ATIS FOR INDIAN CITIES

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Sponsor: Dept. of Electronics and Information Technology, GoI

Executing Agencies: IIT Madras and CDAC-T

Project Objectives

- Identification of User Needs, Functional Requirements and Systems Architecture for ATIS in Indian cities
- Selection of data collection techniques for ATIS in India
- Develop methodologies and decision support tools to support ATIS applications – models, algorithms etc.
- Develop prototypes for following ATIS applications
  a. Variable Message Signs
  b. Web-based Personal Traveller Information System
- Field Implementation, and Evaluation of above Advanced Traveler Information Systems applications

Project currently in advanced stage. First 4 objectives almost complete. Final objective underway.

Limitations of Current Implementations

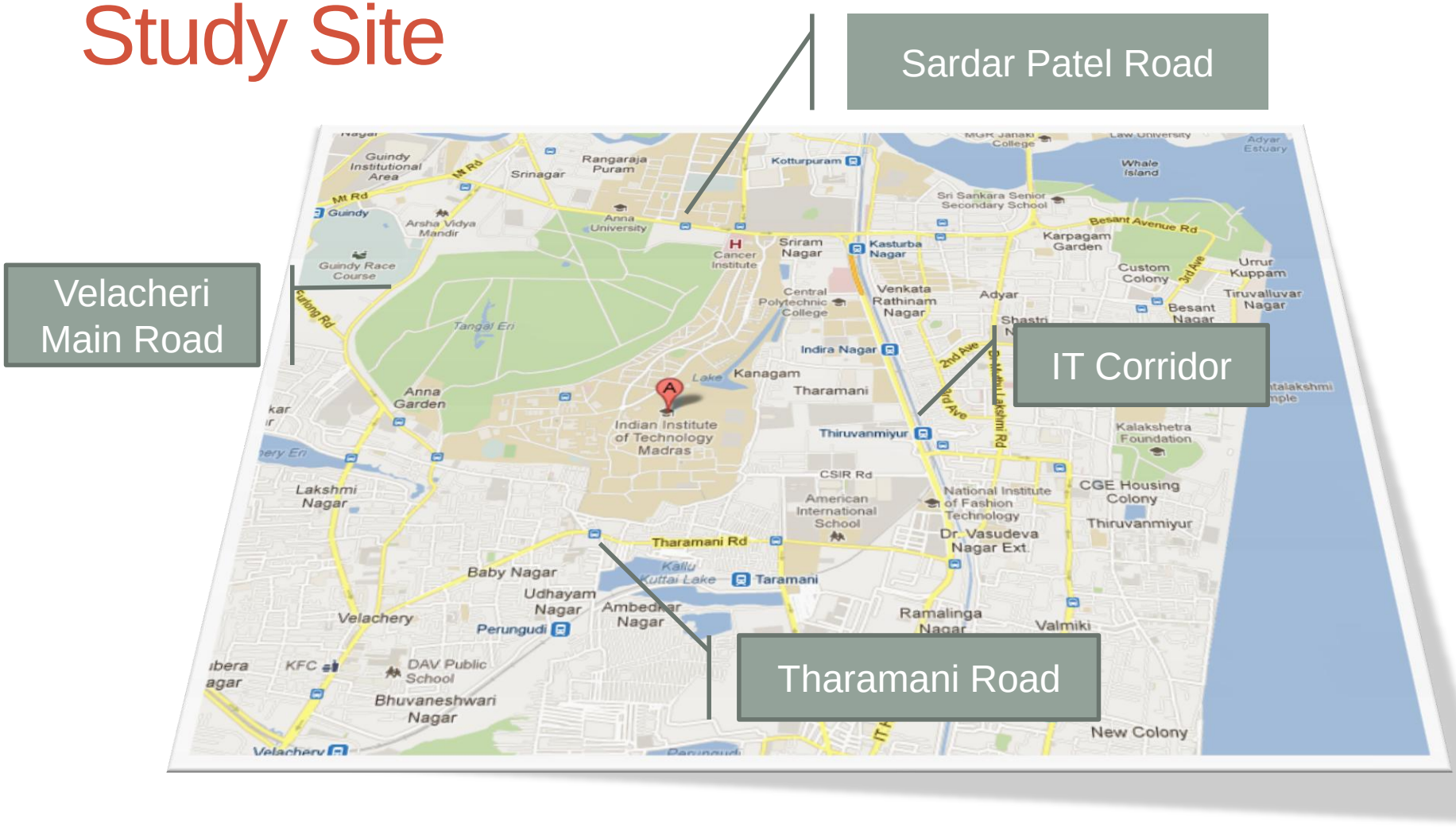
- Not customised to user needs and requirements
- Inadequate real-time data; data from multiple sources needed for large scale implementations
- Not supported by dynamic traffic prediction models
- Network capacity not effectively utilized
- Information strategies ad hoc
- Piecemeal implementation – technology demonstration

Our system: is personalized; uses real-time data from GPS and video cameras, dynamic travel time prediction, alternative information strategies, and fully integrated implementation

User Needs Study

- VMS Information Required:
  - Traffic congestion, travel times, alternate route advice, location of accident/incident
- Web-based Information Required:
  - Roadwork and condition, travel time on alternate routes, accidents
- Language preference
  - Tamil (Local language)
  - English
  - Hindi

Study Site



Over 15 km of road stretch; over 13 major intersections; includes 4 lane and 6 lane divided and undivided roads; three major road user agencies; IIT Madras is at the center

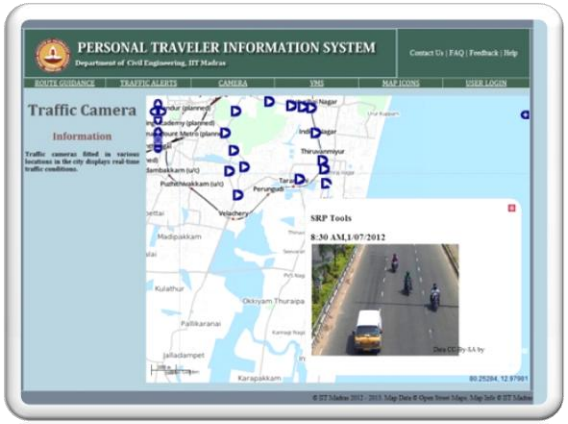
Real-time Data

- ✓Over 100 GPS
  - ✓real-time lat-long information to our servers every 10 sec
- ✓32 video cameras
  - ✓along the corridors – both at mid-block and intersection locations
  - ✓with wireless comm. to central control center

Proposed ATIS Applications

Personal Traveler Information Systems (Web based) - PTIS

- ✓Route guidance, congestion, travel time, incident, road condition
- ✓Customized paths: delays, travel time by vehicle type, bus routes



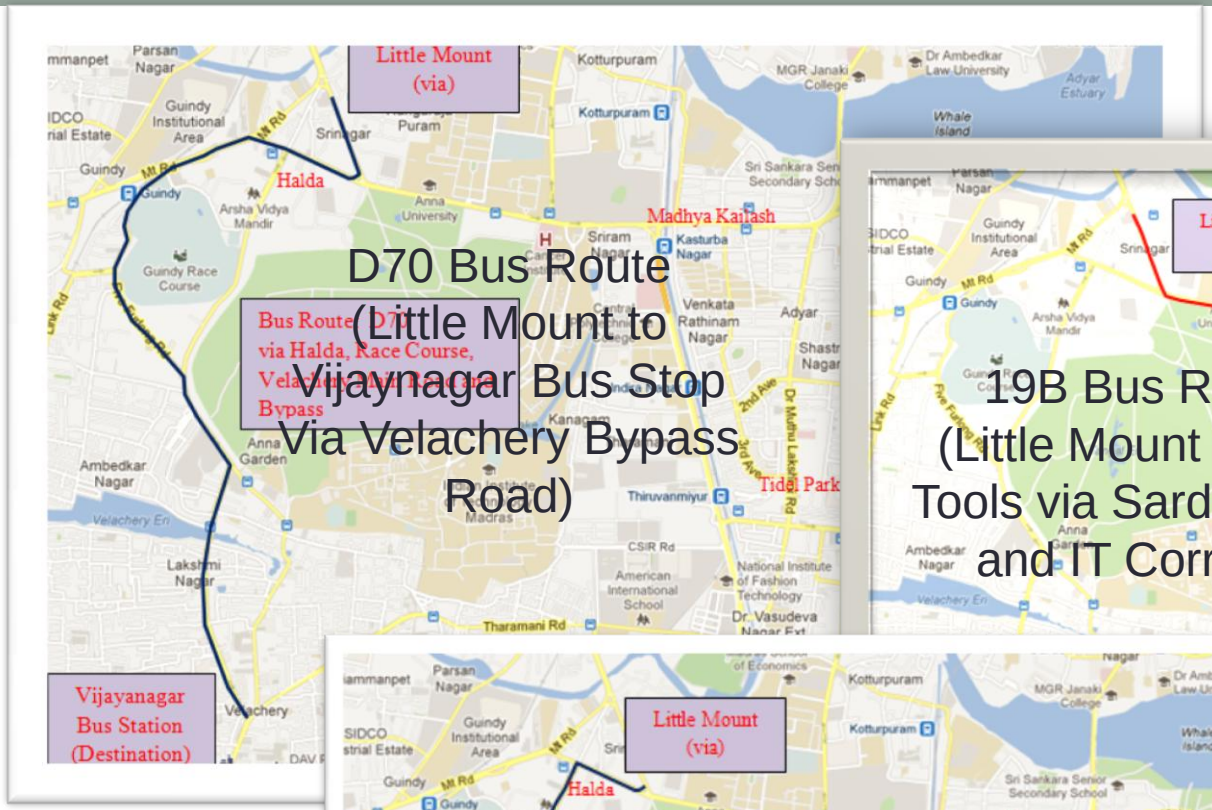
Dynamic Information using Variable Message Signs (VMS)

