Research at IIT Bombay on MSRTC operations

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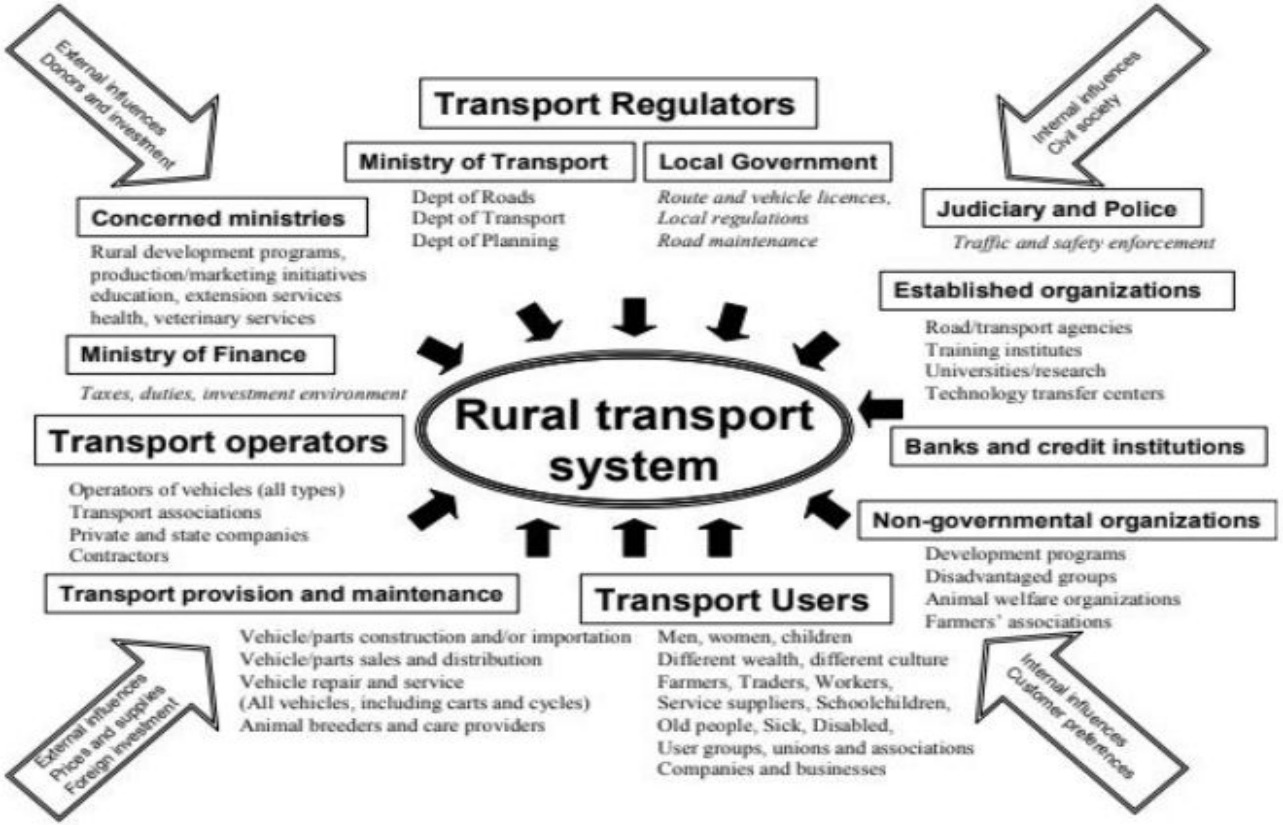
- Introduction to MSRTC operations
- Data Used
- Digital Geography
- Analysing ETIM data and ABC data
- Education and Public Transport

Introduction to MSRTC operations

- Bus Schedule Management: Designing schedules based on the public traffic of the roads.
- Selection of Manav-Vikas buses: based on the schools and students on that routes.
- Creation of new routes: Based on Supply And Demand
- Crew Management: Crew Management is mostly done by the Traffic controller and Depot manager.
- Real Time Vehicle Tracking: Location of Bus vehicles can be tracked on real time basis.
- ETIM/ABC Analysis: based on the number of tickets issued, category of routes, revenue collected, determine profitability of the routes and their status (A, B or C)


External influences
Donors and investment
Transport Regulators
Ministry of Transport
Local Government
Dept of Roads
Dept of Transport
Dept of Planning
Route and vehicle licences,
Local regulations
Road maintenance
Internal influences
Civil society
Judiciary and Police
Traffic and safety enforcement
Concerned ministries
Rural development programs,
production/marketing initiatives
education, extension services
health, veterinary services
Established organizations
Road/transport agencies
Training institutes
Universities/research
Technology transfer centers
Ministry of Finance
Taxes, duties, investment environment
Rural transport system
Transport operators
Operators of vehicles (all types)
Transport associations
Private and state companies
Contractors
Banks and credit institutions
Non-governmental organizations
Development programs
Disadvantaged groups
Animal welfare organizations
Farmers' associations
Transport provision and maintenance
Transport Users
Vehicle/parts construction and/or importation
Vehicle/parts sales and distribution
Vehicle repair and service
(All vehicles, including carts and cycles)
Animal breeders and care providers
Men, women, children
Different wealth, different culture
Farmers, Traders, Workers,
Service suppliers, Schoolchildren,
Old people, Sick, Disabled,
User groups, unions and associations
Companies and businesses
External influences
Prices and supplies
Foreign investment
Internal influences
Customer preferences

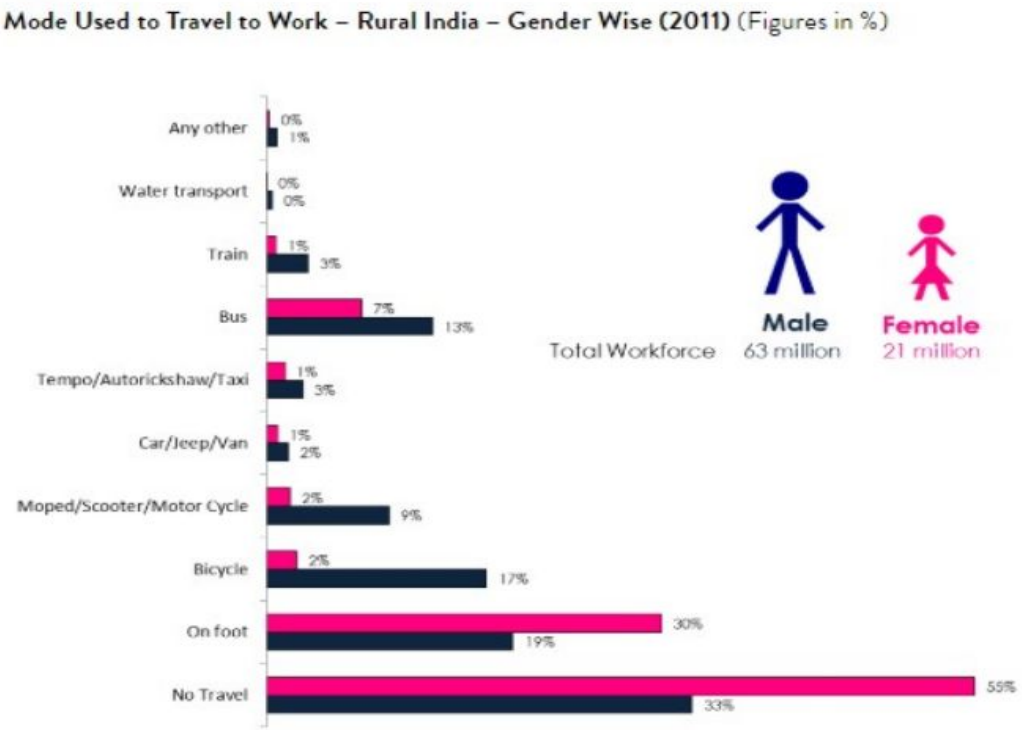


Figure 2.4: Mode of Transport in Rural India

[4] [https://india.uitp.org/articles/mobility-in-rural-india]

