight

Intelligent Vehicles

- Driver Assistance Systems
- Collision Avoidance Systems
- Collision Notification Systems

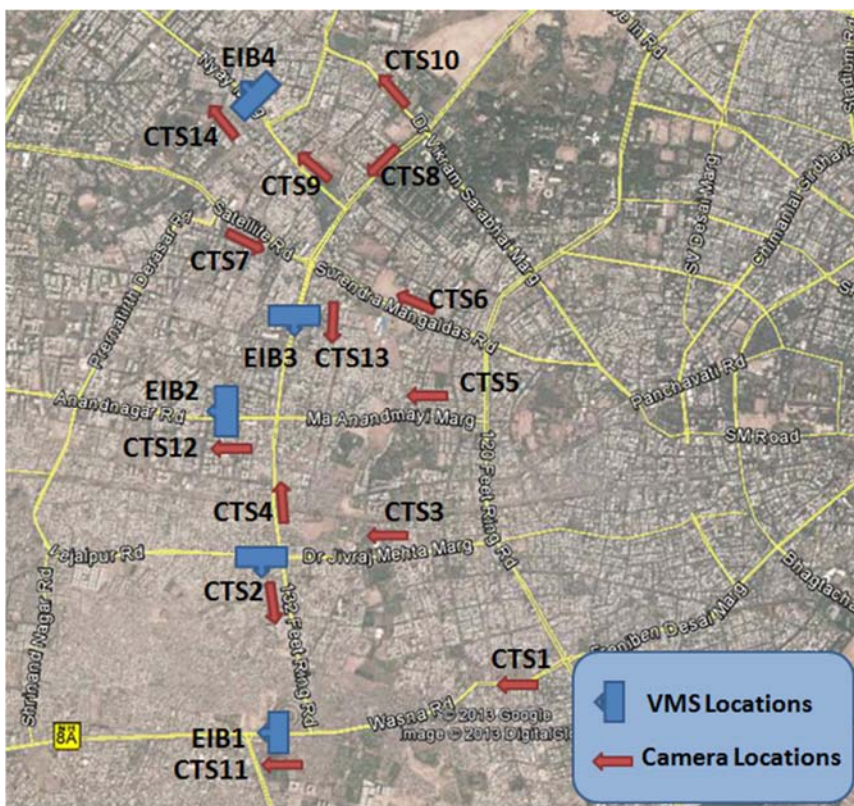
The development of ITS technologies in India is carried out by CDAC, Thiruvananthapuram (nodal agency, Department of Information Technology) in collaboration with IITs and IIMs. Currently work is being carried out on 8 sub-projects shown in the following table:

Project	Likely End User
Wireless Traffic Control System	Local Authorities & Law Enforcement Agencies
Second Generation ATCS (Area Traffic Control System)	Local Authorities in Medium and Large Cities
Real Time Traffic Counting & Monitoring	Traffic Planner/Engineers & Development Authorities
Intelligent Parking Lot Management System	Town Planners & Local Authorities
Advanced Travelers' Information System	Road Users & Traffic Planners/Engineers
Intelligent Transit Trip Planner and Real-time Route Information	Road Users & Traffic Planners/Engineers

Red Light Violation Detection System	Law Enforcement Agencies
Intelligent Traffic Congestion Management System using RFID	Traffic Planner/Engineers & Development Authorities

Zero-Sum Ltd. Japan, who are an experienced wireless communication company of 10 years standing intend to implement a robust ITS system for the City of Ahmedabad. However before embarking upon a full fledge project it proposes to install ITS system on a Trial Basis in the City of Ahmedabad. The system includes provision of Advanced Traveler Information System (ATIS), by providing 14 traffic camera sensors and 4 variable message sign boards on 132' Ring Road. The site locations are shown in **Figure 1**.

Figure 1: ITS Implementation Area in the City of Ahmedabad



An Advanced Traveler Information System (ATIS) implementation is intended to reduce the travel time and delays in a network by optimizing traffic flow on various links. For the evaluation of the ATIS implementation, a thorough impact analysis needs to be carried out. An impact analysis for an ATIS system is typically done by comparing various performance measures before and after implementation of the ATIS system. Such a study is typically carried out in following stages.

- Literature review
- Surveys , Pre and Post Implementations
- Analysis of Survey data
- Conclusion

This section of the report (Pre-Implementation studies) identifies existing traffic conditions both in qualitative and quantitative terms to assess benefits of the proposed AITS system. The section starts with proposed system architecture and identification of performance measures which are monitored and compared in pre - & post – implementation scenarios to assess the impact of ATIS system. System architecture is necessary to be defined prior to implementation to enable smooth coordination amongst various stake holders.

System Architecture

For the proposed project, wherein no additional capacity is being introduced in the road network, the idea is to optimize traffic flow along available alternate routes. The design of such systems is usually based on the performance measure which is to be optimized. Typically the following performance measures are used to evaluate performance of ITS:

- Improved & Faster Data Collection
- Greater Mobility
- Greater Reliability
- Road Safety
- Faster Information Dissemination

- Reduction in Operations and Maintenance Cost
- Improvement in Air Quality etc.

For the current project, the Consultants propose the following performance measures for ITS system

- Faster Data Collection, Analysis & Reporting
- Higher Mobility
- Greater Reliability
- Reduction in Travel Time for 132' Ring Road

To implement the ITS application for the above-mentioned performance measures, an ITS architecture should be developed. ITS architecture means a framework for ensuring institutional agreements and technical integration for implementation of ITS applications or group of applications. Since a National ITS Architecture is not developed in India, the architecture presented in this section, is based on literature reviews and best management principles.

Identification of Stakeholders

It is important to identify stakeholders (other than Zero-Sum Ltd., Japan) as the architecture will represent how the ITS applications / systems that the stakeholders operate are linked with each other. The following stakeholders are identified for this project:

Stakeholder Name	Description
Road Agencies	<ul style="list-style-type: none"> ➤ Ahmedabad Municipal Corporation ➤ National Highway Authority of India ➤ R&B Department, Government of Gujarat
Public Safety Agencies	<ul style="list-style-type: none"> ➤ Ahmedabad City Traffic Police ➤ Emergency/Medical (108 Service)

- Transit Operators
- Ahmedabad Municipal Transport Service
 - Agency implementing proposed Metro Link
- State Motor Carrier Agencies
- Regional Transport Offices

Operational Concept

An operational concept identifies proposed ITS applications (from the 16 applications defined above) and future roles of each stakeholder in the operation of the ITS system. The following components are identified for implementation of ITS in Ahmedabad:

ITS Application	Description
Data Management	Applications that provide surveillance of the Network (traffic information), manages traffic and disseminates information to road users
Arterial Management	Systems that monitor Arterial traffic flow, provides strategies such as lane access control to improve the traffic flow etc. Also includes systems to provide information to road users
Advanced Traveler Information System (ATIS)	Systems that provide static and real-time transportation information to road users.

The following table identifies ITS applications, stakeholders and their role/responsibilities:

ITS Application	Stakeholder	Role / Responsibility
Data Management	Traffic Police, AMC, Zero-Sum	<ul style="list-style-type: none"> ➤ Collect data using road-side devices ➤ Process & Verify the collected data ➤ Information Dissemination
Arterial Management	Traffic Police, AMC, Zero-Sum	<ul style="list-style-type: none"> ➤ Monitor Traffic Conditions ➤ Operate Traffic Operation Devices like Variable Message Signs (VMS), etc.
Advanced Traveler Information System (ATIS)	Traffic Police, Zero-Sum	<ul style="list-style-type: none"> ➤ Information dissemination through devices like variable VMS etc.

Further, all stakeholders are responsible to maintain ITS Inventory under their jurisdiction / operation.

Application Development

For development of various ITS applications, it is essential to define systems which provides an accessible and service-oriented perspective to the defined architecture. The systems can work in stand-alone mode or in combination with other applications to address project objectives of optimizing performance measures. These packages identify the components of the architecture that are to be implemented.

Traffic Detection

This includes a traffic management sub-system, from where communication is done with field detectors, and ancillary equipments. In the current deployment, the detectors proposed are traffic camera with mobile communication link to gather information on traffic flow and traffic characteristics. The data generated by these detectors is transferred to a cloud server and thereby to traffic management center. This helps traffic engineers/managers to monitor traffic and identify road conditions, unusual traffic flows, incidents and crashes and collect traffic counts for future planning.

Traffic Information Dissemination

It provides road-users with information on traffic and weather conditions using Variable Message Signs, and in future through cellular data broadcasts (SMS) and internet webcasts. The information that can be disseminated is of wide range like:

Dynamic Information: Traffic, Road & Weather Conditions; Work Zone advisory; incident advisory; emergency advisory etc.

Static Information: Road Safety slogans; driver advisories etc.

Deployment Plan for ITS System

A draft deployment plan for ITS along 132' Ring Road in Ahmedabad is prepared based on the above architecture and permissions as obtained by Zero-Sum Ltd., from various stake holders of the project. The schematic layout of the map is shown in Figure 1.

Prior to the finalization of deployment plan for ITS, a literature study was carried out to summarize experiences with implementation of similar ITS systems around the world. The following section highlights important "lessons learnt" from implementation of various ITS system components around the world:

Literature Review

Under this section, we have studied

Data Management

Case Study 1: Traffic Detectors along Freeways

In **Denmark**, real-time traffic data are available for the motorway network around Copenhagen. Sensors have been placed over approximately 125 km of the Copenhagen motorway network, mostly in connection with **exits and entries** to the motorway. These detectors register the number of vehicles, the type of vehicle (lorry or car), and the speed at which the vehicle travels.

Benefits of System:

- On the basis of the data collected, the system is able to determine the traffic situation on a given section of motorway.

Lessons Learnt:

- The study shows that data collection through detectors is being used on a certain expressway in Denmark and the system is successful in determining traffic situation a section of the expressway.
- Further, the study also highlights that detectors were placed at exits and entries to the motorway. However, a sound and accurate algorithm should be used to develop inferences from the collected data. Otherwise, a wrong inference may have adverse effects on the performance of the system.

Case Study 2: Traffic Detectors

The **Washington State Department of Transportation, USA** installed a traffic detection system to improve traffic flow and reduce delay at two busy junctions. The system consisted of traffic cameras mounted on existing traffic signal support structures as detectors. Traffic engineers were able to monitor traffic conditions and reduce signal delays by adjusting signal timing at each junction.

Benefits of System:

- Identify or confirm the incidents and abnormal road conditions
- Useful information to road users.

Lessons Learnt:

- Even though the application is not along an expressway, visual data of the road can help traffic engineers to draw logical inferences about traffic on the expressways to optimize a performance measure.

Case Study 3: Weather management (General Weather Information)

In a **Washington State Department of Transportation, USA** general travelers were surveyed, 94 percent agreed or strongly agreed that weather information made travelers better prepared for their trips. More than half agreed the information helped them avoid travel delays.

Lessons Learnt:

- Weather information system, if easily accessible, helps daily commuters to plan their trip to avoid inclement weather.
- Further, the system will be useful only if accurate hourly weather information is available. It may not be possible to deduce such information without the help of Meteorological department.

Case Study 4: Weather management (Wind Detection)

Oregon, USA: Automated wind warning systems were installed at two rural Oregon locations to alert motorists of high crosswind conditions. Message signs are located at each end of the corridor or bridge where motorists can decide to wait until the winds die down or to take a longer alternative route. The systems, which are similar, consist of a local wind gauge (anemometer) with continuous input to a flashing beacon on a static message sign. Communication to the warning signs is automated and is provided by using dialup phone service. The warning signs are activated when average wind speeds reach a predetermined threshold. The severity is automatically recorded. Once verified by staff at the transportation management center, a warning message is posted to the Oregon DOT Trip Check Web site. The signs are deactivated when the wind speed drops below the threshold.

Lessons Learnt:

- Weather information system, if easily accessible, helps commuters to plan their trip to avoid inclement weather or drive with access caution.

Case Study 5: ATIS: Highway Advisory Radio

In a **Washington State Department of Transportation, USA** sponsored survey of commercial vehicle operation companies, 57 percent of respondents said the availability of the new highway advisory radio (HAR) system made them somewhat or a lot safer. Of those interviewed during the post-deployment period, 56 percent indicated they tuned in to one or both of the HAR stations while traveling in the area, and 51 percent found the HAR messages useful. General travelers were also surveyed, and 94 percent agreed or strongly agreed that the website road weather information made travelers better prepared for their trips. More than half agreed the information helped them avoid travel delays.

Benefits of System / Lessons Learnt:

- Useful information to road users.

Case Study 6: ATIS: Webcasts

Pennsylvania, USA: An Internet survey of users of traveler information websites in Philadelphia and Pittsburgh, Pennsylvania, found that 86% of users in Philadelphia and 68% of users in Pittsburgh had changed their original travel route for at least one of their trips based on information received.

Benefits of System / Lessons Learnt:

- Useful information to road users.

Case Study 7: ATIS: Variable Message Signs

Malaysia: The MRR1 freeway area in Kuala Lumpur studied the accuracy of VMS display travel time estimates, and driver response to display messages of varying lengths and formatting. Results show that usage of variable message signs reduces the average travel times during the duration of the incident until the clearing of the resulting congestion by a significant amount. Under the presence of VMS, there is a significant shift of people from higher travel times in case of incident to lower travel times.

Lessons Learnt:

- VMS are most effective when there are alternate routes available to road users, otherwise the information may not be of much use to the road users.

Traffic Management

Case Study 1: Incident Management

In the **United States**, The Vehicle Probe Project (VPP) has been providing data the member agencies since 2008. The agencies have recognized the benefits of VPP data to their respective departments of transportation, traffic management centers, and the public they serve.

During a surprise snowstorm in October 2008, the New Jersey Department of Transportation (NJDOT) Traffic Operations Center was reviewing an accident on Interstate – 80 (expressway) via a closed circuit television (CCTV) camera. The VPP monitoring site identified a second incident where CCTV coverage was not available that involved multiple jack-knifed tractor-trailers along I-80. The knowledge gained from the VPP about the second incident enabled responders to attend to the second incident by as much as an hour than what would be possible without the VPP. The expedited response to the second incident translated into an estimated \$100,000 savings in user delay costs.

Lessons Learnt:

- A vehicle probe may simply be a patrol vehicle equipped with camera and transmission devices. Such vehicles may be very effective in sending real-time incident data to the traffic management center, thereby reducing the response time to incidents.

Law Enforcement

Case Study 1: Enforcement: Variable Message Signs

Colorado, USA: The Rural ITS Toolbox noted a relatively low-tech approach that was used by Colorado DOT to address high speed trucks in mountainous terrain. Colorado DOT has many highways that run through the mountains and have high truck traffic. The Colorado DOT's experience reveals the following with regard to reducing truck speeds on dangerous curves. Consider using simple radar speed detection devices in combination with dynamic message signs (DMS). To convey to truck drivers their current speed and to warn them of impending curves ahead that cannot be safely negotiated at their current speed, use simple radar speed detection devices in combination with DMS. The relatively low-cost system has seen dramatic results. Speed studies conducted before and after the system was installed revealed a reduction in 85th percentile truck speed from 66 to 48 mi/h.

Benefits of System:

- Pre-trip information,
- On-trip Driver information,
- Personal Information Services,
- Route Guidance and Navigation
- Variable message signs have greater impact on road safety avoiding incidents, traffic congestion etc.

Lessons Learnt:

- In India, education and enforcement are essential for proper utilization of the advisory information provided through VMS.
- A simple ITS application can be developed using different system components to address specific issues. For example, a speed indicator device and High Resolution CCTV Camera can be used to take pictures of over-speeding vehicles on expressway.

Case Study 2: Enforcement: Speed Indicator Devices

London, UK: Britain's M25 motorway, which circumnavigates London. On the most heavily-traveled 14-mile (23 km) section (junction 10 to 16) of the M25 variable speed limits combined with automated enforcement have been in force since 1995. Initial results indicated savings in journey times, smoother-flowing traffic, and a fall in the number of accidents, so the implementation was made permanent in 1997. Further trials on the M25 have been thus far proved inconclusive.

Speed management is a key theme in London's Road Safety Plan 2001 (Transport for London, 2001). In 2006, a third of killed or seriously injured (KSI) casualties in London were caused by collisions where excessive or inappropriate speeds were recorded as contributing to the collision. Reducing vehicle speeds in London is therefore an important issue. The final 11 sites were then selected so that they were all 30mph sections of two-way single carriageway roads with no traffic calming, speed cameras, red light cameras, major junctions, sharp bends and no or few pedestrian crossings (any of these may influence drivers' speed choice). In addition, Speed Indicator Devices (SIDs) have the potential for being an additional method for reducing excessive speeds.

Benefits of System:

- An overall speed reduction of 1.4mph was detected across all sites whilst the SIDs was operational. The reduction varied between sites from 0.6mph to 2.6mph.
- The proportions of drivers exceeding 30mph and 36mph (ACPO guidelines) were significantly reduced at all sites.
- It is estimated that the overall reduction in speed would lead to a 5.6% reduction in collisions occurring in the area whilst a SID was operational.
- Reducing vehicle speeds in London is therefore an important issue in road safety that could reduce the number of road casualties in London.

2. Pre-Implementation Surveys

Existing Conditions

Existing Roadway Network

The road network in the city of Ahmedabad has many circular roads called the ring roads which are connected many radials. These radials carry traffic from different parts of the city towards the city center. A combination of these ring roads and radials gives road users multiple route options to reach their destinations. The river of Sabarmati runs from North to South and divides the city of Ahmedabad in to two parts viz. Eastern and Western part. The project road, i.e. 132' Ring Road is an important North-South arterial in the western part of the City of Ahmedabad. It originates near RTO circle and terminates at APMC junction on Ashram Road. It passes through Vadaj, Naranpura, Memnagar, Vastrapur, Satellite and Jivraj Park localities. Important Junctions along 132' Ring Road are RTO, Vadaj, AEC, Helmet Cross Road, IIM or Andhjan Cross Road, Keshavbaug Junction, Shivranjni Junction, Shyamal Junction, Jivraj Park Junction and APMC Junction.

Existing Traffic Conditions

Prior to the implementation of the ATIS system, it is essential to know existing traffic conditions. There are numerous traffic parameters which can be identified for the study, however as per the performance measures identified in the system architecture, the following traffic conditions needs to be assessed prior to the implementation of ATIS system:

- a. Origin and Destination of Traffic using 132' Ring Road
- b. Route taken to reach Destination

Further, since the ATIS system is being implemented for the first time in the City of Ahmedabad, it is necessary to identify perception of road users towards such system. As the principle aim of ATIS is to optimize traffic in a network, a willingness survey was also conducted to assess if people will use alternate route to reduce their travel times.

Lastly, travel time study was carried out within the project influence area to estimate if there are any changes in the travel times after implementation of the ATIS system.

The following sections summarizes survey results conducted to assess traffic pattern around 132' Ring Road.

Route Choice Survey

Finding a shortest route (in terms of distance and time) by taking into account all network features is a difficult task. The problem complexity increases when taking into account combination of transport modes available. There are many factors which influence choice of route, the principal ones being travel time and comfort.

The principal aim of this research is to assess how awareness of alternative route affects travelers' choice. To assess the feasibility of Advanced Traveler Information System (ATIS), it is essential to identify how many travelers are willing to take alternative routes in first place. Further, it should be noted that travelers can only choose routes of which they are aware of; hence the effectiveness of ATIS may be limited in case alternate routes are not known completely to the users.

The Route Choice Survey is carried out to understand road user's route choice behavior and to collect information about their commute. The basic aims are to

1. To identify principle flow pattern of traffic around 132' Ring Road.
2. Develop a suitable display strategy for improving drivers' route choice by providing information which is easy to understand
3. Develop base case parameters to assess if ATIS system affecting selection of road by road users to reach their destination

A survey instrument was designed as shown in **Appendix – 1**. The instrument has general questions related to their trip like origin, destination, route taken, frequency, and purpose of trip. Then the road users were explained how the ATIS system will work. The user was later asked questions on how they perceive the usefulness of ATIS will be in making an alternate route choice. Then the road users were shown two options for ATIS

display – Written and Map. The purpose was to identify how their preferable option considering the amount of time available to them in processing the information shown to taking a decision for an alternate route.

Route choice survey was done at all proposed Electronic Information Board locations. **Appendix 2** shows some photographs taken during the survey. The survey was conducted at the following dates at each EIB location:

Table 1 Route Choice Survey Dates

Location	Date of Survey
EIB – 1	23 rd September, 2014
EIB – 2	24 th September, 2014
EIB – 3	25 th September, 2014
EIB – 4	26 th September, 2014

A large number of samples were taken at each location. However, the first step in the analysis is to purge samples with incomplete data and inaccurate data. The following table summarizes the sample size taken and sample size considered in the analysis.

Table 2 Route Choice Survey Sample Size

Location	Samples Taken	Samples Considered
EIB – 1	885	729
EIB – 2	967	750
EIB – 3	1225	1000
EIB – 4	986	673

Outcome of Route Choice Survey: Origin – Destination Survey

Origin-Destination surveys have been conducted each EIB Location as a part of route choice survey to establish the traffic flow pattern around 132' Ring Road. The data collected has been analyzed to obtain the travel characteristics of the road users of

three categories – two wheelers, three wheelers and four wheelers. The desired pattern of the road users has been established on the basis of the O-D survey data and the traffic zones formulated for the same.

The survey data collected by random sampling includes interviewing of three categories of vehicles defined above. The drivers are interviewed for origin and destination, trip length, frequency and the route travelled etc. In addition the purpose of trip for passenger vehicles is also collected and analyzed.

Zoning System

The location of Origin and Destination zones has been determined in relation to each individual traffic survey station and the possibility of traffic diversion. The analysis of O-D data starts with coding of zones, i.e. categorizing the traffic with respect to its origin and destination. Each zone is designated with a unique code. These codes are termed as O-D Traffic analysis Zones (TAZ). In total, 23 zones were identified for the O-D survey analysis of the project road. The list of traffic analysis zones and respective codes are indicated in Table 3 and zoning map is enclosed at Figure 2.

Table 3 Traffic Analysis Zones

Zone Code	Zone Name
1	Narol – Aslali – Ghodasar
2	Vejalpur, Juhapura
3	Sanand – Viramgam, Ujala, Sarkhej,
4	Anandnagar
5	Iscon, Bopal, Ambli
6	Pakwan, Judges Bunglow, Sindhu Bhavan Road, Shilaj
7	Thaltej
8	Drive-in Road
9	Vastrapur, Vatrapur Lake
10	Mansi Cross Road
11	Andhjan Mandal

Zone Code	Zone Name
12	Keshavbaug
13	Shivranjni
14	Shyamal Cross Road
15	Vejalpur Cross Road
16	APMC
17	Anjali, Paldi
18	Dharnidhar Cross Road
19	Manekbaug Cross Road
20	Nehrunagar Cross Road
21	Panjrapole
22	Towards Vijay Cross Road, University Area
23	Helment Cross Road

EIB – 1 Location at APMC Market

Origin – Destination Pattern

The OD matrix at EIB-1 is shown in **Appendix – 3**. From the survey it is clear that the majority of traffic at EIB-1 (about 60%) originates from Zones 1, 2 and 3 and is bound towards Zone 17 (i.e. towards 120' Ring Road at Anjali Cross Road and further towards Paldi). The rest of the traffic takes a left turn on 132' ring road to reach other destinations. Of these about 11% of the traffic is destined towards Helmet Cross Road (Zone 23), which can be considered as through traffic for 132' Ring Road. Other major destination from APMC market is towards Zone 13 Shivranjani cross road (about 12.93%).

It should be noted that since the majority of the traffic is bound towards Anjali Cross Road, there is a high probability of diverting this traffic on 132' Ring Road and then through an alternate route to its further destinations towards and beyond Paldi area.

Route Choice Survey

The Route Choice matrix at EIB-1 is shown in **Appendix – 4**. It is apparent from the OD matrix at APMC junction that a majority of the traffic goes straight to Anjali Cross Road. In order to reduce the resulting congestion between APMC and Anjali, it is necessary to identify how many trips can be diverted to 132' Ring Road. The destination zones of interest in this case to analyze are from 18 to 23.

Further, there will be some traffic which uses a part of 132' Ring Road to reach Anjali Cross Road. This traffic is actually aware of alternate route available to reach its nearest destination.

Table 4 Route Choice Survey Pattern at EIB-1

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 23 (Helmet Circle)	11.00%	76.25%	23.75%
Zone 22 (Vijay Cross Road)	2.20%	12.50%	87.50%
Zone 20 (Nehrunagar Cross Road)	1.65%	50%	50%

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 19 (Manekbaug Cross Road)	0.83%	66.67%	33.33%
Zone 17 (Anjali Cross Road)	60.25%	11.64%	-

Table 5 Route Choice Survey Result Summary at EIB-1

Destination Zone	Traffic Already Using Alternate Route	Traffic which may be diverted
Zone 23 (Helmet Circle)		2.61%
Zone 22 (Vijay Cross Road)		1.93%
Zone 21 (Panjrapole Cross Road)		
Zone 20 (Nehrunagar Cross Road)		0.83%
Zone 19 (Manekbaug Cross Road)		0.28%
Zone 18 (Dharnidhar Cross Road)		
Zone 17 (Anjali Cross Road)	7.02%	
Total	7.02%	5.64%

EIB – 2 Location near Shyamal Junction

Origin – Destination Pattern

The OD matrix at EIB-2 is shown in **Appendix – 5**. From the survey it is clear that the majority of traffic at EIB-2 (about 61.26%) originates from Zones 4 (Anandnagar). The traffic seems to be equally divided on all three directions with Zone 14, 17, 20 and 23 having more or less equal splits of destination share. The major destination routes are thus Nehrunagar, Manekbaug and Anjali Cross Roads.

It should be noted that since the traffic is bound on three alternate routes from EIB-2, there is a high probability of diverting this traffic on an alternate route to its further destinations. For example, traffic bound towards Anjali Cross Road can use Manekbaug and traffic bound towards Nehrunagar can also use Manekbaug to reach their destination instead of using 132' Ring Road.

Route Choice Survey

The Route Choice matrix at EIB-2 is shown in **Appendix – 6**. It is apparent from the OD matrix at Shyamal junction that the traffic is equally bound towards Nehrunagar, Manekbaug and Anjali Cross Roads. Since the network flow seems to be balanced at this point, there is a high probability of diverting traffic on alternate routes in special conditions like traffic jams or accidents. In order to reduce the resulting congestion during special events, it is necessary to identify how many trips can be diverted on alternate roads.

Table 6 Route Choice Survey Pattern at EIB-2

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 23 (Helmet Circle)	10.23%	93.62%	6.38%
Zone 20 (Nehrunagar Road)	21.44%	51.78%	48.22%
Zone 17 (Paldi – Anjali Cross Road)	17.74%	41.10%	58.90%
Zone 14(Nr. Shyamal Junction)	14.80%	Trip Termination Zone	
Zone 1 (Narol, Aslali, Ghodasar)	7.73%	76.06%	23.94%

Table 7 Route Choice Survey Result Summary at EIB-2

Destination Zone	Traffic Already Using Alternate Route	Traffic which may be diverted
Zone 23 (Helmet Circle)	0.65%	9.90%
Zone 20 (Nehrunagar Road)	9.25%	12.19%
Zone 17 (Paldi – Anjali Cross Road)	8.05%	9.68%
Zone 1 (Narol, Aslali, Ghodasar)	0.44%	7.29%
Total	18.39%	38.74%

EIB – 3 Location near Shivranjani Junction

The OD matrix at EIB-2 is shown in **Appendix – 7**. From the survey it is clear that the majority of traffic at EIB-2 (about 79.42%) originates from Zones 1,4,14, 15 and 16 (Shyamal). Majority of the trips terminate in Zone 13 i.e. around Shivranjani junction (about 35.64%), while a number of trips terminate in and beyond Zone 23 (17.67%).

Route Choice Survey

The Route Choice matrix at EIB-3 is shown in **Appendix – 8**. It is apparent from the OD matrix at Shivranjani EIB Location that the traffic is equally bound towards Shivranjani, Helmet Cross Road and Nehrunagar zones. The only traffic that may be diverted is the trips terminating in Zone 23 and 20 which can use alternate routes from this location. In order to reduce the resulting congestion during special events, it is necessary to identify how many trips can be diverted on alternate roads.

Table 8 Route Choice Survey Pattern at EIB-3

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 23 (Helmet Circle)	17.67%	84.66%	15.34%
Zone 20 (Nehrunagar Road)	9.34%	17.20%	82.18%
Zone 13 (Shivranjani)	35.64%	Termination Zone	

Table 9 Route Choice Survey Result Summary at EIB-3

Destination Zone	Traffic Already Using Alternate Route	Traffic which may be diverted
Zone 23 (Helmet Circle)	2.71%	14.96%
Zone 20 (Nehrunagar Road)	1.61%%	7.73%
Zone 13 (Shivranjani)	Termination Zone	
Total	4.32%	38.74%

EIB – 4 Location at Mansi

Origin – Destination Pattern

The OD matrix at EIB-4 is shown in **Appendix – 9**. From the survey it is clear that the majority of traffic at EIB-4 (about 63.64%) originates from Zones 4 and next majority of traffic originates from Zone 7. Majority of this traffic is bound towards Zone 13 and 20 (about 34.72%) while about 26.08% traffic terminates in Zone 9 and 10. Further a healthy 6.11% traffic is bound towards zone 21 which also has a choice of alternate route at EIB 4.

Route Choice Survey

It is apparent from the OD matrix at Mansi junction that a majority of the traffic is bound towards Nehrunagar, Shivranjni and Panjrapole. In order to reduce the resulting congestion between Mansi and Keshavbaug, it is necessary to identify how many trips can be diverted away from 132' Ring Road. The destination zones of interest in this case to analyze are from 21, 13 and 20.

Table 10 Route Choice Survey Pattern at EIB-4

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using Alternate Route
Zone 21 (Panjrapole Circle)	6.11%	7.32%	92.68%
Zone 20 (Nehrunagar Road)	14.46%	100%	0%
Zone 13 (Shivranjni)	20.27%	100%	0%

Table 11 Route Choice Survey Result Summary at EIB-4

Destination Zone	Traffic Already Using Alternate Route	Traffic which may be diverted
Zone 21 (Panjrapole Circle)	5.51%	0.45%
Zone 20 (Nehrunagar Road)		

Destination Zone	Traffic Already Using Alternate Route	Traffic which may be diverted
Zone 13 (Shivranjni)		
Total	5.51%	0.45%

User Perception Survey:

Along with the origin-destination and route choice survey, a user perception survey was also conducted to identify how general road users perceive the ATIS system being installed. The perception survey captured the following aspects:

- a. Frequency of Trip
- b. Purpose of Trip
- c. Willingness to use alternate route
- d. Perception on usefulness of ATIS
- e. Medium preferred to display information on ATIS

Frequency of Trips

The users were asked *What is the frequency of your trip. (Daily, Weekly or Monthly)* at all four survey locations. Overwhelming majority of respondents answered that their frequency of trips is daily at all four EIB Locations. The following table summarizes respondent's frequency of trip:

Table 12 Summary of Frequency of Trips at All EIB Locations

Description	APMC	Shyamal	Shivranjni	Mansi
Daily	69.97%	79.46%	89.07%	92.71%
Weekly	26.86%	18.37%	8.73%	4.17%
Monthly	3.17%	2.17%	2.21%	3.13%

Purpose of Trips

The users were asked *What is the purpose of your trip. (Business, Educational, Recreational or others)* at all four survey locations. Overwhelming majority of respondents answered that their purpose of trips is business related at all four EIB Locations. The following table summarizes respondent's purpose of trip:

Table 13 Summary of Purpose of Trips at All EIB Locations

Description	APMC	Shyamal	Shivranjni	Mansi
Business	86.68%	85.33%	90.87%	92.86%
Education	4.40%	7.28%	4.91%	3.57%
Miscellaneous	8.93%	5.11%	2.31%	0.74%
Recreation		2.28%	1.91%	2.83%

Willingness to Use Alternate Route

The users were asked *Will you follow any alternate route if it saves your time even though the alternate route may be a bit longer?* at all four survey locations. Overwhelming majority of respondents answered that their purpose of trips is business related at all four EIB Locations. The following table summarizes respondent's purpose of trip:

Table 14 Summary of Willingness to Use Alternate Route Survey at All EIB Locations

Description	APMC	Shyamal	Shivranjni	Mansi
Yes	93.52%	86.63%	88.16%	84.97%
No	6.48%	13.37%	11.84%	15.03%

Perception of ATIS

The users were asked *On a scale of 1 to 10, do you think a system which provides traffic information on available alternate route help you to select alternate routes? (10 being most helpful and 1 being not at all helpful)* at all four survey locations. Overwhelming majority of respondents answered that they will find the system useful (range 8-10).

Table 15 Summary of User Perception on Usefulness of ITS at All EIB Locations

Description	APMC	Shyamal	Shivranjni	Mansi
<5 (Not Useful)	2.3%	3.2%	3.8%	1.9%
5-7	21.1%	21.6%	19.1%	13.5%
8-10 (Useful)	76.5%	75.2%	77.1%	84.5%

Medium preferred to display information on ATIS

The users were asked *Which medium do you think is easier for you to process information on alternate route (map, text or both)?* at all four survey locations.

Overwhelming majority of respondents answered that they prefer to read map at all four EIB Locations. The following table summarizes respondent's answers:

Table 16 Summary of Preferred Medium of Display at All EIB Locations

Description	APMC	Shyamal	Shivranjni	Mansi
Map	80.22%	77.72%	75.63%	80.65%
Written	19.78%	18.80%	21.87%	16.37%
Both	0.00%	3.48%	2.51%	2.98%

Travel Time and Speed Analysis

The purpose of the travel time and speed study is to evaluate the quality of traffic movement along a route and to determine the locations, types and extents of traffic delays. The efficiency of flow is measured by travel and running speeds. In the actual study, total travel and running times are observed and then converted into speed measures.

Before starting the test runs, major intersections or suitable control points were selected along the study route as reference/control locations. The project influence area was divided into seven (7) sections based on the traffic characteristics of the network. These seven sections are summarized below:

Table 17 List of Routes for Travel Time and Speed Analysis

Route 1	From Information Board 1 to Andhjan Cross Roads (132' Ring Road)
Route 2	From Information Board 1 to APMC T-Junction to Anjali Cross Roads
Route 3	From Information Board 2 to Jivraj Park Cross Roads to 120' Ring Road
Route 4	From Information Board 2 to Manek Baug Cross Roads
Route 5	From Jodhpur Cross Roads to Nehrunagar Circle
Route 6	From Mansi Cross Roads to Keshav Baug T-Junction to Andhjan Cross Roads
Route 7	From Mansi Cross Roads to Andhjan Cross Road (Via Camera 10)

Route plans are shown in **Appendix 11**.