- ✓Advisory: congestion, travel time, road condition, weather, incidents
- ✓Guidance: diversion, route selection lane closure

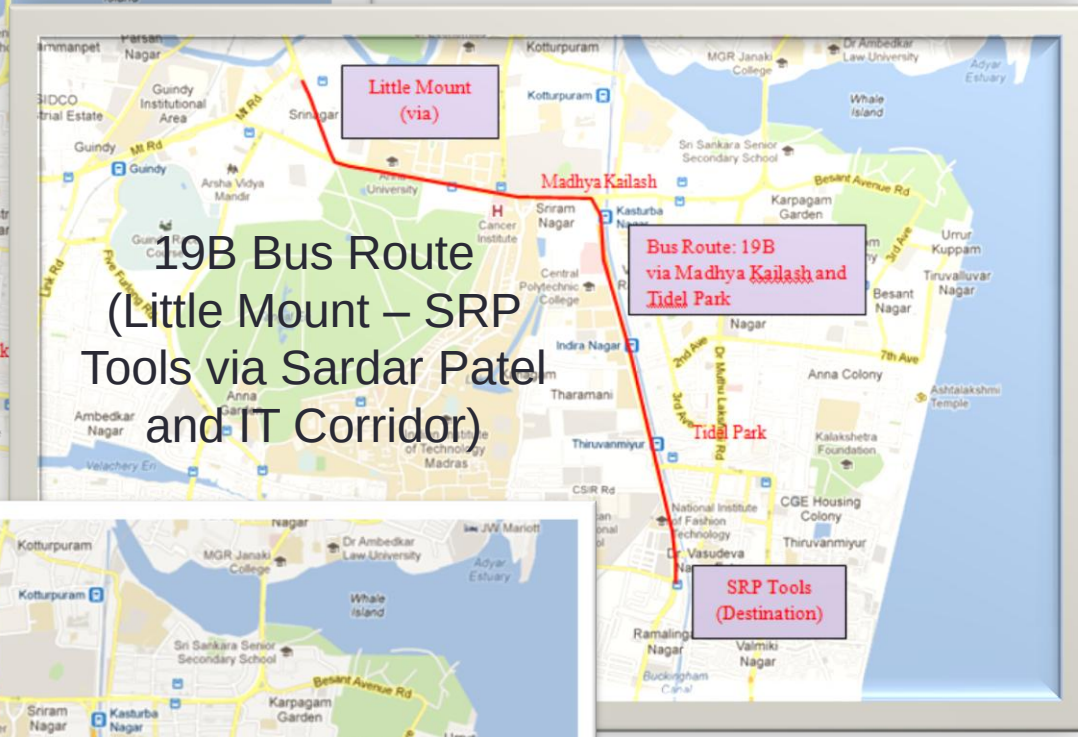
Dynamic Link Travel Time Prediction

- Model developed and tested using Real time GPS data.
- Model combines multiple device data from different bus routes on a given link (19B, M7, D70 for covering whole corridor)
- Provides real time status update and network level coverage instead of route level coverage
- Performance measures of prediction models: MAPE, travel time error, reliability

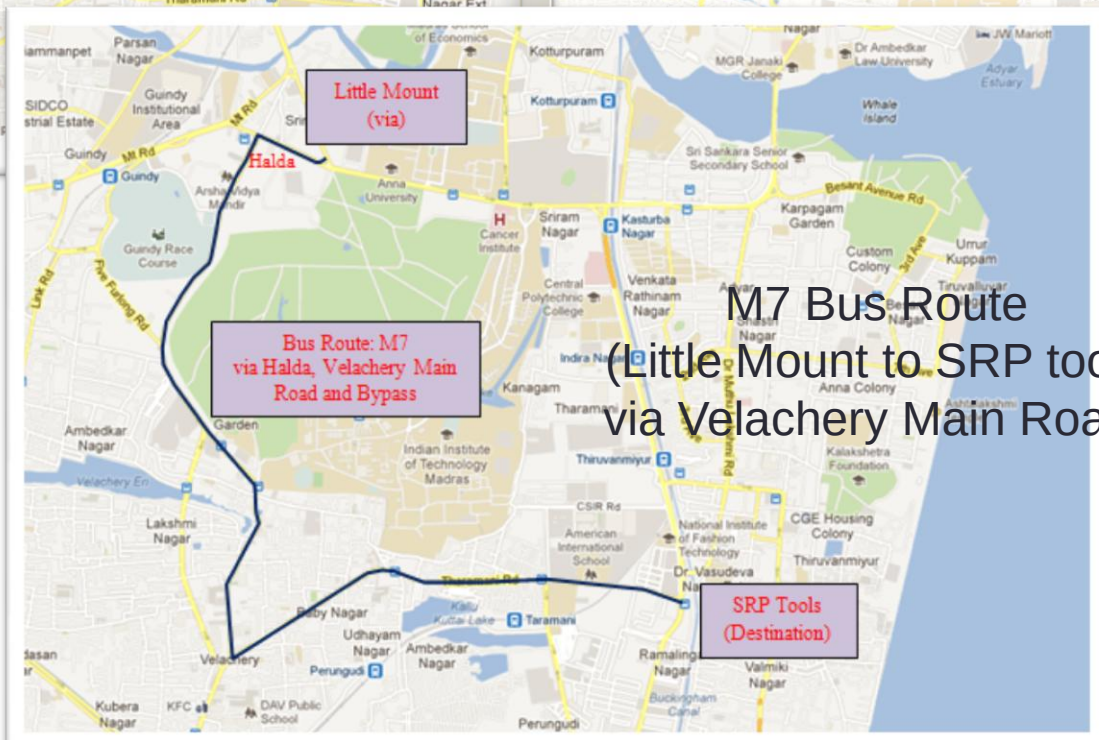
Credibility of information is vital for sustained patronage of any ATIS system – significant effort has been put into developing best models for Indian traffic conditions



D70 Bus Route (Little Mount to Vijaynagar Bus Stop Via Velachery Bypass Road)



19B Bus Route (Little Mount – SRP Tools via Sardar Patel and IT Corridor)



M7 Bus Route (Little Mount to SRP tools via Velachery Main Road)

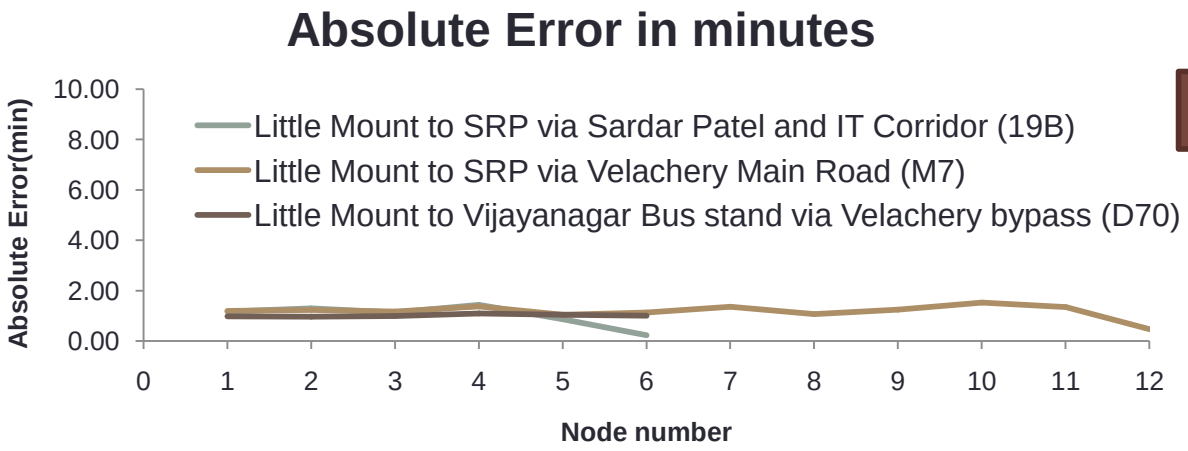
Comparison of Alternative Prediction Models