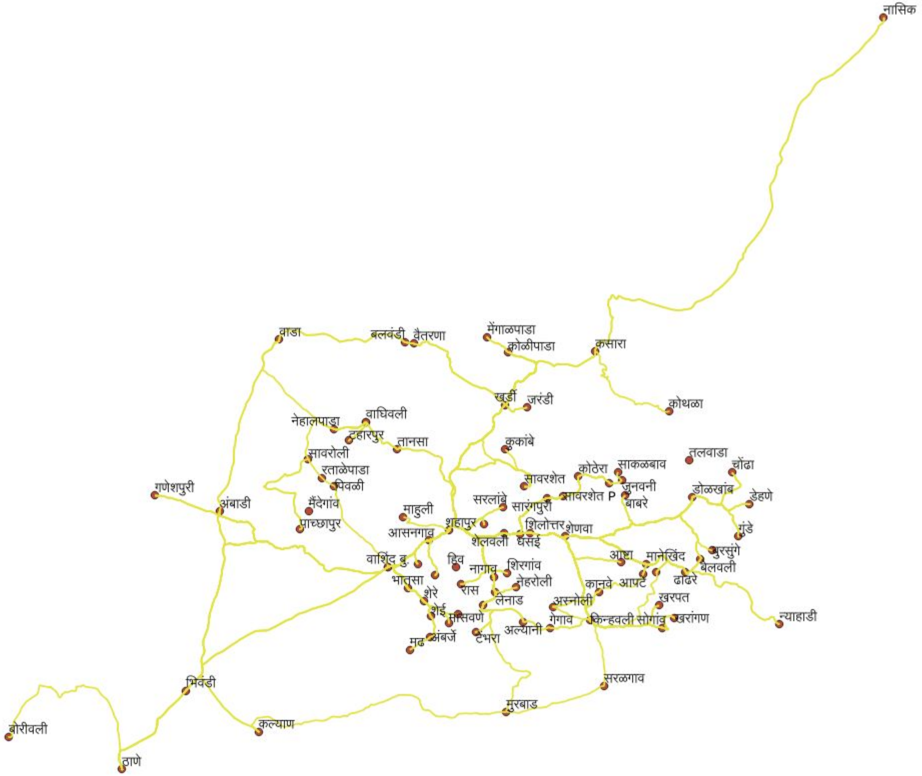
Shahapur (Thane District)

- Taluka
  - 6 towns and 225 villages
  - Major Local train stops: Kasara, Asangaon, Vashind, Atgaon

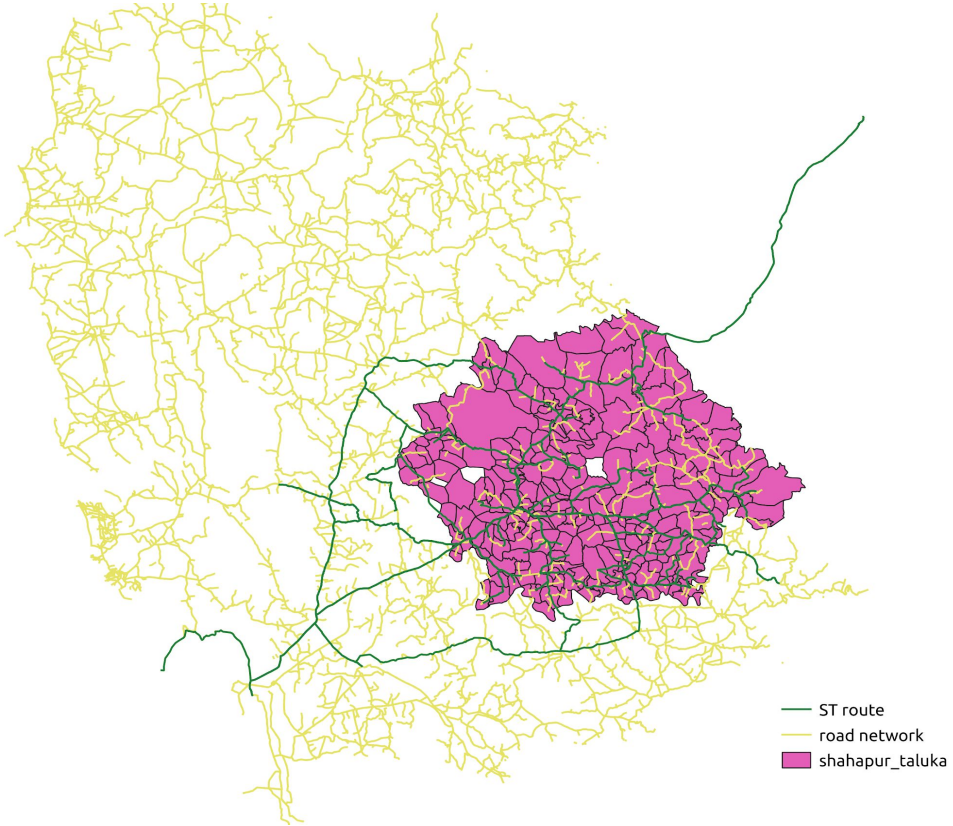
- Bus Depot
  - Number of routes: 266
  - Number of trips as per ABC data: 511
  - Number of buses: 56
  - Number of schedules running per day: 52

Shahapur Village Boundary

Terminals


नासिक
वाडा
बलवंडी
वैतरणा
मेंगाळपाडा
कोळीपाडा
कसारा
खर्डी
जरंडी
कोथळा
नेहालपाडा
वाघिवली
टहारपुर
तानसा
सावरोली
रताळेपाडा
पिवळी
कुकांबे
तलवाडा
कोठेरा
साकळबाव
चोंढा
सावरशेत
जुनवनी
डोळखांब
डेहणे
गणेशपुरी
अंबाडी
मैंदेगांव
सरलांबे
सारंगपुरी
सावरशेत P
बाबरे
माहुली
पाच्छापुर
शहापुर
शिलोत्तर
शेणवा
गुंडे
आसनगाव
शेलवली
धसई
वाशिंद बु.
हिव
आघा
मानेखिंद
बुरसुंगे
नागाव
शिरगांव
बेलवली
भातसा
नेहरोली
कानवे
आपटे
ढाढरे
शेरे
रास
लेनाड
अस्नोली
खरपत
शेई
सासिवणे
गेगाव
किन्हवली
सोगांव
खरांगण
न्याहाडी
मढ
अंबर्जे
टेंभरा
अल्यानी
भिवंडी
सरळगाव
मुरबाड
कल्याण
बोरीवली
ठाणे

ST bus route in Shahapur



Shares of several Modes of Transportation

Data Used

We have used the following data provided for Sinnar and Shahapur talukas:

1. Form4 and Master data: (Source: MSRTC)
    - These two tables give out the planned schedule information, i.e. the scheduled buses, crew, order of bus stops, ticket pricing scheme, whether manav-vikas bus or not etc.
2. ETIM data: (Source: TRIMAX)
    - This data contains the real time information of bus en route, like the ETIM machine number, route number, trip number, ticket issue date and time, from and to stations, number of passengers, type of bus, inspections, tolls etc.
3. ABC data: (Source: TRIMAX)
    - This table is summary data of the trips for the entire month and contains information like money earned from the trip, trip departure time, percentage load factor, ABC status of the trip etc.