A test vehicle is driven along the study route in accordance with moving car technique, in which, a safe level of vehicular operation is maintained by observing proper following and passing distances and by changing speed at reasonable rates of acceleration and decelerations. Delay information is recorded when the traffic flow is stopped or greatly impeded. The duration of traffic delay is measured in units of time along with notations of the corresponding location, cause and frequency of delay to travel.

The following table summarizes average speed and travel times on each of these routes during morning, afternoon and evening peak hours. Section-wise travel times and speed on each of these links are also summarized in **Appendix 12**.

Table 18 Summary of Average Speed and Travel Times (Pre-Implementation)

Route No.	Morning Peak		Afternoon Peak		Evening Peak	
	Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)
1	21.09	12.97	25.21	10.98	23.64	11.62
2	18.48	6.03	19.42	5.74	18.62	5.99
3	23.29	8.28	32.35	5.99	21.15	9.16
4	17.68	4.96	14.63	5.99	14.22	6.16
5	18.89	5.49	20.43	5.08	18.50	5.61
6	19.81	4.77	31.42	3.01	24.25	3.90
7	20.68	5.38	21.63	5.07	15.71	6.98

3 Knowledge Based Expert System

The knowledge based expert system is aimed to assess traffic scenario at any given time in the network by deriving logical inferences from traffic data available from the traffic camera sensors. This data can be used to finalize what information is to be provided to the road users based on the sensor outputs. The system is developed based in the following four steps:

Knowledge acquisition:

This step involves meeting with Traffic Police Department, review of any documents related to traffic flow available with the department as well as extrapolation of traffic data available from the traffic camera sensor. Traffic data was extrapolated from camera sensor between the following dates:

Table 19 Knowledge Acquisition Duration

Camera No.	Location	Data Analysis Period
Cam1	Nr. Anjali Cross Roads	Dec1 12:00 AM to Dec14 11:59 PM (14-days)
Cam2	TV9	
Cam3	Jivraj Road	
Cam4	Flyover	
Cam5	Manekbaug	Data Unavailable
Cam6	Shivranjni	Dec1 12:00 AM to Dec14 11:59 PM (14-days)
Cam7	Nehrunagar	
Cam8	Keshavbaug	
Cam9	IIM	
Cam10	Before IIM Flyover	
Cam11	VMS-1	
Cam12	VMS-2	
Cam13	VMS-3	
Cam14	VMS-4	

Knowledge elucidation:

This step involves processing of expert knowledge to clarify different aspects of the input acquired from the experts and other sources. The knowledge in this study is categorized to develop simple general rules that are applicable to the ATIS system, performing under various traffic and network conditions. For example, if the sensor shows zero traffic, then either there is no traffic or a small incident which is blocking traffic on the link.

The algorithm design to assess traffic conditions relies on average speed observed during 1-minute intervals. From the available raw data, speed density relations were plotted and regression lines were plotted to estimate free flow speed & Jam Density. The result is summarized in the following table:

Table 20 Summary of Traffic Parameters at Different Camera Locations

Camera No.	Location	Free Flow Speed (kmph)	Jam Density (vehicles/Km)	Speed (y) – Density (x) Equation
Cam1	Nr. Anjali Cross Roads	35.14	-	Speed = -0.1 x density +35.14
Cam2	TV9	34.74	115	speed = -0.30 x density +34.74
Cam3	Jivraj Road	28.94	-	speed = -0.05 x density +28.94
Cam4	Flyover	48.43	160	speed = -0.30 x density +48.43
Cam5	Manekbaug	-	-	-
Cam6	Nehrunagar	35.58	-	speed = -0.05 x density +35.58
Cam7	Shivranjni	45.41	-	speed = -0.26 x density +45.41
Cam8	Keshavbaug	42.55	-	speed = -0.21 x density +42.55
Cam9	IIM	37.12	-	speed = 0.21 x density +37.12
Cam10	Before IIM Flyover	37.83	-	speed = -0.15 x density +37.83
Cam11	VMS-1	32.34	-	speed = -0.17 x density +32.34
Cam12	VMS-2	30.64	-	speed = -0.09 x density +30.64
Cam13	VMS-3	49.21	127	speed = -0.387 x density +49.21

Basic Speed Density Curves are summarized in **Appendix 13**. The above relationships will be used in deriving expert system parameters where speed will be used to assess traffic levels on different links. For example, if vehicles consistently log free flow speed

with lower values of density, then the traffic is under saturated. If vehicles consistently log lower speeds with density nearing jam density, then the traffic flow is saturated.

Some basic speed characteristics during different time of day are summarized in **Appendix 14**. These are used to identify peak hours at each sensor location throughout the day.

Knowledge representation:

This step is the development of a rules or rule base using the expert knowledge obtained and processed previously. In this step, basic simple rules for individual EIB Locations are developed to assess traffic conditions.

After thorough review of the available data, important attributes to be used in the classification process are identified. It appears that due to the heterogeneous nature of traffic, the speed-density curves do not show jam density. At certain locations, the slope of the curvatures is positive which gives a completely opposite to the standard speed density relations. With availability of more data, these curves may be improved to achieve greater similarity between actual and standard speed density curves.

In absence of the standard speed-density curves, it is difficult to define saturation levels of the traffic. However, based on the available traffic data and research in India, the consultants propose the following parameters describing traffic conditions are selected as set of attributes:

1. Traffic Condition

Traffic Condition	Speed
Over Saturated	<20 kmph
Saturated	20 to 30 kmph
Under Saturated	>30kmph

2. Time of Day

1. Peak Hour
2. Off Peak Hour

3. Special events

1. Traffic Jam at Intermediate Nodes
2. Road Diversions / Closure etc.

Since the traffic sensor camera is at fixed locations, there may be some events happening between two detectors which may trigger special traffic scenario. These have to be detected with the help of traffic police. For example, between VMS-1 and Camera -1, there may be traffic jam near Vasna Bus Stop. Since our camera is located right at Anjali cross road, we may not be able to detect the Jam at Vasna Bus Stop. As a result, the Anajali Cross Road is fed less traffic which may lead us to show fast traffic on link between VMS-1 and Camera-1 whereas the condition is actually opposite.

The governing rules for camera sensors are summarized in the following table:

Table 21 Governing Rules for Camera Sensors

Rules	Level of Saturation	Time of Day	Special Events	Derivation
Rule 1	Under Saturated	Peak Hour	Yes	Very Slow Moving Traffic
Rule 2	Saturated	Peak Hour	Yes	Very Slow Moving Traffic
Rule 3	Over Saturated	Peak Hour	Yes	Very Slow Moving Traffic
Rule 4	Under Saturated	Peak Hour	No	Fast Moving Traffic
Rule 5	Saturated	Peak Hour	No	Slow Moving Traffic
Rule 6	Over Saturated	Peak Hour	No	Very Slow Moving Traffic
Rule 7	Under Saturated	Off Peak Hour	Yes	Very Slow Moving Traffic
Rule 8	Saturated	Off Peak Hour	Yes	Very Slow Moving Traffic
Rule 9	Over Saturated	Off Peak Hour	Yes	Very Slow Moving Traffic
Rule 10	Under Saturated	Off Peak Hour	No	Fast Moving Traffic
Rule 11	Saturated	Off Peak Hour	No	Slow Moving Traffic
Rule 12	Over Saturated	Off Peak Hour	No	Very Slow Moving Traffic

Implementation:

This step involves the implementation of expert rules. In this case, the rule base is developed in the form of a database of rules that represent various factors related to the network and recommendations in the form of “*if –then*” rules.

As a first step, for each VMS location, applicable camera sensors are identified. Then the camera sensors are grouped together such that each group falls along one alternate route location. For example at VMS 1, Cam2 and Cam3 can be grouped together to identify traffic on alternate route. If any of Cam2 or Cam3 shows very slow traffic, it is advisable to use Route along Cam1 to reach the destination.

Table 22 Applicable Camera List for Alternate Routes at Each EIB Location

VMS Location	Alt Route 1	Alt Route 2	Alt Route 3	Alt Route 4
VMS 1	Cam1	Cam 2, Cam3		
VMS2	Cam4, Cam2, Cam1	Cam4, Cam3	Cam 5	Cam 13, Cam 6
VMS 3	Cam9, Cam8	Cam6		
VMS 4	Cam7	Cam8, Cam9	Cam10	

Based on the above table, if inference from any of the above camera is very slow traffic, it is advisable not to use that route. The projection on the LED may be changed accordingly.

4. Post Implementation Surveys

General

The City of Ahmedabad has envisioned the need to upgrade its infrastructure at a very sophisticated scale to meet the needs for economic growth. The Ahmedabad Municipal Corporation (AMC) along with Ahmedabad Traffic Police (ATP) is primarily responsible for maintaining traffic flow and safety on city roads by the way of construction of roads, maintenance of roads, construction of traffic signals and law enforcement. As a part of its modernization drive AMC entered in to an agreement with Zero Sum Ltd., Japan to provide state-of-art Advanced Traveler Information System (ATIS) on one of the city corridors on a trial basis. The objectives of the project are to understand the effectiveness Intelligent Transportation System Application in heterogeneous traffic conditions prevailing in Ahmedabad. Further, the study also aims to study viability of such project through innovative methods in public private partnership.

As a part of the study, a pre-implementation traffic survey was conducted to identify existing traffic conditions. This section of the report summarizes post – implementation study of traffic conditions by way of conducting different traffic surveys. The results of post implementation surveys are compared with pre-implementation surveys to assess any changes in the traffic conditions and subsequently the effectiveness of ATIS system.

Route Choice & User Satisfaction Survey

Survey Goals and Objectives

The survey goal is to find Road User's Satisfaction levels with the ATIS system and thereby understanding the effectiveness of the ATIS system.

The specific objectives of the survey are:

- ✓ Elicit view on user satisfaction with the current ITS system
- ✓ To highlight road user satisfaction, experience and suggestions on ATIS system
- ✓ To develop greater understanding of road users' need and expectations

- ✓ The study should provide inputs for further improvement of road network, its operation and management on the proposed road corridor
- ✓ To submit the finding of surveys to the client.

Survey Locations

The survey was done at all Electronic Information Board locations shown in Figure 1 at the following dates:

Table 23 Route Choice Survey Dates (Post Implementation Stage)

Location	Date of Survey
EIB – 1	23 rd December, 2014
EIB – 2	24 th December, 2014
EIB – 3	25 th December, 2014
EIB – 4	26 th December, 2014

A large number of samples were taken at each location. However, the first step in the analysis is to purge samples with incomplete data and inaccurate data. The following table summarizes the sample size taken and sample size considered in the analysis.

Table 24 Route Choice Survey Sample Size (Post Implementation)

Location	Samples Taken	Samples Considered
EIB – 1	875	726
EIB – 2	796	710
EIB – 3	693	609
EIB – 4	635	529

A survey instrument shown in **Appendix 15** was designed for the survey.

Outcome of the Survey:

Destination – Route Followed Survey

Destination route followed surveys have been conducted each EIB Location as a part of user satisfaction survey to establish a pattern of route selection post implementation of ATIS. The data collected has been analyzed to obtain the travel characteristics of the road users. The desired pattern of the road users has been established on the basis of the traffic zones formulated within the influence area of the ATIS.

The surveyed data collected by random sampling includes interviewing of three categories of vehicles defined above. The drivers are interviewed for destination, route followed, use of information board for route selection to reach their destination and satisfaction level with current information board. Further, the users gave a feedback of the system on their own which were also recorded.

Zoning System

The location of Destination zones has been determined in relation to each individual traffic survey station and the possibility of traffic diversion. The analysis of data starts with coding of zones, i.e. categorizing the traffic with respect to its origin and destination. Each zone is designated with a unique code. These codes are termed as Traffic analysis Zones (TAZ). In total, 23 zones were identified for the survey analysis of the project road. The list of traffic analysis zones and respective codes are indicated in Table 3 and zoning map is shown at Figure 2. The zoning system used in the post implementation survey was same as the one used in pre-implementation surveys.

EIB – 1 Location at APMC Market Route Choice Survey

The Route Choice matrix at EIB-1 is shown in **Appendix – 16**. It is apparent from the OD matrix presented in the pre-implementation report that at APMC junction that a majority of the traffic goes straight to Anjali Cross Road. In order to reduce the resulting congestion between APMC and Anjali, it is necessary to identify if any trips are using 132' Ring Road. The destination zones of interest in this case to analyze are from 18 to 23.

Further, there will be some traffic which uses a part of 132' Ring Road to reach Anjali Cross Road. This traffic is actually aware of alternate route available to reach its nearest destination.

Table 25 Route Choice Survey Pattern at EIB-1 (Post Implementation)

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 23 (Helmet Circle)	9.35%	91.47%	8.53%
Zone 22 (Vijay Cross Road)	2.86%	22.38%	77.62%
Zone 20 (Nehrunagar Cross Road)	2.15%	41.86%	58.14%
Zone 19 (Manekbaug Cross Road)	1.25%	59.20%	40.80%
Zone 17 (Anjali Cross Road)	62.50%	2.56%	-

EIB – 2 Location near Shyamal Junction Route Choice Survey

The Route Choice matrix at EIB-1 is shown in **Appendix – 17**. It is apparent from the OD matrix at Shyamal junction presented in the pre-implementation report that the traffic is equally bound towards Nehrunagar, Manekbaug and Anjali Cross Roads. Since the network flow seems to be balanced at this point, there is a high probability of diverting traffic on alternate routes in special conditions like traffic jams or accidents. In order to reduce the resulting congestion during special events, it is necessary to identify how many trips can be diverted on alternate roads.

Table 26 Route Choice Survey Pattern at EIB-2 (Post Implementation)

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 23 (Helmet Circle)	8.62%	80.73%	19.26%
Zone 20 (Nehrunagar Road)	25.72%	43.27%	56.73%

Destination Zone	% of Total Traffic	% Using 132' Ring Road	% Using 120' Ring Road
Zone 17 (Paldi – Anjali Cross Road)	15.32%	82.70%	17.30%
Zone 14(Nr. Shyamal Junction)	11.84%	Termination Zone	

EIB – 3 Location near Shivranjani Junction Route Choice Survey

The Route Choice matrix at EIB-1 is shown in **Appendix – 18**. It is apparent from the OD matrix at Shivranjani EIB Location presented in the pre-implementation report that the traffic is equally bound towards Shivranjani, Helmet Cross Road and Nehrunagar zones. The only traffic that may be diverted is the trips terminating in Zone 23 and 20 which can use alternate routes from this location.

Table 27 Route Choice Survey Pattern at EIB-3 (Post Implementation)

Destination Zone	% of Total Traffic	% Using Shorter Route	% Using Alternate Route
Zone 23 (Helmet Circle)	17.84%	100%	0%
Zone 20 (Nehrunagar Road)	21.62%	98.80%	1.20%
Zone 13 (Shivranjani)	19.36%	Termination Zone	
Zone 21 (Panjrapole)	5.17%	27.08%	72.92%

EIB – 4 Location at Mansi Route Choice Survey

The Route Choice matrix at EIB-1 is shown in **Appendix – 19**. It is apparent from the OD matrix at Mansi junction presented in the pre-implementation report that a majority of the traffic is bound towards Nehrunagar, Shivranjani and Panjrapole. In order to reduce the resulting congestion between Mansi and Keshavbaug, it is necessary to identify how many trips are diverted away from 132' Ring Road. The destination zones of interest in this case to analyze are from 21, 13 and 20.

Table 28 Route Choice Survey Pattern at EIB-4 (Post Implementation)

Destination Zone	% of Total Traffic	% Using Shorter Route	% Using Alternate Route
Zone 21 (Panjrapole Circle)	5.49%	31.03%	68.97%
Zone 20 (Nehrunagar Road)	13.07%	100%	0%
Zone 13 (Shivranjni)	18.18%	100%	0%

User Satisfaction Survey:

Along with the route choice survey, a user satisfaction survey was also conducted to identify how general road users perceive the ATIS system being installed. The perception survey captured the following aspects:

- f. Whether road users are using information on VMS to take alternate route to reach destinations?
- g. Are they satisfied with the type of information being provided on the VMS?

Use Information in Taking Alternate Route

The users were asked *Do you take alternate route based on the information on the above board to reach your destination? (Y/N)* at all four survey locations. The following table summarizes respondent's frequency of trip:

Table 29 Survey Result for Use of ATIS in taking Alternate Route

Description	APMC	Shyamal	Shivranjni	Mansi
Yes	15.3%	11.5%	7.3%	8.2%
No	84.7%	88.5%	92.7%	91.8%

Satisfaction with ATIS

The users were asked *On a scale of 1 to 10, Are you satisfied with the information shown on the board? (10 being most helpful and 1 being not at all helpful)* at all four survey locations. Overwhelming majority of respondents answered that they will find the system useful (range 8-10).

Table 30 Survey Result for Satisfaction with ATIS System

Description	APMC	Shyamal	Shivranjni	Mansi
<5 (Not Useful)	2.8%	4.1%	3.5%	2.3%
5-7	23.4%	19.4%	15.3%	15.6%
8-10 (Useful)	73.8%	76.5%	81.2%	82.1%

Travel Time and Speed Analysis

The purpose of the travel time and speed study is to evaluate the quality of traffic movement along a route and to determine the locations, types and extents of traffic delays. The efficiency of flow is measured by travel and running speeds. In the actual study, total travel and running times are observed and then converted into speed measures.

Before starting the test runs, major intersections or suitable control points were selected along the study route as reference/control locations. The project influence area was divided into seven (7) sections based on the traffic characteristics of the network. These seven sections are summarized below and shown in Appendix 11:

Table 31 List of Routes for Travel Time and Speed Analysis

Route 1	From Information Board 1 to Andhjan Cross Roads (132' Ring Road)
Route 2	From Information Board 1 to APMC T-Junction to Anjali Cross Roads
Route 3	From Information Board 2 to Jivraj Park Cross Roads to 120' Ring Road
Route 4	From Information Board 2 to Manek Baug Cross Roads
Route 5	From Jodhpur Cross Roads to Nehrunagar Circle
Route 6	From Mansi Cross Roads to Keshav Baug T-Junction to Andhjan Cross Roads
Route 7	From Mansi Cross Roads to Andhjan Cross Road (Via Camera 10)

A test vehicle is driven along the study route in accordance with moving car technique, in which, a safe level of vehicular operation is maintained by observing proper following and passing distances and by changing speed at reasonable rates of acceleration and

decelerations. Delay information is recorded when the traffic flow is stopped or greatly impeded. The duration of traffic delay is measured in units of time along with notations of the corresponding location, cause and frequency of delay to travel.

The following table summarizes average speed and travel times on each of these routes during morning, afternoon and evening peak hours. Section-wise travel times and speed on each of these links are also summarized in Appendix 20.

Table 32 Summary of Average Speed and Travel Times (Post-Implementation)

Route No.	Morning Peak		Afternoon Peak		Evening Peak	
	Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)
1	21.96	12.76	26.29	10.57	22.36	12.26
2	17.71	6.30	20.93	5.33	18.69	5.96
3	21.16	9.15	21.21	9.13	27.17	7.13
4	14.74	5.94	18.09	4.84	12.63	6.94
5	20.17	5.15	20.60	5.04	18.04	5.75
6	22.70	4.16	34.59	2.73	24.62	3.84
7	19.62	5.60	22.98	4.77	18.38	5.97

4. Conclusions

For the current project, the Consultants have proposed the following performance measures for ITS system in the pre-implementation report:

- Faster Data Collection, Analysis & Reporting
- Higher Mobility
- Greater Reliability

The following sections summarize conclusions derived from pre-implementation and post implementation surveys carried out to assess the effectiveness of the ATIS system.

Faster Data Collection, Analysis & Reporting

- a. This is probably the first time in the City of Ahmedabad that a system capable of capturing and analyzing traffic conditions has been successfully installed and is under implementation.
- b. The data available from the system will open doors to conduct systematic traffic research with focus on quantitative analysis supported by real-time data.
- c. It is observed that due to heterogeneity in the traffic, speed density relationships observed from the detector data are not similar to standard curves. With availability of more data in the future, the curve may be updated with more data points to achieve better results.
- d. The system is capable of collecting traffic parameters which has resulted in calculation of basic traffic parameters at camera locations. These are summarized below:

Table 33 Summary of Traffic Parameters at Different Camera Locations

Camera No.	Location	Free Flow Speed (kmph)	Jam Density (vehicles/Km)	Speed (y) – Density (x) Equation
Cam1	Nr. Anjali Cross Roads	35.14	-	Speed = -0.1 x density +35.14
Cam2	TV9	34.74	115	speed = -0.30 x density +34.74
Cam3	Jivraj Road	28.94	-	speed = -0.05 x density +28.94
Cam4	Flyover	48.43	160	speed = -0.30 x density +48.43

Camera No.	Location	Free Flow Speed (kmph)	Jam Density (vehicles/Km)	Speed (y) – Density (x) Equation
Cam5	Manekbaug	-	-	-
Cam6	Nehrunagar	35.58	-	speed = -0.05 x density +35.58
Cam7	Shivranjni	45.41	-	speed = -0.26 x density +45.41
Cam8	Keshavbaug	42.55	-	speed = -0.21 x density +42.55
Cam9	IIM	37.12	-	speed = 0.21 x density +37.12
Cam10	Before IIM Flyover	37.83	-	speed = -0.15 x density +37.83
Cam11	VMS-1	32.34	-	speed = -0.17 x density +32.34
Cam12	VMS-2	30.64	-	speed = -0.09 x density +30.64
Cam13	VMS-3	49.21	127	speed = -0.387 x density +49.21

- e. Additional data availability in the future can also be used to update knowledge based expert system on a regular basis to derive effective inferences on traffic conditions in the network.
- f. With availability of more data in the future, the above traffic related parameters can be fine-tuned and seasonal variations may be also be derived.

Higher Mobility

Average Speed and Travel Times

The following table summarizes average speed and travel times obtained from pre-implementation and post-implementation studies:

Table 34 Comparison of Average Speed and Travel Times (Pre & Post Implementation Stages)

Route No.	Study Period	Morning Peak		Afternoon Peak		Evening Peak	
		Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)
1	Pre	21.09	12.97	25.21	10.98	23.64	11.62
	Post	21.96	12.76	26.29	10.57	22.36	12.26
	Diff	0.87	-0.21	1.69	-0.23	-1.28	0.64
2	Pre	18.48	6.03	19.42	5.74	18.62	5.99

Route No.	Study Period	Morning Peak		Afternoon Peak		Evening Peak	
		Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)	Speed (kmph)	Travel Time (min)
	Post	17.71	6.3	20.93	5.33	18.69	5.96
	Diff	-0.77	0.27	1.51	-0.41	0.07	-0.03
	Pre	23.29	8.28	32.35	5.99	21.15	9.16
3	Post	21.16	9.15	21.21	9.13	27.17	7.13
	Diff	-2.13	0.87	-11.14	3.14	6.02	-2.03
	Pre	17.68	4.96	14.63	5.99	14.22	6.16
4	Post	14.74	5.94	18.09	4.84	12.63	6.94
	Diff	-2.94	0.98	3.46	-1.15	-1.59	0.78
	Pre	18.89	5.49	20.43	5.08	18.5	5.61
5	Post	20.17	5.15	20.6	5.04	18.04	5.75
	Diff	1.28	-0.34	0.17	-0.04	-0.46	0.14
	Pre	19.81	4.77	31.42	3.01	24.25	3.9
6	Post	22.7	4.16	34.59	2.73	24.62	3.84
	Diff	2.89	-0.61	3.17	-0.28	0.37	-0.06
	Pre	20.68	5.38	21.63	5.07	15.71	6.98
7	Post	19.62	5.6	22.98	4.77	18.38	5.97
	Diff	-1.06	0.22	1.35	-0.30	2.67	-1.01

Pre and Post implementation travel time study show either decrease or increase in the speed of vehicles along various routes. Even though inconclusive, certain links have shown variation in speed during different time of day implying dynamic distribution of traffic over the network. This may be linked to the implementation of the ATIS system.

The primary arterial of 132' ring road (Route 1 in the above table) for which the system has been designed has shown increase in average speed and decrease in travel time after implementation of the ATIS system.

Higher Reliability

No special events were observed or recorded during the study period, hence reliability of the ITS system under such circumstances could not be assessed.

Traffic Distribution

Traffic distribution or traffic flow optimization over the network is a measure of higher network reliability. Each EIB location has unique traffic and network characteristics associated with it. The following section summarizes effectiveness of ATIS system in distributing traffic across the network on alternate routes under varying traffic and Network Conditions:

EIB – 1: Near APMC Market

Traffic Characteristics	Network Characteristics
Major traffic flow towards one zone	Only one alternate route with reasonable length available to compete with route carrying major traffic

Destination Zone	Pre-Implementation Survey Results		Post-Implementation Survey Results		% Traffic Rerouting with ATIS
	% Using 132' Ring Road	% Using 120' Ring Road	% Using 132' Ring Road	% Using 120' Ring Road	
Zone 23 (Helmet Circle)	76.25%	23.75%	91.47%	8.53%	0.16%
Zone 22 (Vijay Cross Road)	12.50%	87.50%	22.38%	77.62%	0.37%
Zone 20 (Nehrunagar Cross Road)	50%	50%	41.86%	58.14%	0.07%
Zone 19 (Manekbaug Cross Road)	66.67%	33.33%	59.20%	40.80%	0.19%

Zone 17 (Anjali Cross Road)	11.64%	-	2.56%	-	5.41%
Total					6.20%

EIB – 2: Near Shyamal Junction

Traffic Characteristics	Network Characteristics
More zones carrying considerable Traffic on either sides of the arterial (East and West)	Alternate route with equal distances available for selection

Destination Zone	Pre-Implementation Survey Results		Post-Implementation Survey Results		% Traffic Rerouting with ATIS
	% Using 132' Ring Road	% Using 120' Ring Road	% Using 132' Ring Road	% Using 120' Ring Road	
Zone 23 (Helmet Circle)	93.62%	6.38%	80.73%	19.26%	2.62%
Zone 20 (Nehrunagar Road)	51.78%	48.22%	43.27%	56.73%	0.03%
Zone 17 (Paldi – Anjali Cross Road)	41.10%	58.90%	82.70%	17.30%	5.38%
Total					8.02%

EIB – 3: Near Shivranjini Junction

Traffic Characteristics	Network Characteristics
Major traffic flow towards one zone	Only one alternate route with more length available to compete with route

	carrying major traffic
--	------------------------

Destination Zone	Pre-Implementation Survey Results		Post-Implementation Survey Results		% Traffic Rerouting with ATIS
	% Using 132' Ring Road	% Using 120' Ring Road	% Using Shorter Route	% Using Alternate Route	
Zone 23 (Helmet Circle)	84.66%	15.34%	100%	0%	2.88%
Zone 20 (Nehrunagar Road)	17.20%	82.18%	98.80%	1.20%	1.60%
Zone 17 (Paldi – Anjali Cross Road)	Termination Zone		Termination Zone		-
Total					4.48%

EIB – 4: Near Mansi Junction

Traffic Characteristics	Network Characteristics
Lesser traffic flow towards one zone with available alternate route. Major traffic flows towards zone with no alternate route available.	Only one zone has alternate route with almost unequal length available to compete, but the zone attracts very few trips.

Destination Zone	Pre-Implementation Survey Results		Post-Implementation Survey Results		% Traffic Rerouting with ATIS
	% Using 132' Ring Road	% Using 120' Ring Road	% Using Shorter Route	% Using Alternate Route	
Zone 21 (Panjrapole Circle)	7.32%	92.68%	5.49%	31.03%	1.26%

Zone 20 (Nehrunagar Road)	100%	0%	13.07%	100%	-
Zone 13 (Shivranjani)	100%	0%	18.18%	100%	-
Total					1.26%

From the above tables, the following conclusions can be drawn:

- ATIS system is most effective when more alternate routes are available (like in case of EIB-2).
- ATIS system is also effective at locations where major traffic is bound towards routes facing chronic congestion. In case of EIB-3, Nehrunagar junction faces chronic congestion, while route choice survey has shown higher number of rerouting as a result of ATIS implementation.
- ATIS system is least effective when lesser number of zones attracts traffic through alternate route (EIB-4).

Cost Benefit Analysis

In order to determine the cost effectiveness of ATIS system a cost-benefit analysis was carried out from the pre-implementation and post-implementation survey results. This analysis is carried out for a period of thirty years. The cost benefit analysis presents benefit-cost ratio and net present value of the project.

Of these three economic indicators, the Net Present Value and Benefit-Cost ratio are important. The Net Present Value is appropriate for comparing differential economic worth of projects while evaluating project alternatives that result in equal categorical benefits but unequal costs. All benefits and costs over an alternative's life cycle are discounted to the present, and the costs are subtracted from the benefits to yield a NPV. If benefits exceed costs, the NPV is positive and the project is worth pursuing. Net Present Value is given by the following equation:

Net Present Value,

$$NPV = \sum_{t=T_c}^{T_c+T} \frac{B_t [(1+g)^t + R - M]}{(1+r)^t} - \sum_{t=1}^{T_c} \frac{C}{(1+r)^t}$$

Where,

C = Total Project Cost

T_c = Construction period of the Project (assumed 1 year for project)

T = Expected Life time of the project (assumed to be 1+29=30 for project)

B_t = Monetary Value of Benefit (travel time savings)

gt = growth rate in year t

R = Fare Box Revenue (Advertisement Revenue)

M = Annual Operating Cost.

r = Interest Rate

The NPV formula above has two important parts. First is the present value of cost while the second term is the present value of benefits. Here maintenance cost is considered as a negative benefit. The fare box revenue is from advertisement revenues which are not available to the research team. In such a case, sensitivity analysis is presented with ranging fare box revenue (22%, 25% and 30%) of the capital cost per year. The maintenance cost as provided to the Consultants is 20% of the capital cost per year.

Benefit to cost ratio method is generally used when project funding is restricted. Benefit to cost ratio is obtained by placing present value of benefits in the numerator and

present value of cost in the denominator. The cost includes only construction cost as in net present value. Benefit to cost ratio is given by the following equation:

$$BCR = \frac{\sum_{t=T_c}^{T_c+T} \frac{B_t [(1+g_t)^{(t-T_c)} + R - M]}{(1+r)^t}}{\sum_{t=1}^{T_c} \frac{C}{(1+r)^t}}$$

Benefit to Cost Ratio,

Cost of entire system implementation is shared by Zero-Sum Ltd. Japan to the research team. The cost of implementation for the study is considered as USD 1.0 million which is roughly INR 6.0cr.

The next step is to consider benefits that calculated from the pre-implementation and post-implementation surveys. Main benefits are reduction in travel time and emissions. For benefit cost analysis, monetary value has to be assigned to these benefits. The monetary value for reduction in travel time depends on different state / area or one can use the average wage available in literature¹ in India.

Benefit	Monetary Value
Travel Time Saving	INR 75/Hour

One important consideration while evaluating benefits is that during the project duration growth rate may vary. Hence to find reduction in travel time etc. new surveys shall be carried out for each year. Also travel demand is not constant throughout the day. However travel time savings obtained in peak and off-peak durations are averaged and considered in the analysis. Knowing the average travel time difference per day, one can estimate the total travel time saving for 365 days.

¹ As per The 23rd
Survey of Investment Related Costs in Asia and Oceania
http://www.jetro.go.jp/en/reports/survey/pdf/2013_05_01_biz.pdf.

standard value of growth rate suggested by IRC is 7.5%. Interest rate of 12% is considered for the study.

Once all parameters are known net present value and benefit to cost return using above formulas.

Benefit Cost Analysis

Step 1: Travel Time Difference in Pre-Implementation and Post-Implementation Scenario

The following table summarizes travel time variation in pre-implementation and post-implementation scenario:

Route No.	Morning Peak		Afternoon Peak		Evening Peak	
	Speed	Travel Time (min)	Speed	Travel Time (min)	Speed	Travel Time (min)
1	0.87	-0.21	1.69	-0.23	-1.28	0.64
2	-0.77	0.27	1.51	-0.41	0.07	-0.03
3	-2.13	0.87	-11.14	3.14	6.02	-2.03
4	-2.94	0.98	3.46	-1.15	-1.59	0.78
5	1.28	-0.34	0.17	-0.04	-0.46	0.14
6	2.89	-0.61	3.17	-0.28	0.37	-0.06
7	-1.06	0.22	1.35	-0.3	2.67	-1.01

Step 2: Calculate number of vehicles at each Camera Location.