Route	Model 1	Model 2	Model 3
	MAPE % (MAE - min)	MAPE % (MAE - min)	MAPE % (MAE - min)
Route 19B Sardar Patel and IT Corridor	7.56 (1.17)	24.62 (3.46)	23.82 (3.35)
Route M7 Via Velachery Main	4.94 (1.20)	14.21 (3.37)	13.82 (3.29)
Route D70 Via Velachery Bypass	7.39 (0.98)	13.54 (1.72)	13.29 (1.69)

Model 1 – Speed inverse (travel time/km); Model 2 – travel time using last probe vehicle; Model 3 – travel time using last 2 probe vehicles

The best model has errors of less than 10%

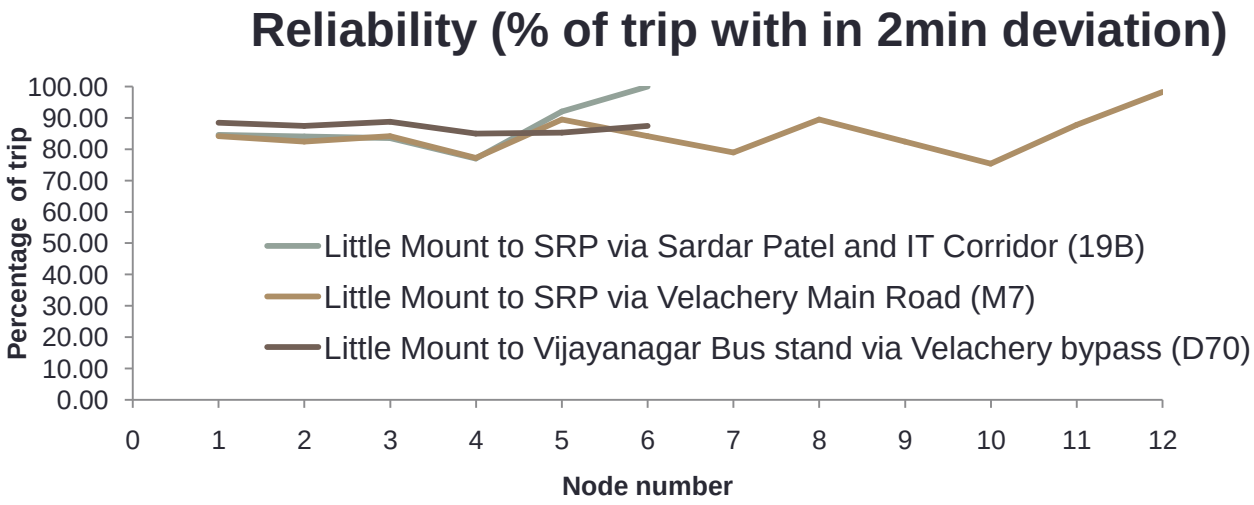
Prediction Accuracy & Reliability



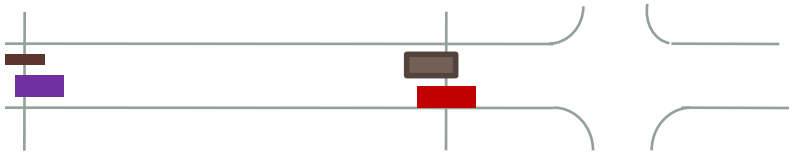
Errors remain within 2 min

Over 85% predictions very reliable

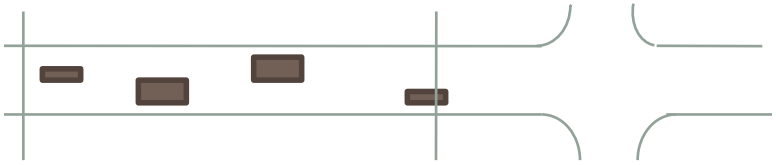
Reliability of predictions is another key factor for building credibility



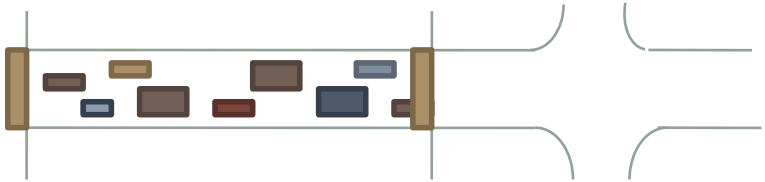
Data from Multiple Sources



- Location sources
  - Provide location characteristics
  - Spatial characteristics will not be captured



- Spatial sensors alone
  - Capture spatial variation
  - Less penetration rate of probe vehicles
    - Travel time from sample of vehicles which is sparse and limited, biased
  - Cannot give density, flow
- Combining both can give average characteristics of the entire stream
  - This approach is known as data fusion



Data Fusion Models and Results

- Kalman Filter Model for density and travel time estimation

$$k(t) = k(t-1) + u(t-1,t) + w(t-1)$$

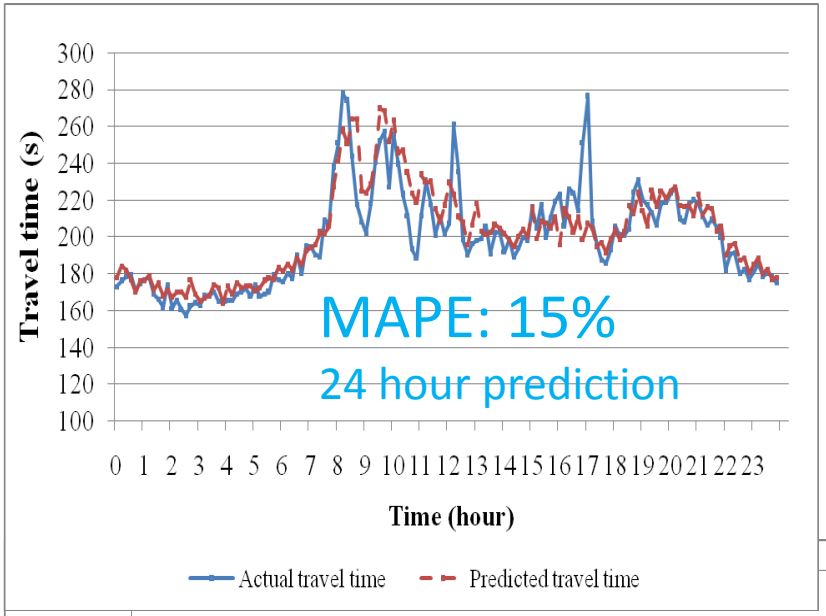
$$SMS(t) = \frac{q(t)}{k(t)} + z(t)$$

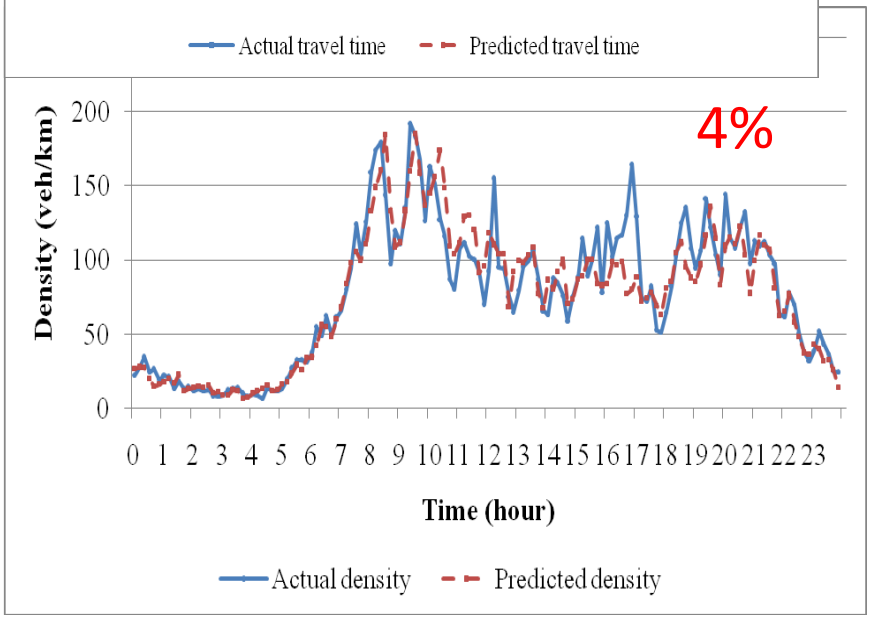
Density Prediction:

Seasonal ARIMA(0,1,7) × $(1,1,1)_1$

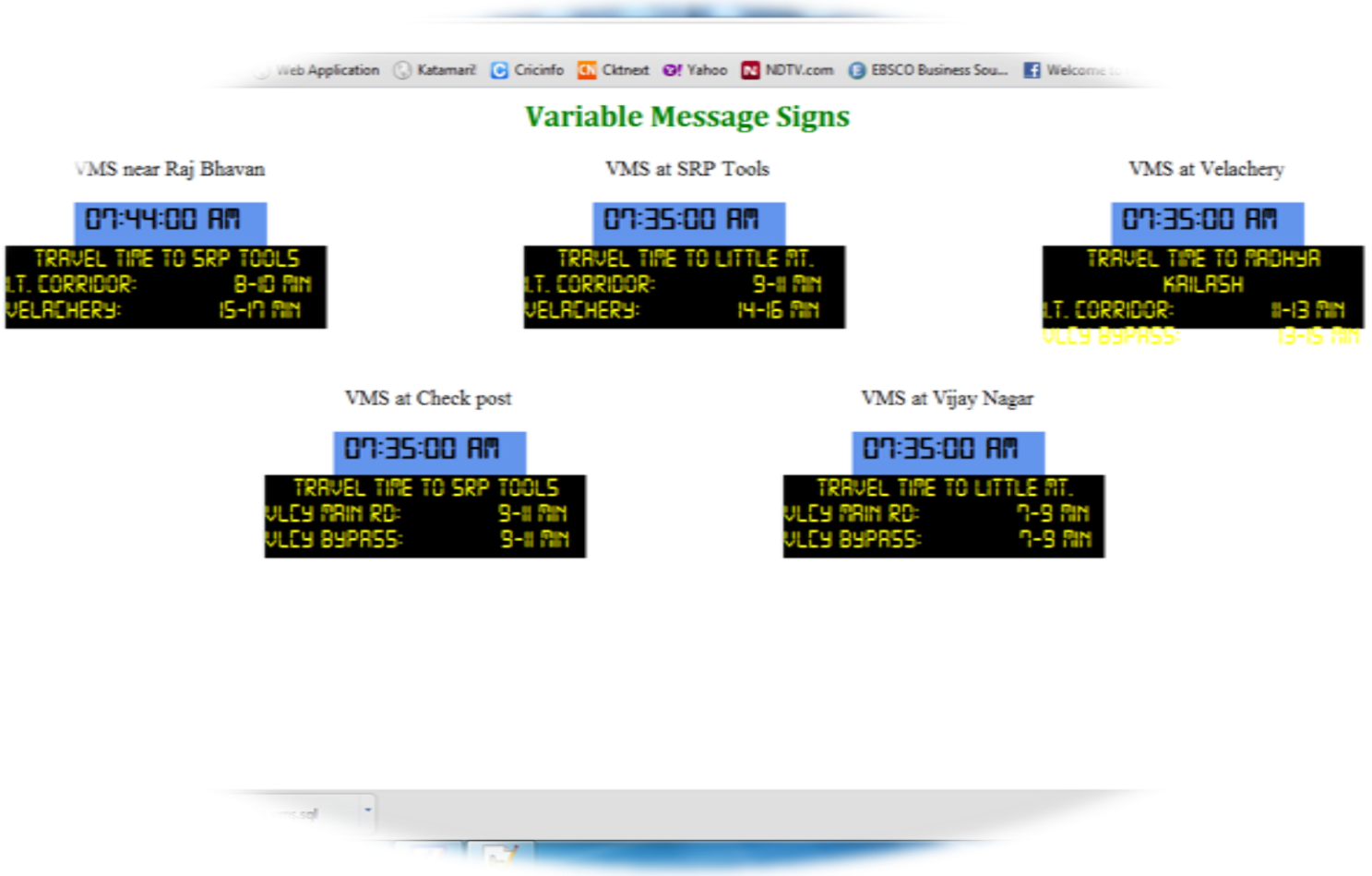
Travel Time Prediction:

Seasonal ARIMA(0,1,3) × $(1,1,1)_1$





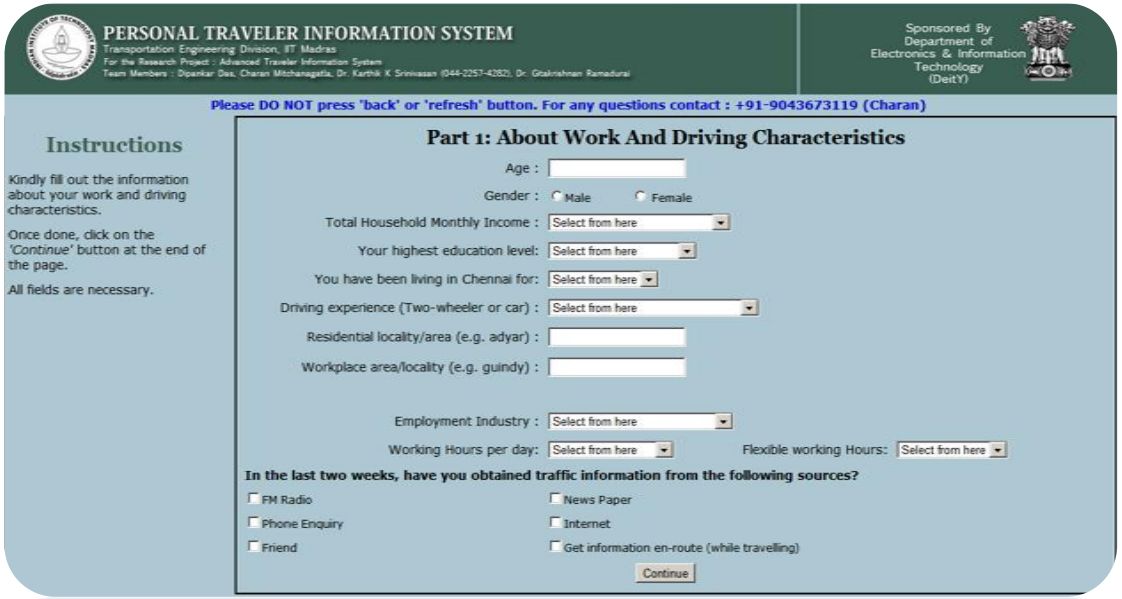
User Interface - PTIS



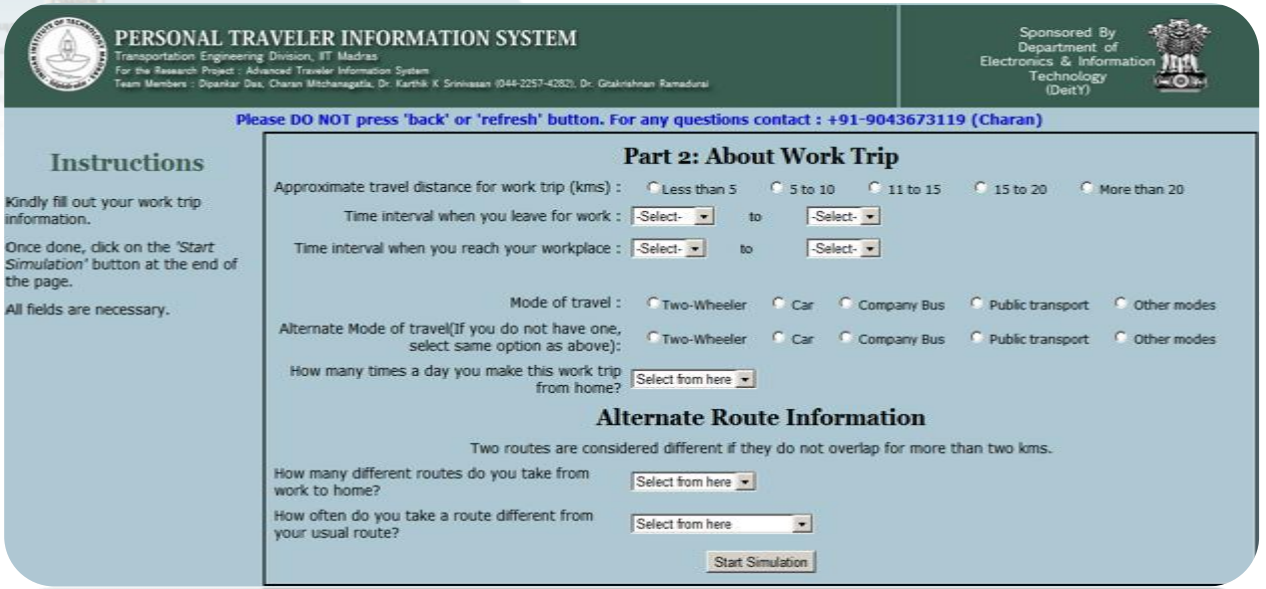
PTIS Simulator

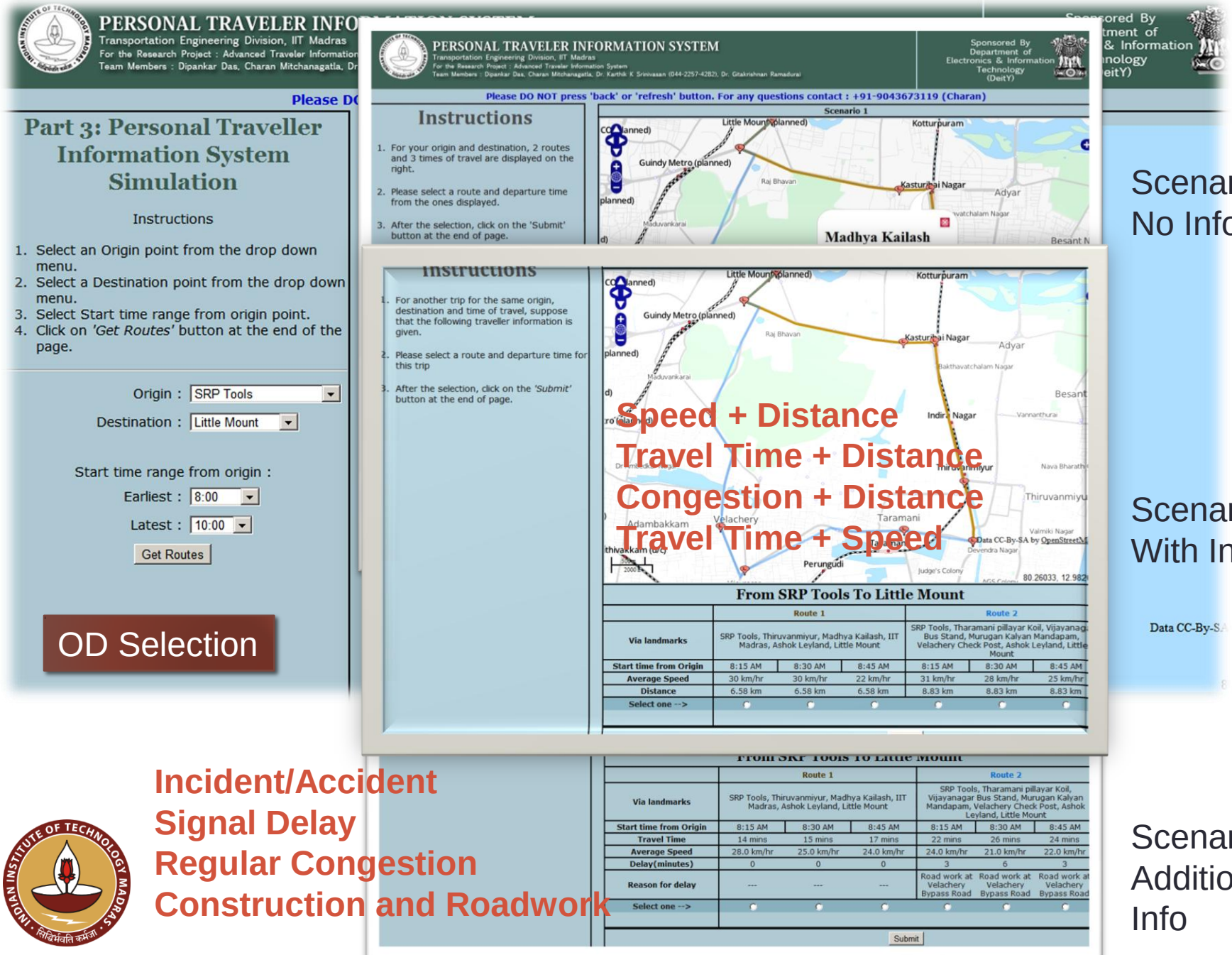
- Stated choice experiments using web-based prototype
- Over 150 responses obtained from regular users of the study site corridors
- Exploratory Analysis of experimental data performed
- Preliminary models of user response to different types of information and formats developed.

Can be accessed at
http://115.115.108.126:8080/dipankar/ptis_new/new_webpage/



Information about users, their driving and work trip characteristics are collected