New Datasets Formed

New tables:

1. Day-wise analysis of ETIM data.
2. Monthly schedule for all ETIM machines.
3. Average ridership of a trip.

New attributes added:

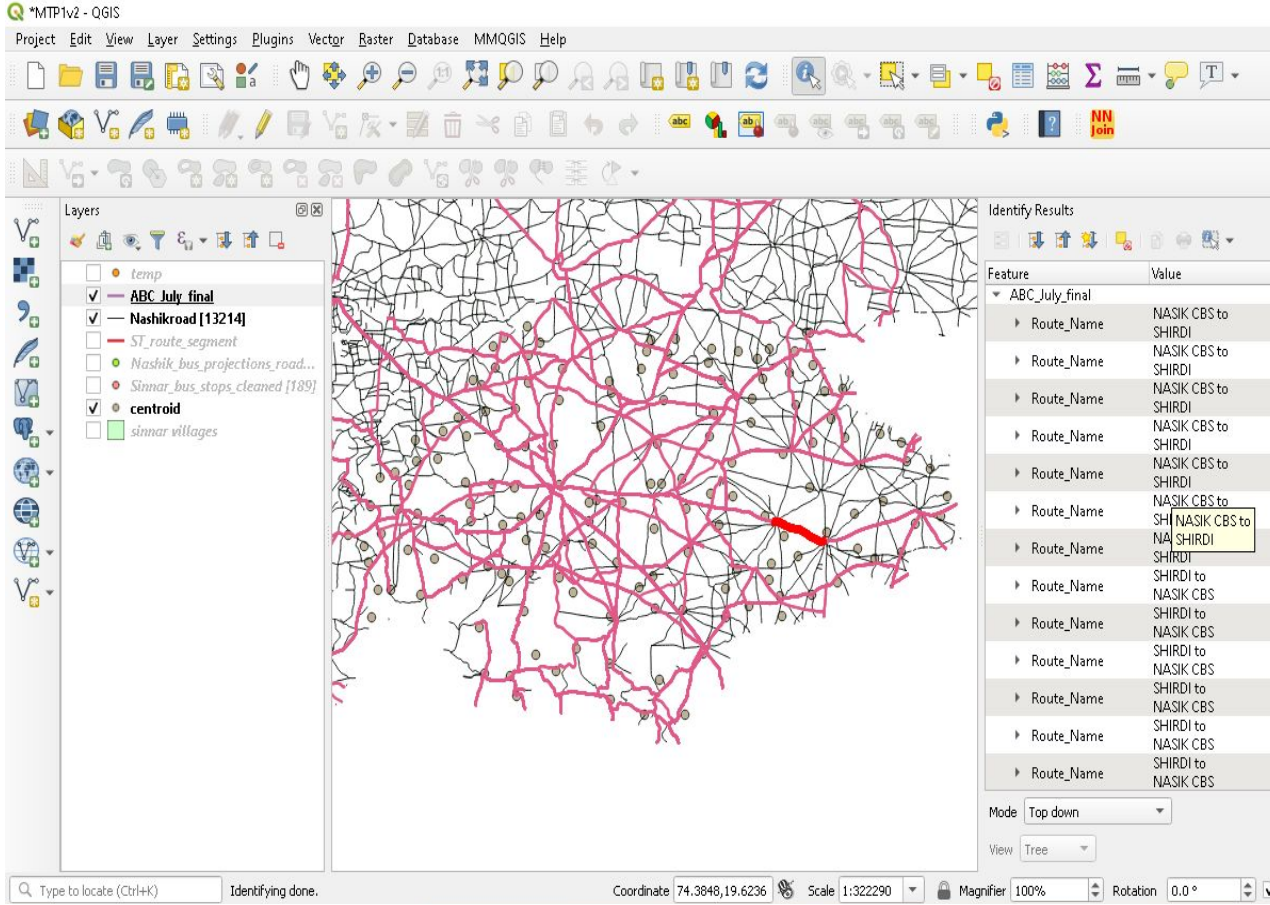
1. Trip number from ETIM is added to ABC.
2. Number of passengers in ETIM.
3. Punctuality of a trip over a month.
4. Sanity of a route.

Digital Geography (Sinnar)

Digital Geography-

- Digital Geography is an representation of all MSRTC operational data like (ABC analysis, ETIM analysis) through a GIS-based graphical interface.

- Helps in better decision making based on visuals.



Digital Geography-

1. Data Source Used:
    - Road Network (Source: MRSAC)
    - Bus Stops Latitude & Longitude (Source: MRSAC)
    - Master Data (Source: MSRTC)
    - Route Segment (shortest path on two consecutive bus stops on a route based on length)
    - ETIM data (Source: TRIMAX, Month- July 2019)
    - ABC data
    - Form 4 data (Source: MSRTC)
    - Sinnar villages Shapefile. (Source: iitb.cse.ac.in)

Elements of Digital Geography:

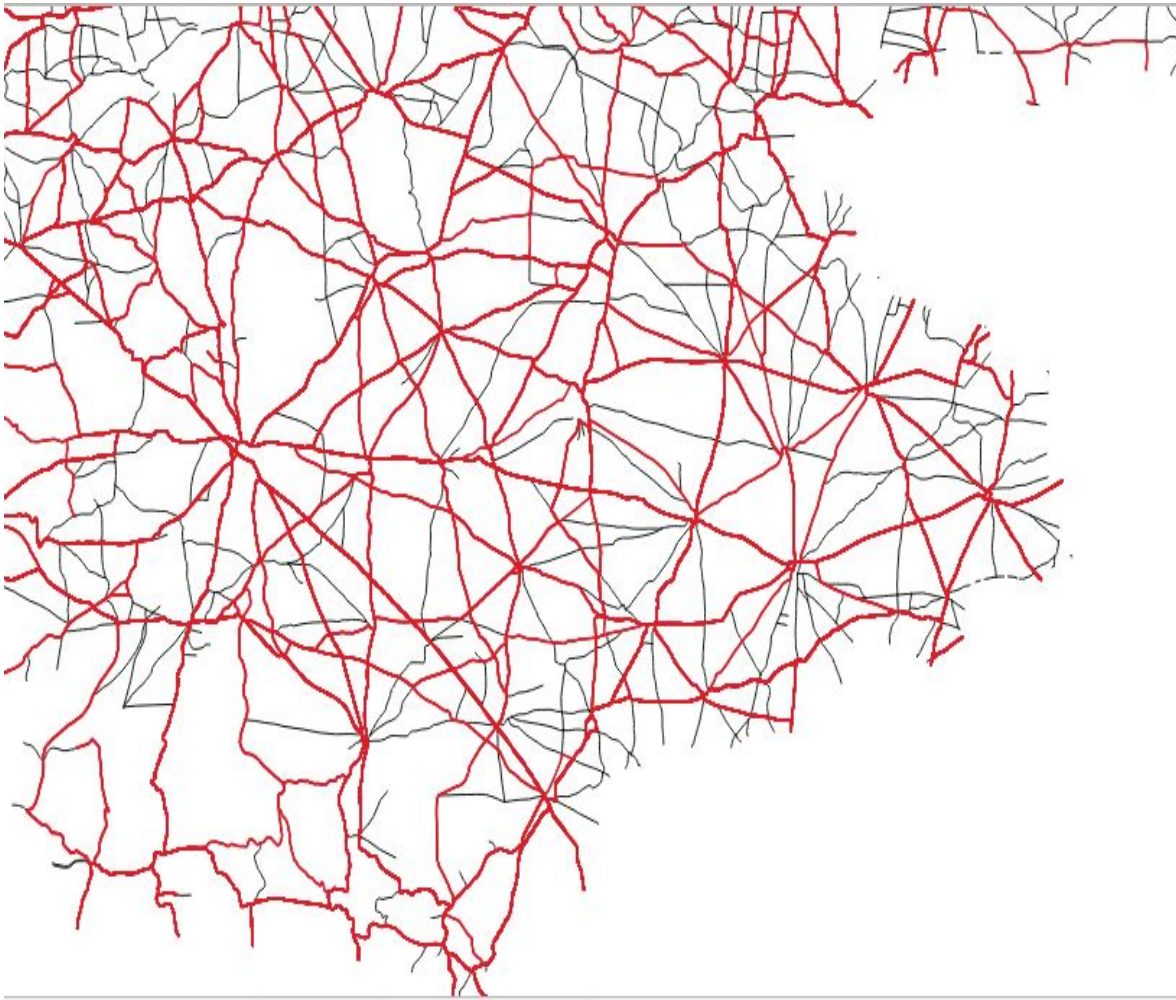
1. Route Segment: Path covered by bus between two consecutive bus stops.
2. ST Road Network: Road network on which MSRTC Buses runs.
3. Hub Distance: Distance of village centroid to ST road network. (Assuming residential village resides at centroid)
4. Village Projections: Nearest point on ST road network from Village centroid.
5. Bus Stops:
6. Operational data like ABC data, ETIM data etc., can be displayed route segment-wise.
7. Sinnar Villages

Sinnar Villages

ST Road Network:

Red line signifies road where MSRTC Bus Services runs.

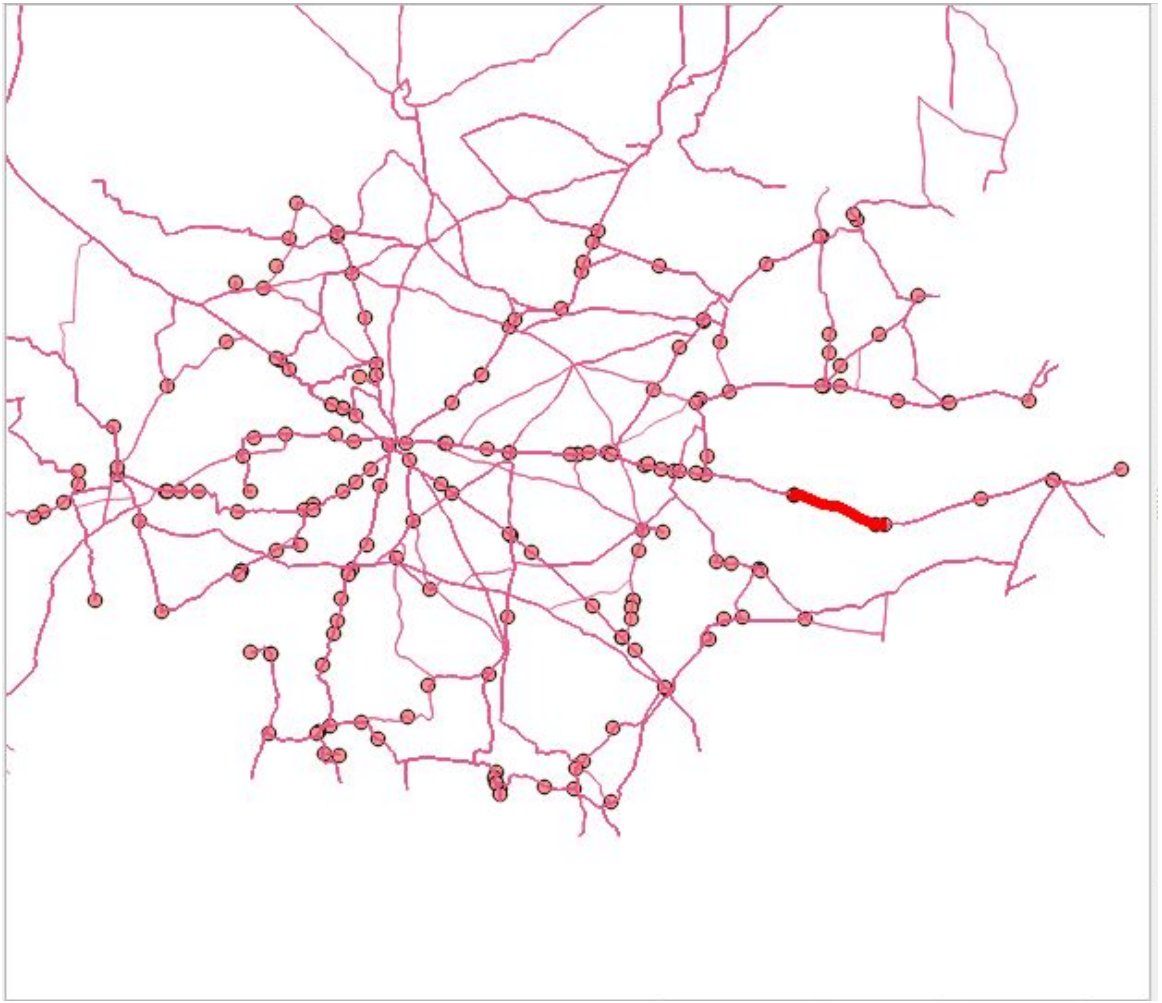
Black lines represent the road network.



Route Segment:

In the figure you can see the route Segment highlighted , Each piece of ST road Network lying in between two consecutive Bus Stops.

Pink Dots are Bus Stops



Route Segment (Attributes):

1. Route_no:
2. Origin:
3. Destination:
4. Route Name:
5. Length
6. Starting route Stop (From)
7. Ending route Stop (To)
8. Trip_no. Passing through this route segment