The following table summarizes number of vehicles at each Camera Location:

Camera Location	Count	Unit
Cam 1	30173	Vehicles Per Day
Cam 2	22044	Vehicles Per Day
Cam 3	9528	Vehicles Per Day
Cam 4	33974	Vehicles Per Day
Cam 5	20000	Vehicles Per Day
Cam 6	31337	Vehicles Per Day
Cam 7	35490	Vehicles Per Day

Camera Location	Count	Unit
Cam 8	38439	Vehicles Per Day
Cam 9	34361	Vehicles Per Day
Cam 10	31515	Vehicles Per Day

Step 3: Calculation of Travel Time Difference for each Route

In this step, average number of vehicles on each route is first calculated as an average number of vehicles passing through all camera locations along the route. Then this number is multiplied with average passenger per vehicle to total saving in travel time calculated from Step 1. The entire Step 3 is shown in the following Table:

Route No.	Travel Time Difference			Total Change in Travel Time Per Day	Camera Along Route	Average Vehicles Per Day (Nos.)	Average Passenger per Vehicle (Nos.)	Total Travel Saving Per Day (in min)
	AM Peak	Afternoon Peak	Evening Peak					
1	-0.21	-0.23	0.64	0.20	CTS 2, CTS 9	28202.5	2.0	(11,281.00)
2	0.27	-0.41	-0.03	-0.17	CTS 1	30173	2.0	10,258.82
3	0.87	3.14	-2.03	1.98	CTS 3, CTS 4	21751	2.0	(86,133.96)
4	0.98	-1.15	0.78	0.61	CTS 5	20000	2.0	(24,400.00)
5	-0.34	-0.04	0.14	-0.24	CTS 6, CTS 7	33413.5	2.0	16,038.48
6	-0.61	-0.28	-0.06	-0.95	CTS 8, CTS 9	36400	2.0	69,160.00
7	0.22	-0.3	-1.01	-1.09	CTS 10	31515	2.0	68,702.70
Total Travel Time Saving								42,345.04

Step 4: Calculation of Benefits and Cost Over project Life Duration

Total Project Cost (Rs.)	:	60,000,000.00
Construction Period (in Years)	:	1 Year
Expected Project Life	:	30 (1+29) Years
Total Travel Time Saving per Day (in minutes)	:	42,345.04
Total Travel Time Saving in first year of implementation (in hrs) = (365*42,345.04 /60)	:	257,598.99
Average Wage (monetary value of time)	:	75 Rs/Hr
Growth Rate	:	7.5%
Interest Rate	:	12%

Then, Net Present Value of Cost and Benefits for 22% fare box revenue are calculation based on the equations present above. The calculated vales are summarized in the following Table:

Net Present Value of Cost	
Year 1	53,571,428.57

Net Present Value of Benefit (for Fair Box Revenue equal to 22% of Capital Cost per Year)	
Year 2	17,513,487.59
Year 3	14,683,029.36
Year 4	13,045,962.84
Year 5	11,643,903.10
Year 6	10,396,055.58

Net Present Value of Benefit (for Fair Box Revenue equal to 22% of Capital Cost per Year)	
Year 7	9,282,173.30
Year 8	8,287,653.45
Year 9	7,399,690.49
Year 10	6,606,866.51
Year 11	5,898,987.95
Year 12	5,266,953.53
Year 13	4,702,637.08
Year 14	4,198,783.11
Year 15	3,748,913.49
Year 16	3,347,244.19
Year 17	2,988,610.88
Year 18	2,668,402.57
Year 19	2,382,502.30
Year 20	2,127,234.19
Year 21	1,899,316.24
Year 22	1,695,818.07
Year 23	1,514,123.28
Year 24	1,351,895.79
Year 25	1,207,049.81
Year 26	1,077,723.04
Year 27	962,252.72
Year 28	859,154.21
Year 29	767,101.98

Net Present Value of Benefit (for Fair Box Revenue equal to 22% of Capital Cost per Year)	
Year 30	684,912.48
NPV of Benefit	148,208,439.13

Hence,

Benefit-Cost-Ratio will be : 2.77

NPV of the Project : INR 94,637,010.56 /=

Sensitivity Analysis for varying Fare Box Revenue

	Fair Box Revenue per Year as % of Capital Cost		
	22%	25%	28%
BCR	2.77	3.01	3.25
NPV_{Project}	9.46 cr	10.75 cr	12.04 cr

Road User Response to the System

User Perception Versus Satisfaction:

User perception survey was carried out for the system prior to its implementation to assess if the ATIS system will benefit the users. The following was the perception on usefulness of the system in helping road users to select alternate route:

Table 35 User Perception Survey Results from Pre-Implementation Stage

Description	APMC (EIB-I)	Shyamal (EIB-II)	Shivranjni (EIB-III)	Mansi (EIB-IV)
<5 (Not Useful)	2.3%	3.2%	3.8%	1.9%
5-7	21.1%	21.6%	19.1%	13.5%
8-10 (Useful)	76.5%	75.2%	77.1%	84.5%

From the above table, about 78.32% people perceived that the system will help the users to select alternate route and save travel time.

After implementation of the ATIS system, a user satisfaction survey was carried out to assess if the perception of road users was actually being met. The road users were asked if they are satisfied with the ATIS system. The following table summarizes the satisfaction levels:

Table 36 User Satisfaction Survey Results from Post-Implementation Stage

Description	APMC	Shyamal	Shivranjni	Mansi
<5 (Not Useful)	2.8%	4.1%	3.5%	2.3%
5-7	23.4%	19.4%	15.3%	15.6%
8-10 (Useful)	73.8%	76.5%	81.2%	82.1%

There is a higher level of satisfaction among the road users with the VMS system, with around 80% of the road user surveyed satisfied with its working. Hence it can be concluded that the ATIS system has met expectations of the road users.

Willingness to use vs. Actual usage

Prior to implementation of the system, a survey to assess willingness to use alternate route based on information provided by the VMS was carried out. The following table summarizes the user responses in willingness to use alternate routes:

Table 37 Willingness to use Survey Results from Pre-Implementation Stage

Description	APMC	Shyamal	Shivranjni	Mansi
Yes	93.52%	86.63%	88.16%	84.97%
No	6.48%	13.37%	11.84%	15.03%

After implementation of the system, the users were again asked if they are taking alternate routes or using the information provided on the VMS to select their routes. The following table summarizes the user responses in use of VMS data to select alternate routes:

Table 38 Use of ATIS to Select Alternate Route in Post Implementation Stage

Description	APMC	Shyamal	Shivranjni	Mansi
Yes	15.3%	11.5%	7.3%	8.2%
No	84.7%	88.5%	92.7%	91.8%

From the above two tables, even though about 80% of users were willing to take alternate route based on data provided in the VMS, on an average 10.57% of the people actually use the information to select their route. The above average, may not match pre-implementation survey, but the average figure is quite significant as 10.57% and is in line with results of similar implementation across the world summarized in the Literature review.

Summary & Future Scope of Work

1. Since ATIS utilizes the roadway capacity effectively by enabling dynamic distribution of traffic over network rather than increasing the roadway capacity,

benefits from these systems are very limited. This is evident from the changes in travel times and speed over the network.

2. Instead of Route based study of travel time and average speed, link & node based analysis should be carried out to actually assess if the diverted traffic is not using links already carrying more traffic.
3. Before implementing the next phase of ATIS, it is essential that the decision makers have a clear idea of how the system will work under their network conditions. More research is needed in this field to test the effectiveness of VMS on different types of network and traffic conditions. Documentation and availability of its performance on different network configuration will be of great use for decision makers.
4. The expert system developed here is an important tool where the effectiveness of the ATIS can be considerably increased if implemented and updated on a regular basis.

APPENDIX 1 TO 20

Appendix: 1 Origin and Destination Survey Form (Pre-Implementation Phase)

Location:

Survey Time: From:To:

Date:

Up Direction:

Weather:

Dn Direction:

Sr No.	Type of Vehicle	Origin Place	Destination Place	Route Followed	Trips (D/W/M)	Purpose of Trip <ul style="list-style-type: none"> • Business • Job • Student 	Alternate Route followed (Y/N)	Perception on Information Board
1	2	3	4	5	6	7	8	9
1								
2								
3								
4								
5								
6								
7								

Questions Asked:

Column 3: Where are you coming from?

Column 4: Where are you going to?

Column 5: Which route will you take to reach your *destination*? (Destination to be replaced by place answered in column 4)

Column 6: What is the frequency of your trip? (Daily, Weekly or Monthly)

Column 7: What is the purpose of your trip?

Column 8: Will you follow any alternate route if it saves your time even though the alternate route may be a bit longer?

Column 9: On a scale of 1 to 10, do you think a system which provides traffic information on available alternate route help you to select alternate routes? (10 being most helpful and 1 being not at all helpful)

Column 10: Which medium do you think is easier for you to process information on alternate route (map or text)?

Appendix 2: Survey Photographs (Dt. 23-26 Sept, 2014)









Appendix 3 : Origin Destination Matrix for Total All Near APMC Market (EIB-1)

Location: Near APMC Market
Chainage: EIB-1

Date: 23/9/2014

Zones		Destination Zones																							Grand Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Origin Zone	1					0.28		0.14		0.14	0.69			8.67	2.61	0.96	0.69	14.03			0.28		0.69	5.36	34.53	
	2												0.14	2.06	0.69	1.65	0.41	21.18		0.28	0.69		0.41	2.48	29.99	
	3										0.14	0.14		1.93	0.55	1.10	0.28	23.25		0.55	0.69		0.55	3.16	32.32	
	4																									
	5																									
	6																									
	7																		0.14							0.14
	8																									
	9																									
	10																									
	11																									
	12																									
	13																									
	14																									
	15																									
	16													0.28		0.55		1.65						0.55		3.03
	17																									
	18																									
	19																									
	20																									
	21																									
	22																									
	23																									
Grand Total						0.28		0.14		0.14	0.83	0.14	0.14	12.93	3.85	4.26	1.38	60.25		0.83	1.65		2.20	11.00	100.00	

Appendix - 4 : Route Choice Matrix for All Vehicles Near APMC Market (EIB-1)

Location: Near APMC Market
Chainage: EIB-1

Date: 23/9/2014

Zones		Route Choice through Zone																							Grand Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Destination Zone	1																									
	2																									
	3																									
	4																									
	5													0.28												0.28
	6																									
	7												0.14													0.14
	8																									
	9										0.14															0.14
	10											0.83														0.83
	11											0.14														0.14
	12												0.14													0.14
	13												4.40	8.53												12.93
	14												0.14		3.71											3.85
	15														4.26											4.26
	16															1.38										1.38
	17													0.41	1.10	5.50	52.54				0.69					60.25
	18																									
	19													0.55			0.28									0.83
	20												0.28	0.28	0.28		0.83									1.65
	21																									
	22													0.28			0.69				0.41		0.14	0.69		2.20
	23											5.23	0.55	2.06	0.41	0.14	0.14		0.14		0.14		1.79	0.55		11.00
Grand Total											5.36	0.96	5.91	12.10	9.77	7.02	54.47		0.14	1.10		1.93	1.24	100.00		

Appendix - 5 : Origin Destination Matrix for All Vehicles Near Shyamal Cross Road (EIB-2)

Location: Near Shyamal Road
Chainage: EIB-2

Date: 24-Sep-2014

Zones		Destination Zone																					Grand Total		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		22	23
Origin Zone	1																								
	2										0.11		0.22											0.33	
	3			0.11	0.33						0.11	0.11	0.87	0.87		0.33	0.44			1.09	0.44	0.22	6.42	11.32	
	4	5.33	0.22		0.54	0.11				0.76		0.33		4.46	9.36	0.22	4.68	13.17	1.20	1.20	13.38	2.72	0.44	3.05	61.26
	5	1.09		0.11	0.22				0.11	0.11		0.22		0.54	1.52	0.11	1.09	2.29	0.11		1.96		0.11	0.44	10.12
	6	0.11												0.44	0.11		0.22	0.22						0.11	1.20
	7	0.22			0.22										0.11		0.65	0.54	0.11		0.76			0.11	2.72
	8																								
	9																		0.11						0.11
	10													0.22											0.22
	11																								
	12																								
	13																								
	14	0.98			0.22			0.22				0.11		1.20	2.72	0.22	0.65	0.65		0.11	4.03		0.11	0.11	11.32
	15													0.33		0.11		0.33		0.11	0.22				1.09
	16									0.11					0.11										0.22
	17																			0.11					0.11
	18																								
	19																								
	20																								
	21																								
	22																								
	23																								
Grand Total		7.73	0.22	0.22	1.52	0.11		0.22	0.11	0.98		0.87	0.11	8.27	14.80	0.65	7.62	17.74	1.52	1.41	21.44	3.16	0.87	10.23	100.00

Appendix - 6 : Route Choice Matrix for All Vehicles Near Shyamal Cross Road (EIB-2)

Location: Near Shyamal Road
Chainage: EIB-2

Date: 24-Sep-2014

Zones		Route Choice through Zone																							Grand Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Destination Zone	1	0.76											0.11	4.79		1.31	0.33	0.11			0.22		0.11	7.73	
	2													0.22											0.22
	3			0.11																			0.11		0.22
	4				0.11										0.87			0.22		0.11	0.11	0.11			1.52
	5												0.11												0.11
	6																								
	7												0.22												0.22
	8																							0.11	0.11
	9										0.11	0.11	0.54	0.22											0.98
	10													0.44	0.33		0.11								
	11																								0.87
	12				0.11																				0.11
	13										0.11	0.11	1.31	5.55		0.33	0.11				0.44	0.22		0.11	8.27
	14	0.33	0.11		1.74					0.11			0.44	9.90	0.11	0.44	0.33	0.22	0.22	0.54	0.33				14.80
	15	0.11												0.11	0.22	0.22									0.65
	16	0.11											0.11	4.57	0.76	1.63	0.11				0.33				7.62
	17	0.54			0.11	0.11							0.11	1.85		1.09	3.37	7.18	0.87	0.98	1.41		0.11		17.74
	18								0.11			0.11	0.33	0.44			0.22	0.11		0.22					1.52
	19												0.33	0.54					0.11	0.44					1.41
	20				0.54					0.11		0.11	3.37	5.98		0.11	0.44	0.11	2.83	6.31	1.20	0.11	0.22		21.44
	21		0.11										0.33	1.41		0.22			0.44	0.44	0.22				3.16
	22											0.11	0.44	0.11	0.11									0.11	0.87
	23											7.07	0.11	0.76	1.31						0.65			0.33	10.23
Grand Total		1.85	0.22	0.11	2.61	0.11			0.11	0.22	0.22	7.51	0.44	8.92	38.19	1.20	5.44	5.11	7.73	4.57	10.45	3.81	0.11	1.09	100.00

Appendix - 7 : Origin destination Matrix for All Vehicles Near Shivranjani Cross Road (EIB-3)

Location: Near Shivranjani Cross Road
Chainage: EIB-3

Date: 26-Sep-2014

Zones		Destination Zone																							Grand Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Origin Zone	1					0.40	0.20	0.60	0.10	1.51	0.10	0.30		4.22	0.50		0.30	0.20	0.20		1.00	0.40	0.30	5.32	15.66	
	2								0.20			0.20		0.20	0.10						0.10			0.20	1.00	
	3				0.10	0.20		0.30	0.20	0.30				1.91	0.10			0.10			0.10	0.20	0.20	2.21	5.92	
	4		0.10		0.20	0.40	0.10	0.20	0.10	0.80	0.40	0.50	0.10	2.71	0.80			0.10			1.81	0.40		1.61	10.34	
	5						0.30		0.10	0.40				0.90	0.40						0.20	0.10		0.40	2.81	
	6													0.10											0.10	
	7					0.10							0.10	0.60									0.20		0.10	1.10
	8																									
	9													0.10							0.20	0.30				0.60
	10																						0.10			0.10
	11																									
	12					0.10								0.30										0.20		0.60
	13	0.10		0.10		0.30				0.10		0.10		1.00	0.60			0.20	0.10		0.20	0.40		0.30	3.51	
	14	0.10				0.30	0.20	0.30	0.50	1.41	1.20	1.10	0.70	10.54	1.20		0.20	0.90		0.20	3.01	1.41	0.80	3.71	27.81	
	15					0.10		0.20		0.70	0.50	0.70	0.10	2.81	0.40						1.31	0.10	0.20	2.01	9.14	
	16					0.50	0.50	0.40	0.20	1.51	0.50	0.80	0.40	8.23	0.60		0.10			0.20	1.00	0.40		1.10	16.47	
	17				0.10	0.20			0.10	0.20	0.20	0.10	0.10	1.00	0.30								0.10	0.50	2.91	
	18													0.20	0.10						0.10				0.40	
	19						0.10		0.10					0.60	0.10						0.20		0.10		1.20	
	20									0.10				0.10											0.20	
	21																									
	22																									
	23													0.10											0.10	
Grand Total		0.20	0.10	0.10	0.40	2.61	1.41	2.01	1.61	7.03	2.91	3.82	1.51	35.64	5.22		0.60	1.51	0.30	0.60	9.34	3.61	1.81	17.67	100.00	

Appendix - 8 : Route Choice Matrix for All Vehicles Near Shivranjni EIB (EIB-3)

Location: Near Mansi Cross Road
Chainage: EIB-3

Date: 26-Sep-2014

Zones		Route Choice through Zone																							Grand Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Destination Zone	1												0.10	0.10											0.20
	2															0.10									0.10
	3													0.10											0.10
	4												0.20	0.20											0.40
	5						0.10					0.20	0.10	1.61	0.50								0.10		2.61
	6						0.10		0.10		0.10		0.20	0.50	0.20						0.10		0.10		1.41
	7							0.10		0.20				1.20									0.50		2.01
	8								0.10	0.10		0.10		0.30	0.10								0.90		1.61
	9	0.10			0.10				0.10	0.20	0.40	1.00	0.20	3.82	0.80						0.10		0.10	0.10	7.03
	10	0.10				0.10		0.10					0.20	1.71	0.50								0.20	0.20	2.91
	11						0.10		0.10	0.10	0.10	0.50	0.10	1.81	0.40							0.30		0.30	3.82
	12										0.10	0.20	0.10	0.90	0.10							0.10			1.51
	13	0.10			0.10		0.10	0.20	0.30	0.30	0.20	1.91		18.37	12.55		0.20	0.10			0.70		0.20	0.30	35.64
	14						0.10		0.20	0.10		0.30		2.81	0.90						0.20	0.20		0.40	5.22
	15																								
	16												0.10	0.40			0.10								0.60
	17	0.10												0.70	0.30						0.10	0.20		0.10	1.51
	18													0.30											0.30
	19													0.50	0.10										0.60
	20	0.10									0.10	0.40		5.12	2.01			0.20				1.00	0.20	0.20	9.34
	21											0.30	0.10	1.71	0.50							0.30	0.10	0.10	3.61
	22											0.10		0.70	0.10							0.50	0.10		1.81
	23	0.20		0.10				0.20				1.10	0.10	10.44	2.81							0.20		2.51	17.67
Grand Total	0.70		0.10	0.20	0.10	0.50	0.60	0.90	1.00	1.00	6.12	1.20	53.21	22.29	0.10	0.30	0.30		0.30	3.21	0.90	0.40	6.53	100.00	

Appendix - 9 : Route Choice Matrix for All Vehicles Near Mansi Cross Road (EIB-4)

Location: Near Mansi Cross Road
Chainage: EIB-4

Date: 26-Sep-2014

Zones		Route Choice through Zone																							Grand Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Destination Zone	1						0.15				1.34			0.30			1.04								2.83	
	2																									
	3																									
	4																									
	5																									
	6																									
	7																									
	8																									
	9											11.18														11.18
	10						0.60					14.31														14.90
	11										0.15	1.49														1.64
	12										3.58															3.58
	13										14.90	0.15	5.22													20.27
	14											0.15	6.56													6.71
	15																									
	16										0.15							1.19	0.45							1.79
	17										0.30		1.64				0.30	0.30				2.24				4.77
	18																					1.79				1.79
	19										0.45	0.15	1.94													2.53
	20										0.45	0.15	13.86													14.46
	21										1.19	4.32	0.45									0.15				6.11
	22										0.45	2.53	0.15													3.13
	23										1.64	2.38														4.02
Grand Total						0.75					50.37	4.32	7.45	29.66			2.53	0.75			4.17				100.00	

Appendix - 10 : Origin Destination Matrix for All Vehicles Near Mansi Cross Road (EIB-4)

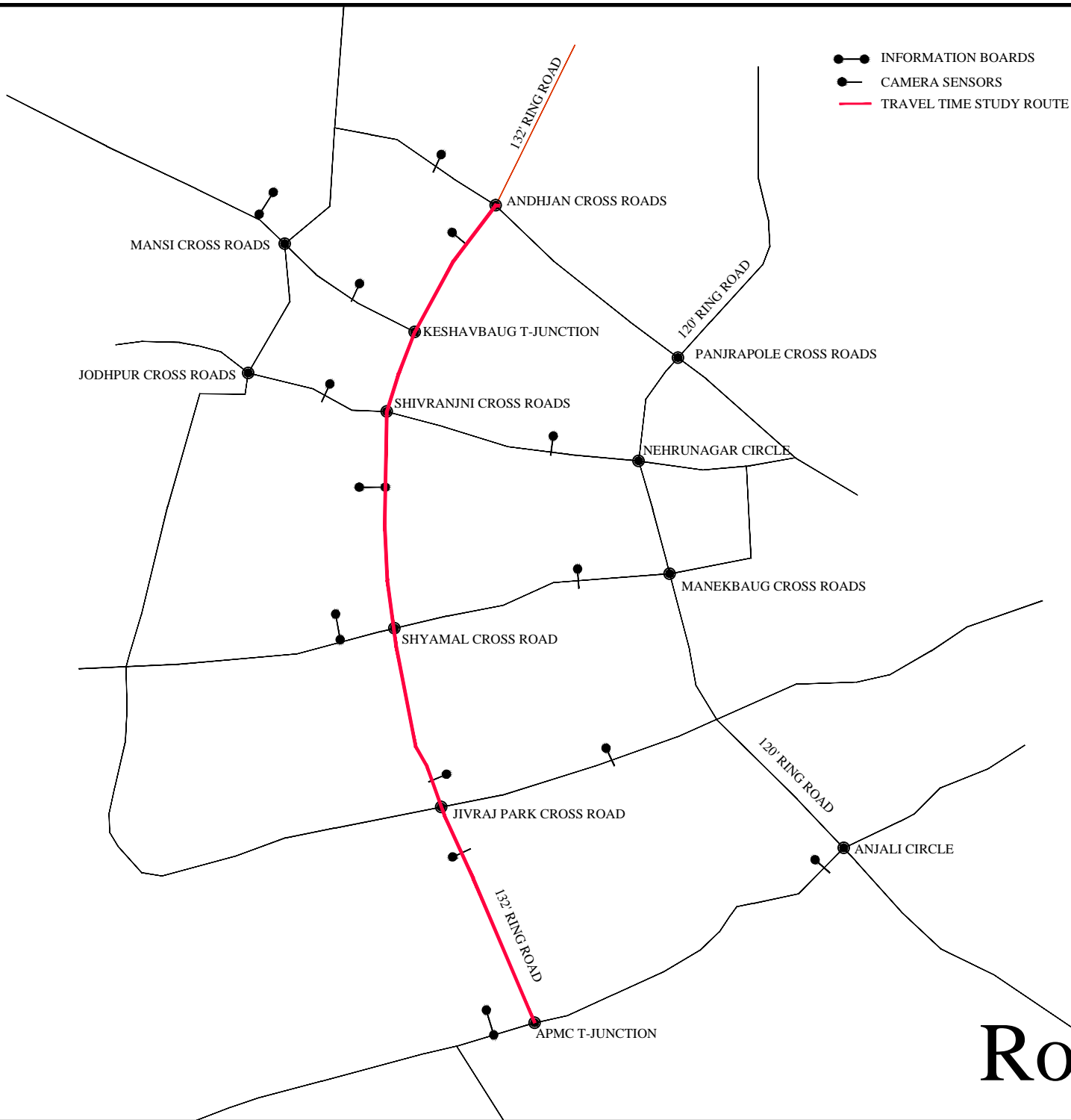
Location: Near Mansi Cross Road
Chainage: EIB-4

Date: 26-Sep-2014

Zones		Destination Zone																					Grand Total				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		22	23		
Origin Zone	1	0.15								0.30			0.45									0.30		1.19			
	2																										
	3	0.15								0.30	0.89	0.89	0.15	0.45	0.30			0.15	0.15	0.15	1.19	0.45	0.30	0.15	5.66		
	4													0.15											0.15		
	5	0.15								1.04	1.49			0.30	0.15		0.30	0.45		0.30	1.04	0.30	0.15		5.81		
	6	1.64								7.90	10.73	0.45	2.53	12.67	3.43		0.75	2.53	1.34	1.64	8.35	4.47	2.38	2.83	63.64		
	7	0.60								1.64	1.49	0.15	0.45	4.17	1.79		0.75	0.75	0.15	0.45	3.28	0.89			16.54		
	8											0.15	0.30		0.15			0.89						0.75	2.24		
	9														0.45				0.15		0.30			0.30	1.19		
	10	0.15								0.30			0.15	2.24	0.30						0.30				3.58		
	11																										
	12																										
	13																										
	14																										
	15																										
	16																										
	17																										
	18																										
	19																										
	20																										
	21																										
	22																										
	23																										
Grand Total		2.83										11.18	14.90	1.64	3.58	20.27	6.71		1.79	4.77	1.79	2.53	####	6.11	3.13	4.02	100.00