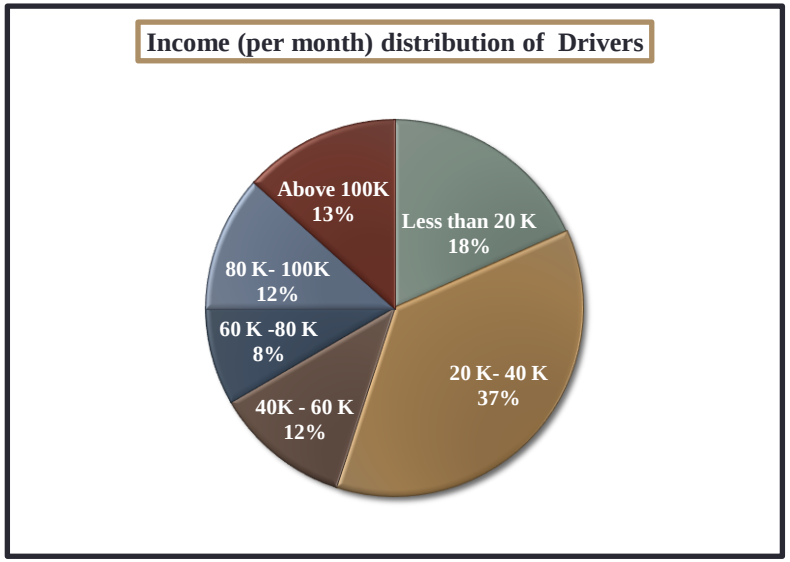
Scenario 1
No Info

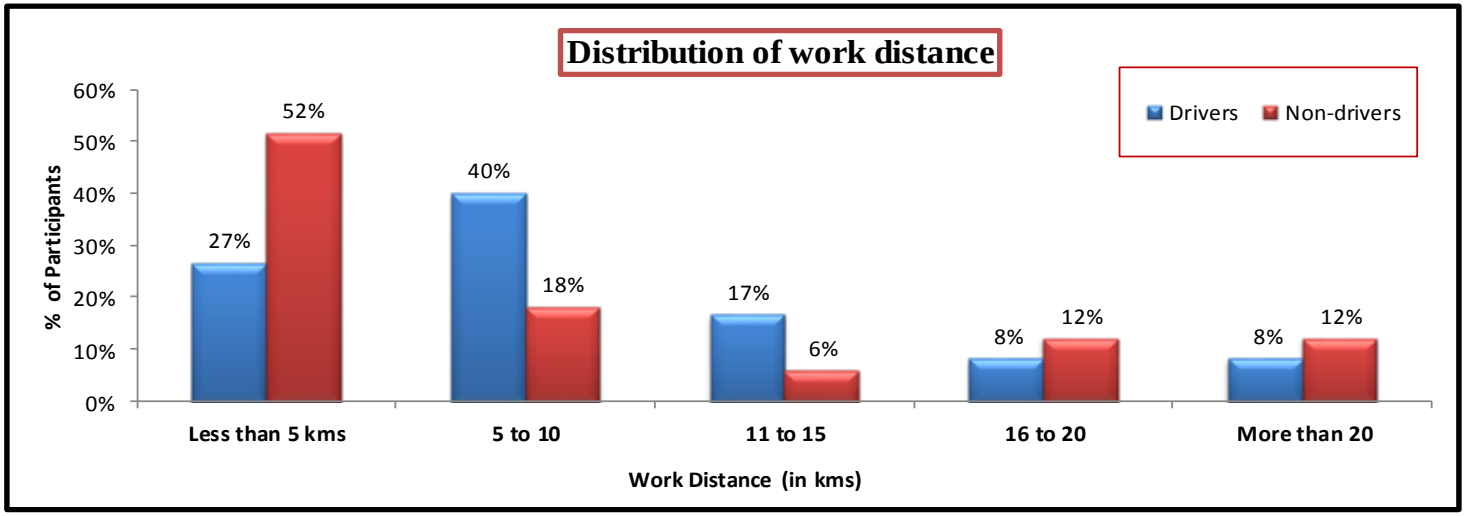
Scenario 2
With Info

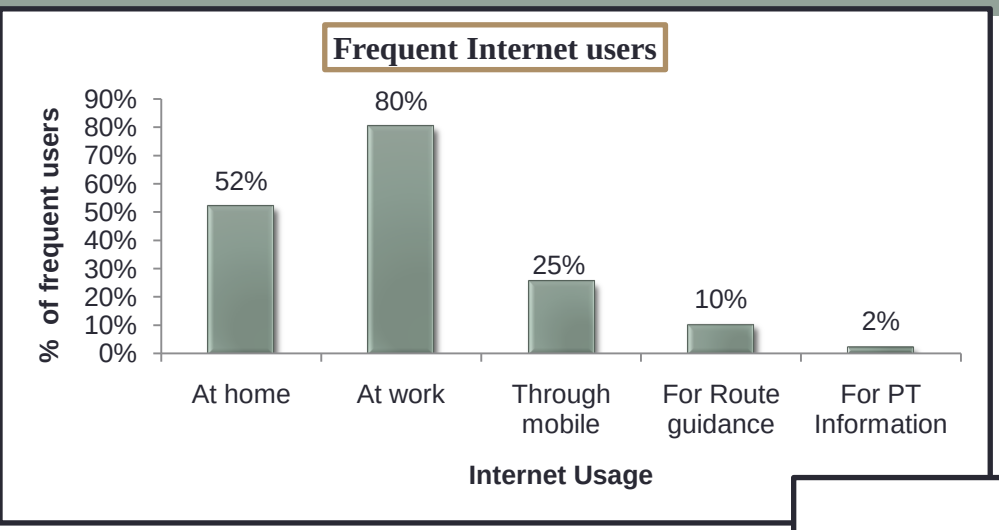
Scenario 3, 4
Additional
Info

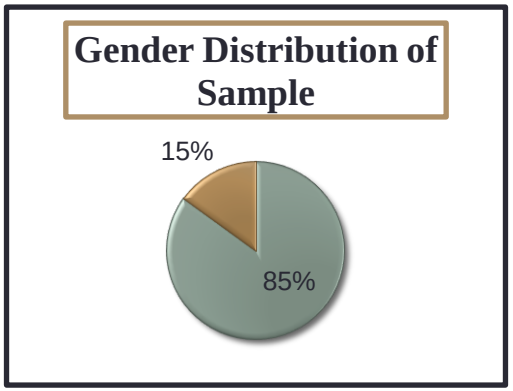
PTIS Simulator Survey Results

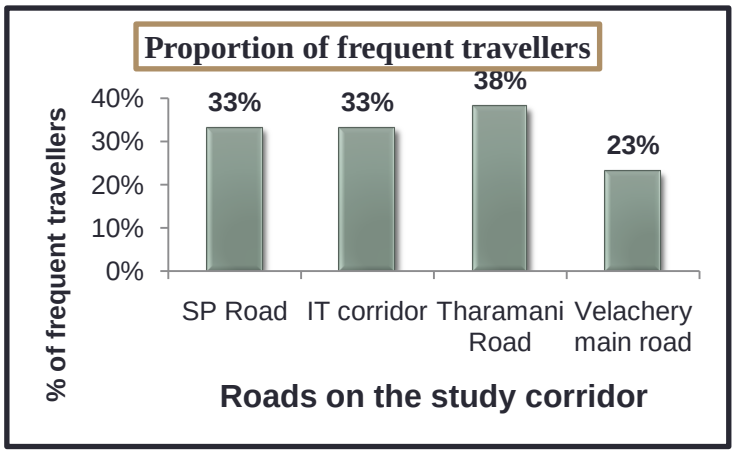
- 159 participants; 795 responses
- Current analysis 93 total - 60 drive their personal vehicles

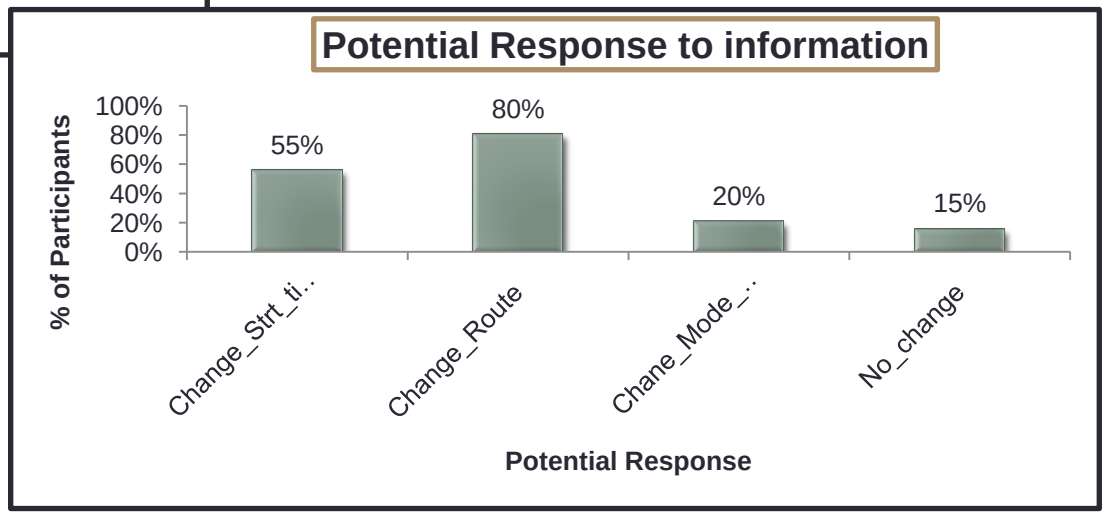


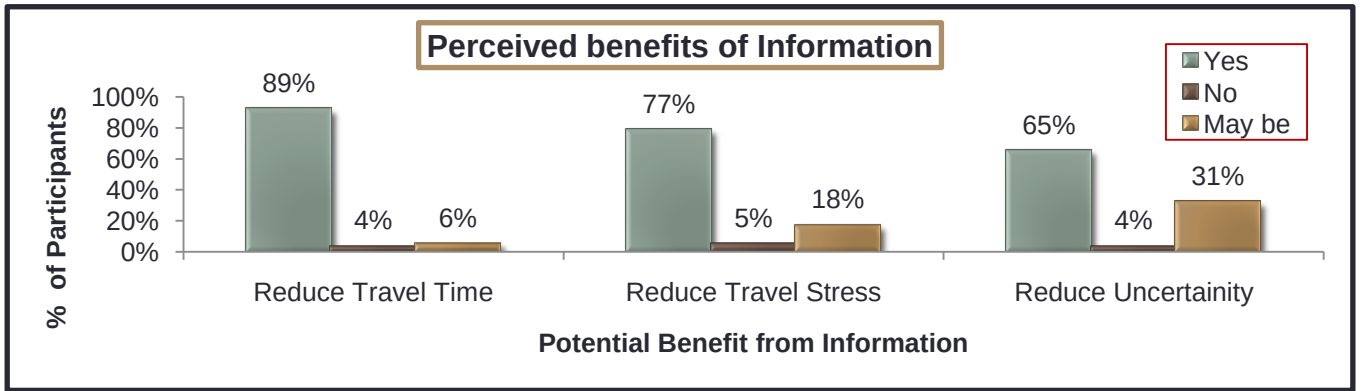



Frequent Internet users
% of frequent users
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
52%
80%
25%
10%
2%
At home
At work
Through mobile
For Route guidance
For PT Information
Internet Usage


Gender Distribution of Sample
15%
85%


Proportion of frequent travellers
% of frequent travellers
40%
30%
20%
10%
0%
33%
33%
38%
23%
SP Road
IT corridor
Tharamani Road
Velachery main road
Roads on the study corridor