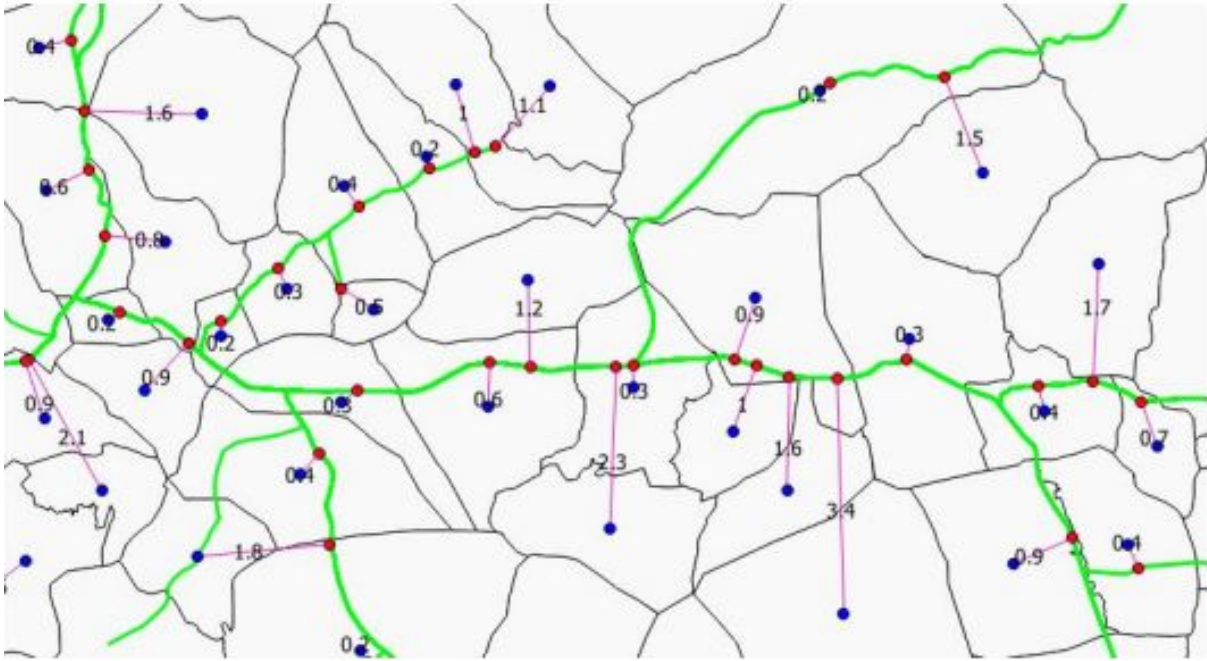
	Route_no	Orgin	Destinatio	From	From_Code	To	To_Code	Trip_Numbe	Route_Name	length km
1	10086	SLWSN	SNNR	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	7.49022401
2	10086	SLWSN	SNNR	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	7.49022401
3	10086	BGP	SLWSN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	3.15796821
4	10086	BGP	SLWSN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	3.15796821
5	10086	KKAGNN	MMNANN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	24.2484958
6	10086	KKAGNN	MMNANN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	24.2484958
7	10086	TAKLE	KKAGNN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	23.8252675
8	10086	TAKLE	KKAGNN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	23.8252675
9	10086	MMNANN	MAANN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	2.99053011
10	10086	MMNANN	MAANN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	2.99053011
11	10086	NMASN	BGP	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	14.0141627
12	10086	NMASN	BGP	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	14.0141627
13	10086	KPSN	NMASN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	11.8197238
14	10086	KPSN	NMASN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	11.8197238
15	10086	MAANN	BGLSN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	11.2915969
16	10086	MAANN	BGLSN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	11.2915969
17	10086	BGLSN	HVRGN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to SINNAR	10.2029190
18	10086	BGLSN	HVRGN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S228206	TARUKHEDLE to SINNAR	10.2029190
19	10086	HVRGN	KPSN	TARUKHEDLE	TAKLE	SINNAR	SNNR	S224835	TARUKHEDLE to	1.85485745

Hub Distance, Village centroid, Village Projections:

Blue Dots represents Centroid of Village

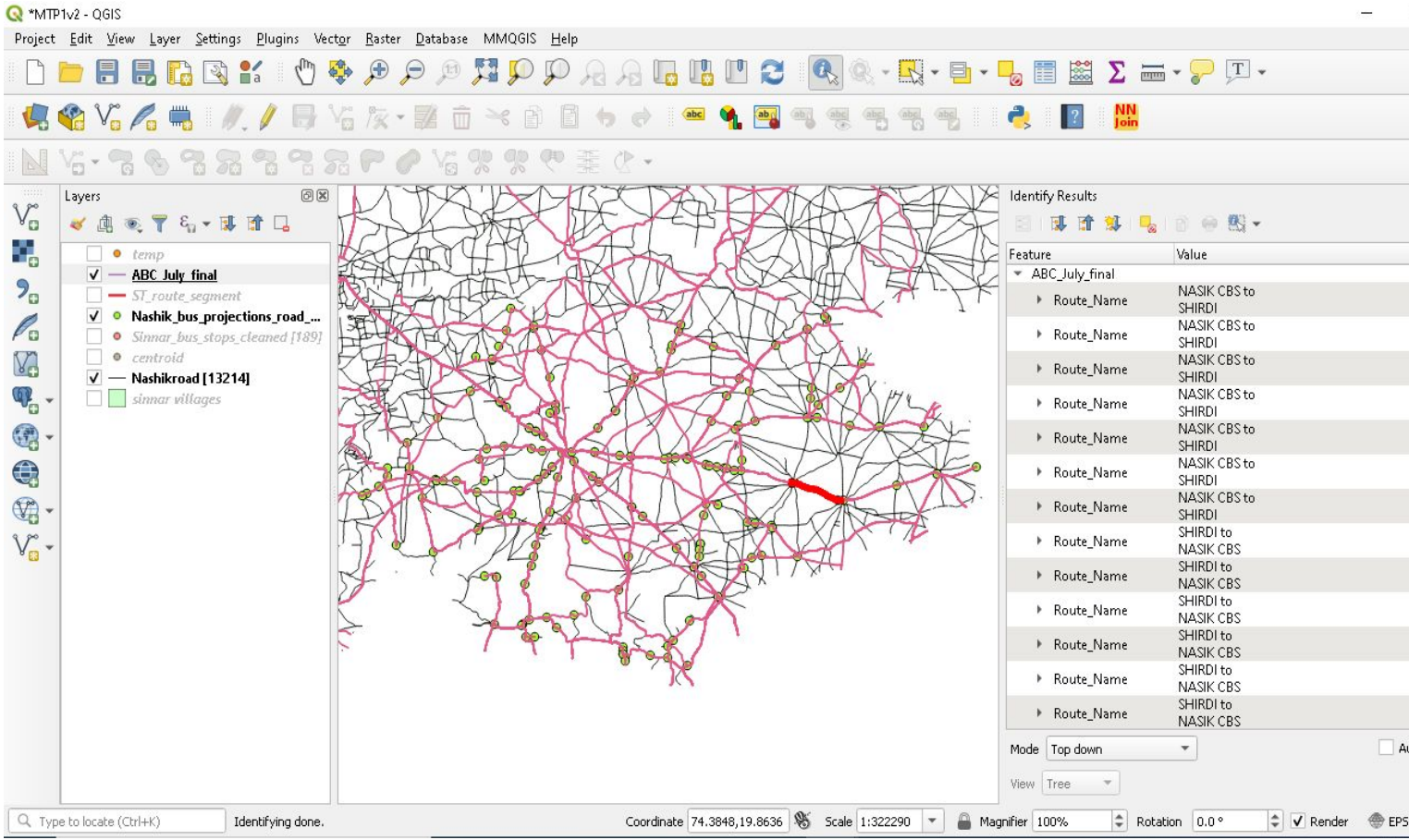
Pink Line represents Hub Distance line

Red Dots signifies Village Projections



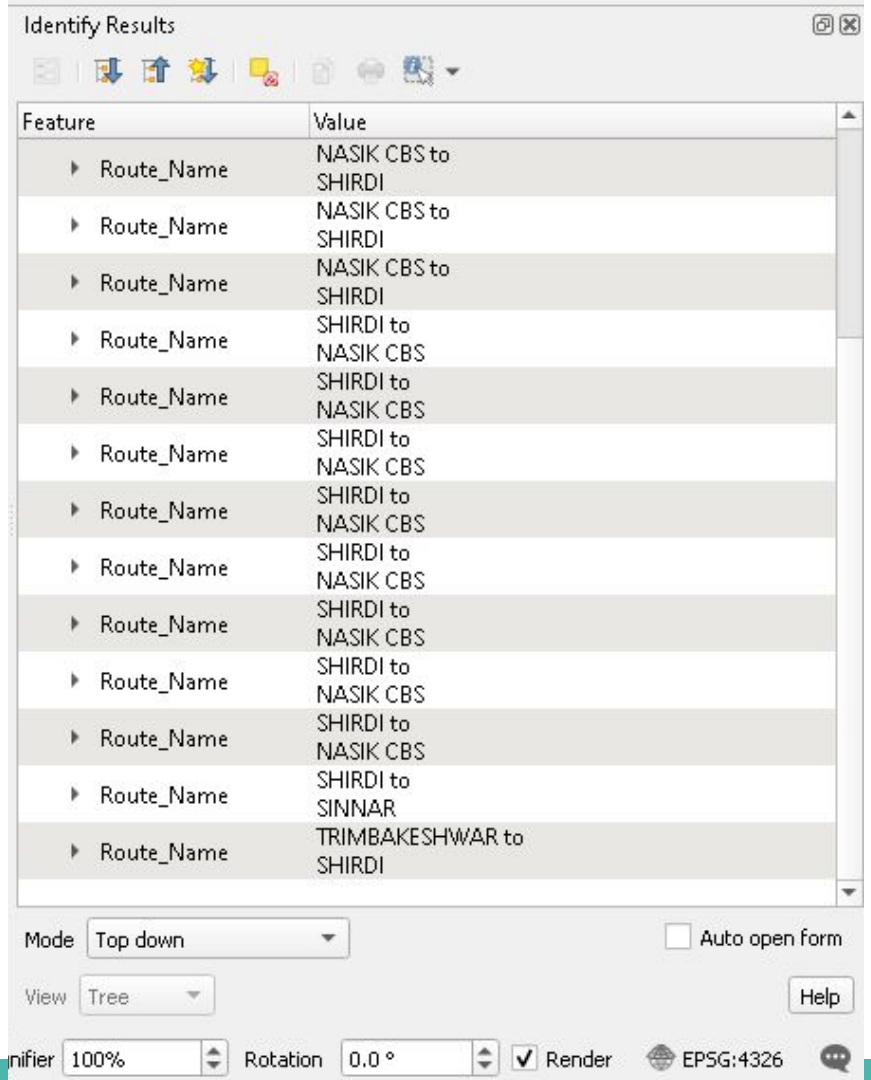
Working:

Select an route Segment.



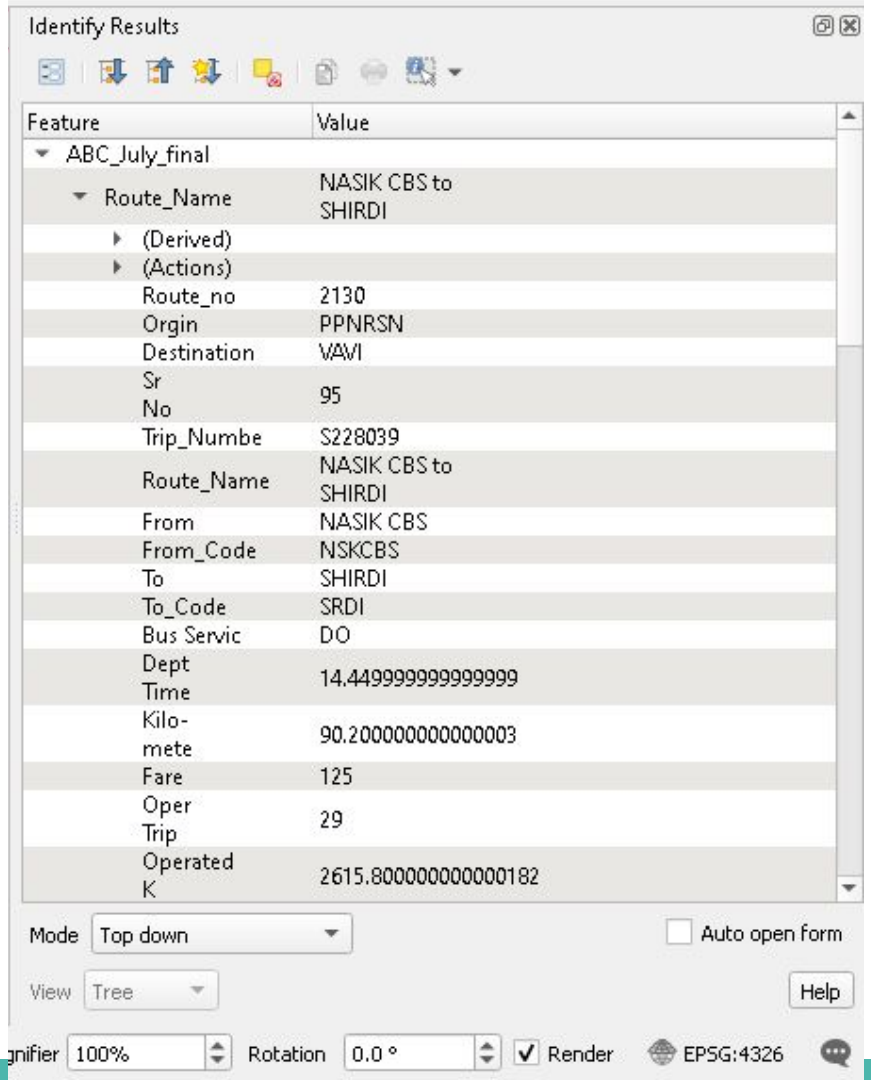
Working: (Continued)

TIn the right side, a panel will open named ”Identify Features”, you can all the routes and trips from which that route segment is a part of.