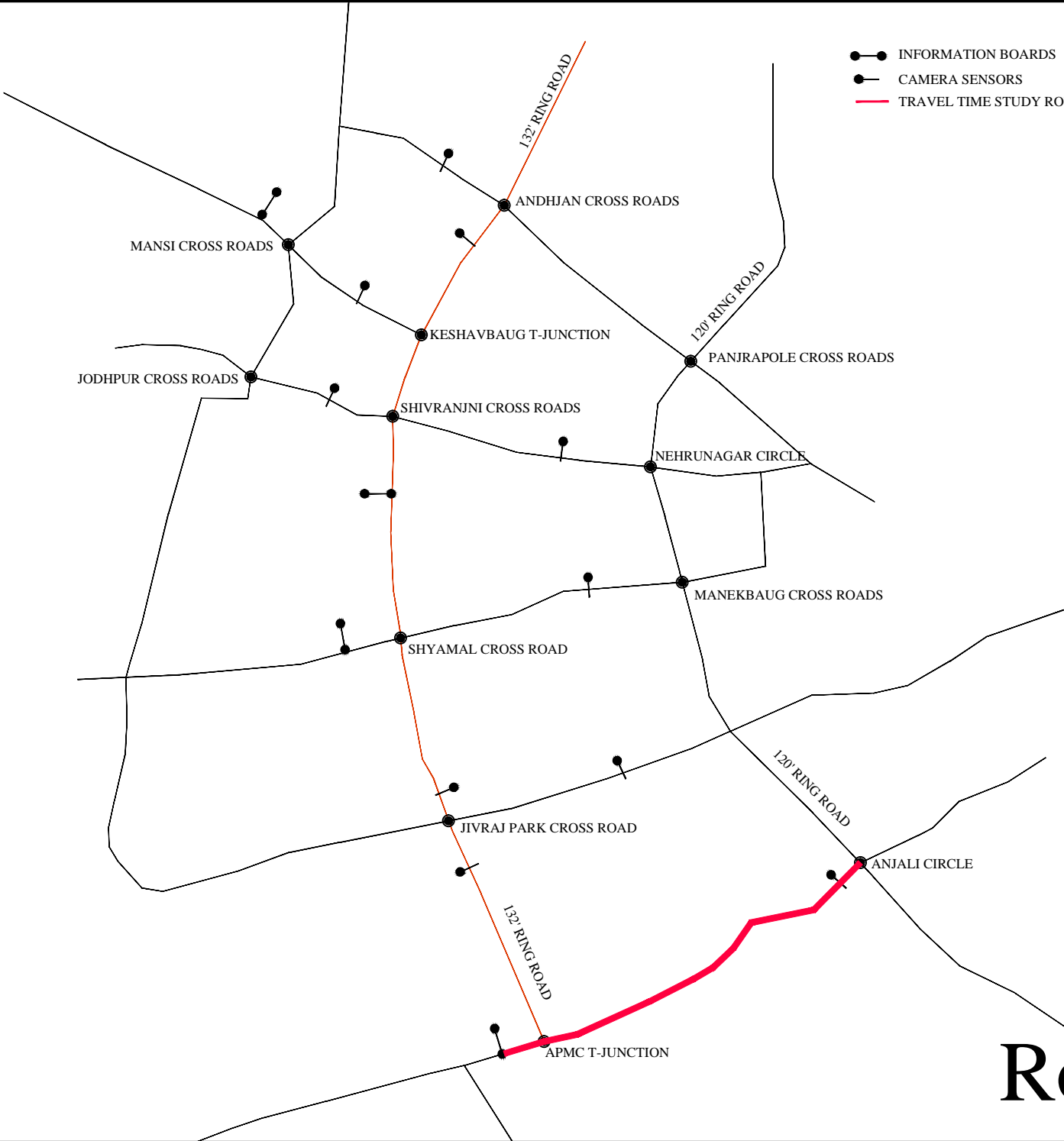
APPENDIX 11

ROUTE MAPS FOR TRAVEL TIME
STUDIES



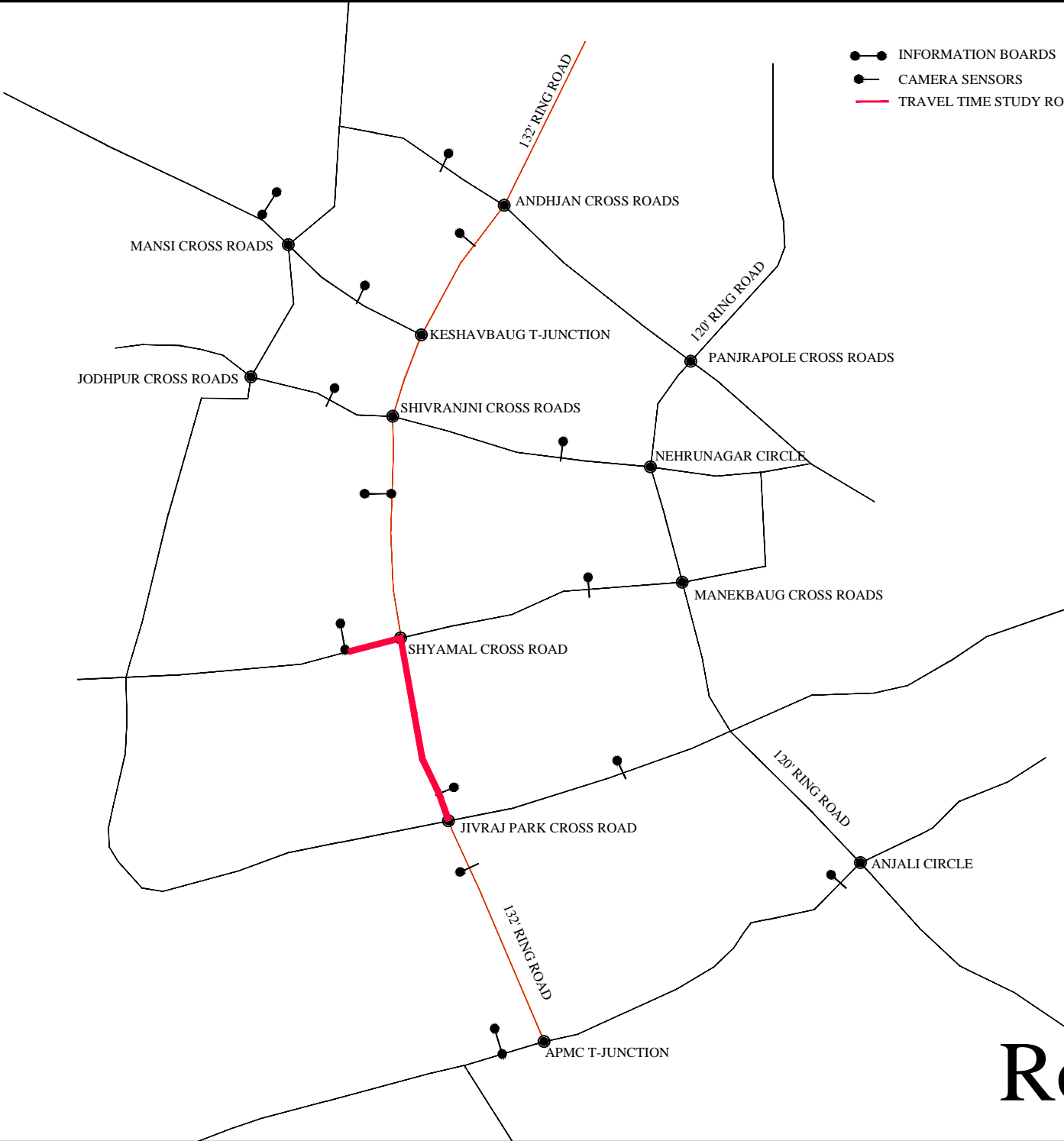
Route 1

- INFORMATION BOARDS
- CAMERA SENSORS
- TRAVEL TIME STUDY ROUTE



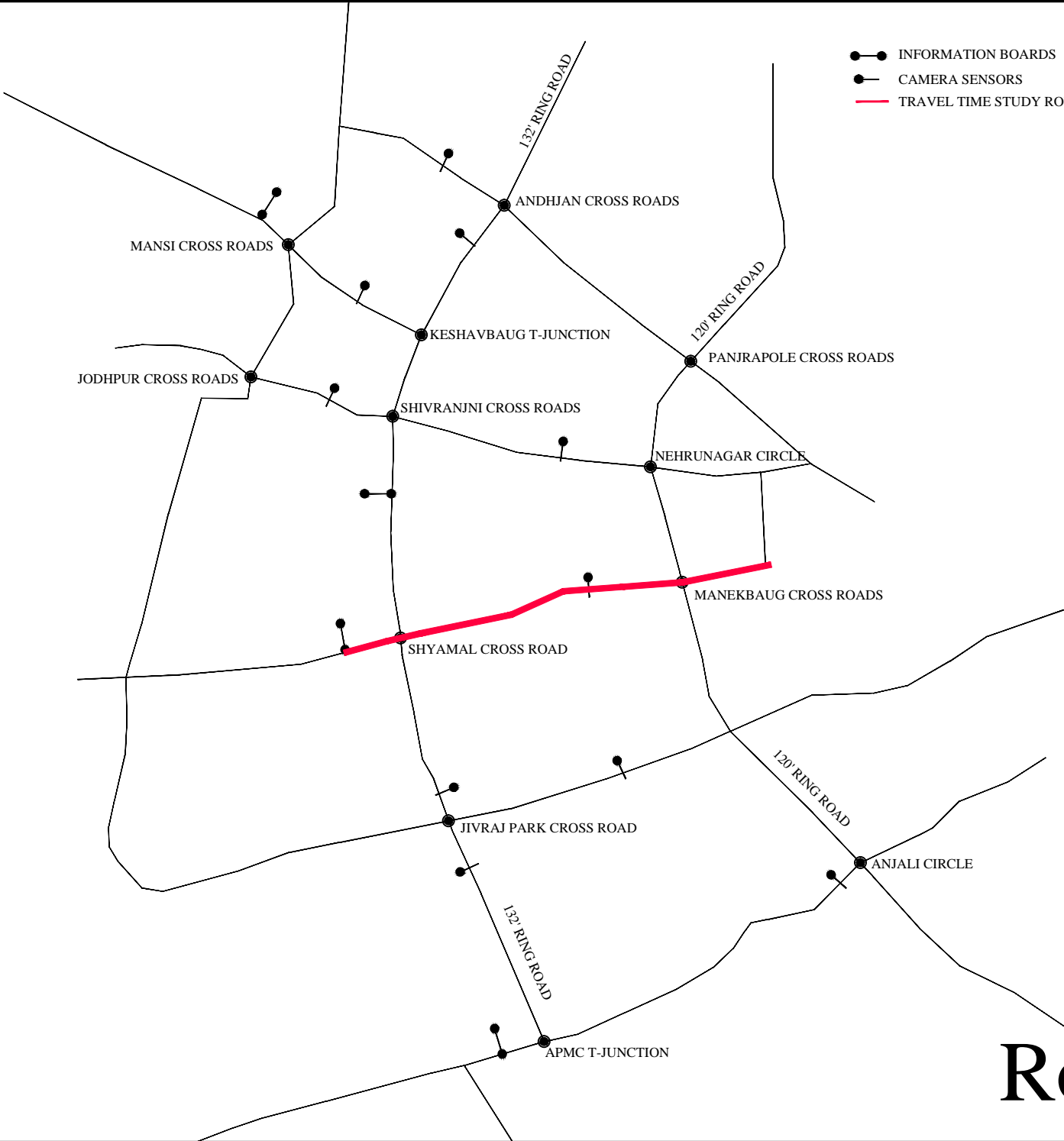
Route 2

- INFORMATION BOARDS
- CAMERA SENSORS
- TRAVEL TIME STUDY ROUTE



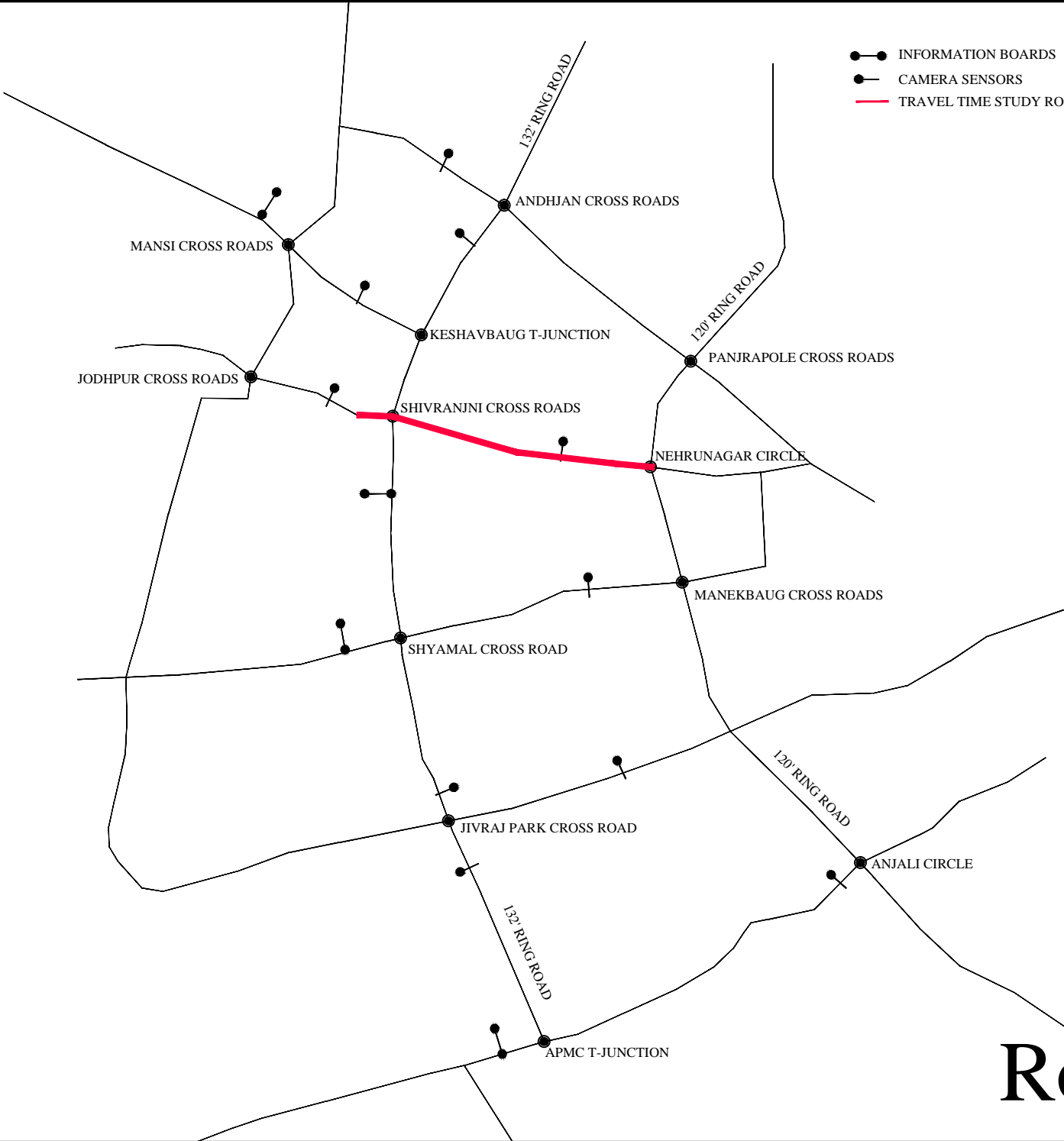
Route 3

- INFORMATION BOARDS
- CAMERA SENSORS
- TRAVEL TIME STUDY ROUTE



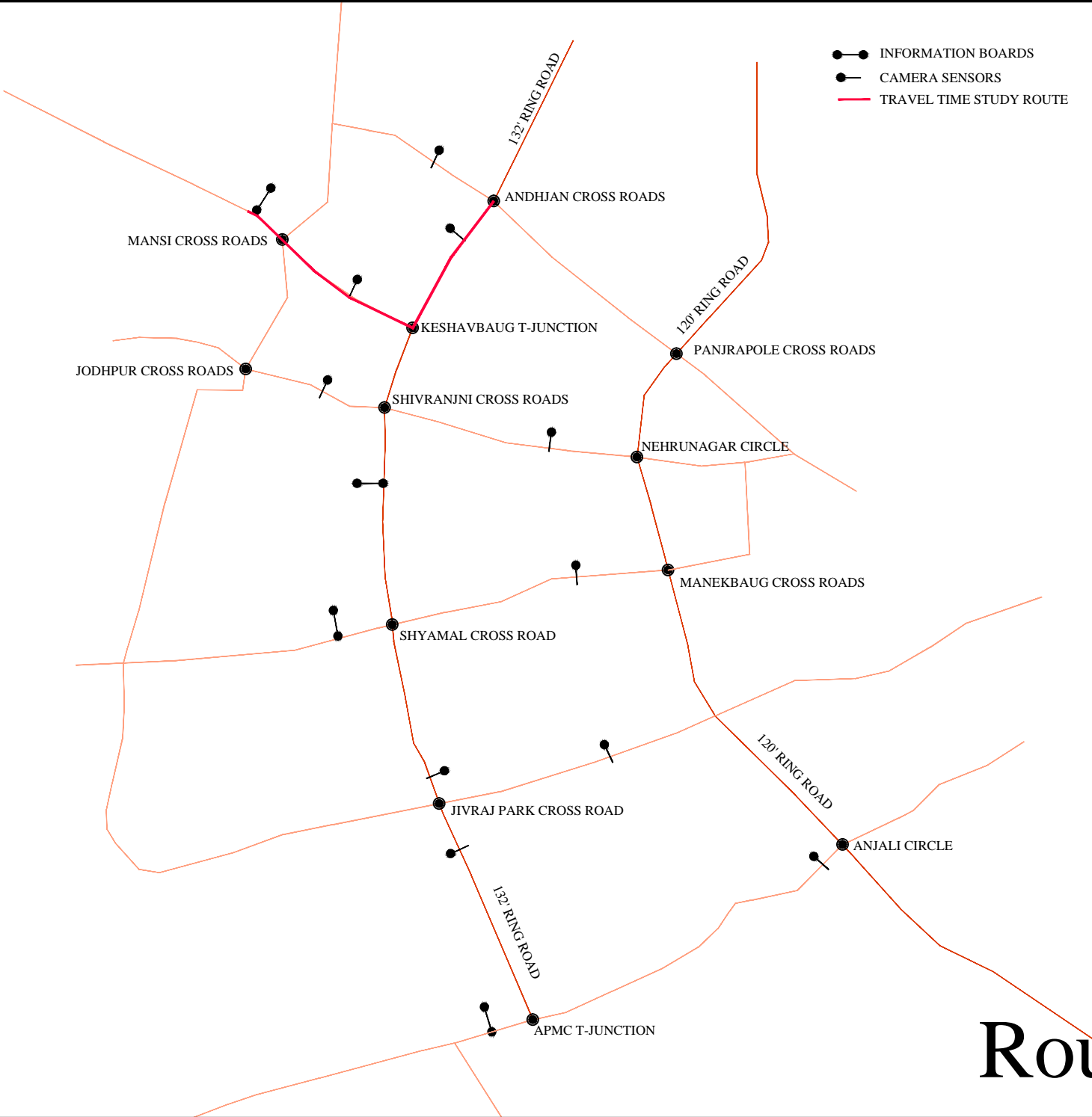
Route 4

- INFORMATION BOARDS
- CAMERA SENSORS
- TRAVEL TIME STUDY ROUTE



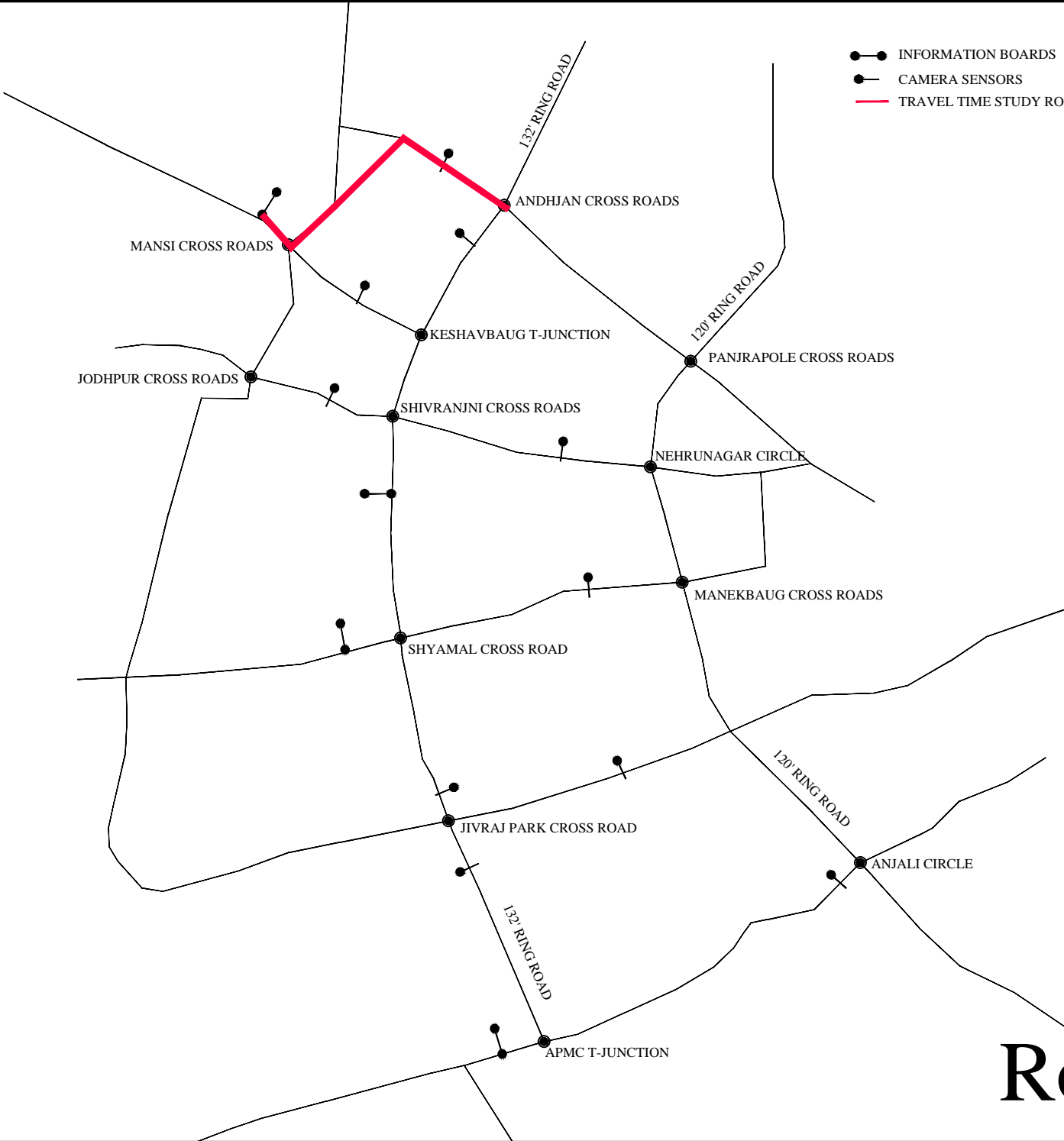
Route 5

- INFORMATION BOARDS
- CAMERA SENSORS
- TRAVEL TIME STUDY ROUTE



Route 6

- INFORMATION BOARDS
- CAMERA SENSORS
- TRAVEL TIME STUDY ROUTE



Route 7

Route 1: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Average Trip Travel Time (min)	Avg. Travel Time (min)
Evening Peak	APMC to Vejalpur	1,220.00	5.02	14.59				
	Vejalpur to Shyamal	950.00	0.78	72.77				
	Shyamal to Shivranjni	1,085.00	1.22	53.51				
	Shivranjni to Keshavbaug	450.00	0.95	28.42				
	Keshavbaug to Andhjan	775.00	3.05	15.25	24.40		11.02	
	APMC to Vejalpur	1,220.00	3.30	22.18				
	Vejalpur to Shyamal	950.00	3.10	18.39				
	Shyamal to Shivranjni	1,085.00	2.60	25.04				
	Shivranjni to Keshavbaug	450.00	2.67	10.13				
	Keshavbaug to Andhjan	775.00	1.28	36.23	20.76		12.95	
	APMC to Vejalpur	1,220.00	4.13	17.71				
	Vejalpur to Shyamal	950.00	1.60	35.63				
	Shyamal to Shivranjni	1,085.00	2.40	27.12				
	Shivranjni to Keshavbaug	450.00	1.63	16.53				
	Keshavbaug to Andhjan	775.00	1.23	37.70	24.44		11.00	
	APMC to Vejalpur	1,220.00	2.53	28.89				
	Vejalpur to Shyamal	950.00	2.17	26.31				
Shyamal to Shivranjni	1,085.00	2.25	28.93					
Shivranjni to Keshavbaug	450.00	3.58	7.53					
Keshavbaug to Andhjan	775.00	3.17	14.68	19.62		13.70		
APMC to Vejalpur	1,220.00	2.53	28.89					
Vejalpur to Shyamal	950.00	2.17	26.31					
Shyamal to Shivranjni	1,085.00	2.25	28.93					
Shivranjni to Keshavbaug	450.00	3.58	7.53					
Keshavbaug to Andhjan	775.00	3.17	14.68	19.62	23.64	13.70	11.62	

Route 2: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning Peak	APMC to Vasna	1,210.00	3.93	18.46			
	Vasna to Anjali	650.00	4.07	9.59	13.95		
	APMC to Vasna	1,210.00	3.98	18.23			
	Vasna to Anjali	650.00	7.05	5.53	10.11		
	APMC to Vasna	1,210.00	3.97	18.30			
	Vasna to Anjali	650.00	2.98	13.07	16.06		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	3.00	13.00	18.60		
	APMC to Vasna	1,210.00	2.05	35.41			
	Vasna to Anjali	650.00	3.00	13.00	22.10		
	APMC to Vasna	1,210.00	2.98	24.34			
	Vasna to Anjali	650.00	3.00	13.00	18.65		
	APMC to Vasna	1,210.00	2.03	35.70			
	Vasna to Anjali	650.00	3.02	12.93	22.10		
APMC to Vasna	1,210.00	2.03	35.70				
Vasna to Anjali	650.00	3.02	12.93	22.10			
APMC to Vasna	1,210.00	2.97	24.47				
Vasna to Anjali	650.00	3.00	13.00	18.70			
APMC to Vasna	1,210.00	1.98	36.61				
Vasna to Anjali	650.00	3.02	12.93	22.32			
APMC to Vasna	1,210.00	1.93	37.55				
Vasna to Anjali	650.00	4.05	9.63	18.65	18.49	6.04	
	APMC to Vasna	1,210.00	4.07	17.85			
	Vasna to Anjali	650.00	2.98	13.07	15.83		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	3.00	13.00	18.60		
	APMC to Vasna	1,210.00	2.98	24.34			
	Vasna to Anjali	650.00	3.00	13.00	18.65		
	APMC to Vasna	1,210.00	3.00	24.20			

Route 2: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Afternoon Peak	Vasna to Anjali	650.00	1.98	19.66	22.39		
	APMC to Vasna	1,210.00	4.02	18.07			
	Vasna to Anjali	650.00	2.98	13.07	15.94		
	APMC to Vasna	1,210.00	2.95	24.61			
	Vasna to Anjali	650.00	3.00	13.00	18.76		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	1.98	19.66	22.39		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	1.98	19.66	22.39		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	1.98	19.66	22.39		
		APMC to Vasna	1,210.00	2.98	24.34		
	Vasna to Anjali	650.00	1.98	19.66	22.47		
	APMC to Vasna	1,210.00	4.07	17.85			
	Vasna to Anjali	650.00	4.00	9.75	13.83	19.42	5.75
Evening Peak	APMC to Vasna	1,210.00	4.07	17.85			
	Vasna to Anjali	650.00	4.00	9.75	13.83		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	4.02	9.71	15.90		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	3.00	13.00	18.60		
	APMC to Vasna	1,210.00	3.00	24.20			
	Vasna to Anjali	650.00	1.98	19.66	22.39		
	APMC to Vasna	1,210.00	2.98	24.34			
	Vasna to Anjali	650.00	0.97	40.34	28.25		
APMC to Vasna	1,210.00	4.07	17.85				
Vasna to Anjali	650.00	2.98	13.07	15.83			
APMC to Vasna	1,210.00	3.05	23.80				
Vasna to Anjali	650.00	3.00	13.00	18.45			

Route 2: Travel Time and Speed Study (Pre-Implementation Stage)
Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	APMC to Vasna	1,210.00	3.05	23.80			
	Vasna to Anjali	650.00	3.00	13.00	18.45		
	APMC to Vasna	1,210.00	2.98	24.34			
	Vasna to Anjali	650.00	4.02	9.71	15.94		
	APMC to Vasna	1,210.00	2.98	24.34			
	Vasna to Anjali	650.00	3.02	12.93	18.60	18.63	5.99

Route 3: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	EIB 2 to Shyamal	210.00	2.00	6.30			
	Shyamal to Vejalpur	950.00	3.42	16.68			
	Vejalpur to Jivraj	1,130.00	2.62	25.91			
	Jivraj to Dharnidhar	938.00	3.90	14.43	16.23		
	EIB 2 to Shyamal	210.00	2.25	5.60			
	Shyamal to Vejalpur	950.00	1.23	46.22			
	Vejalpur to Jivraj	1,130.00	2.28	29.69			
	Jivraj to Dharnidhar	938.00	2.30	24.47	24.01		
	EIB 2 to Shyamal	210.00	1.08	11.63			
	Shyamal to Vejalpur	950.00	1.12	51.04			
	Vejalpur to Jivraj	1,130.00	1.17	58.11			
	Jivraj to Dharnidhar	938.00	2.23	25.20	34.59		
	EIB 2 to Shyamal	210.00	1.12	11.28			
	Shyamal to Vejalpur	950.00	1.25	45.60			
	Vejalpur to Jivraj	1,130.00	2.23	30.36			
	Jivraj to Dharnidhar	938.00	1.15	48.94	33.68		
Evening							
	EIB 2 to Shyamal	210.00	2.25	5.60			
	Shyamal to Vejalpur	950.00	2.17	26.31			
	Vejalpur to Jivraj	1,130.00	3.17	21.41			
	Jivraj to Dharnidhar	938.00	1.25	45.02	21.93		
	EIB 2 to Shyamal	210.00	1.20	10.50			
	Shyamal to Vejalpur	950.00	2.23	25.52			
	Vejalpur to Jivraj	1,130.00	1.32	51.49			
	Jivraj to Dharnidhar	938.00	1.17	48.24	32.73		
	EIB 2 to Shyamal	210.00	1.17	10.80			
	Shyamal to Vejalpur	950.00	2.25	25.33			
	Vejalpur to Jivraj	1,130.00	2.28	29.69			
	Jivraj to Dharnidhar	938.00	3.23	17.41	21.68		
	EIB 2 to Shyamal	210.00	2.25	5.60			
	Shyamal to Vejalpur	950.00	3.27	17.45			
	Vejalpur to Jivraj	1,130.00	2.08	32.54			
	Jivraj to Dharnidhar	938.00	3.33	16.88	17.71		
	EIB 2 to Shyamal	210.00	2.67	4.73			
	Shyamal to Vejalpur	950.00	4.17	13.68			
	Vejalpur to Jivraj	1,130.00	3.25	20.86			
	Jivraj to Dharnidhar	938.00	2.28	24.65	15.66		
	EIB 2 to Shyamal	210.00	2.67	4.73			
	Shyamal to Vejalpur	950.00	4.17	13.68			
	Vejalpur to Jivraj	1,130.00	3.25	20.86			
	Jivraj to Dharnidhar	938.00	2.28	24.65	15.66	23.39	8.28
Afternoon							
	EIB 2 to Shyamal	210	2.2500	5.60			
	Shyamal to Vejalpur	950	4.8333	11.79			
	Vejalpur to Jivraj	1130	1.8333	36.98			

Route 3: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Jivraj to Dharnidhar	938	2.8667	19.63	16.44		
	EIB 2 to Shyamal	210	2.08333	6.05			
	Shyamal to Vejalpur	950	1.26667	45.00			
	Vejalpur to Jivraj	1130	1	67.80			
	Jivraj to Dharnidhar	938	9	6.25	14.51		
	EIB 2 to Shyamal	210	3.41667	3.69			
	Shyamal to Vejalpur	950	3.33333	17.10			
	Vejalpur to Jivraj	1130	1.5	45.20			
	Jivraj to Dharnidhar	938	2.56667	21.93	17.91		
	EIB 2 to Shyamal	210	2.16667	5.82			
	Shyamal to Vejalpur	950	3.08333	18.49			
	Vejalpur to Jivraj	1130	2.41667	28.06			
	Jivraj to Dharnidhar	938	2.25	25.01	19.53		
	EIB 2 to Shyamal	210	3.33333	3.78			
	Shyamal to Vejalpur	950	5.25	10.86			
	Vejalpur to Jivraj	1130	2.25	30.13			
	Jivraj to Dharnidhar	938	3.25	17.32	13.75		
	EIB 2 to Shyamal	210	2.25	5.60			
	Shyamal to Vejalpur	950	1.5	38.00			
	Vejalpur to Jivraj	1130	1.23333	54.97			
	Jivraj to Dharnidhar	938	1.33333	42.21	30.66		
	EIB 2 to Shyamal	210	1.5	8.40			
	Shyamal to Vejalpur	950	2.16667	26.31			
	Vejalpur to Jivraj	1130	3.83333	17.69			
	Jivraj to Dharnidhar	938	1.16667	48.24	22.35		
	EIB 2 to Shyamal	210	1.08333	11.63			
	Shyamal to Vejalpur	950	1.25	45.60			
	Vejalpur to Jivraj	1130	1.5	45.20			
	Jivraj to Dharnidhar	938	1.66667	33.77	35.21		
	EIB 2 to Shyamal	210	1.75	7.20			
	Shyamal to Vejalpur	950	2.25	25.33			
	Vejalpur to Jivraj	1130	2.28333	29.69			
	Jivraj to Dharnidhar	938	3.2	17.59	20.42		
	EIB 2 to Shyamal	210	2.28333	5.52			
	Shyamal to Vejalpur	950	2.28333	24.96			
	Vejalpur to Jivraj	1130	2.28333	29.69			
	Jivraj to Dharnidhar	938	2.5	22.51	20.71	21.15	9.16
	EIB 2 to Shyamal	210	1.95	6.46			
	Shyamal to Vejalpur	950	2.5	22.80			
	Vejalpur to Jivraj	1130	3.16667	21.41			
	Jivraj to Dharnidhar	938	1.03333	54.46	22.39		
	EIB 2 to Shyamal	210	0.83333	15.12			
	Shyamal to Vejalpur	950	0.5	114.00			

Route 3: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Vejalpur to Jivraj	1130	3.16667	21.41			
	Jivraj to Dharnidhar	938	2.16667	25.98	29.05		
	EIB 2 to Shyamal	210	1.38333	9.11			
	Shyamal to Vejalpur	950	1	57.00			
	Vejalpur to Jivraj	1130	3.33333	20.34			
	Jivraj to Dharnidhar	938	1.16667	48.24	28.14		
	EIB 2 to Shyamal	210	1.16667	10.80			
	Shyamal to Vejalpur	950	1.16667	48.86			
	Vejalpur to Jivraj	1130	1.25	54.24			
	Jivraj to Dharnidhar	938	1.33333	42.21	39.39		
	EIB 2 to Shyamal	210	0.75	16.80			
	Shyamal to Vejalpur	950	0.91667	62.18			
	Vejalpur to Jivraj	1130	1.08333	62.58			
	Jivraj to Dharnidhar	938	1.18333	47.56	49.24		
	EIB 2 to Shyamal	210	5.41667	2.33			
	Shyamal to Vejalpur	950	1.25	45.60			
	Vejalpur to Jivraj	1130	2.16667	31.29			
	Jivraj to Dharnidhar	938	1.21667	46.26	19.27		
	EIB 2 to Shyamal	210	2	6.30			
	Shyamal to Vejalpur	950	1.16667	48.86			
	Vejalpur to Jivraj	1130	1.25	54.24			
	Jivraj to Dharnidhar	938	2.16667	25.98	29.42		
	EIB 2 to Shyamal	210	1.16667	10.80			
	Shyamal to Vejalpur	950	1.16667	48.86			
	Vejalpur to Jivraj	1130	1.33333	50.85			
	Jivraj to Dharnidhar	938	1.55	36.31	37.13		
	EIB 2 to Shyamal	210	1.15	10.96			
	Shyamal to Vejalpur	950	1.13333	50.29			
	Vejalpur to Jivraj	1130	1.28333	52.83			
	Jivraj to Dharnidhar	938	1.2	46.90	40.63		
	EIB 2 to Shyamal	210	1.25	10.08			
	Shyamal to Vejalpur	950	1.26667	45.00			
	Vejalpur to Jivraj	1130	1.66667	40.68			
	Jivraj to Dharnidhar	938	2.53333	22.22	28.84	32.35	5.99

Route 4: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	Shyamal to Manekbaug soc	1,260.00	3.77	20.07			
	Manekbaug soc to Manekbaug cross road	200.00	3.43	3.50	12.17		
	Shyamal to Manekbaug soc	1,260.00	3.65	20.71			
	Manekbaug soc to Manekbaug cross road	200.00	2.00	6.00	15.50		
	Shyamal to Manekbaug soc	1,260.00	4.30	17.58			
	Manekbaug soc to Manekbaug cross road	200.00	1.12	10.75	16.17		
	Shyamal to Manekbaug soc	1,260.00	1.83	41.24			
	Manekbaug soc to Manekbaug cross road	200.00	2.47	4.86	20.37		
	Shyamal to Manekbaug soc	1,260.00	2.03	37.18			
	Manekbaug soc to Manekbaug cross road	200.00	2.78	4.31	18.19		
	Shyamal to Manekbaug soc	1,260.00	1.70	44.47			
	Manekbaug soc to Manekbaug cross road	200.00	1.60	7.50	26.55		
	Shyamal to Manekbaug soc	1,260.00	5.13	14.73			
	Manekbaug soc to Manekbaug cross road	200.00	2.25	5.33	11.86		
	Shyamal to Manekbaug soc	1,260.00	2.17	34.89			
	Manekbaug soc to Manekbaug cross road	200.00	2.08	5.76	20.61	17.68	4.96
Afternoon							
	Shyamal to Manekbaug soc	1,260.00	1.00	75.60			
	Manekbaug soc to Manekbaug cross road	200.00	1.50	8.00	35.04		
	Shyamal to Manekbaug soc	1,260.00	2.80	27.00			
	Manekbaug soc to Manekbaug cross road	200.00	1.55	7.74	20.14		
	Shyamal to Manekbaug soc	1,260.00	2.98	25.34			
	Manekbaug soc to Manekbaug cross road	200.00	2.28	5.26	16.63		
	Shyamal to Manekbaug soc	1,260.00	2.43	31.07			
	Manekbaug soc to Manekbaug cross road	200.00	2.82	4.26	16.69		
	Shyamal to Manekbaug soc	1,260.00	3.90	19.38			
	Manekbaug soc to Manekbaug cross road	200.00	6.00	2.00	8.85		
		1,260.00					
	Shyamal to Manekbaug soc	200.00	1.48	8.09			
	Manekbaug soc to Manekbaug cross road		0.93	-	4.97		
	Shyamal to Manekbaug soc	1,260.00	2.60	29.08			
	Manekbaug soc to Manekbaug cross road	200.00	5.83	2.06	10.39		

Route 4: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Shyamal to Manekbaug soc	1,260.00	5.00	15.12			
	Manekbaug soc to Manekbaug cross road	200.00	15.00	0.80	4.38	14.63	5.99
	Evening						
	Shyamal to Manekbaug soc	1,260.00	0.82	92.57			
	Manekbaug soc to Manekbaug cross road	200.00	3.00	4.00	22.95		
	Shyamal to Manekbaug soc	1,260.00	3.97	19.06			
	Manekbaug soc to Manekbaug cross road	200.00	1.43	8.37	16.22		
	Shyamal to Manekbaug soc	1,260.00	3.13	24.13			
	Manekbaug soc to Manekbaug cross road	200.00	1.98	6.05	17.12		
	Shyamal to Manekbaug soc	1,260.00	3.17	23.87			
	Manekbaug soc to Manekbaug cross road	200.00	2.53	4.74	15.37		
	Shyamal to Manekbaug soc	1,260.00	6.25	12.10			
	Manekbaug soc to Manekbaug cross road	200.00	2.42	4.97	10.11		
		1,260.00					
	Shyamal to Manekbaug soc	200.00	4.13	2.90			
	Manekbaug soc to Manekbaug cross road		2.67	-	1.76		
	Shyamal to Manekbaug soc	1,260.00	3.18	23.75			
	Manekbaug soc to Manekbaug cross road	200.00	2.55	4.71	15.28		
	Shyamal to Manekbaug soc	1,260.00	3.27	23.14			
	Manekbaug soc to Manekbaug cross road	200.00	2.58	4.65	14.97	14.22	6.16

Route 5: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	Jodhpur to Shivrangjni	400.00	1.00	24.00			
	Shivrangjni to Nehrunagar	1,330.00	3.00	26.60	25.95		
	Jodhpur to Shivrangjni	400.00	1.67	14.40			
	Shivrangjni to Nehrunagar	1,330.00	6.33	12.60	12.98		
	Jodhpur to Shivrangjni	400.00	2.13	11.25			
	Shivrangjni to Nehrunagar	1,330.00	4.00	19.95	16.92		
	Jodhpur to Shivrangjni	400.00	1.25	19.20			
	Shivrangjni to Nehrunagar	1,330.00	3.83	20.82	20.42		
	Jodhpur to Shivrangjni	400.00	2.58	9.29			
	Shivrangjni to Nehrunagar	1,330.00	3.42	23.36	17.30		
	Jodhpur to Shivrangjni	400.00	2.00	12.00			
	Shivrangjni to Nehrunagar	1,330.00	3.25	24.55	19.77	18.89	5.49
Afternoon							
	Jodhpur to Shivrangjni	400.00	1.08	22.15			
	Shivrangjni to Nehrunagar	1,330.00	4.58	17.41	18.32		
	Jodhpur to Shivrangjni	400.00	1.08	22.15			
	Shivrangjni to Nehrunagar	1,330.00	4.33	18.42	19.16		
	Jodhpur to Shivrangjni	400.00	1.75	13.71			
	Shivrangjni to Nehrunagar	1,330.00	4.25	18.78	17.30		
	Jodhpur to Shivrangjni	400.00	1.17	20.57			
	Shivrangjni to Nehrunagar	1,330.00	4.25	18.78	19.16		
	Jodhpur to Shivrangjni	400.00	1.58	15.16			
	Shivrangjni to Nehrunagar	1,330.00	3.33	23.94	21.11		
	Jodhpur to Shivrangjni	400.00	1.00	24.00			
	Shivrangjni to Nehrunagar	1,330.00	3.00	26.60	25.95		
	Jodhpur to Shivrangjni	400.00	1.00	24.00			
	Shivrangjni to Nehrunagar	1,330.00	3.75	21.28	21.85		
	Jodhpur to Shivrangjni	400.00	1.75	13.71			
	Shivrangjni to Nehrunagar	1,330.00	4.50	17.73	16.61		
	Jodhpur to Shivrangjni	400.00	1.00	24.00			

Route 5: Travel Time and Speed Study (Pre-Implementation Stage)**Date: 30th September**

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Shivranjni to Nehrunagar	1,330.00	3.25	24.55	24.42	20.43	5.08
Evening							
	Jodhpur to Shivranjni	400.00	4.25	5.65			
	Shivranjni to Nehrunagar	1,330.00	4.17	19.15	12.33		
	Jodhpur to Shivranjni	400.00	1.50	16.00			
	Shivranjni to Nehrunagar	1,330.00	5.17	15.45	15.57		
	Jodhpur to Shivranjni	400.00	2.50	9.60			
	Shivranjni to Nehrunagar	1,330.00	3.25	24.55	18.05		
	Jodhpur to Shivranjni	400.00	1.25	19.20			
	Shivranjni to Nehrunagar	1,330.00	4.00	19.95	19.77		
	Jodhpur to Shivranjni	400.00	1.00	24.00			
	Shivranjni to Nehrunagar	1,330.00	2.00	39.90	34.60		
	Jodhpur to Shivranjni	400.00	1.25	19.20			
	Shivranjni to Nehrunagar	1,330.00	4.25	18.78	18.87		
	Jodhpur to Shivranjni	400.00	2.25	10.67			
	Shivranjni to Nehrunagar	1,330.00	5.50	14.51	13.39		
	Jodhpur to Shivranjni	400.00	2.25	10.67			
	Shivranjni to Nehrunagar	1,330.00	4.50	17.73	15.38	18.50	5.61