Potential Response to information
% of Participants
100%
80%
60%
40%
20%
0%
55%
80%
20%
15%
Change_Strt_ti..
Change_Route
Chane_Mode_...
No_change
Potential Response


Perceived benefits of Information
% of Participants
100%
80%
60%
40%
20%
0%
89%
4%
6%
77%
5%
18%
65%
4%
31%
Yes
No
May be
Reduce Travel Time
Reduce Travel Stress
Reduce Uncertainity
Potential Benefit from Information

PTIS Simulator Results

Binary logit model for compliance

Variable	Coefficient	std.error	t-stat
constant	1.32	0.35	3.80
sp_2	-0.64	0.35	-1.82
sp_3	-0.97	0.32	-3.00
sp_4	-0.42	0.33	-1.27
d_sig	-1.15	0.38	-3.01
err_r	-0.32	0.16	-1.97
fam_net	-0.76	0.22	-3.41
wrk_dis	-0.32	0.22	-1.41
age3	1.06	0.33	3.23
gender	-0.71	0.31	-2.32
int_work	0.36	0.23	1.59

Number of observations= 465, Log-likelihood at convergence = -283.06, Log-likelihood initial = -322.31

Binary logit model for switching

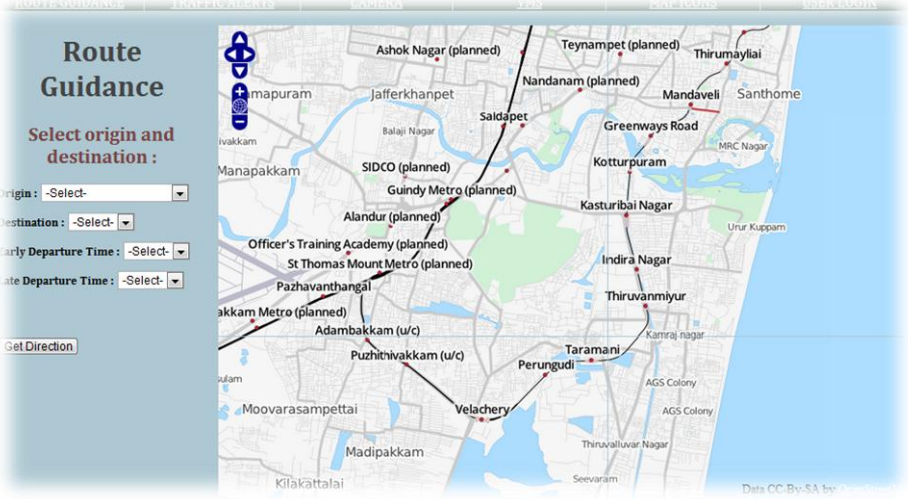
Variable	Coeff-icient	std.error	t-stat
constant	1.37	0.38	3.64
sp_1	-1.13	0.54	-2.09
sp_5	-0.84	0.46	-1.82
veh_4w	1.02	0.39	2.62
dri_exp	-0.97	0.29	-3.39
int_work	-0.83	0.33	-2.51
int_rg	-0.57	0.35	-1.62
p1d_1	0.21	0.08	2.46
p1d_3	0.10	0.04	2.27

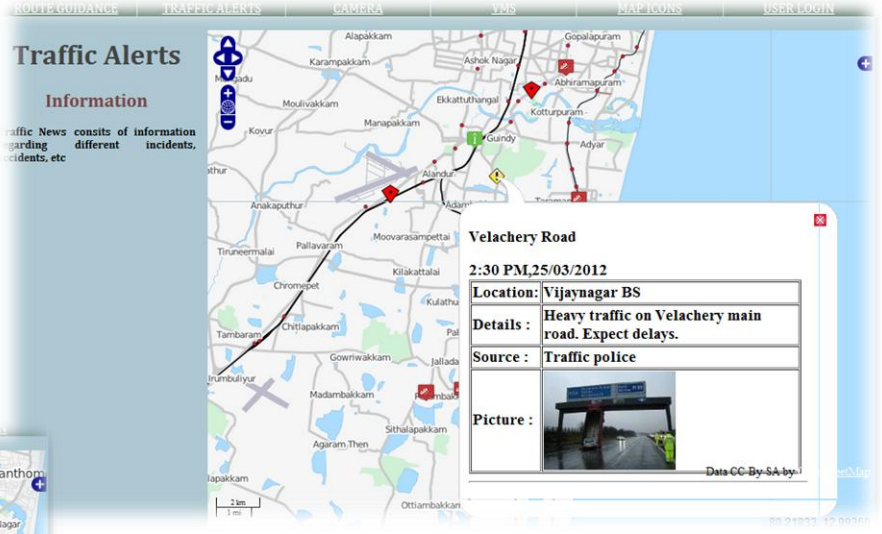
Number of observations= 279, Log-likelihood at convergence = -164.21, Log-likelihood initial = -193.39

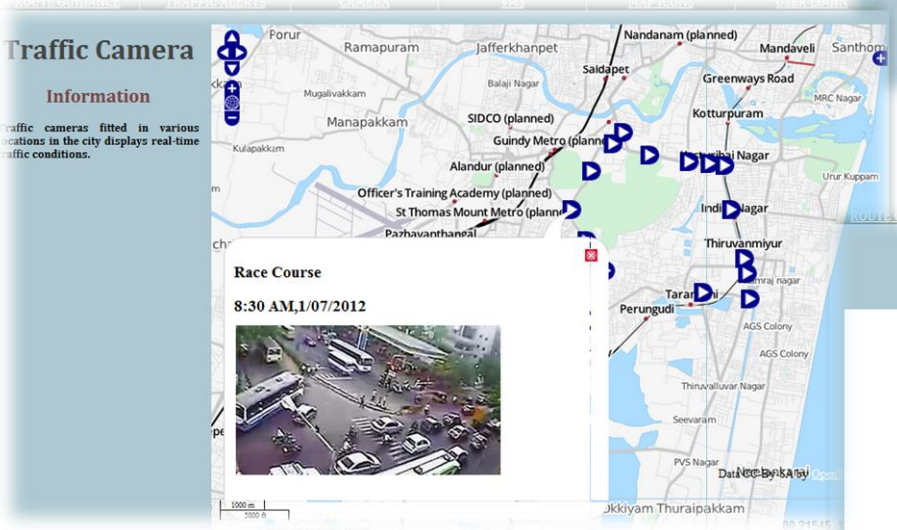
PTIS Simulator Results

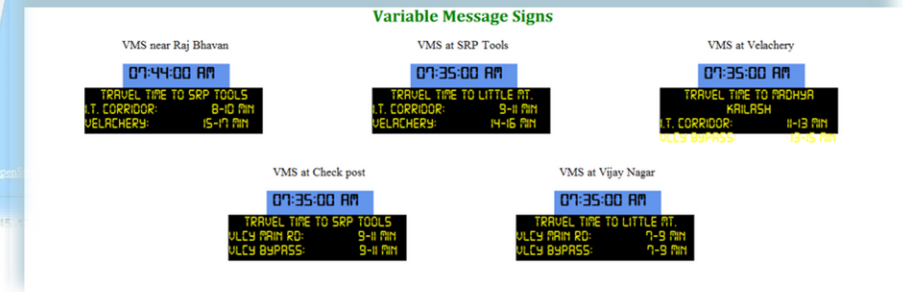
- Compliance is least when qualitative information is provided
- Familiarity of the OD pair does not really affect the compliance
- Underestimating travel times reduces compliance, where-as error on the left hand side has no significant impact
- Compliance lesser for long distance commuters
- Car drivers more likely to switch routes under information
- Response to information less for experienced drivers
- Switching of routes and or departure times are more likely when there is a significant travel time differential between alternate route and current route

PTIS Web Interface









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In Closing…

Traffic Technology Today.com
From the publisher of traffic TECHNOLOGY INTERNATIONAL

NEWS >> **3rd July 2012**

MassDOT unveils real-time VMS network

The Massachusetts Department of Transportation (MassDOT) has unveiled a new network of variable message signs (VMS) that offer real-time traffic information along the Interstate 93 corridor from Canton to the New Hampshire border. At the same time, the agency is also helping Cape Cod travelers by introducing new traffic resources, including new online CCTV cameras showing road conditions on Route 6 Westbound and using VMS boards to share with drivers the extent of the heavy traffic leaving the Cape on Sundays. The Real-Time Traffic Management pilot includes I-93 Northbound and Southbound travel time information via a network of 22 VMS. The signs display travel times in segments between various interchanges. As traffic slows, road sensors send updated travel times every minute to the message boards, letting drivers know how long it will be until they reach their destination. MassDOT is currently working on linking the real-time traffic information for customers via its '511' travel information internet site and in the future will make it accessible to third parties through its open data initiative.