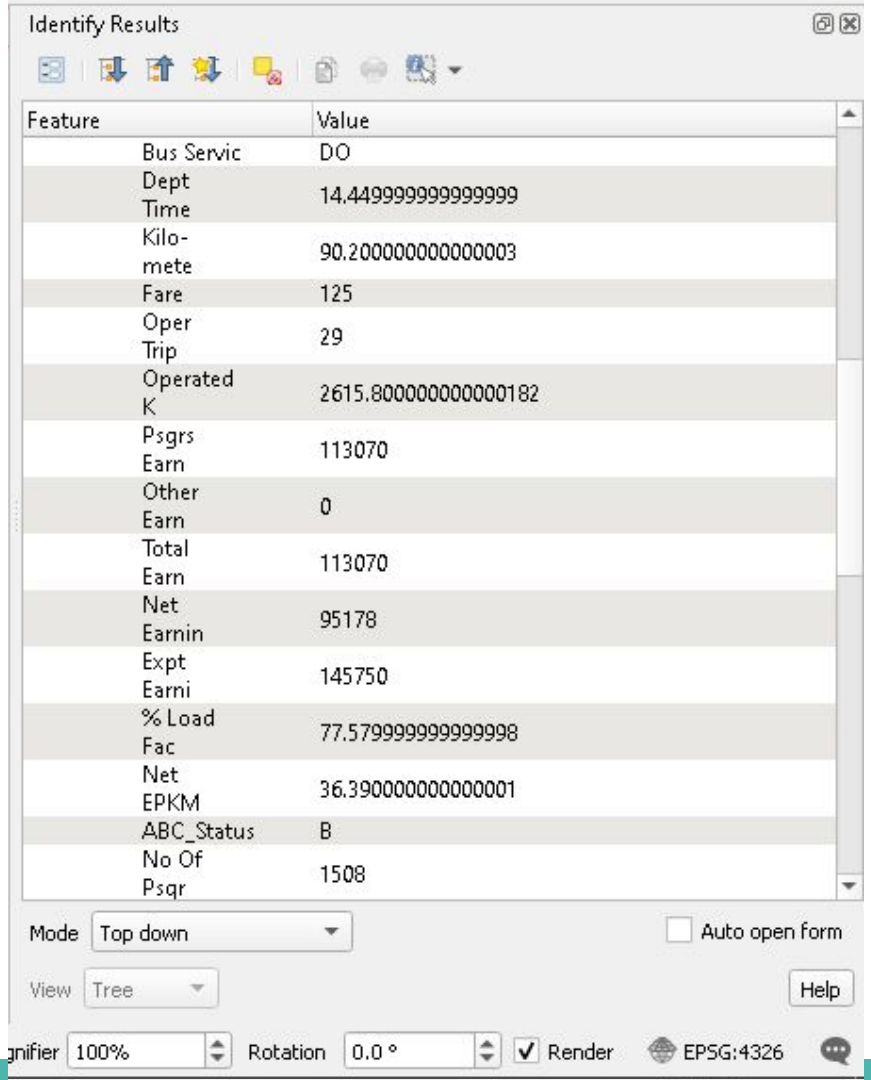
Working: (Continued)

Click on any feature, you can see the details about the route segment. Any data can be shown through this model route segment-wise



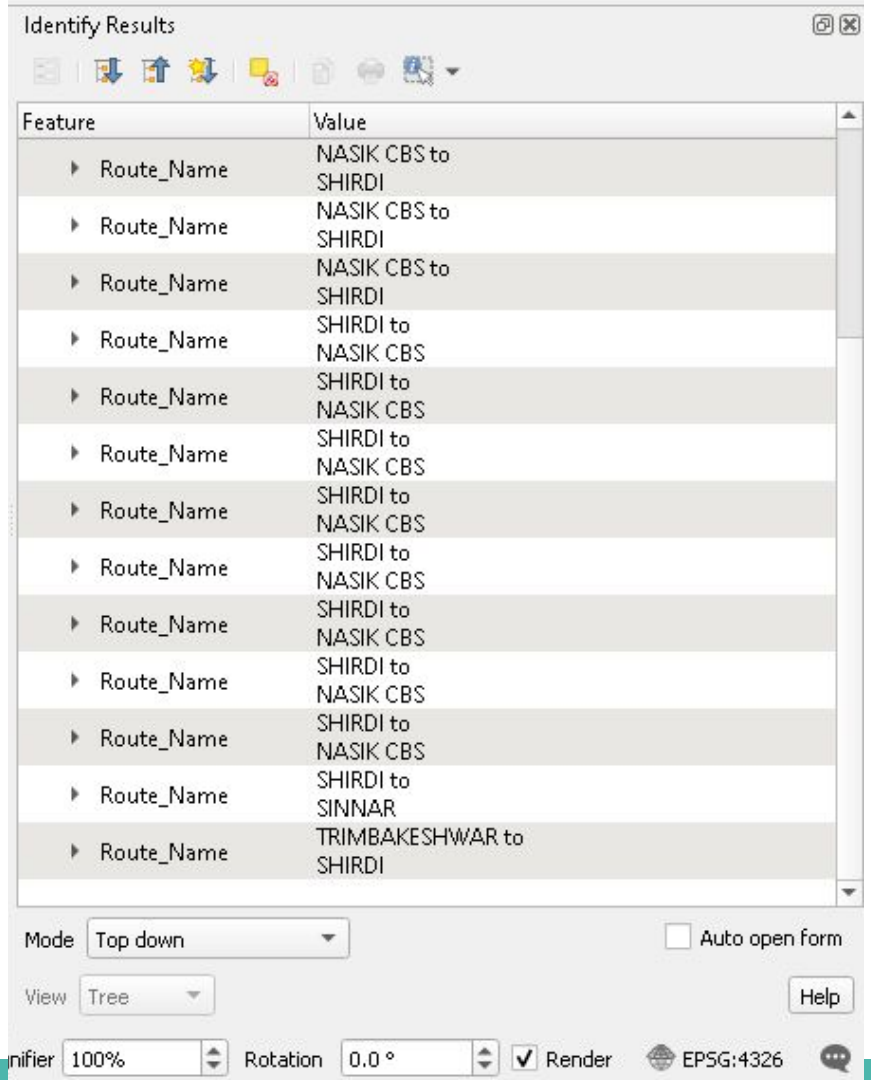
Working: (Continued)

Click on any feature, you can see the details about the route segment. Any data can be shown through this model route segment-wise



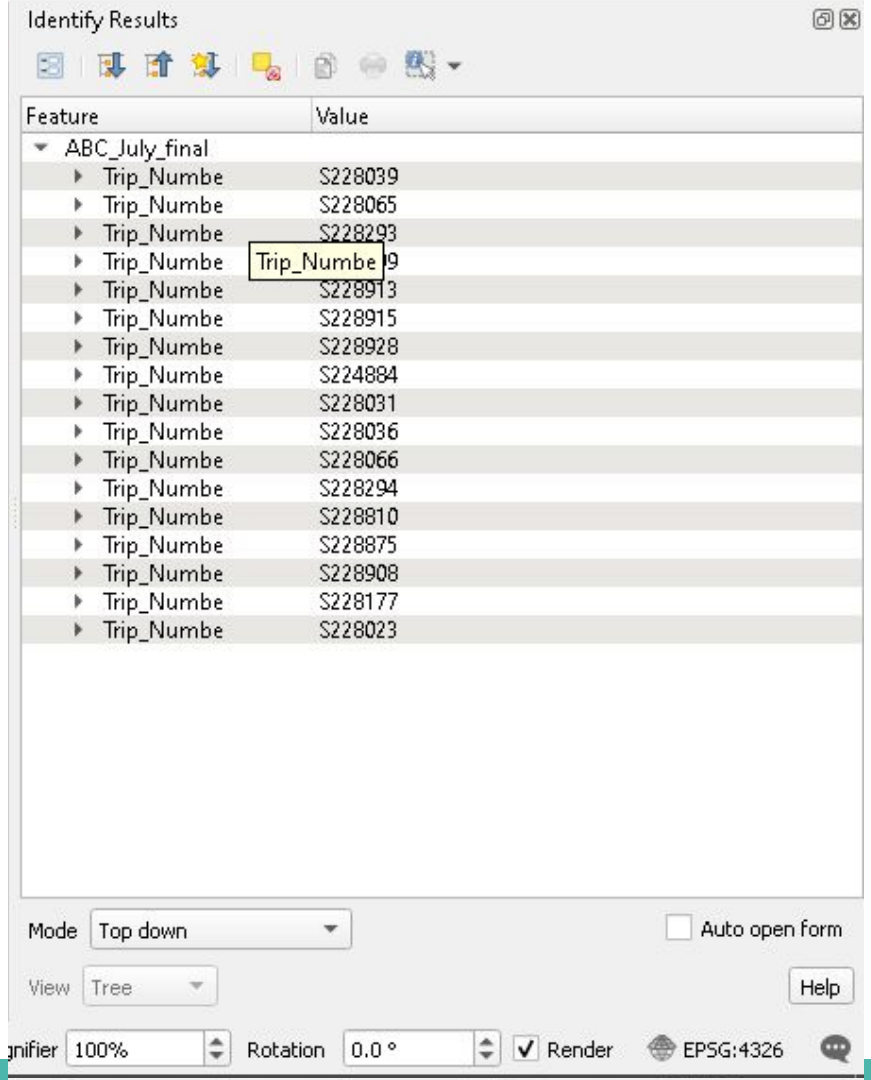
Working: (Continued)

Total no. of features displayed the number of trips passed through that route in the month of July, 2019



Working: (Continued)

Apart from selecting Route name, we can also show any other attribute to be displayed while selecting feature for better understanding.