Route 6: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	Mansi to Keshavbaug	800.00	1.88	25.49			
	Keshavbaug to Andhjan	775.00	6.80	6.84	10.88		
	Mansi to Keshavbaug	800.00	1.72	27.96			
	Keshavbaug to Andhjan	775.00	4.42	10.53	15.41		
	Mansi to Keshavbaug	800.00	2.80	17.14			
	Keshavbaug to Andhjan	775.00	4.50	10.33	12.95		
	Mansi to Keshavbaug	800.00	1.60	30.00			
	Keshavbaug to Andhjan	775.00	2.77	16.81	21.64		
	Mansi to Keshavbaug	800.00	1.20	40.00			
	Keshavbaug to Andhjan	775.00	3.20	14.53	21.48		
	Mansi to Keshavbaug	800.00	1.30	36.92			
	Keshavbaug to Andhjan	775.00	2.68	17.33	23.72		
	Mansi to Keshavbaug	800.00	1.38	34.70			
	Keshavbaug to Andhjan	775.00	3.13	14.84	20.92		
	Mansi to Keshavbaug	800.00	1.53	31.30			
	Keshavbaug to Andhjan	775.00	2.75	16.91	22.06		
	Mansi to Keshavbaug	800.00	1.70	28.24			
	Keshavbaug to Andhjan	775.00	3.27	14.23	19.03		
	Mansi to Keshavbaug	800.00	1.38	34.70			
	Keshavbaug to Andhjan	775.00	2.67	17.44	23.33		
	Mansi to Keshavbaug	800.00	1.27	37.89			
	Keshavbaug to Andhjan	775.00	2.30	20.22	26.50	19.81	4.77
Afternoon							
	Mansi to Keshavbaug	800.00	1.38	34.70			
	Keshavbaug to Andhjan	775.00	2.87	16.22	22.24		
	Mansi to Keshavbaug	800.00	1.37	35.12			
	Keshavbaug to Andhjan	775.00	1.17	39.86	37.30		
	Mansi to Keshavbaug	800.00	1.17	41.14			
	Keshavbaug to Andhjan	775.00	1.33	34.87	37.80		
	Mansi to Keshavbaug	800.00	1.27	37.89			

Route 6: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Mansi to Keshavbaug	800.00	1.68	28.51			
	Keshavbaug to Andhjan	775.00	1.10	42.27	33.95		
	Mansi to Keshavbaug	800.00	1.45	33.10			
	Keshavbaug to Andhjan	775.00	1.40	33.21	33.16		
	Mansi to Keshavbaug	800.00	2.95	16.27			
	Keshavbaug to Andhjan	775.00	1.32	35.32	22.15		
	Mansi to Keshavbaug	800.00	2.80	17.14			
	Keshavbaug to Andhjan	775.00	1.27	36.71	23.24		
	Mansi to Keshavbaug	800.00	2.70	17.78			
	Keshavbaug to Andhjan	775.00	1.42	32.82	22.96		
	Mansi to Keshavbaug	800.00	2.73	17.56			
	Keshavbaug to Andhjan	775.00	1.38	33.61	22.96		
	Mansi to Keshavbaug	800.00	3.72	12.91			
	Keshavbaug to Andhjan	775.00	1.55	30.00	17.94		
	Mansi to Keshavbaug	800.00	3.23	14.85			
	Keshavbaug to Andhjan	775.00	1.77	26.32	18.90		
	Mansi to Keshavbaug	800.00	2.63	18.23			
	Keshavbaug to Andhjan	775.00	2.00	23.25	20.40		
	Mansi to Keshavbaug	800.00	1.57	30.64			
	Keshavbaug to Andhjan	775.00	3.05	15.25	20.47		
	Mansi to Keshavbaug	800.00	2.95	16.27			
	Keshavbaug to Andhjan	775.00	4.33	10.73	12.97		
	Mansi to Keshavbaug	800.00	2.72	17.67			
	Keshavbaug to Andhjan	775.00	1.70	27.35	21.40	24.25	3.90

Route 7: Travel Time and Speed Study (Pre-Implementation Stage)

Date: 30th September

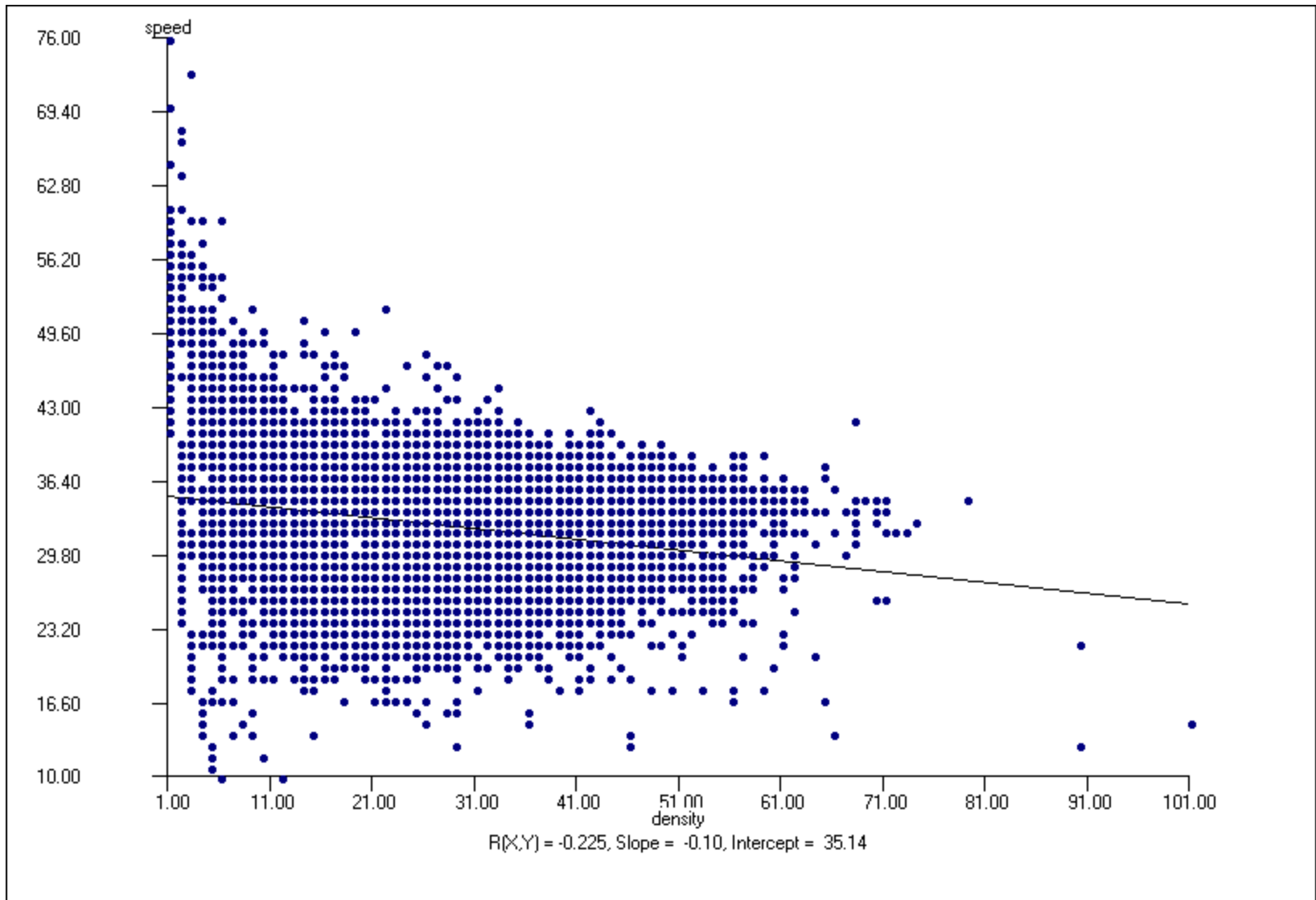
	Section	Distance (m) (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	EIB 4 to Mansi	180.00	0.40	27.00			
	Mansi to Vastrapur	720.00	1.92	22.54			
	Vastrapur to lim	930.00	2.72	20.54	23.36		
	EIB 4 to Mansi	180.00	0.73	14.73			
	Mansi to Vastrapur	720.00	1.93	22.34			
	Vastrapur to lim	930.00	2.92	19.13	18.73		
	EIB 4 to Mansi	180.00	0.72	15.07			
	Mansi to Vastrapur	720.00	1.77	24.45			
	Vastrapur to lim	930.00	2.27	24.62	21.38		
	EIB 4 to Mansi	180.00	1.07	10.13			
	Mansi to Vastrapur	720.00	1.68	25.66			
	Vastrapur to lim	930.00	2.52	22.17	19.32		
	EIB 4 to Mansi	180.00	0.52	20.90			
	Mansi to Vastrapur	720.00	1.70	25.41			
	Vastrapur to lim	930.00	4.42	12.63	19.65		
	EIB 4 to Mansi	180.00	0.73	14.73			
	Mansi to Vastrapur	720.00	1.83	23.56			
	Vastrapur to lim	930.00	2.38	23.41	20.57		
	EIB 4 to Mansi	180.00	0.87	12.46			
	Mansi to Vastrapur	720.00	1.95	22.15			
	Vastrapur to lim	930.00	1.93	28.86	21.16		
	EIB 4 to Mansi	180.00	1.03	10.45			
	Mansi to Vastrapur	720.00	1.98	21.78			
	Vastrapur to lim	930.00	1.93	28.86	20.37		
	EIB 4 to Mansi	180.00	1.10	9.82			
	Mansi to Vastrapur	720.00	2.20	19.64			
	Vastrapur to lim	930.00	2.57	21.74	17.06	21.63	5.08
Evening							
	EIB 4 to Mansi	180.00	0.40	27.00			
	Mansi to Vastrapur	720.00	1.93	22.34			
	Vastrapur to lim	930.00	2.72	20.54	23.29		
	EIB 4 to Mansi	180.00	1.85	5.84			
	Mansi to Vastrapur	720.00	2.15	20.09			
	Vastrapur to lim	930.00	3.13	17.81	14.58		
	EIB 4 to Mansi	180.00	1.57	6.89			
	Mansi to Vastrapur	720.00	2.43	17.75			
	Vastrapur to lim	930.00	3.45	16.17	13.61		
	EIB 4 to Mansi	180.00	1.35	8.00			

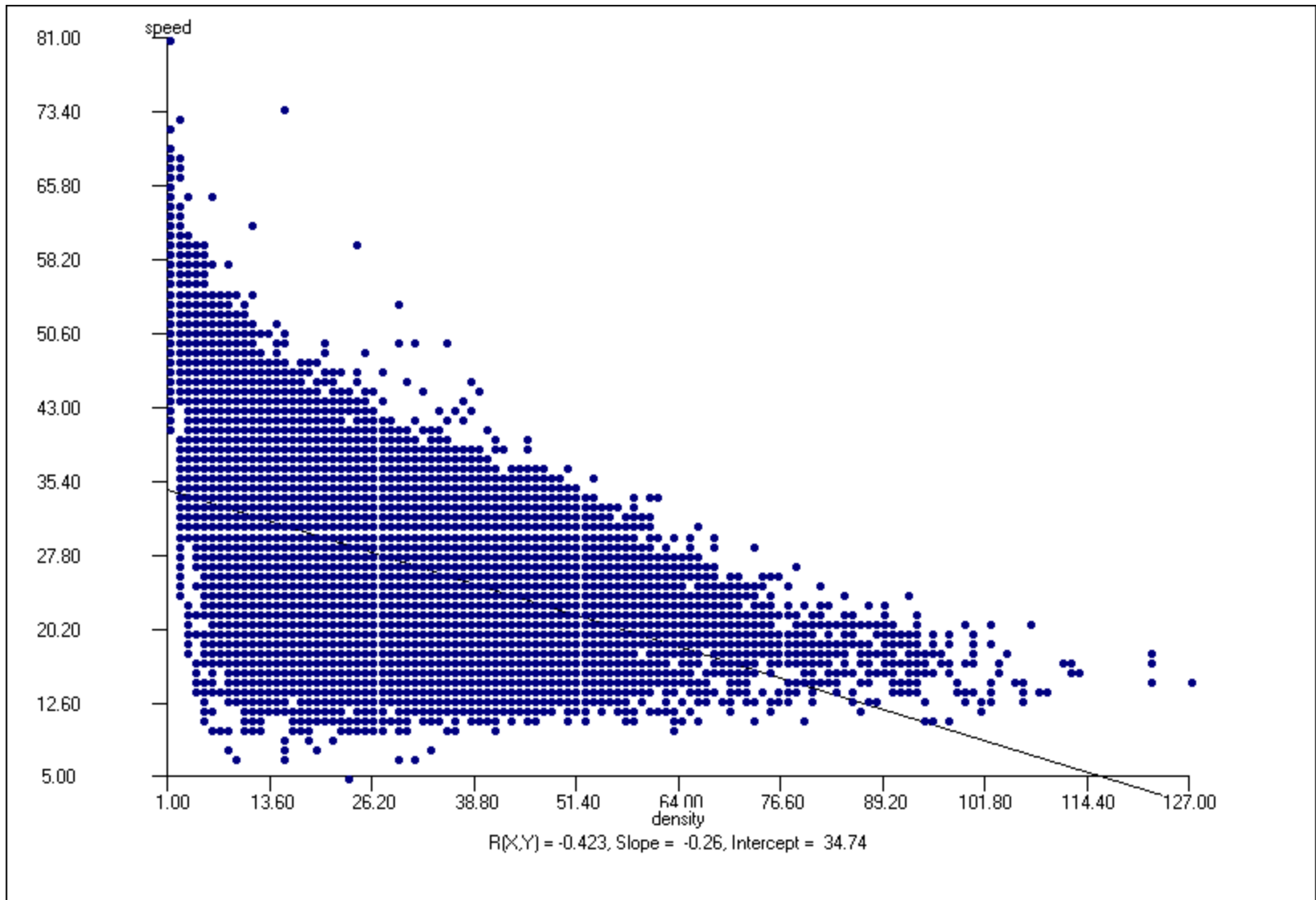
Route 7: Travel Time and Speed Study (Pre-Implementation Stage)

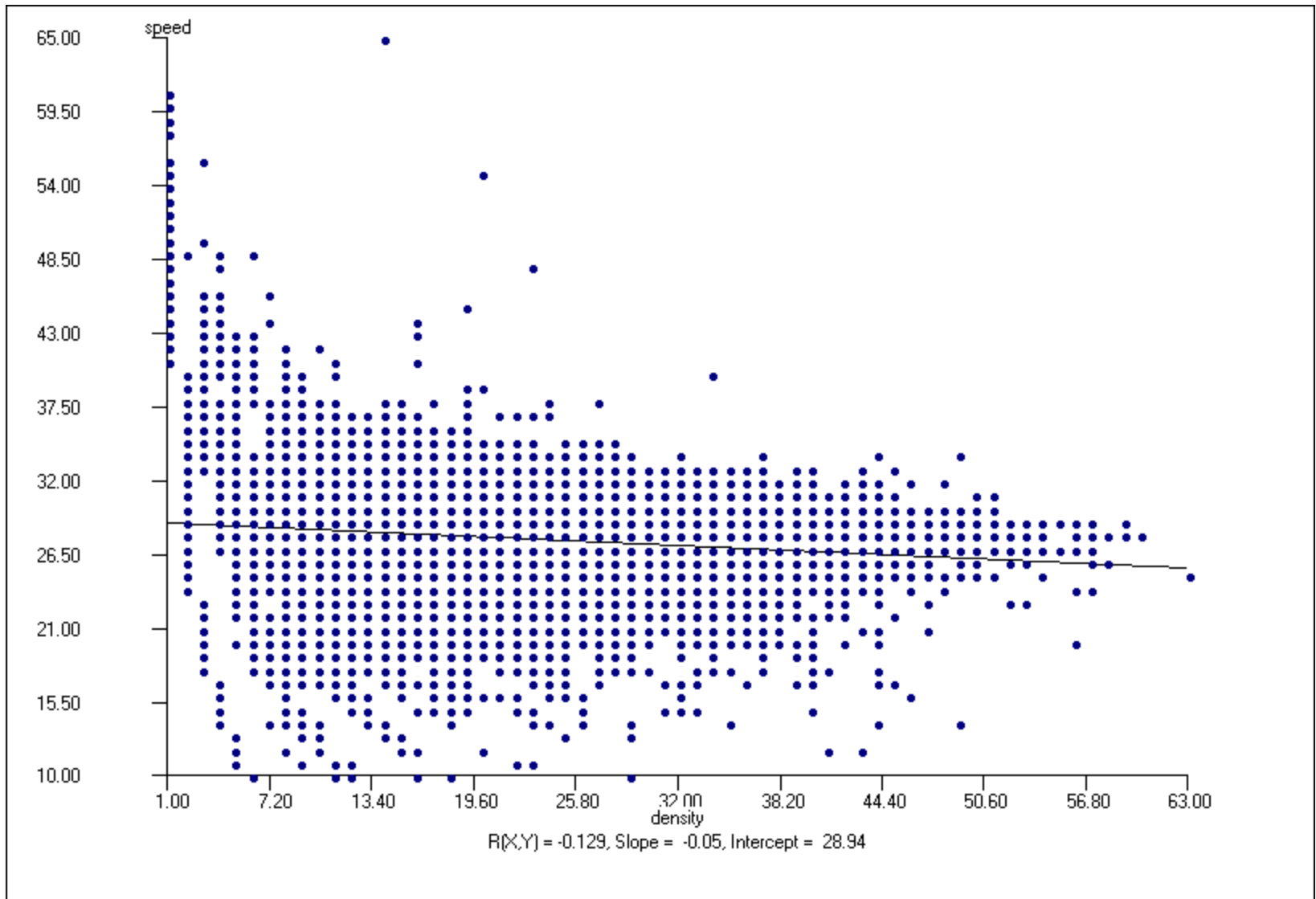
Date: 30th September

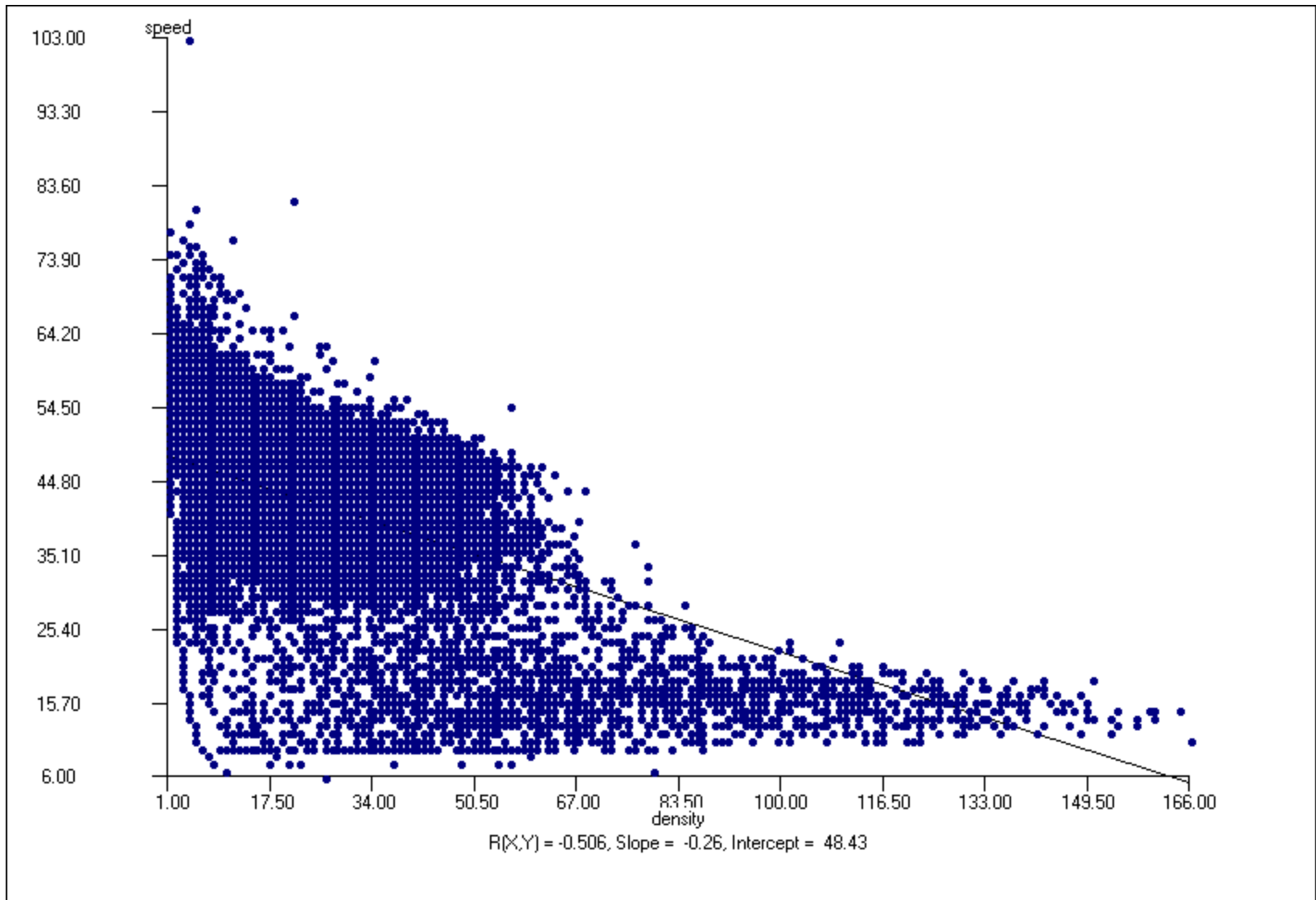
	Section	Distance (m) (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Mansi to Vastrapur	720.00	2.13	20.25			
	Vastrapur to lim	930.00	8.02	6.96	11.74		
	EIB 4 to Mansi	180.00	1.18	9.13			
	Mansi to Vastrapur	720.00	2.20	19.64			
	Vastrapur to lim	930.00	2.50	22.32	17.03		
	EIB 4 to Mansi	180.00	1.95	5.54			
	Mansi to Vastrapur	720.00	2.30	18.78			
	Vastrapur to lim	930.00	3.03	18.40	14.24		
	EIB 4 to Mansi	180.00	0.93	11.57			
	Mansi to Vastrapur	720.00	2.98	14.48			
	Vastrapur to lim	930.00	2.72	20.54	15.53	15.72	6.99

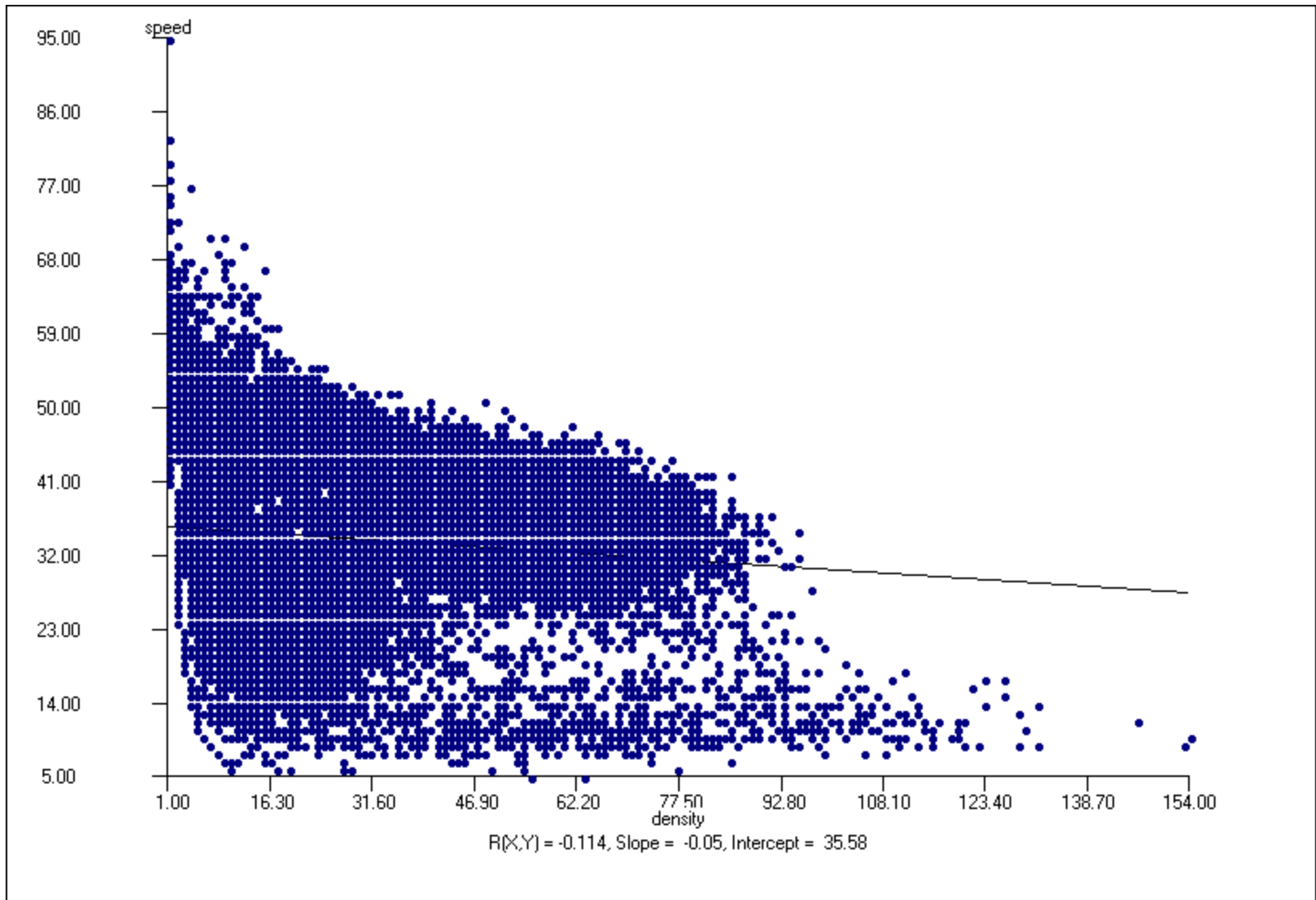
APPENDIX 13
SPEED DENSITY RELATIONSHIP CURVES