MassDOT is also bringing online seven additional cameras for residents and visitors interested in road conditions on Cape Cod. The Cape Cod Regional Transit Authority is now hosting two new cameras on its website. Six new VMS boards are also being deployed to communicate road conditions. MassDOT is intending to provide further resources for Cape Cod travelers by expanding the statewide real-time traffic initiative to Western Massachusetts along I-91. Launching the new travel information system, MassDOT secretary and CEO, Richard A Davey, said, "Just in time for the busy July 4th holiday, we are launching a service people have been clamoring for. Real-time traffic data will

IIT Madras unveils real-time VMS and PTIS system…

- Personalized
- Predictive
- People-friendly

Near Future…

THANK YOU!

Questions and Comments?

ADDITIONAL SLIDES

Number	Location Name	Location Type	Location Side	Agency	Proposed Equipment
1	Sardar Patel Road (Between Halda-Raj Bhavan)	Mid-Block	Shoulder	Traffic Police Corporation	2 Cameras 1 Antenna
2	Velachery Check Post	Intersection	Shoulder	Traffic Police Corporation	2 Cameras 1 Antenna
3	Gurunanak College	Intersection	Shoulder	Traffic Police Corporation	2 Cameras 1 VMS 1 Antenna
4	Tharamani Periyar Nagar	Intersection	Shoulder	Traffic Police State Highway	3 Cameras 1 Antenna
5	TIDEL Park	Intersection	Shoulder / median	Traffic Police TNRDC	3 Cameras 1 Antenna
6	Cancer Institute	Intersection	Shoulder / median	Traffic Police Corporation	2 Cameras 1 Antenna
7	Madhya Kailash	Intersection	Shoulder (right)	Traffic Police TNRDC	1 Camera 1 Antenna
8	Little Mount	Mid-Block	Shoulder (both)	Corporation Traffic Police	2 Cameras 2 VMS 1 Antenna
9	Velachery Main Road (North of Aquatic Complex)	Mid-Block	Shoulder (west)	Corporation Traffic Police	2 Cameras 1 Antenna
10	Velachery Main Road	Mid-Block	Shoulder (west)	Corporation Traffic Police	2 Cameras 1 Antenna
11	Sardar Patel Road - Opposite to Hot Chips	Mid-Block	Median	Corporation Traffic Police	2 Cameras 1 Antenna
12	Sardar Patel Road – Anna University	Mid-Block	Median	Corporation Traffic Police	1 Camera 1 Antenna
13	Velachery Bypass Road	Mid-Block	Median	State Highway Traffic Police	2 Cameras 1 Antenna
14	Velachery Vijaya Nagar	Intersection	Shoulder (south)	State Highway Traffic Police	1 VMS 1 Antenna
15	Tharamani Road (East of TCS Office)	Mid-Block	Median	State Highway Traffic Police	2 Cameras 1 Antenna
16	SRP Tools	Intersection	Median (VMS) Shoulder (antenna)	TNRDC Traffic Police	1 VMS 1 Antenna
17	Rajiv Gandhi IT Expressway (near NIFT)	Mid-Block	Median	TNRDC Traffic Police	2 Cameras 1 Antenna
18	Rajiv Gandhi IT Expressway (near CPT)	Mid-Block	On FOB	TNRDC Traffic Police	2 Cameras 1 Antenna

Number of GPS Devices Installed in MTC Buses

Route number	From	To	No. of GPS devices installed
M7	T.Nagar	Thiruvanmiyur	8
21L	Broadway	Velachery	7
M119A	T.Nagar	Chemmanchery S.C.B.	7
D70	Ambathur Estate	Velachery	12
23C	Besant Nagar	Ayanavaram B.S	12
M70	CMBT	Thiruvanmiyur	10
5A	Tambaram	T. Nagar	5
M119	T.Nagar	Chemmanchery S.C.B.	5
5B	Mylapore	T. Nagar	6
5E	Vadapalani	Besant Nagar	5
47A	Besant Nagar	ICF	9

PTIS Simulator Results

Information Provided		% Compliance					Compliance for information combinations
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	
No Information		67%					67%
Speed	Distance		70%	50%	50%	62%	62%
TT	Distance		64%	45%	50%	58%	58%
TT_range	Distance		46%	80%	50%	54%	54%
Congest-ion	Distance		41%	65%	62%	56%	56%
TT	Speed		45%	75%	63%	63%	63%
TT_range	Speed		77%	56%	82%	70%	70%

A user is said to comply if he is choosing the best alternative (least travel time option) available to him

Only about 2/3rds of users comply

Variable Definitions

Variable	Description
info	1 if traffic information is provided and 0 if no information apart from distance is provided. The value will be 0 for scenario 1 and 1 for other scenarios
sp_1	1 if the information provided is speed and distance, 0 otherwise
sp_2	1 if the information provided is travel time and distance, 0 otherwise
sp_3	1 if the information provided is congestion and distance, 0 otherwise
sp_4	1 if the information provided is travel time and speed, 0 otherwise
sp_5	1 if the information provided is speed, distance and delay, 0 otherwise
sp_6	1 if the information provided is travel time, distance and delay, 0 otherwise
sp_7	1 if the information provided is congestion, distance and delay, 0 otherwise
sp_8	1 if the information provided is travel time, speed and delay, 0 otherwise

Variable Definitions

sit_fam	**1 if the respondent is familiar with the O-D pair, 0 otherwise. The value will be 1 for scenarios 1-4 and 0 for fifth scenario**
TT_point	1 if Travel Time point value is provided, 0 for the rest
TT_range	1 if Travel Time range is provided, 0 for the rest
dviation	The deviation value (z*CoV) presented when Travel time range is provided, 0 when travel time range is not displayed
s_delay	1 if source of delay is mentioned, 0 otherwise. The value is 1 for scenarios 3 and 4
d_acc	1 if source of delay is accident, 0 otherwise
d_const	1 if source of delay is construction work, 0 otherwise
d_sig	1 if source of delay is signal delays, 0 otherwise
d_que	1 if source of delay is traffic queues, 0 otherwise
err_l	Average error in reported time on negative side. No matter what information is displayed, only travel time value is considered
err_r	Average error in reported time on positive side. No matter what information is displayed, only travel time value is considered
max_err	Absolute value of max error in reported time

Variable Definitions

veh_2w	**1 if primary mode of commute of respondent is 2 wheeler, 0 otherwise**
veh_4w	1 if primary mode of commute of respondent is 4 wheeler, 0 otherwise
veh_oth	1 if primary mode of commute is neither a 2 wheeler nor a 4 wheeler, 0 otherwise
fam_net	1 if the respondent is familiar with at least 2 roads on the study corridor, 0 otherwise
wrk_dis	1 if work distance of the respondent is greater than 10 km, 0 otherwise
switch	1 if the respondent uses alternate routes many times a week,0 otherwise
age1	1 if age of the respondent is between 18 years and 25 years, 0 otherwise
age2	1 if age of the respondent is between 26 years and 35 years, 0 otherwise
age3	1 if age of the respondent is between 36 years and 45 years, 0 otherwise
age4	1 if age of respondent is above 45 years, 0 otherwise
gender	1 if the respondent is male, 0 if the respondent is female
dri_exp	1 if the driving experience of the respondent more than 3 years,0 otherwise

Variable Definitions

int_hom	**1 if respondent accesses internet at home many times a week, 0 otherwise**
int_work	1 if respondent accesses internet at work many times a week, 0 otherwise
int_mob	1 if respondent accesses internet through mobile many times a week, 0 otherwise
int_rg	1 if respondent accesses internet for route guidance many times a week, 0 otherwise
int_pt	1 if respondent access internet for PT Information many times a week, 0 otherwise
p1d_1	Difference between the value of the lead parameter on the best of the six alternatives and current alternative. Value is 0 for scenario 1
p1d_2	Difference between the value of the lead parameter on the best of the six alternatives and the second best of the six alternatives. Value is 0 for scenario 1
p1d_3	Difference between the value of the lead parameter on the best of the 3 alternatives on the alternate route and current alternative. Value is 0 for scenario 1
p1d_4	Difference between the value of the lead parameter on the best of the 3 alternatives on the same route and current alternative. Value is 0 for scenario 1