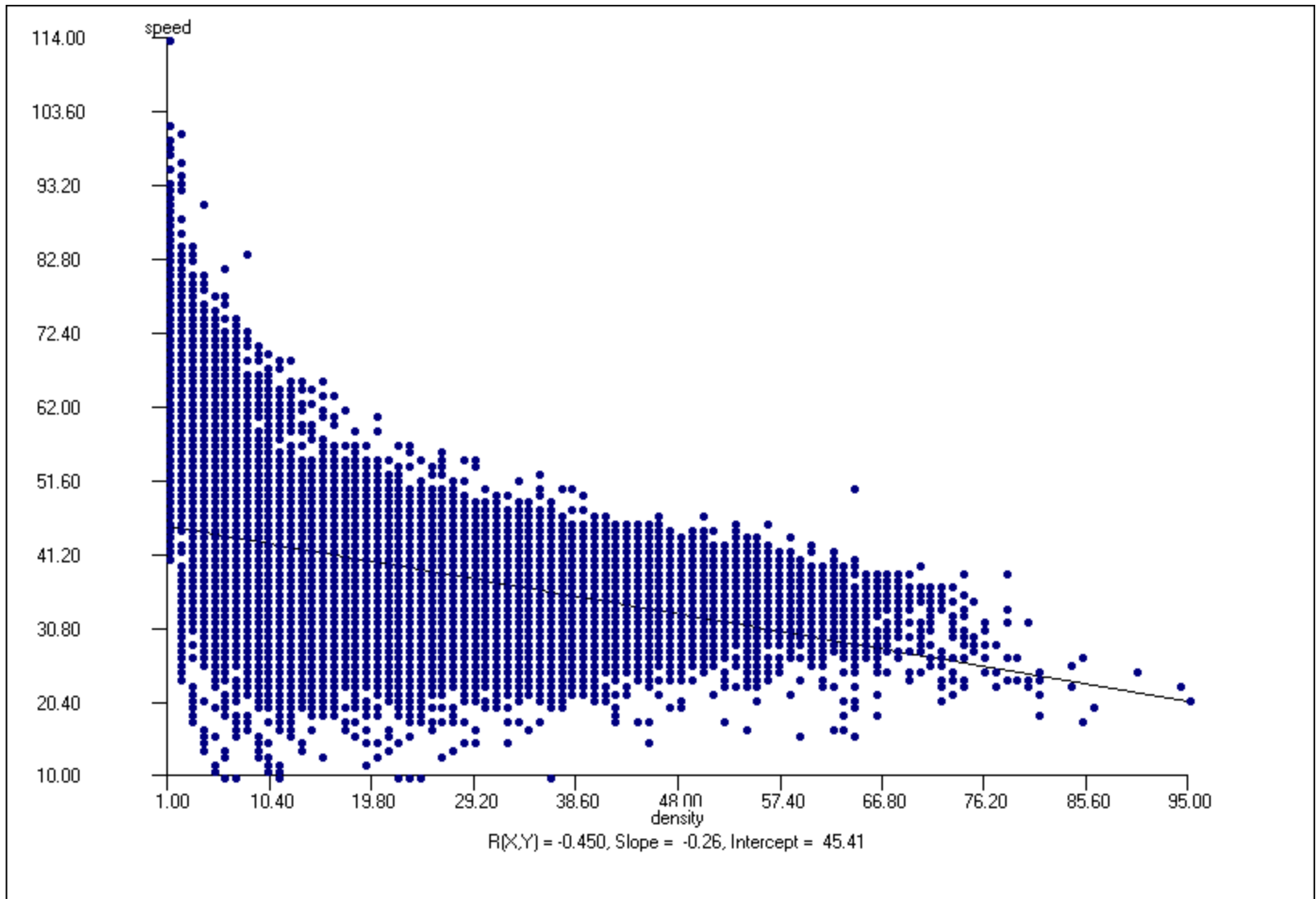


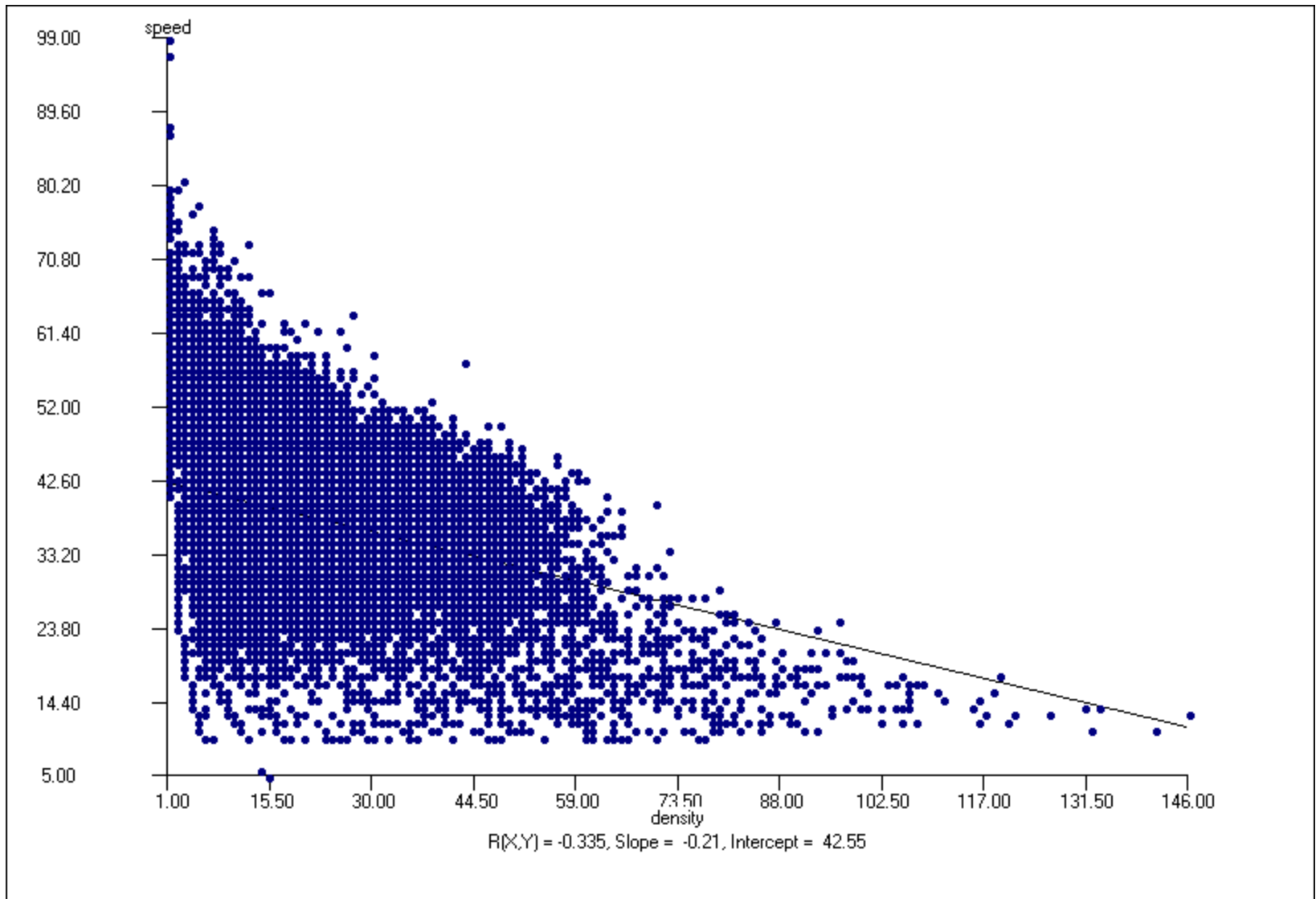


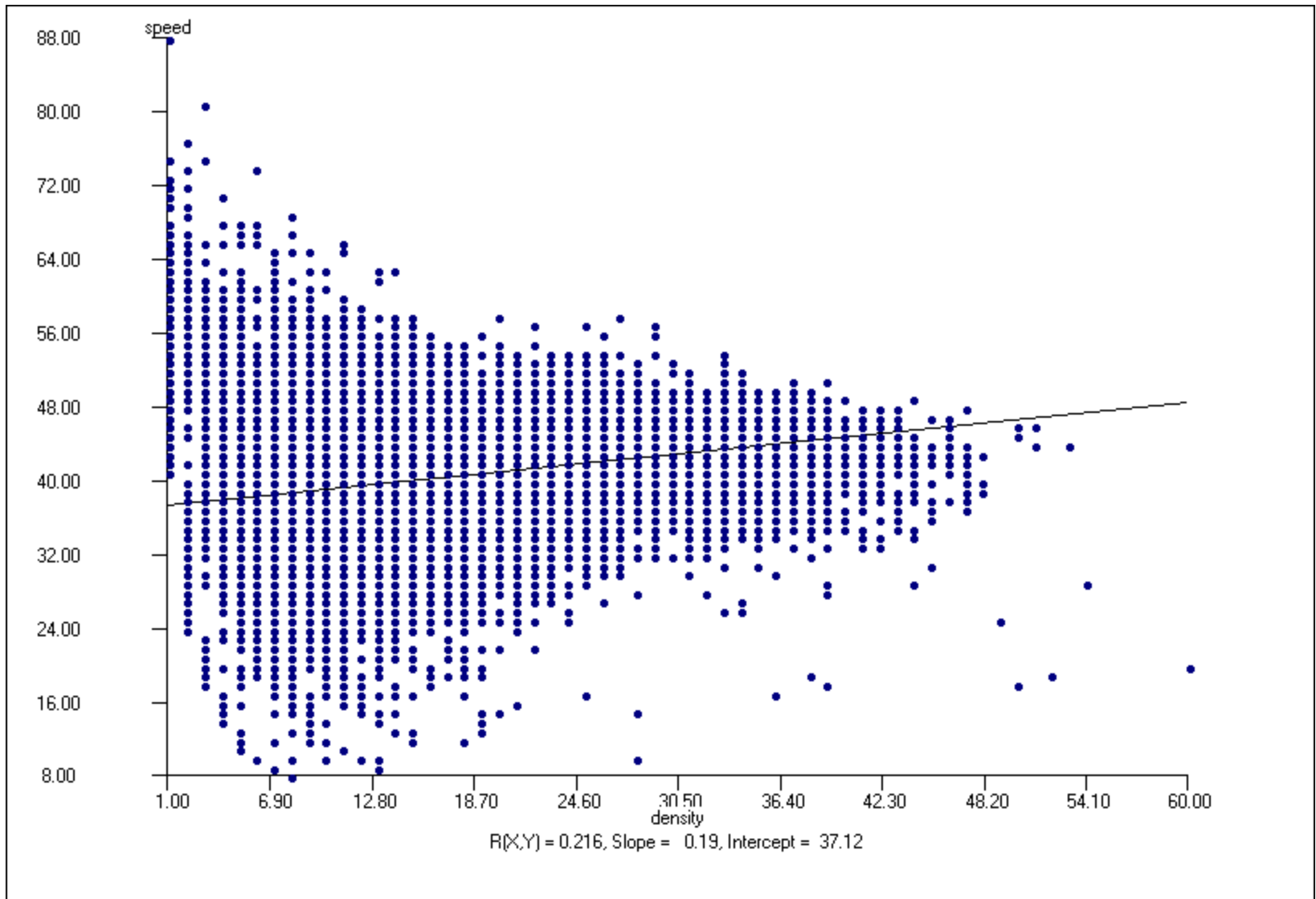


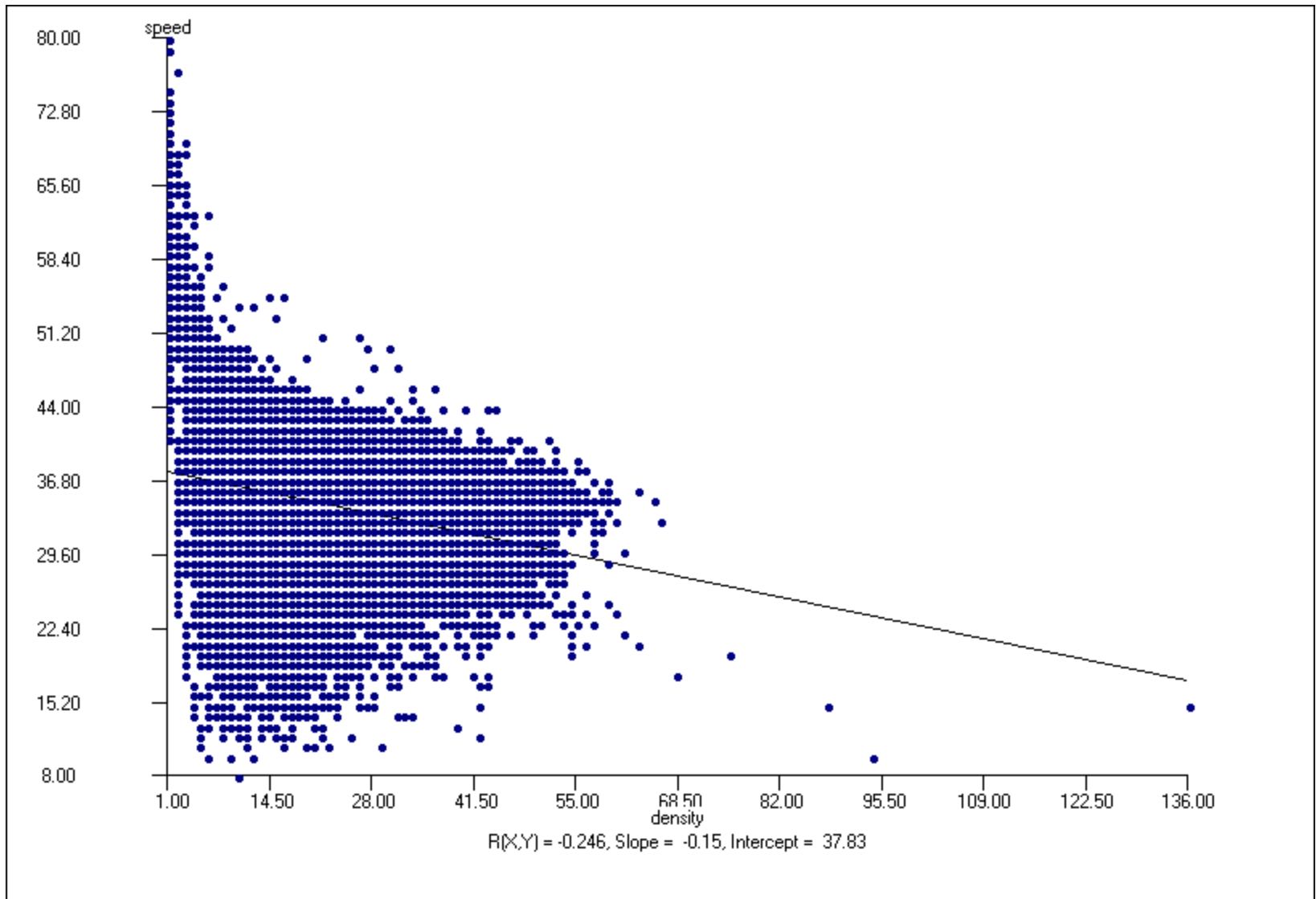


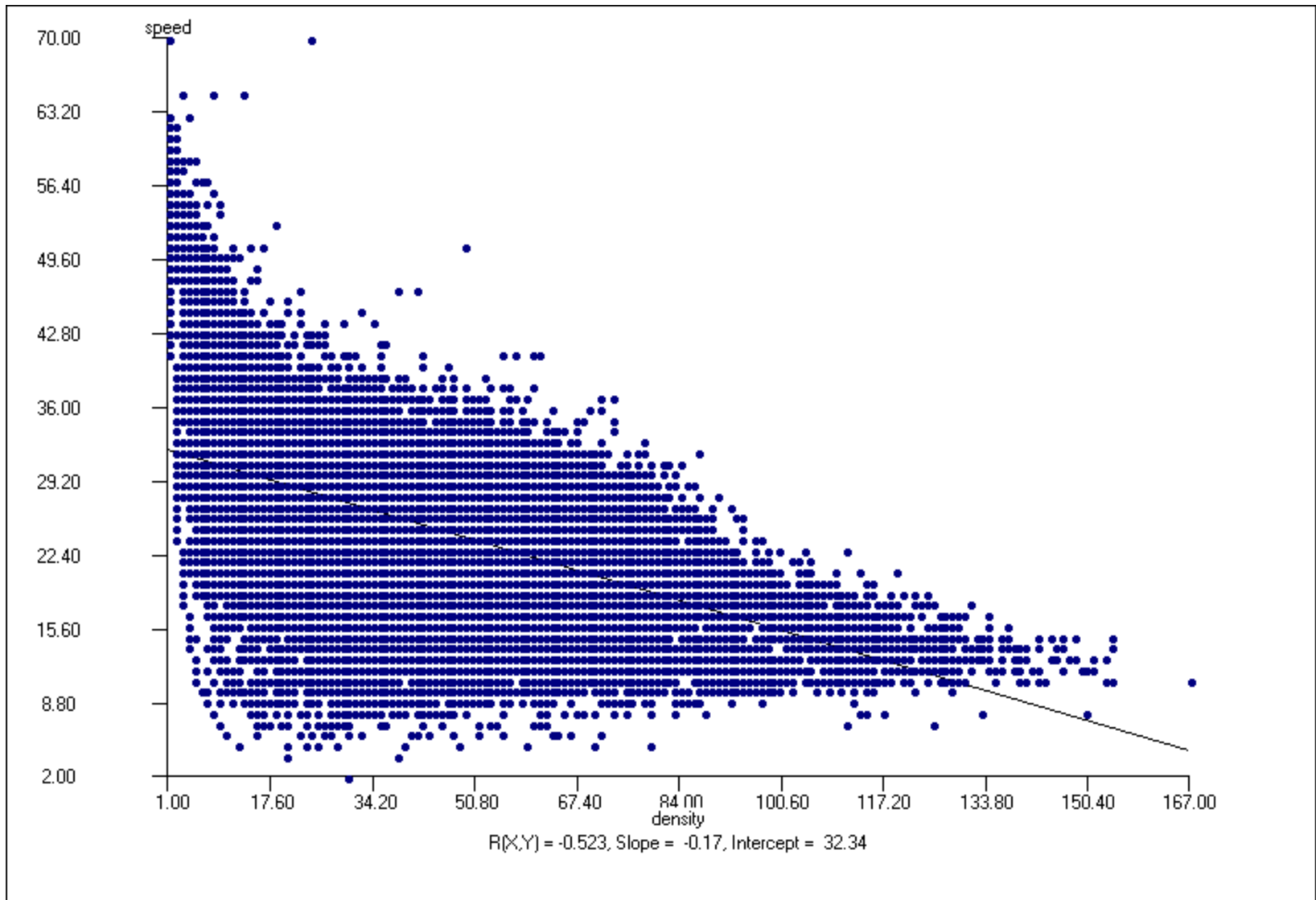


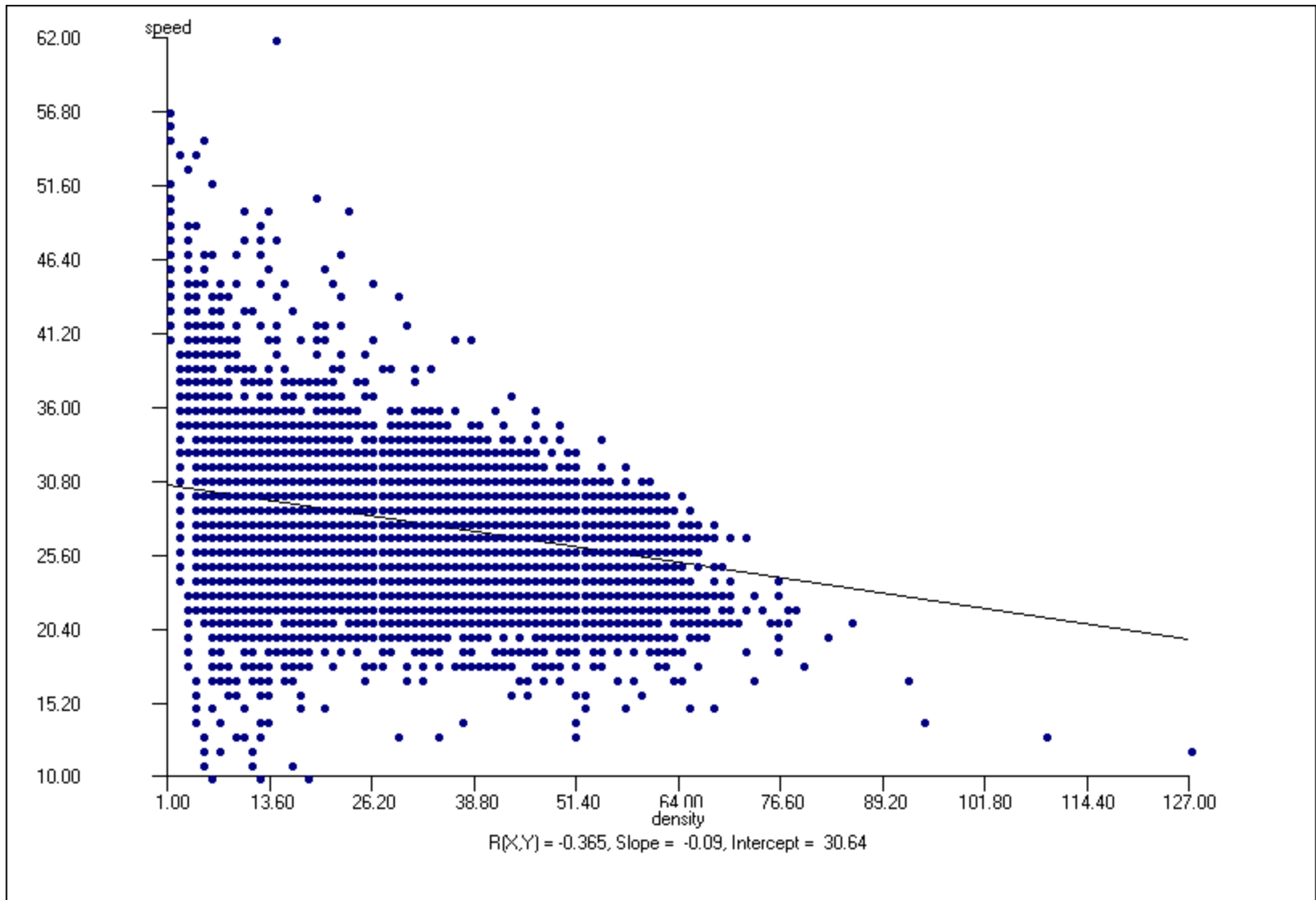


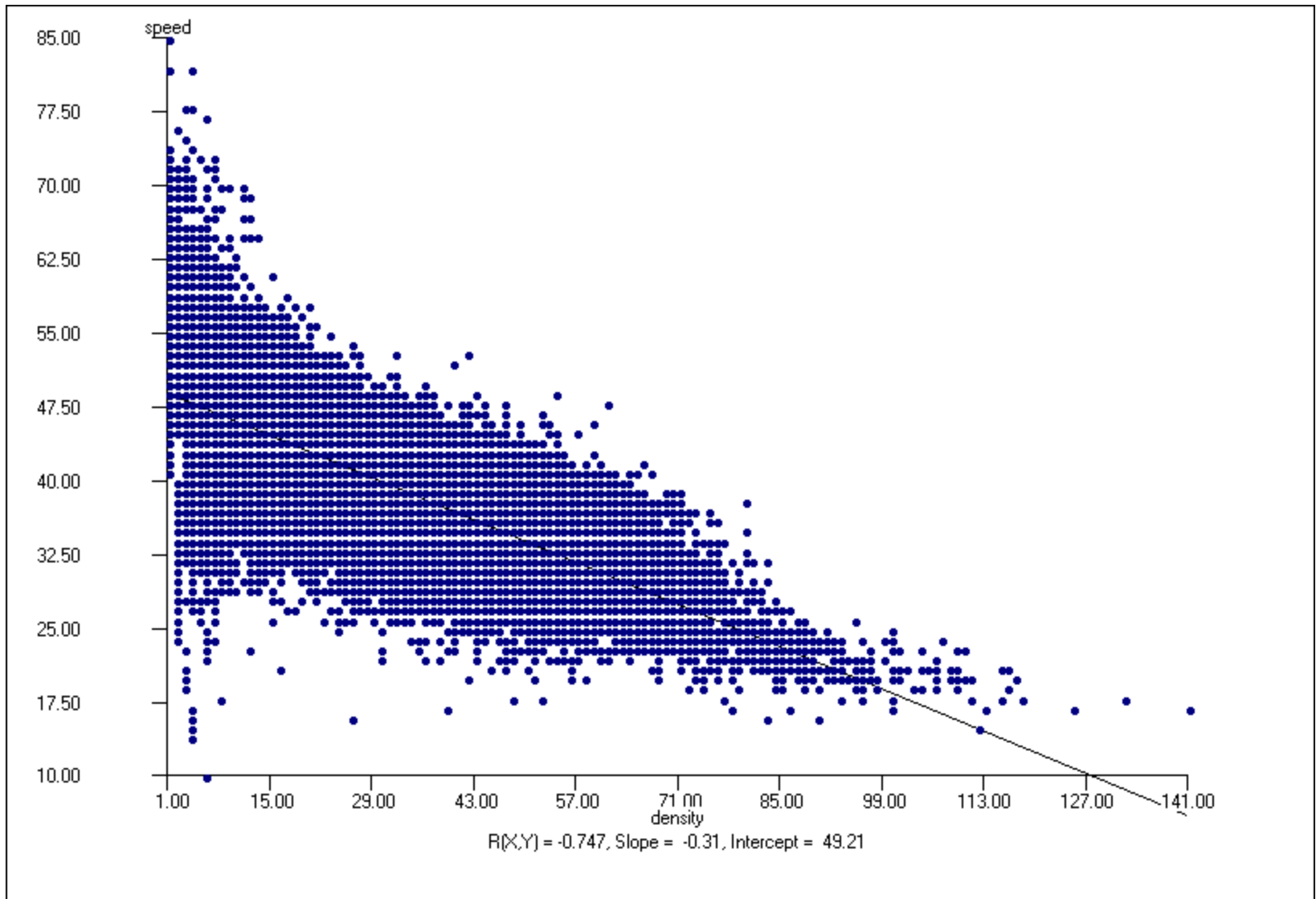








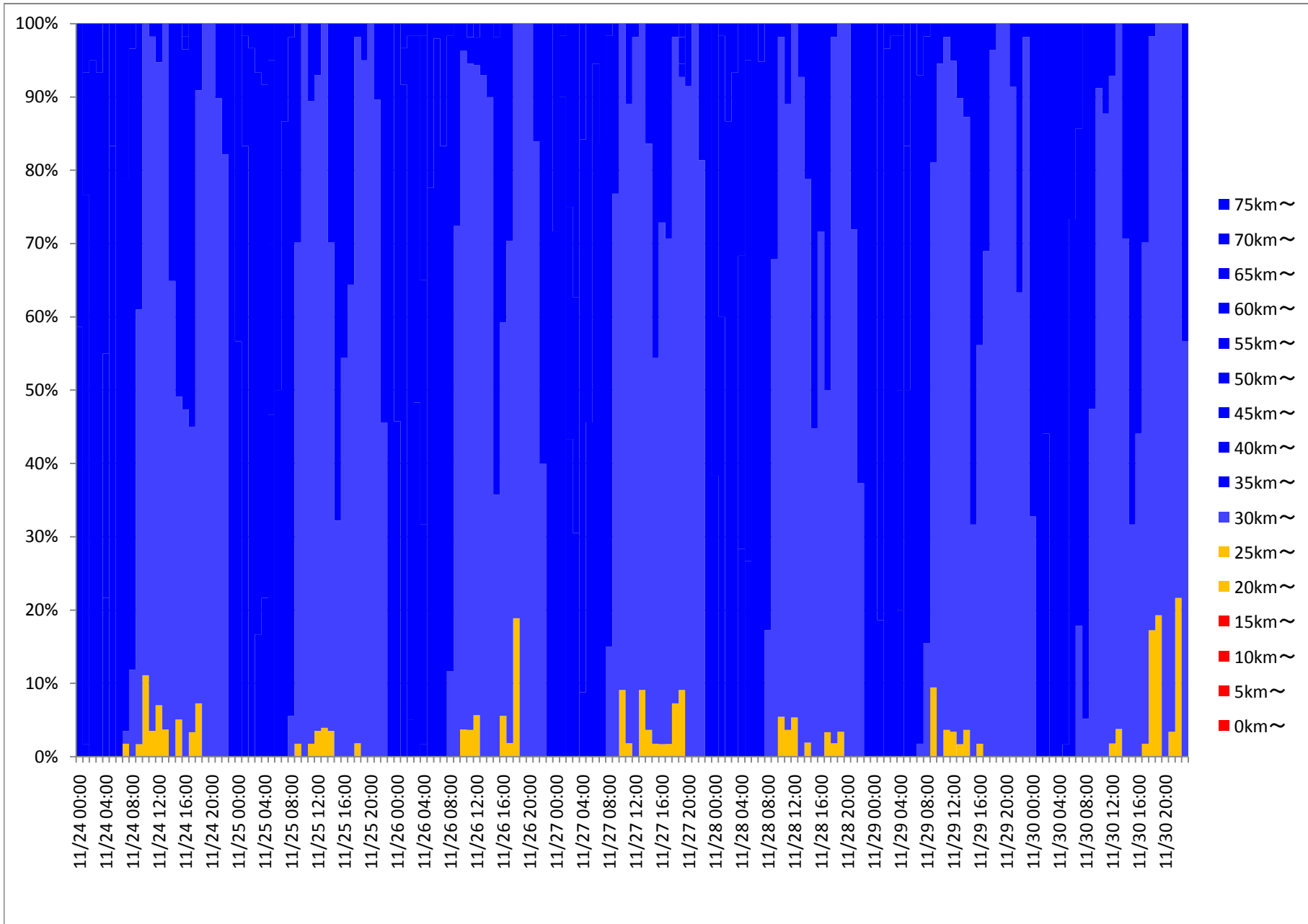




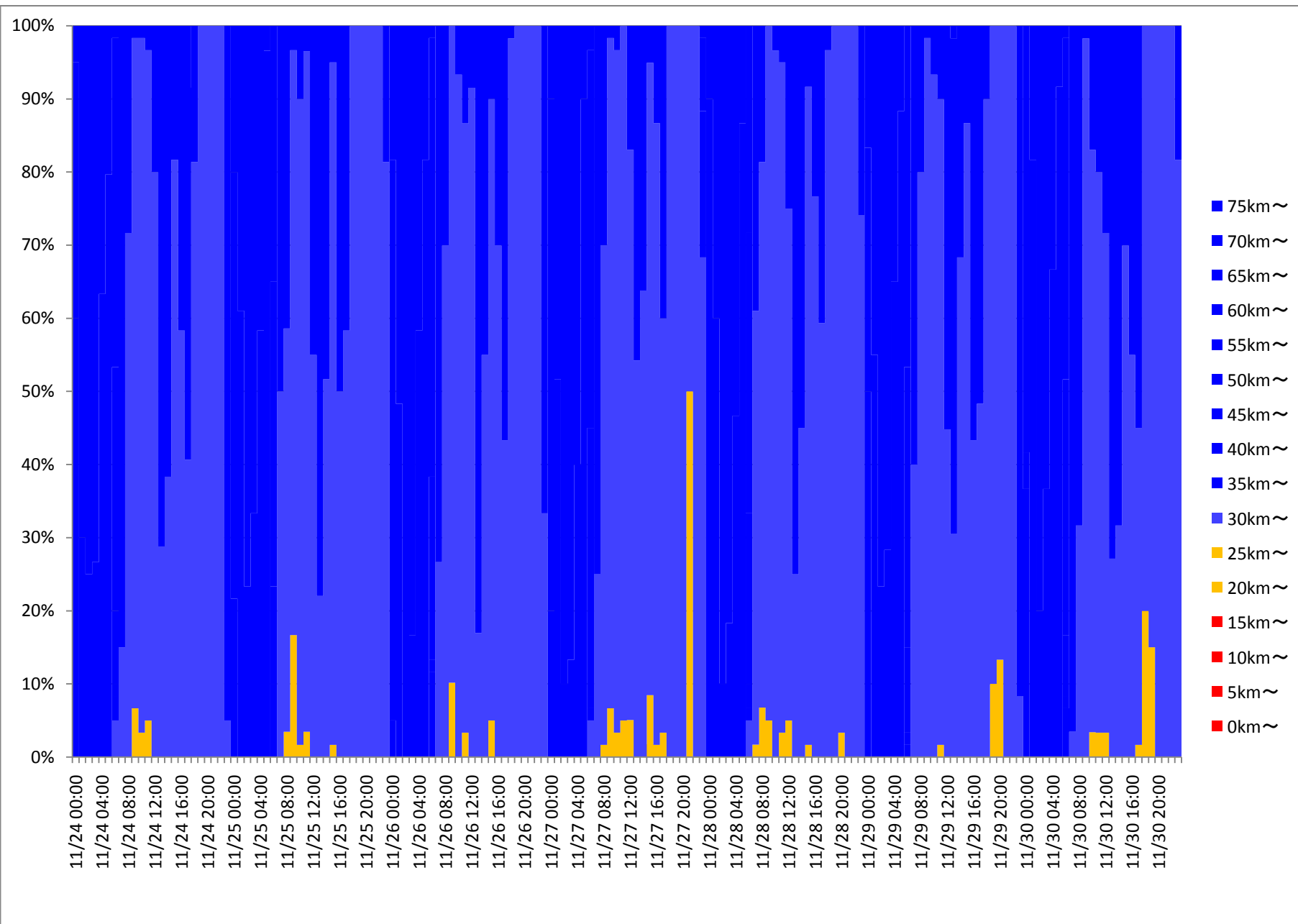
APPENDIX 14

SPEED VS. TIME OF DAY GRAPHS

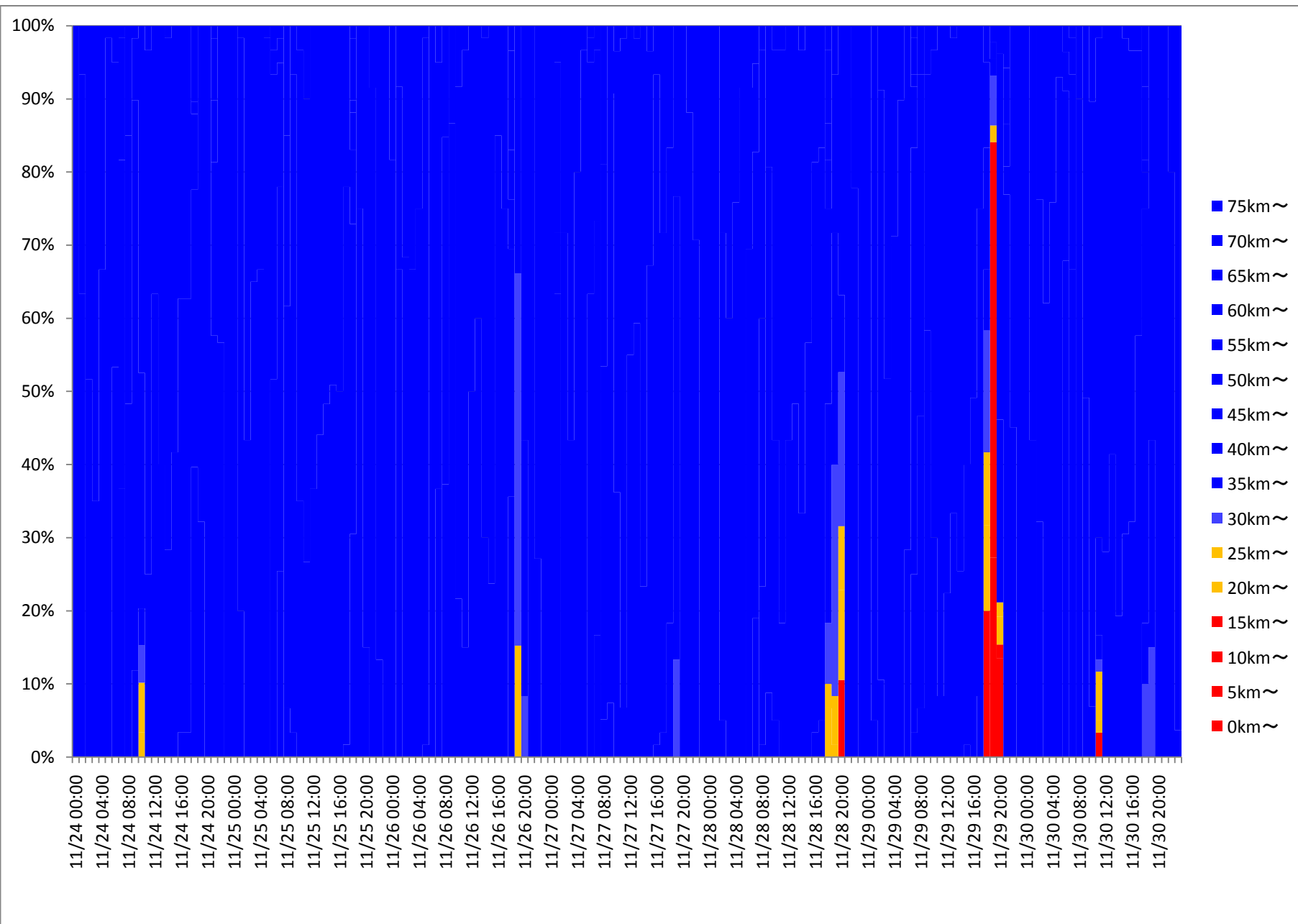
CTS 1



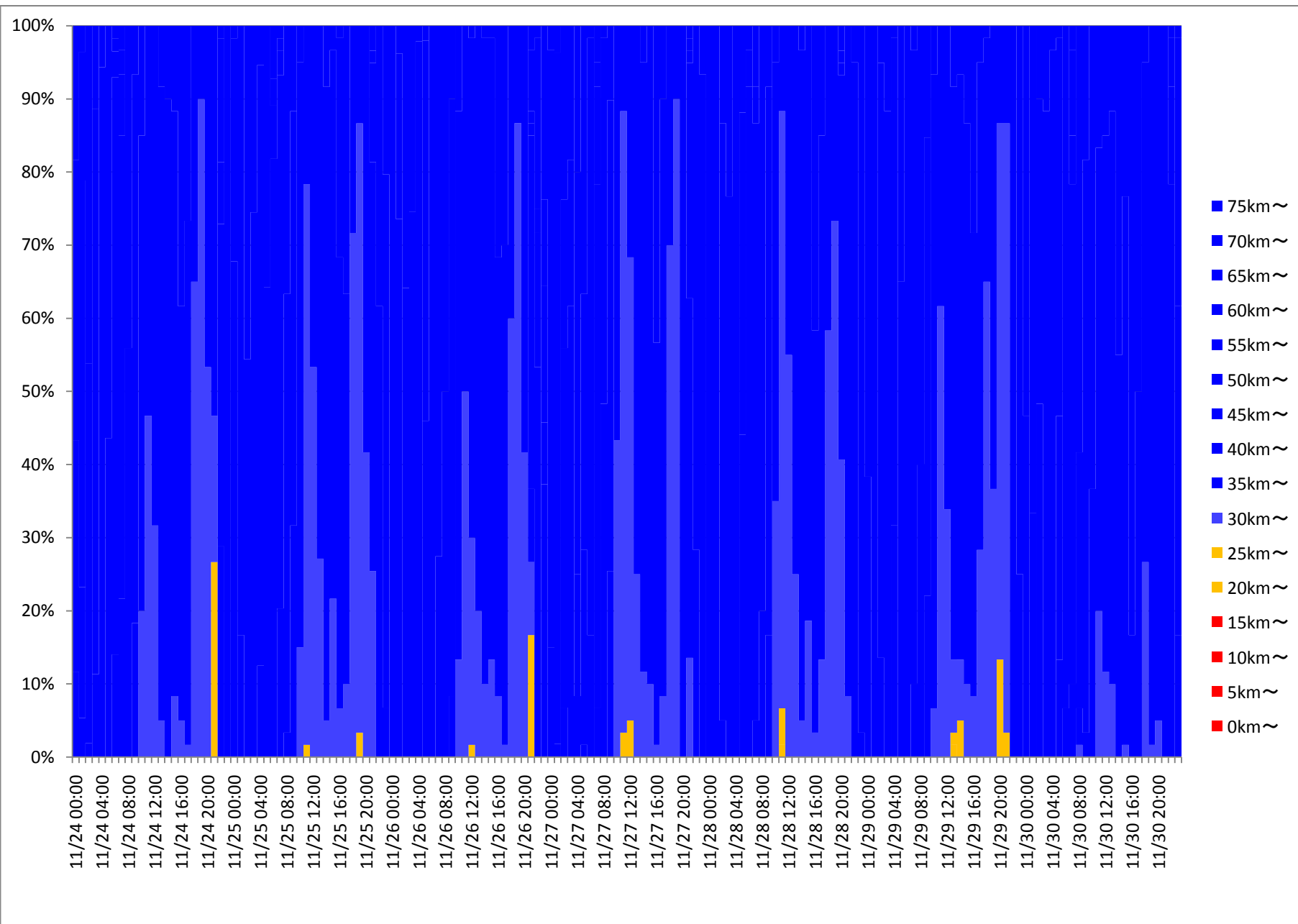
CTS 3



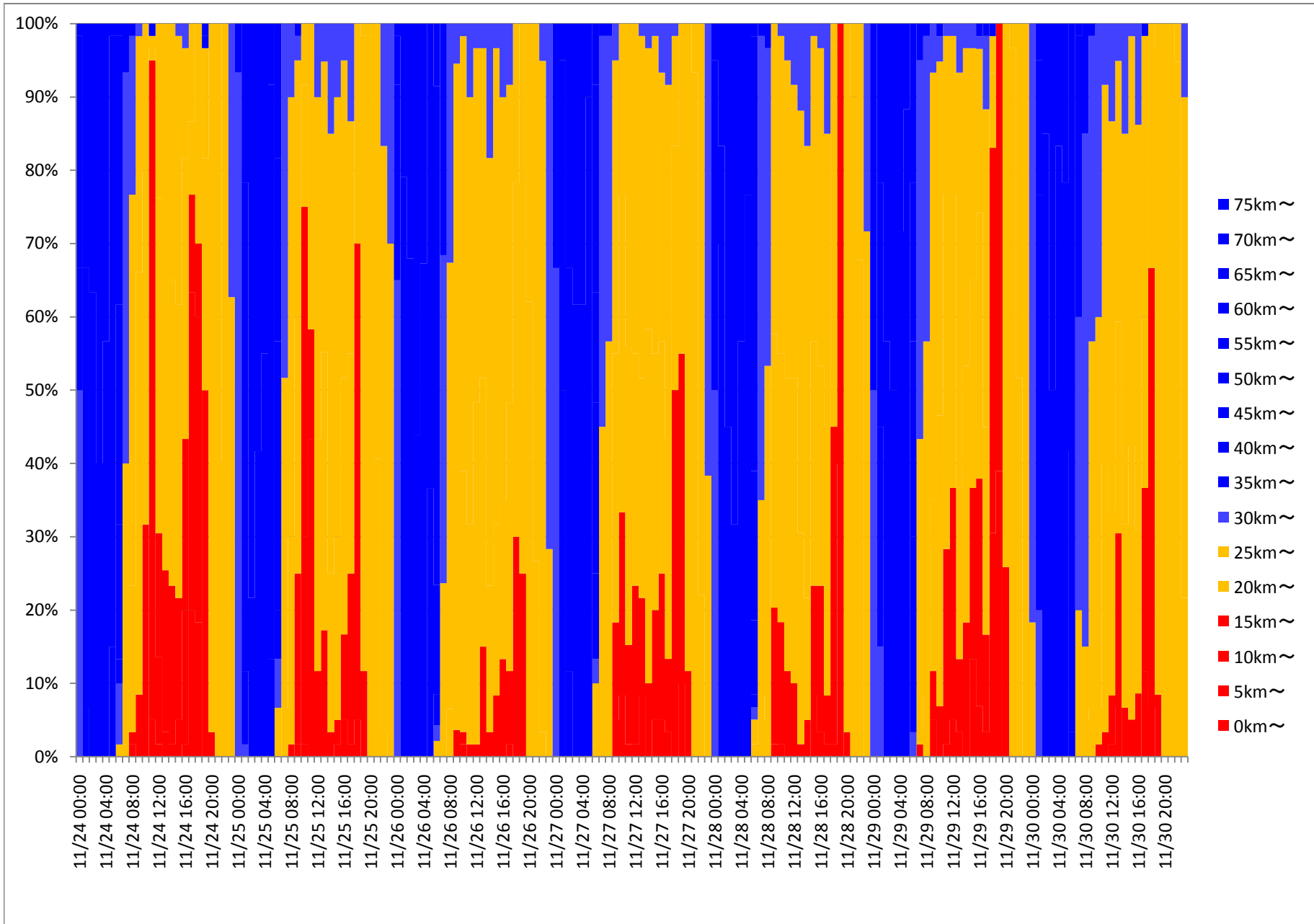
CTS 4



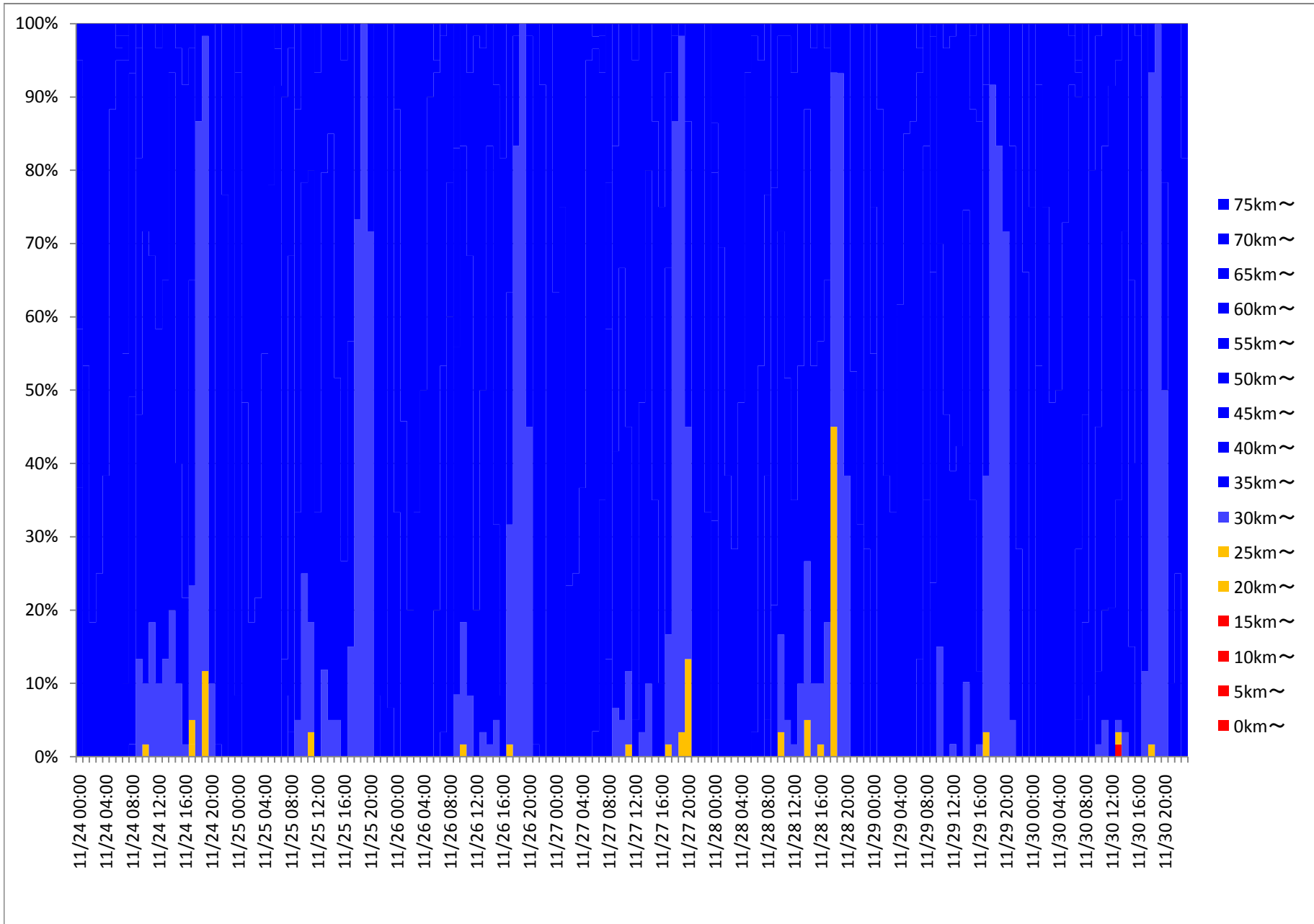
CTS 7



CTS 11



CTS 13



Appendix 15 Origin and Destination Survey Form (Post Implementation)

Location:

Survey Time: From:To:

Date:

Up Direction:

Weather:

Dn Direction:

Sr No.	Type of Vehicle	Destination Place	Route Followed	Do you take alternate route based on the information on the above board to reach your destination? (Y/N)	Are you satisfied with the information shown on the board?
1	2	3	4	5	6
1					
2					
3					
4					
5					
6					
7					

Questions Asked:

Column 3: Where are you going to?

Column 4: Which route will you take to reach your *destination*?

Column 5: Do you take alternate route based on the information on the above board to reach your destination? (Y/N)

Column 6: On a scale of 1 to 10, **Are you satisfied with the information shown on the board?** (10 being most helpful and 1 being not at all helpful)

Appendix - 16 : Route Choice Matrix for All Vehicles Near APMC Market (EIB-1)

Post Implementation Phase

Location: Near APMC Market

Chainage: EIB-1

Date: 23rd December, 2014

(in % of Total Trips)

Zones	Route Choice through Zone																							Grand Total		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			
Destination Zone	1																									
	2																									
	3																									
	4																									
	5													0.23												0.23
	6																									
	7													0.12												0.12
	8																									
	9										0.12															0.12
	10											0.95														0.95
	11											0.16														0.16
	12												0.12													0.12
	13													3.36	7.63											10.99
	14													0.42		2.85										3.27
	15															4.67										4.67
	16																1.26									1.26
	17														0.25	1.35	6.35	54.55								62.50
	18																									
	19														0.74			0.51								1.25
	20													0.35	0.20	0.35		1.25								2.15
	21																									
	22											0.36			0.28			0.75			0.32			1.15		2.86
	23											6.05		1.56	0.25	0.14	0.14	0.14	0.14		0.27		0.25	0.55		9.35
Grand Total											6.53	1.11	6.16	9.35	9.36	7.75	57.20			0.59		0.25	1.70	100.00		

Appendix - 17 : Route Choice Matrix for All Vehicles Near Shyamal Cross Road

Post Implementation Phase

Location: Near Shyamal Road

Chainage: EIB-2

Date: 24th December, 2014

(in % of Total Trips)

Zones		Route Choice through Zone																							Grand Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Destination Zone	1	0.76												3.46		1.96									6.18	
	2													0.17												0.17
	3		0.17																							0.17
	4				1.83																					1.83
	5													0.13												0.13
	6																									
	7													0.26												0.26
	8																							0.13		0.13
	9										0.14		0.36	0.54	0.14											1.18
	10																									
	11													0.35	0.35											0.70
	12													0.09												0.09
	13													0.86	8.41											9.27
	14														11.84											11.84
	15														0.14	0.38										0.52
	16														4.57	2.53	2.15				0.87					10.12
	17														1.85	2.15	1.09	2.65	7.35	0.23						15.32
	18														0.35	0.22				0.36	0.29					1.22
	19														0.54						1.16					1.70
	20														8.57	2.56					12.36	2.23				25.72
	21											0.14	0.14	0.36	1.26						0.14	1.56	0.19			3.79
	22											0.14		0.48	0.14	0.14									0.14	1.04
	23											5.23	0.14	0.14	1.31							1.66			0.14	8.62
Grand Total		1.85	0.22	0.11	2.61	0.11			0.11	0.22	0.22	7.51	0.44	8.92	38.19	1.20	5.44	5.11	7.73	4.57	10.45	3.81	0.11	1.09	100.00	

Appendix - 18 : Route Choice Matrix for All Vehicles Near Shivranjni Road

Post Implementation Phase

Location: Near Shivranjni Road

Chainage: EIB-3

Date: 25th December, 2014

(in % of Total Trips)

Zones		Route Choice through Zone																							Grand Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Destination Zone	1																								
	2															0.14									0.14
	3																								
	4													0.20											0.20
	5												18.41												18.41
	6										0.10		0.20	0.50											0.80
	7							0.28		1.25				2.35										0.26	4.14
	8											1.26											1.25		2.51
	9									0.14	0.35	1.85		0.28											2.62
	10												0.56	1.10											1.66
	11											0.14		1.35								0.45			1.94
	12													2.45											2.45
	13													19.36											19.36
	14																								
	15																								
	16																								
	17																								
	18																								
	19																								
	20													4.95								16.41	0.26		21.62
	21												0.56	1.75	0.14							1.26	1.46		5.17
	22												0.14		0.60							0.25	0.14		1.13
	23												1.10	0.10	14.13									2.51	17.84
Grand Total								0.28		1.39	0.45	5.05	2.61	65.82		0.14					18.37	1.86	4.02	100.00	

Appendix -19 : Route Choice Matrix for All Vehicles Near Mansi Cross Road

Post Implementation Phase

Location: Near Mansi Cross Road

Chainage: EIB-4

Date: 26th December, 2014

(in % of Total Trips)

Zones		Route Choice through Zone																							Grand Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Destination Zone	1										1.14			1.89											3.03
	2																								
	3																								
	4																								
	5																								
	6																								
	7																								
	8																								
	9											12.50													12.50
	10											16.48													16.48
	11											0.19		2.84											3.03
	12											3.98													3.98
	13											6.06		12.12											18.18
	14													0.19	5.68										5.87
	15																								
	16											0.19			1.33				0.38						1.89
	17											0.19			1.70			0.19				3.22			5.30
	18																					1.89			1.89
	19											0.38		0.19	2.27										2.84
	20											0.19		0.19	12.69										13.07
	21											1.14	3.60	0.57								0.19			5.49
	22													2.84											2.84
	23													3.60											3.60
Grand Total											42.42	3.60	22.54	25.57			0.19	0.38			5.30			100.00	

Route 1: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning						
	APMC to Vejalpur	1220	1.25	58.55		
	Vejalpur to Shyamal	950	3.33	17.10		
	Shyamal to Shivranjni	1085	2.60	25.03		
	Shivranjni to Keshavbaug	450	2.25	12.00		
	Keshavbaug to Andhjan	775	1.93	24.05		
	APMC to Vejalpur	1220	5.97	12.27		
	Vejalpur to Shyamal	950	1.50	37.99		
	Shyamal to Shivranjni	1085	1.47	44.38		
	Shivranjni to Keshavbaug	450	0.95	28.42		
	Keshavbaug to Andhjan	775	2.80	16.60		
	APMC to Vejalpur	1220	3.05	24.00		
	Vejalpur to Shyamal	950	4.70	12.13		
	Shyamal to Shivranjni	1085	1.41	46.17		
	Shivranjni to Keshavbaug	450	0.83	32.39		
	Keshavbaug to Andhjan	775	1.63	28.46		
	APMC to Vejalpur	1220	7.65	9.57		
	Vejalpur to Shyamal	950	1.33	42.86		
	Shyamal to Shivranjni	1085	7.03	9.25		
	Shivranjni to Keshavbaug	450	1.08	24.92		
	Keshavbaug to Andhjan	775	1.80	25.83		
	APMC to Vejalpur	1220	2.90	25.24		
	Vejalpur to Shyamal	950	4.25	13.41		
	Shyamal to Shivranjni	1085	1.30	50.07		
	Shivranjni to Keshavbaug	450	1.33	20.30		
	Keshavbaug to Andhjan	775	1.08	42.94		
	APMC to Vejalpur	1220	3.95	18.53		
	Vejalpur to Shyamal	950	3.73	15.26		
	Shyamal to Shivranjni	1085	2.25	28.93		
	Shivranjni to Keshavbaug	450	1.53	17.61		
	Keshavbaug to Andhjan	775	2.87	16.22		
	APMC to Vejalpur	1220	3.35	21.85		
	Vejalpur to Shyamal	950	1.40	40.71		
	Shyamal to Shivranjni	1085	1.23	52.77		
	Shivranjni to Keshavbaug	450	2.03	13.28		
	Keshavbaug to Andhjan	775	1.55	30.00	21.96	12.76
Afternoon						

Route 1: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	APMC to Vejalpur	1220	1.72	42.63		
	Vejalpur to Shyamal	950	1.33	42.74		
	Shyamal to Shivranjni	1085	3.35	19.43		
	Shivranjni to Keshavbaug	450	1.33	20.30		
	Keshavbaug to Andhjan	775	2.40	19.37		
	APMC to Vejalpur	1220	2.90	25.24		
	Vejalpur to Shyamal	950	4.25	13.41		
	Shyamal to Shivranjni	1085	1.30	50.07		
	Shivranjni to Keshavbaug	450	1.33	20.30		
	Keshavbaug to Andhjan	775	1.17	39.85		
	APMC to Vejalpur	1220	2.83	25.83		
	Vejalpur to Shyamal	950	1.35	42.21		
	Shyamal to Shivranjni	1085	2.33	27.89		
	Shivranjni to Keshavbaug	450	1.08	24.92		
	Keshavbaug to Andhjan	775	3.35	13.88		
	APMC to Vejalpur	1220	2.83	25.83		
	Vejalpur to Shyamal	950	1.35	42.21		
	Shyamal to Shivranjni	1085	2.33	27.89		
	Shivranjni to Keshavbaug	450	1.08	24.92		
	Keshavbaug to Andhjan	775	3.35	13.88		
	APMC to Vejalpur	1220	3.37	21.74		
	Vejalpur to Shyamal	950	1.05	54.27		
	Shyamal to Shivranjni	1085	0.92	71.00		
	Shivranjni to Keshavbaug	450	0.78	34.46		
	Keshavbaug to Andhjan	775	0.63	73.41		
	APMC to Vejalpur	1220	2.42	30.25		
	Vejalpur to Shyamal	950	2.93	19.43		
	Shyamal to Shivranjni	1085	4.70	13.85		
	Shivranjni to Keshavbaug	450	1.03	26.12		
	Keshavbaug to Andhjan	775	2.18	21.29		
	APMC to Vejalpur	1220	1.92	38.18		
	Vejalpur to Shyamal	950	2.78	20.47		
	Shyamal to Shivranjni	1085	3.75	17.36		
	Shivranjni to Keshavbaug	450	2.42	11.17		
	Keshavbaug to Andhjan	775	0.48	96.19		
	APMC to Vejalpur	1220	2.27	32.29		

Route 1: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Vejalpur to Shyamal	950	1.97	28.98		
	Shyamal to Shivrانجني	1085	2.40	27.12		
	Shivrانجني to Keshavbaug	450	2.38	11.33		
	Keshavbaug to Andhjan	775	1.17	39.85	26.29	10.57
Evening						
	APMC to Vejalpur	1220	2.68	27.27		
	Vejalpur to Shyamal	950	0.78	72.75		
	Shyamal to Shivrانجني	1085	1.83	35.50		
	Shivrانجني to Keshavbaug	450	2.35	11.49		
	Keshavbaug to Andhjan	775	2.02	23.05		
	APMC to Vejalpur	1220	0.65	112.59		
	Vejalpur to Shyamal	950	2.60	21.92		
	Shyamal to Shivrانجني	1085	3.07	21.22		
	Shivrانجني to Keshavbaug	450	0.85	31.76		
	Keshavbaug to Andhjan	775	5.80	8.02		
	APMC to Vejalpur	1220	6.03	12.13		
	Vejalpur to Shyamal	950	0.70	81.41		
	Shyamal to Shivrانجني	1085	1.22	53.50		
	Shivrانجني to Keshavbaug	450	0.68	39.50		
	Keshavbaug to Andhjan	775	4.00	11.62		
	APMC to Vejalpur	1220	2.43	30.08		
	Vejalpur to Shyamal	950	2.10	27.14		
	Shyamal to Shivrانجني	1085	2.05	31.75		
	Shivrانجني to Keshavbaug	450	3.05	8.85		
	Keshavbaug to Andhjan	775	1.28	36.23		
	APMC to Vejalpur	1220	6.07	12.06		
	Vejalpur to Shyamal	950	1.58	35.99		
	Shyamal to Shivrانجني	1085	1.40	46.49		
	Shivrانجني to Keshavbaug	450	1.62	16.70		
	Keshavbaug to Andhjan	775	1.48	31.34		
	APMC to Vejalpur	1220	3.20	22.87		
	Vejalpur to Shyamal	950	1.65	34.54		
	Shyamal to Shivrانجني	1085	2.65	24.56		
	Shivrانجني to Keshavbaug	450	4.60	5.87		
	Keshavbaug to Andhjan	775	3.17	14.68	22.36	12.2690144

Route 2: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	APMC to Vasna	1210	2.53	28.65			
	Vasna to Anjali	650	4.48	8.70	15.90181		
	APMC to Vasna	1210	2.70	26.88			
	Vasna to Anjali	650	7.73	5.04	10.69435		
	APMC to Vasna	1210	4.77	15.23			
	Vasna to Anjali	650	1.52	25.71	17.75772		
	APMC to Vasna	1210	3.42	21.24			
	Vasna to Anjali	650	4.47	8.73	14.15362		
	APMC to Vasna	1210	1.83	39.59			
	Vasna to Anjali	650	2.15	18.14	28.01113		
	APMC to Vasna	1210	3.75	19.36			
	Vasna to Anjali	650	3.00	13.00	16.53003		
	APMC to Vasna	1210	1.50	48.39			
	Vasna to Anjali	650	4.28	9.10	19.29297		
	APMC to Vasna	1210	2.62	27.74			
	Vasna to Anjali	650	3.82	10.22	17.34368		
	APMC to Vasna	1210	2.33	31.16			
	Vasna to Anjali	650	3.33	11.71	19.71731		
	APMC to Vasna	1210	2.41	30.12			
	Vasna to Anjali	650	3.41	11.44	19.17526		
	APMC to Vasna	1210	2.22	32.75			
	Vasna to Anjali	650	4.35	8.96	16.99153		
	APMC to Vasna	1210	1.88	38.54			
	Vasna to Anjali	650	3.42	11.41	21.05239		
	APMC to Vasna	1210	2.33	31.11			
	Vasna to Anjali	650	5.82	6.70	13.69051	17.71633	6.299272
Afternoon							
	APMC to Vasna	1210	2.25	32.26			

Route 2: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Vasna to Anjali	650	3.65	10.68	18.91147		
	APMC to Vasna	1210	3.85	18.85			
	Vasna to Anjali	650	3.12	12.51	16.01594		
	APMC to Vasna	1210	1.65	43.99			
	Vasna to Anjali	650	3.30	11.82	22.54095		
	APMC to Vasna	1210	3.65	19.89			
	Vasna to Anjali	650	2.38	16.36	18.49354		
	APMC to Vasna	1210	2.78	26.08			
	Vasna to Anjali	650	2.10	18.57	22.84867		
	APMC to Vasna	1210	2.50	29.04			
	Vasna to Anjali	650	2.58	15.12	21.9685		
	APMC to Vasna	1210	2.33	31.16			
	Vasna to Anjali	650	2.41	16.18	23.5443		
	APMC to Vasna	1210	2.00	36.30			
	Vasna to Anjali	650	3.00	13.00	22.32		
	APMC to Vasna	1210	2.85	25.47			
	Vasna to Anjali	650	1.88	20.70	23.57275		
	APMC to Vasna	1210	3.67	19.80			
	Vasna to Anjali	650	2.37	16.48	18.49354		
	APMC to Vasna	1210	2.78	26.08			
	Vasna to Anjali	650	2.05	19.02	23.08504		
	APMC to Vasna	1210	1.98	36.60			
	Vasna to Anjali	650	1.47	26.59	32.34136		
	APMC to Vasna	1210	3.88	18.69			
	Vasna to Anjali	650	2.50	15.60	17.47953		
	APMC to Vasna	1210	4.70	15.44			
	Vasna to Anjali	650	5.00	7.80	11.50285	20.93703	5.330268
Evening							
	APMC to Vasna	1210	4.63	15.67			
	Vasna to Anjali	650	6.00	6.50	10.4932		

Route 2: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	APMC to Vasna	1210	2.98	24.33			
	Vasna to Anjali	650	4.63	8.42	14.64915		
	APMC to Vasna	1210	3.45	21.04			
	Vasna to Anjali	650	4.07	9.59	14.84404		
	APMC to Vasna	1210	2.50	29.03			
	Vasna to Anjali	650	1.57	24.89	27.43714		
	APMC to Vasna	1210	3.55	20.45			
	Vasna to Anjali	650	1.40	27.85	22.54095		
	APMC to Vasna	1210	4.40	16.50			
	Vasna to Anjali	650	3.70	10.54	13.77502		
	APMC to Vasna	1210	3.23	22.45			
	Vasna to Anjali	650	2.50	15.60	19.46122		
	APMC to Vasna	1210	1.98	36.60			
	Vasna to Anjali	650	4.05	9.63	18.49354		
	APMC to Vasna	1210	2.22	32.75			
	Vasna to Anjali	650	1.98	19.66	26.56612	18.6956	5.96932

Route 3: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	EIB 2 to Shyamal	210.00	2.13	5.91			
	Shyamal to Vejalpur	950.00	3.83	14.87			
	Vejalpur to Jivraj	1,130.00	3.78	17.92			
	Jivraj to Dharnidhar	938.00	4.03	13.95	14.05		
	EIB 2 to Shyamal	210.00	2.90	4.34			
	Shyamal to Vejalpur	950.00	1.41	40.43			
	Vejalpur to Jivraj	1,130.00	2.45	27.67			
	Jivraj to Dharnidhar	938.00	3.13	17.96	19.57		
	EIB 2 to Shyamal	210.00	1.58	7.96			
	Shyamal to Vejalpur	950.00	1.52	37.57			
	Vejalpur to Jivraj	1,130.00	1.58	42.91			
	Jivraj to Dharnidhar	938.00	2.70	20.84	26.24		
	EIB 2 to Shyamal	210.00	1.12	11.28			
	Shyamal to Vejalpur	950.00	1.33	42.86			
	Vejalpur to Jivraj	1,130.00	2.80	24.21			
	Jivraj to Dharnidhar	938.00	1.70	33.11	27.88		
	EIB 2 to Shyamal	210.00	2.98	4.22			
	Shyamal to Vejalpur	950.00	2.15	26.51			
	Vejalpur to Jivraj	1,130.00	4.72	14.37			
	Jivraj to Dharnidhar	938.00	1.33	42.32	17.32		
	EIB 2 to Shyamal	210.00	1.05	12.00			
	Shyamal to Vejalpur	950.00	2.95	19.32			
	Vejalpur to Jivraj	1,130.00	1.58	42.81			
	Jivraj to Dharnidhar	938.00	1.41	39.91	27.69		
	EIB 2 to Shyamal	210.00	0.88	14.26			
	Shyamal to Vejalpur	950.00	2.78	20.47			
	Vejalpur to Jivraj	1,130.00	2.68	25.26			
	Jivraj to Dharnidhar	938.00	2.77	20.34	21.24		
	EIB 2 to Shyamal	210.00	2.17	5.81			
	Shyamal to Vejalpur	950.00	5.13	11.10			
	Vejalpur to Jivraj	1,130.00	2.18	31.05			
	Jivraj to Dharnidhar	938.00	3.17	17.77	15.31	21.16	9.15
Afternoon							
	EIB 2 to Shyamal	210	3.23	3.90			
	Shyamal to Vejalpur	950	3.78	15.06			

Route 3: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Vejalpur to Jivraj	1130	2.03	33.34			
	Jivraj to Dharnidhar	938	4.23	13.29	14.58		
	EIB 2 to Shyamal	210	3.03	4.15			
	Shyamal to Vejalpur	950	1.88	30.26			
	Vejalpur to Jivraj	1130	1.40	48.42			
	Jivraj to Dharnidhar	938	6.75	8.34	14.82		
	EIB 2 to Shyamal	210	1.87	6.75			
	Shyamal to Vejalpur	950	3.37	16.93			
	Vejalpur to Jivraj	1130	1.50	45.20			
	Jivraj to Dharnidhar	938	2.93	19.18	20.03		
	EIB 2 to Shyamal	210	1.47	8.59			
	Shyamal to Vejalpur	950	2.13	26.71			
	Vejalpur to Jivraj	1130	1.50	45.20			
	Jivraj to Dharnidhar	938	2.88	19.52	24.26		
	EIB 2 to Shyamal	210	4.83	2.61			
	Shyamal to Vejalpur	950	6.00	9.50			
	Vejalpur to Jivraj	1130	2.05	33.07			
	Jivraj to Dharnidhar	938	3.30	17.05	11.97		
	EIB 2 to Shyamal	210	1.23	10.21			
	Shyamal to Vejalpur	950	1.40	40.71			
	Vejalpur to Jivraj	1130	1.68	40.36			
	Jivraj to Dharnidhar	938	1.33	42.20	34.30		
	EIB 2 to Shyamal	210	1.75	7.20			
	Shyamal to Vejalpur	950	1.41	40.43			
	Vejalpur to Jivraj	1130	4.70	14.42			
	Jivraj to Dharnidhar	938	1.15	48.93	21.49		
	EIB 2 to Shyamal	210	0.72	17.58			
	Shyamal to Vejalpur	950	1.38	41.20			
	Vejalpur to Jivraj	1130	1.58	42.91			
	Jivraj to Dharnidhar	938	2.32	24.29	32.29		
	EIB 2 to Shyamal	210	1.92	6.57			
	Shyamal to Vejalpur	950	2.20	25.90			
	Vejalpur to Jivraj	1130	2.55	26.58			
	Jivraj to Dharnidhar	938	3.33	16.88	19.36		

Route 3: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	EIB 2 to Shyamal	210	1.92	6.57			
	Shyamal to Vejalpur	950	2.20	25.90			
	Vejalpur to Jivraj	1130	2.55	26.58			
	Jivraj to Dharnidhar	938	3.33	16.88	19.36		
	EIB 2 to Shyamal	210	1.88	6.69			
	Shyamal to Vejalpur	950	2.48	22.95			
	Vejalpur to Jivraj	1130	1.95	34.76			
	Jivraj to Dharnidhar	938	2.95	19.07	20.90	21.21	9.13
Evening							
	EIB 2 to Shyamal	210	2.63	4.78			
	Shyamal to Vejalpur	950	3.75	15.20			
	Vejalpur to Jivraj	1130	3.10	21.87			
	Jivraj to Dharnidhar	938	1.66	33.90	17.38		
	EIB 2 to Shyamal	210	0.83	15.12			
	Shyamal to Vejalpur	950	1.25	45.60			
	Vejalpur to Jivraj	1130	1.63	41.50			
	Jivraj to Dharnidhar	938	2.88	19.52	29.34		
	EIB 2 to Shyamal	210	1.62	7.79			
	Shyamal to Vejalpur	950	1.25	45.59			
	Vejalpur to Jivraj	1130	4.90	13.83			
	Jivraj to Dharnidhar	938	1.70	33.10	20.46		
	EIB 2 to Shyamal	210	1.25	10.08			
	Shyamal to Vejalpur	950	1.43	39.76			
	Vejalpur to Jivraj	1130	2.08	32.60			
	Jivraj to Dharnidhar	938	1.83	30.75	29.37		
	EIB 2 to Shyamal	210	0.40	31.49			
	Shyamal to Vejalpur	950	1.33	42.74			
	Vejalpur to Jivraj	1130	1.42	47.85			
	Jivraj to Dharnidhar	938	1.73	32.53	39.68		
	EIB 2 to Shyamal	210	7.95	1.58			
	Shyamal to Vejalpur	950	1.48	38.42			
	Vejalpur to Jivraj	1130	3.23	20.96			
	Jivraj to Dharnidhar	938	1.58	35.62	13.59		
	EIB 2 to Shyamal	210	1.35	9.33			
	Shyamal to Vejalpur	950	1.48	38.42			
	Vejalpur to Jivraj	1130	1.48	45.70			

Route 3: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Jivraj to Dharnidhar	938	1.52	37.10	33.20		
	EIB 2 to Shyamal	210	0.98	12.81			
	Shyamal to Vejalpur	950	1.57	36.38			
	Vejalpur to Jivraj	1130	1.50	45.20			
	Jivraj to Dharnidhar	938	1.73	32.46	33.48		
	EIB 2 to Shyamal	210	1.67	7.56			
	Shyamal to Vejalpur	950	1.75	32.56			
	Vejalpur to Jivraj	1130	1.58	42.91			
	Jivraj to Dharnidhar	938	1.92	29.36	28.01	27.17	7.13

Route 4: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	Shyamal to Manekbaug soc	1260	4.17	18.14			
	Manekbaug to Manekbaug X road	200	5.10	2.35	9.45		
	Shyamal to Manekbaug soc	1260	3.93	19.24			
	Manekbaug to Manekbaug X road	200	4.58	2.62	10.29		
	Shyamal to Manekbaug soc	1260	4.33	17.46			
	Manekbaug to Manekbaug X road	200	4.56	2.63	9.85		
	Shyamal to Manekbaug soc	1260	3.93	19.22			
	Manekbaug to Manekbaug X road	200	2.78	4.31	13.04		
	Shyamal to Manekbaug soc	1260	4.93	15.32			
	Manekbaug to Manekbaug X road	200	1.02	11.80	14.72		
	Shyamal to Manekbaug soc	1260	2.25	33.59			
	Manekbaug to Manekbaug X road	200	3.40	3.53	15.50		
	Shyamal to Manekbaug soc	1260	2.33	32.45			
	Manekbaug to Manekbaug X road	200	1.50	8.00	22.87		
	Shyamal to Manekbaug soc	1260	2.43	31.06			
	Manekbaug to Manekbaug X road	200	1.73	6.92	21.02		
	Shyamal to Manekbaug soc	1260	4.42	17.11			
	Manekbaug to Manekbaug X road	200	2.60	4.61	12.48		
	Shyamal to Manekbaug soc	1260	2.08	36.35			
	Manekbaug to Manekbaug X road	200	2.75	4.36	18.13	14.74	5.94
Afternoon							
	Shyamal to Manekbaug soc	1260	1.70	44.47			
	Manekbaug to Manekbaug X road	200	2.20	5.45	22.4582		
	Shyamal to Manekbaug soc	1260	4.62	16.37			
	Manekbaug to Manekbaug X road	200	2.50	4.80	12.30667		
	Shyamal to Manekbaug soc	1260	2.33	32.45			
	Manekbaug to Manekbaug X road	200	1.50	8.00	22.87027		
	Shyamal to Manekbaug soc	1260	2.43	31.06			
	Manekbaug to Manekbaug X road	200	1.73	6.92	21.0198		
	Shyamal to Manekbaug soc	1260	2.75	27.49			
	Manekbaug to Manekbaug X road	200	1.35	8.89	21.36158		

Route 4: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Shyamal to Manekbaug soc	1260	2.38	31.71			
	Manekbaug to Manekbaug X road	200	1.15	10.43	24.7875		
	Shyamal to Manekbaug soc	1260	2.57	29.45			
	Manekbaug to Manekbaug X road	200	1.82	6.60	19.98079		
	Shyamal to Manekbaug soc	1260	4.10	18.44			
	Manekbaug to Manekbaug X road	200	3.25	3.69	11.91598		
	Shyamal to Manekbaug soc	1260	1.95	38.77			
	Manekbaug to Manekbaug X road	200	0.93	12.85	30.37753		
	Shyamal to Manekbaug soc	1260	2.90	26.06			
	Manekbaug to Manekbaug X road	200	7.12	1.69	8.743676		
	Shyamal to Manekbaug soc	1260	6.35	11.90			
	Manekbaug to Manekbaug X road	200	20.47	0.59	3.265972	18.09891	4.84
	Evening						
	Shyamal to Manekbaug soc	1260	2.65	28.53			
	Manekbaug to Manekbaug X road	200	2.08	5.76	18.50491		
	Shyamal to Manekbaug soc	1260	3.75	20.16			
	Manekbaug to Manekbaug X road	200	1.63	7.35	16.26919		
	Shyamal to Manekbaug soc	1260	3.42	22.12			
	Manekbaug to Manekbaug X road	200	1.55	7.74	17.63406		
	Shyamal to Manekbaug soc	1260	7.43	10.17			
	Manekbaug to Manekbaug X road	200	1.25	9.60	10.08627		
		1260					
	Shyamal to Manekbaug soc	200	6.03	1.99			
	Manekbaug to Manekbaug X road		1.40	-	1.614027		
	Shyamal to Manekbaug soc	1260	4.62	16.37			
	Manekbaug to Manekbaug X road	200	2.50	4.80	12.30667		
	Shyamal to Manekbaug soc	1260	4.55	16.61			
	Manekbaug to Manekbaug X road	200	2.75	4.36	11.9976	12.63039	6.94

Route 5: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	Jodhpur to Shivranjni	400	1.10	21.82			
	Shivranjni to Nehrunagar	1330	4.00	19.95	20.35		
	Jodhpur to Shivranjni	400	1.30	18.46			
	Shivranjni to Nehrunagar	1330	2.15	37.11	30.08		
	Jodhpur to Shivranjni	400	2.10	11.43			
	Shivranjni to Nehrunagar	1330	7.67	10.41	10.63		
	Jodhpur to Shivranjni	400	2.98	8.04			
	Shivranjni to Nehrunagar	1330	4.55	17.53	13.78		
	Jodhpur to Shivranjni	400	1.85	12.97			
	Shivranjni to Nehrunagar	1330	2.30	34.69	25.01		
	Jodhpur to Shivranjni	400	1.35	17.77			
	Shivranjni to Nehrunagar	1330	4.95	16.12	16.47		
	Jodhpur to Shivranjni	400	2.50	9.60			
	Shivranjni to Nehrunagar	1330	1.67	47.87	24.91	20.17	5.15
Afternoon							
	Jodhpur to Shivranjni	400	1.42	16.94			
	Shivranjni to Nehrunagar	1330	5.90	13.52	14.18		
	Jodhpur to Shivranjni	400	0.80	29.99			
	Shivranjni to Nehrunagar	1330	3.73	21.37	22.89		
	Jodhpur to Shivranjni	400	1.02	23.60			
	Shivranjni to Nehrunagar	1330	5.58	14.29	15.72		
	Jodhpur to Shivranjni	400	1.92	12.52			
	Shivranjni to Nehrunagar	1330	1.72	46.48	28.56		
	Jodhpur to Shivranjni	400	0.83	28.92			
	Shivranjni to Nehrunagar	1330	5.58	14.30	16.19		
	Jodhpur to Shivranjni	400	0.83	28.79			
	Shivranjni to Nehrunagar	1330	4.28	18.63	20.28		
	Jodhpur to Shivranjni	400	2.30	10.43			

Route 5: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Shivranjni to Nehrunagar	1330	2.07	38.61	23.77		
	Jodhpur to Shivranjni	400	1.30	18.46			
	Shivranjni to Nehrunagar	1330	2.15	37.11	30.08		
	Jodhpur to Shivranjni	400	1.28	18.70			
	Shivranjni to Nehrunagar	1330	5.38	14.82	15.57		
	Jodhpur to Shivranjni	400	2.30	10.43			
	Shivranjni to Nehrunagar	1330	5.88	13.56	12.68		
	Jodhpur to Shivranjni	400	1.20	20.00			
	Shivranjni to Nehrunagar	1330	2.70	29.55	26.61	20.60	5.04
Evening	Jodhpur to Shivranjni	400	4.55	5.27			
	Shivranjni to Nehrunagar	1330	3.83	20.81	12.38		
	Jodhpur to Shivranjni	400	1.63	14.69			
	Shivranjni to Nehrunagar	1330	6.38	12.50	12.95		
	Jodhpur to Shivranjni	400	1.92	12.52			
	Shivranjni to Nehrunagar	1330	1.72	46.48	28.56		
	Jodhpur to Shivranjni	400	1.60	15.00			
	Shivranjni to Nehrunagar	1330	4.10	19.46	18.21		
	Jodhpur to Shivranjni	400	1.10	21.81			
	Shivranjni to Nehrunagar	1330	2.30	34.69	30.52		
	Jodhpur to Shivranjni	400	1.80	13.33			
	Shivranjni to Nehrunagar	1330	3.83	20.81	18.42		
	Jodhpur to Shivranjni	400	3.33	7.20			
	Shivranjni to Nehrunagar	1330	7.50	10.64	9.58		
	Jodhpur to Shivranjni	400	1.55	15.48			
	Shivranjni to Nehrunagar	1330	6.03	13.22	13.69	18.04	5.75

Route 6: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Mansi to Keshavbaug	800	9.90	4.85			
	Keshavbaug to Andhjan	775	1.68	27.62	8.16		
	Mansi to Keshavbaug	800	1.93	24.82			
	Keshavbaug to Andhjan	775	2.03	22.86	23.82		
	Mansi to Keshavbaug	800	1.30	36.92			
	Keshavbaug to Andhjan	775	2.08	22.32	27.93		
	Mansi to Keshavbaug	800	1.38	34.69			
	Keshavbaug to Andhjan	775	0.80	58.11	43.27		
	Mansi to Keshavbaug	800	1.10	43.63			
	Keshavbaug to Andhjan	775	1.10	42.26	42.95		
	Mansi to Keshavbaug	800	1.78	26.91			
	Keshavbaug to Andhjan	775	1.02	45.73	33.74		
	Mansi to Keshavbaug	800	1.57	30.63			
	Keshavbaug to Andhjan	775	0.90	51.66	38.30		
	Mansi to Keshavbaug	800	1.67	28.79			
	Keshavbaug to Andhjan	775	0.87	53.64	37.30		
	Mansi to Keshavbaug	800	2.40	20.00			
	Keshavbaug to Andhjan	775	1.18	39.29	26.37		
	Mansi to Keshavbaug	800	0.80	59.99			
	Keshavbaug to Andhjan	775	0.88	52.63	56.13	34.59	2.73
Evening							
	Mansi to Keshavbaug	800	1.98	24.20			
	Keshavbaug to Andhjan	775	1.88	24.69	24.43		
	Mansi to Keshavbaug	800	1.20	39.99			
	Keshavbaug to Andhjan	775	0.60	77.48	52.49		
	Mansi to Keshavbaug	800	2.52	19.07			
	Keshavbaug to Andhjan	775	0.95	48.94	27.25		
	Mansi to Keshavbaug	800	2.58	18.60			
	Keshavbaug to Andhjan	775	1.33	34.96	24.17		
	Mansi to Keshavbaug	800	2.08	23.04			

Route 6: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	Keshavbaug to Andhjan	775	1.82	25.59	24.23		
	Mansi to Keshavbaug	800	2.37	20.28			
	Keshavbaug to Andhjan	775	1.90	24.47	22.14		
	Mansi to Keshavbaug	800	3.93	12.20			
	Keshavbaug to Andhjan	775	1.85	25.13	16.34		
	Mansi to Keshavbaug	800	2.60	18.46			
	Keshavbaug to Andhjan	775	1.05	44.28	25.89		
	Mansi to Keshavbaug	800	2.83	16.94			
	Keshavbaug to Andhjan	775	1.82	25.59	20.32		
	Mansi to Keshavbaug	800	1.88	25.48			
	Keshavbaug to Andhjan	775	1.05	44.28	32.21		
	Mansi to Keshavbaug	800	4.55	10.55			
	Keshavbaug to Andhjan	775	1.95	23.84	14.54		
	Mansi to Keshavbaug	800	2.13	22.50			
	Keshavbaug to Andhjan	775	2.40	19.37	20.84		
	Mansi to Keshavbaug	800	1.65	29.09			
	Keshavbaug to Andhjan	775	4.52	10.29	15.32		
	Mansi to Keshavbaug	800	2.80	17.14			
	Keshavbaug to Andhjan	775	3.98	11.67	13.93		
	Mansi to Keshavbaug	800	1.55	30.96			
	Keshavbaug to Andhjan	775	1.13	41.02	35.21	24.62	3.84

Route 7: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
Morning							
	EIB 4 to Mansi	180	1.57	6.88			
	Mansi to Vastrapur	720	1.32	32.80			
	Vastrapur to lim	930	2.97	18.81	19.50		
	EIB 4 to Mansi	180	1.05	10.28			
	Mansi to Vastrapur	720	2.28	18.92			
	Vastrapur to lim	930	2.15	25.95	18.38		
	EIB 4 to Mansi	180	1.17	9.26			
	Mansi to Vastrapur	720	1.67	25.91			
	Vastrapur to lim	930	2.05	27.21	20.79		
	EIB 4 to Mansi	180	0.93	11.57			
	Mansi to Vastrapur	720	1.40	30.85			
	Vastrapur to lim	930	2.70	20.66	21.03		
	EIB 4 to Mansi	180	0.50	21.60			
	Mansi to Vastrapur	720	1.43	30.13			
	Vastrapur to lim	930	2.70	20.66	24.13		
	EIB 4 to Mansi	180	0.48	22.34			
	Mansi to Vastrapur	720	2.35	18.38			
	Vastrapur to lim	930	1.93	28.91	23.21		
	EIB 4 to Mansi	180	2.42	4.47			
	Mansi to Vastrapur	720	7.85	5.50			
	Vastrapur to lim	930	1.83	30.49	13.49		
	EIB 4 to Mansi	180	1.08	9.97			
	Mansi to Vastrapur	720	1.80	24.00			
	Vastrapur to lim	930	3.63	15.35	16.44	19.62104	5.596035
Afternoon							
	EIB 4 to Mansi	180	0.70	15.43			
	Mansi to Vastrapur	720	1.18	36.50			
	Vastrapur to lim	930	3.32	16.82	22.92		
	EIB 4 to Mansi	180	0.22	49.84			
	Mansi to Vastrapur	720	2.43	17.75			
	Vastrapur to lim	930	1.30	42.91	36.83		
	EIB 4 to Mansi	180	0.50	21.60			
	Mansi to Vastrapur	720	2.88	14.98			
	Vastrapur to lim	930	2.00	27.89	21.49		

Route 7: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	EIB 4 to Mansi	180	0.78	13.78			
	Mansi to Vastrapur	720	2.55	16.94			
	Vastrapur to lim	930	3.83	14.55	15.09		
	EIB 4 to Mansi	180	0.85	12.70			
	Mansi to Vastrapur	720	1.56	27.69			
	Vastrapur to lim	930	1.38	40.33	26.91		
	EIB 4 to Mansi	180	1.35	8.00			
	Mansi to Vastrapur	720	1.88	22.98			
	Vastrapur to lim	930	2.63	21.19	17.39		
	EIB 4 to Mansi	180	0.75	14.40			
	Mansi to Vastrapur	720	1.85	23.35			
	Vastrapur to lim	930	1.95	28.61	22.12		
	EIB 4 to Mansi	180	1.13	9.53			
	Mansi to Vastrapur	720	1.85	23.35			
	Vastrapur to lim	930	2.65	21.05	17.98		
	EIB 4 to Mansi	180	1.30	8.31			
	Mansi to Vastrapur	720	1.38	31.22			
	Vastrapur to lim	930	1.18	47.15	28.89		
	EIB 4 to Mansi	180	0.60	18.00			
	Mansi to Vastrapur	720	2.60	16.61			
	Vastrapur to lim	930	2.13	26.15	20.25	22.98645	4.776726
Evening							
	EIB 4 to Mansi	180	0.25	43.19			
	Mansi to Vastrapur	720	1.58	27.28			
	Vastrapur to lim	930	3.23	17.25	29.24		
	EIB 4 to Mansi	180	2.60	4.15			
	Mansi to Vastrapur	720	2.28	18.92			
	Vastrapur to lim	930	2.53	22.02	15.03		
	EIB 4 to Mansi	180	1.58	6.84			
	Mansi to Vastrapur	720	1.41	30.64			
	Vastrapur to lim	930	2.50	22.32	19.93		
	EIB 4 to Mansi	180	1.55	6.97			
	Mansi to Vastrapur	720	1.65	26.18			
	Vastrapur to lim	930	3.00	18.60	17.25		

Route 7: Travel Time and Speed Study (Post-Implementation Stage)

Date: 30th December, 2014

	Section	Distance (m)	Travel Time (min)	Speed (km/hr)	Average Trip Speed (km/hr)	Avg. Speed (km/hr)	Avg. Travel Time (min)
	EIB 4 to Mansi	180	0.80	13.50			
	Mansi to Vastrapur	720	1.55	27.87			
	Vastrapur to lim	930	10.40	5.36	15.58		
	EIB 4 to Mansi	180	1.13	9.53			
	Mansi to Vastrapur	720	2.60	16.61			
	Vastrapur to lim	930	3.58	15.57	13.90		
	EIB 4 to Mansi	180	2.92	3.70			
	Mansi to Vastrapur	720	3.30	13.09			
	Vastrapur to lim	930	4.40	12.68	9.82		
	EIB 4 to Mansi	180	0.63	17.05			
	Mansi to Vastrapur	720	1.88	22.93			
	Vastrapur to lim	930	1.43	38.92	26.30	18.38161	5.973362

મે.મ્યુનિસિપલ કમિશ્નરસાહેબશ્રી, Wc/s

વિષય:- અમદાવાદ શહેરમાં ટ્રાફિકની સમસ્યાના નિવારણ માટે Trial Intelligent Transport System Solutions(ITS) પ્રોજેક્ટ અંતર્ગત વાસણા રોડ, એ.પી.એમ.સી.થી ૧૩૨ ફૂટના રોડ તરફ, શ્યામલ જંકશનથી શિવરંજની જંકશન થી કેશવબાગ થી જજીસ બંગલો વસ્ત્રાપુર રોડ પર ૪ જગ્યાએ એલ.ઇ.ડી.બોર્ડ તેમજ જુદી જુદી ૧૦ જગ્યાએ ટ્રાફિક સેન્સર લગાવવા જરૂરી કેબલ નાખવા સુચિત રૂટના કુલ ૧૪ લોકેશન પર કામગીરી કરવા Zero-Sum Ltd.Japan ને રોડ ઓપનીંગ પરમીશન કોઈ પણ જાતના વહીવટી ચાર્જ લીધા સિવાય આપવાની મંજૂરી આપવા તથા ખોદાણ કરેલ જગ્યાએ રીઈન્સ્ટેન્ટમેન્ટની કામગીરી જે તે ઝોન ધ્વારા કરાવવાની સુચના આપવાની મંજૂરી આપવા બાબત.

વિગત:- અમદાવાદ શહેરમાં ટ્રાફિકની સમસ્યાના નિવારણ માટે Trial Intelligent Transport System Solutions(ITS) પ્રોજેક્ટ અંતર્ગત વાસણા રોડ, એ.પી.એમ.સી.થી ૧૩૨ ફૂટના રોડ તરફ, શ્યામલ જંકશનથી શિવરંજની જંકશન થી કેશવબાગ થી જજીસ બંગલો વસ્ત્રાપુર રોડ તરફ ની કામગીરી માટે એલ.ઇ.ડી.બોર્ડ તેમજ ટ્રાફિક સેન્સર લગાવવાના થાય છે. સદર કામગીરીમાં Trial Intelligent Transport System Solutions(ITS) ના અમલીકરણ માટે અમદાવા મ્યુનિસિપલ કોર્પોરેશન, અમદાવાદ ટ્રાફિક પોલીસ તથા જાપાન એક્સપેસવે ઇન્ટરનેશનલ કંપની લી.ના સંયુક્ત ઉપક્રમે એમ.ઓ.યુ. કરવામાં આવેલ છે. અને સદર કામ સ્ટેન્ડીંગ કમિટી ઠ.નં-૧૩૦૫ તા.૦૩.૧૦.૨૦૧૨ તથા મ્યુ. કોર્પોરેશન ઠરાવ નં.-૧૯૩૫ તા.૨૯.૧૦.૨૦૧૨ થી મંજૂર થયેલ છે.

સદર કામગીરીમાં એલ.ઇ.ડી.બોર્ડ તેમજ ટ્રાફિક સેન્સર લગાવવાના જેના માટે પાવર કેબલ તેમજ કંટ્રોલ કેબલ લેઈંગ કરવા તથા સેકશન પીલર ઇન્સ્ટોલ કરવા વાસણા રોડ, એ.પી.એમ.સી.થી ૧૩૨ ફૂટના રોડ તરફ, શ્યામલ જંકશનથી શિવરંજની જંકશન થી કેશવબાગ થી જજીસ બંગલો વસ્ત્રાપુર રોડ તરફ નીચે દર્શાવ્યા મુજબની જગ્યા પર રોડ ઓપનીંગ પરમીશનની જરૂરીયાત છે.

અનુ. નં.	રોડનુ નામ	જગ્યાનુ નામ	આર.ઓ.માટેનુ ખોદાણ(મીટર)	રિમાર્ક્સ
CAMERA Location				
૧	વાસણા રોડ	જવાહરનગર બસ સ્ટેન્ડ પછી, જવાહરનગર કો.ઓ.હા.સોસાયટી સામે, સ્ટ્રીટલાઈટ પોલ નં.JN8915 પાસે	૨૦	સ્થળની વિગત દર્શાવતો સ્કેચ પ્લાન આ સાથે સામેલ કરેલ છે.
૨	૧૩૨ ફૂટ રીંગ રોડ	TV9 જંકશન પછી, રણછોડરાય મંદિર સામે, ગાયત્રીનગર સામે	૩૦	
૩	જીવરાજ મહેતા રોડ	વેજલપુર પાર્કની સામે, ચંચળ પાર્ટી પ્લોટ પછી, સ્ટ્રીટલાઈટ પોલ નં.PGV3640 પાસે	૨૦	
૪	૧૩૨ ફૂટ રીંગ રોડ	શ્યામલ જંકશન ફ્લાયઓવર થી ૧૦' મીટર આગળ, મણીભદ્ર એવન્યુની સામે, સ્ટ્રીટલાઈટ પોલ નં.JSV41269 પાસે	૨૦	
૫	મા આનંદમયી માર્ગ	માણેકબાગ સોસાયટી, ૧૮૩ માણેકબાગ સોસાયટી સામે, સ્ટ્રીટલાઈટ પોલ નં.MBT2568 પાસે	૧૦	
૬	સેટેલાઈટ રોડ	માણેક બાગ જંકશનથી ૧૫૦ મીટર, ઓસન પાર્ક કોમ્પ્લેક્સ સામે, હોટેલ મન રેસીડન્સી પછી, બેટર હોમ	૧૦	

		ફર્નિચર પછી, સ્ટ્રીટલાઈટ પોલ નં.784013 પછી		
૭	સેટેલાઈટ રોડ	જોધપુર ચાર રસ્તા બસ સ્ટોપ પાસે, જોધપુર ચાર રસ્તા ટ્રાફિક સિગ્નલ પછી,ટેલિફોન એક્ષચેન્જ સામે,આચાર્ય નરેન્દ્ર દેવ સોસાયટી પછી, સ્ટ્રીટલાઈટ પોલ નં.VRJ39290 પછી	૨૦	
૮	૧૩૨ ફૂટ રીંગ રોડ	આઈ.આઈ.એમ.ચાર રસ્તા ની દક્ષિણ બાજુમાં ૩૦૦મીટરના અંતરે,આઈ.આઈ.એમ.સર્વિસ ગેટ પછી,બી.આર.ટી.એસ. CH6700 પછી	૫૦૦	
૯	જજીસ બંગલો રોડ	કેશવ બાગ જંકશનથી ૩૦૦મીટરના અંતરે,અભિશીલ્પ બિલ્ડીંગની સામે, સ્ટ્રીટલાઈટ પોલ નં.SSJ38935 પછી	૧૫	
૧૦	આઈ.આઈ.એમ.રોડ	આઈ.આઈ.એમ.ગેટથી ૫૦મીટરના અંતરે,એસ.બી.આઈ.ઓફિસીયલ સોસાયટી પછી,જુની આર.ટી.ઓ.ચેક પોસ્ટ પાસે,ટોરેન્ટ પાવર સબ-સ્ટેશનની સામે, સ્ટ્રીટલાઈટ પોલ નં.51846 પછી	૫૦	
VMS Location				
૧	વાસણા રોડ	સ્ટોન ફેક્ટરી પછી,એ.પી.એમ.સી.બિલ્ડીંગની સામે, સ્ટ્રીટલાઈટ પોલ નં.ST1726 પાસે	૩૦૦	સ્થળની વિગત દર્શાવતો સ્કેચ પ્લાન આ સાથે સામેલ કરેલ છે.
૨	૧૩૨ ફૂટ રીંગ રોડ	શ્યામલ જંકશન ફ્લાયઓવર થી ૧૦ મીટર આગળ,મણીભદ્ર એવન્યુની સામે, સ્ટ્રીટલાઈટ પોલ નં.JSV41269 પાસે	૫૦	
૩	૧૩૨ ફૂટ રીંગ રોડ	શિવાલીક-૨ કોમ્પ્લેક્ષ પછી,તિર્યજલ બિલ્ડીંગની સામે, સ્ટ્રીટલાઈટ પોલ નં.ACJ40126 પછી	૧૫	
૪	જજીસ બંગલો રોડ	અભિશ્રી એપ્રીઓટ પછી,બાલાજી એવન્યુની સામે,રિલાયન્સ જવેલ શો-રૂમની પાસે, સ્ટ્રીટલાઈટ પોલ નં.PBJ38899 પછી	૩૦	

સદર કામગીરીમાં એલ.ઈ.ડી.બોર્ડ તેમજ ટ્રાફિક સેન્સર લગાવવાના જેના માટે પાવર કેબલ તેમજ કંટ્રોલ કેબલ લેઈંગ કરવા તથા સેક્શન પીલર ઇન્સ્ટોલ Zero-Sum Ltd.Japan ને તેમની સાથે થયેલ એમ.ઓ.યુ. મુજબ કોર્પોરેશન દ્વારા જરૂરી પરમીશન આપવાની થાય છે. સદર કામમાં કોર્પોરેશન દ્વારા કોઈ પણ જાતનો ખર્ચ કરવાનો થતો નથી. સદર કામમાં નક્કી કરવામાં આવેલ રૂટ પર ચાર નંગ એલ.ઈ.ડી. બોર્ડ તથા ૧૦ નંગ ટ્રાફિક સેન્સર ઇન્સ્ટોલ કરવામાં આવશે. જ્યારે ચાર નંગ કમ્પ્યુટીંગ ડિવાઈસ ઉપયોગ અર્થે આપવામાં આવશે. જે અંગેનો સંપૂર્ણ ખર્ચ જાપાન સરકાર દ્વારા ભોગવવામાં આવશે અને કોઈ પણ ખર્ચ કોર્પોરેશનને ભોગવવાનો થતો નથી. જેથી Zero-Sum Ltd. દ્વારા સદર પ્રોજેક્ટ કોઈ પણ જાતનો ખર્ચ લીધા વગર કરવામાં આવતો હોઈ તથા સદર કામના ખર્ચના બજેટની ગણતરીમાં રોડ ઓપનીંગનો ચાર્જ ગણતરીમાં લીધેલ ન હોઈ રોડ ઓપનીંગ માટે કોઈપણ જાતનો વહિવટી ચાર્જ તેમની પાસે ન લેવા માટે તેમના તા.૨૫/૦૪/૨૦૧૩ ના પત્રથી ભલામણ કરેલ છે. વધુમાં સદર પ્રોજેક્ટમા Zero-Sum Ltd. દ્વારા ઇલેક્ટ્રોનિક ઇન્ફોર્મેશન બોર્ડમાંથી એડવર્ટાઈઝની જે આવક મળશે તે અ.મ્યુ.કો. માં જમા કરાવવામાં આવશે.

આમ અમદાવાદ શહેરમાં ટ્રાફિકની સમસ્યાના નિવારણ માટે Trial Intelligient Transport System Solutions(ITS) પ્રોજેક્ટ અંતર્ગત વાસણા રોડ,એ.પી.એમ.સી.થી ૧૩૨ ફૂટના રોડ તરફ,શ્યામલ

જંકશનથી શિવરંજની જંકશન થી કેશવભાગ થી જજીસ બંગલો વસ્ત્રાપુર રોડ તરફ ની કામગીરીમાં ૪ જગ્યાએ એલ.ઈ.ડી.બોર્ડ તેમજ ૧૦ જગ્યાએ ટ્રાફિક સેન્સર લગાવવા જરૂરી કેબલ નાખવા સુચિત રૂટના કુલ ૧૪ લોકેશન પર કામગીરી કરવા Zero-Sum Ltd.Japan ને રોડ ઓપનીંગ પરમીશન કોઈ પણ જાતના વહીવટી ચાર્જ લીધા સિવાય મંજૂરી આપવા તથા ખોદાણ કરેલ જગ્યાએ રીઈન્સ્ટેન્ટમેન્ટની કામગીરી જે તે ઝોન ધ્વારા કરાવવાની સુચના આપવાની મંજૂરી આપવા ખાતા દ્વારા ભલામણ કરવામાં આવેલ છે.

મંજૂરી:-ઉપરોક્ત સઘળી હકીકતથી વિદીત થઈ અમદાવાદ શહેરમાં ટ્રાફિકની સમસ્યાના નિવારણ માટે Trial Intelligent Transport System Solutions(ITS) પ્રોજેક્ટ અંતર્ગત વાસણા રોડ, એ.પી.એમ.સી.થી ૧૩૨ ફૂટના રોડ તરફ, શ્યામલ જંકશનથી શિવરંજની જંકશન થી કેશવભાગ થી જજીસ બંગલો વસ્ત્રાપુર રોડ પર ૪ જગ્યાએ એલ.ઈ.ડી.બોર્ડ તેમજ જુદી જુદી ૧૦ જગ્યાએ ટ્રાફિક સેન્સર લગાવવા જરૂરી કેબલ નાખવા સુચિત રૂટના કુલ ૧૪ લોકેશન પર કામગીરી કરવા Zero-Sum Ltd.Japan ને રોડ ઓપનીંગ પરમીશન કોઈ પણ જાતના વહીવટી ચાર્જ લીધા સિવાય આપવાની મંજૂરી આપવા તથા ખોદાણ કરેલ જગ્યાએ રીઈન્સ્ટેન્ટમેન્ટની કામગીરી જે તે ઝોન ધ્વારા કરાવવાની સુચના આપવાની મંજૂરી આપવા વિનંતી છે.

સિવાય
આ.ઈ.

સિવાય
આ.સી.ઈ.

સિવાય
ડે.સી.ટી.એન્જી.
(ટ્રાફિક)

સિવાય
૨૪/૫/૧૫.
એડી.સીટી એન્જીનીયર
(ટ્રાફિક)

સિવાય
ડે.મ્યુ.કમિશ્નર

સિવાય
મ્યુનિસિપલ કમિશ્નર

ઉપરના મુજબ
મ્યુનિ કમિશ્નર
ઠરાવ નંબર 56
તારીખ: 7/5/2014

એ. સ્વામી હાલકી
ઠરાવ નંબર
સિવાય
AR

સિવાય
AR

DICE (Traffic) વડાકાં
સિવાય
815114
AddCE
(Traffic)

ACE (Traffic) વડા
સિવાય
7/5/14
મ્યુ. (C.E.)

મે.એડી.સીટી એન્જનીયરશ્રી, Wc/s

પ.ઝોન/નવા પ.ઝોન

અમદાવાદ શહેરમાં ટ્રાફિકની સમસ્યાના નિવારણ માટે Trial Intelligent Transport System Solutions(ITS) પ્રોજેક્ટ અંતર્ગત વાસણા રોડ, એ.પી.એમ.સી.થી ૧૩૨ ફૂટના રોડ તરફ, શ્યામલ જંકશનથી શિવરંજની જંકશન થી કેશવબાગ થી જજીસ બંગલો વસ્ત્રાપુર રોડ પર ૪ જગ્યાએ એલ.ઈ.ડી.બોર્ડ તેમજ જુદી જુદી ૧૦ જગ્યાએ ટ્રાફિક સેન્સર લગાવવા જરૂરી કેબલ નાખવા સુચિત રૂટના કુલ ૧૪ લોકેશન પર કામગીરી કરવા Zero-Sum Ltd.Japan ને રોડ ઓપનીંગ પરમીશન કોઈ પણ જાતના વહીવટી ચાર્જ લીધા સિવાય આપવાની તથા ખોદાણ કરેલ જગ્યાએ રીઈન્સ્ટેન્ટમેન્ટની કામગીરી જે તે ઝોન ધ્વારા કરાવવાની મે.મ્યુ.કમિશ્નર ઠ.નં.-તા.૦૭.૦૫.૨૦૧૪ થી મંજૂરી મળેલ છે. જેની નકલ આ સાથે સામેલ છે. જે ધ્યાનમાં લઈ Zero-Sum Ltd.Japan ને રોડ ઓપનીંગ પરમીશન આપવા માટે આપના ખાતેથી જરૂરી કાર્યવાહી કરવા વિનંતી છે.

સાંચી
આ.ઈ.

સાંચી
આ.સી.ઈ.

સાંચી
ડે.સીટી.એન્જ.
(ટ્રાફિક)

સાંચી
એડી.સીટી એન્જનીયર
(ટ્રાફિક)

બિડાણ:- ૧) મે.મ્યુનિ કમિશ્નરશ્રીના ઠરાવની નકલ

૨) રોડ ઓપનીંગ દર્શાવતો સાઈટ સ્કેચ

નકલ રવાના: ૧) એડી.સીટી.એન્જનીયર(બી.આર.ટી.એસ.)જાણ સાડુ

૨) જનરલ મેનેજર(જનમાર્ગી)

૩) Zero-Sum Ltd.Japan

**Date: 18th December' 2014,
Ahmedabad**

Letter of ITS (Intelligent Transport System) Trial Project Certification

Reference: No G/725/Traffic/806//2013 – Letter from Jt. Commissioner of Police,
Traffic Ahmedabad City

: No 3251 Date 30/10/2013 – Letter from Municipal Commissioner,
Ahmedabad Municipal Corporation accepting proposal for Implementing
Trial ITS Solution in Ahmedabad

: No 4620 Date 27/12/2013 – Letter from Municipal Commissioner,
Ahmedabad Municipal Corporation granting permission order for the
implementation of Trial ITS Solution By Zero-Sum Ltd, Japan in Ahmedabad.

This letter is to certify that the Trial Intelligent Transport System Solutions (ITS) project in Ahmedabad Gujarat implemented by Zero-Sum LTD, Japan has been implemented as per their proposal dated 25th October' 2013. To this end, the project

- Collects Traffic Information: The ITS solution collectstraffic information from fourteen (14)camera based Traffic Volume sensors and Traffic police inputs.
- Process Traffic Information: The collected traffic information is being processed on a cloud based control centre which analyses the gathered traffic information to understand the traffic flow and congested areas in the target area.
- Information Provision: The ITS solution displays the processed information on four (4)7*3 meterselectronic information boards across key decision making points in the target areas on 132 feet Ring Road in the areas of APMC Junction, Shymal Junction, Shivaranjani Junction and Mansi Junction. This information is aiding motorists in making decision on which roads to avoid and taking up alternate routes to reach their destination. All locations have been chosen after due consultation and inputs from Traffic Police of Ahmedabad.
- Innovative commercial use of the Information board is taking place through displaying 50% screen space for commercial advertisements for the monetization of the project.
- Taking valuable feedback from Ahmedabad Traffic Police on account of commuter safety, no video based advertisement is being displayed on any of the electronic information boards.

- The Information boards also display information in both Gujarati and English as the per the recommendation of the Ahmedabad Traffic Police.
- The User interface for displaying traffic information on the information board has also been finalized after consultation with Ahmedabad Traffic Police for their inputs on local commuter behaviour and their understanding or interpretation of traffic information
- Tablet computing devices with the ability for Traffic Police to control and add inputs on traffic Jam information and other emergency information has also been provisioned and handed over to the Ahmedabad Traffic Police.
- On the job training on how to use the tablet device and operate the electronic information boards remotely has been imparted to identified officials of the Ahmedabad Traffic Police.



For Ahmedabad Traffic Police

Additional Commissioner of police

Name: HARIKRISHNA PATEL

Date: 18/12/14

For Zero-Sum LTD, Japan



Name: KIKUCHI CHIKARA

Date: 18th Dec. 2014



Gzb plans to speed on info superhighway

Lalit Kumar | TNN

Ghaziabad: The city is on the road to become hi-tech in about six months time, at least that's what the Ghaziabad Development Authority claims.

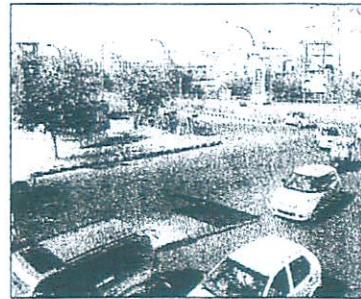
The Ghaziabad Development Authority (GDA) is installing two Wi-Fi corridors, with a total length of 65km for motorists and residents. It is installing 350 towers all over the city, each equipped with several video cameras, through which cops can watch every move law breakers might make from a control room. About 150 of these towers have already been set up, which will also provide 4G internet. There will be 20 jumbo-sized LED screens on which

motorists can get real-time information on the volume of traffic on different routes will also be put up.

Sixteen smaller screens will be set up around UP Gate, where the traffic comes in from Delhi via NH-24. These screens will provide information about routes in Ghaziabad and beyond.

In case anyone wonders how much the projects will cost the city, the answer is 'nil'. The LED screens will run advertisements for the company setting them up 70% of the time. The towers will also carry display advertisements.

The Wi-Fi services will be free for users for 30 minutes. Indirapuram will be covered in the first phase, followed



HI-TECH: UP Gate to get 16 LED screens

by Raj Nagar District Centre and then the rest of the city, said GDA vice-chairman Santosh Yadav.

GDA officer on special duty D P

Singh said, "One Wi-Fi corridor will run from UP Gate to Muradnagar, via Mohan Nagar, Meerut t-point and Raj Nagar Extension crossing. Another will run from UP Gate to Lal Kuan, via Hapur Chungi and Dasna on NH-24."

Singh added, "The project is the brainchild of GDA chairman Santosh Yadav, who wants to turn Ghaziabad into a city of the future. We hope to have them ready by June-end. Reliance Geo has already set up 150 towers."

Singh added, "The towers, LED screens and related activity will be run on solar energy." He also said 3-4 of the jumbo LED screens will be "operational by the time CM Akhilesh Yadav visits the city on January 20".