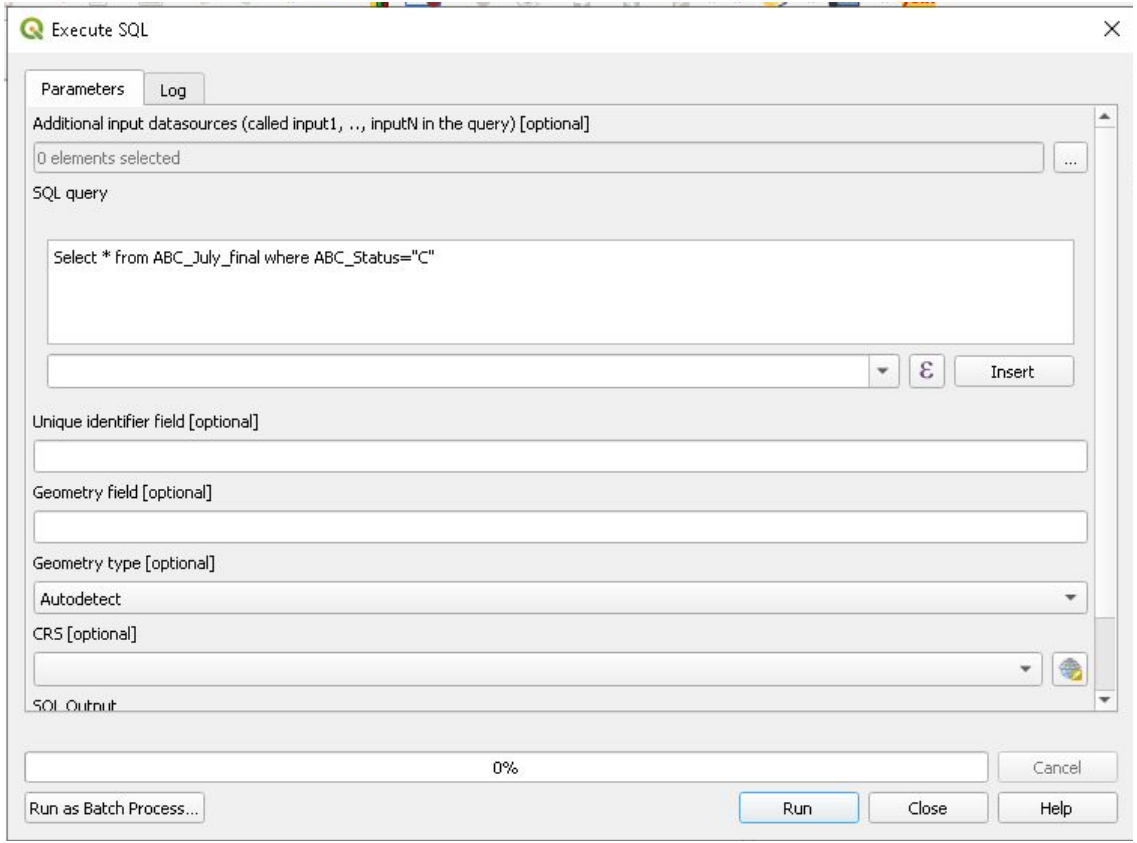


Working: (Continued)

Digital Geography also offer SQL Query based Outputs, so that you can get customized output

For Eg-

Query- Select * from ABC_July_final where ABC_Status="C"

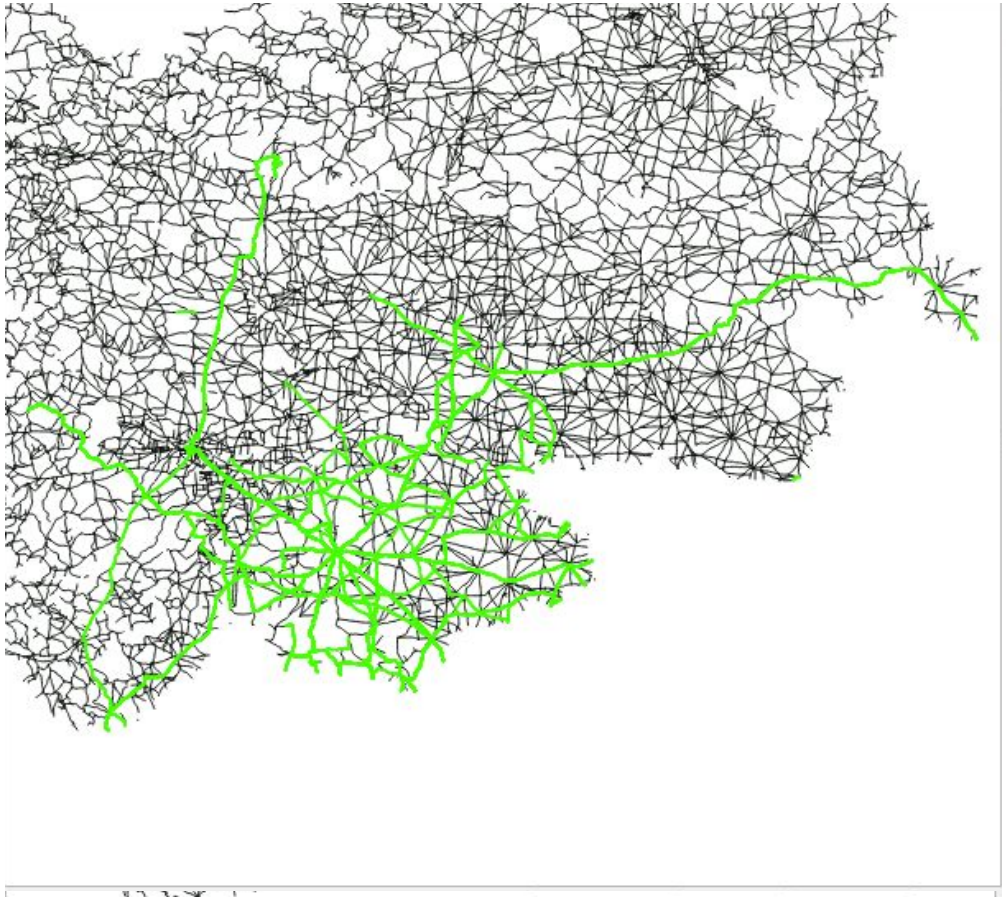


Query Output

Objective-To get all routes which has ABC_Status=”A”

Query-
Select * from ABC_July_final where ABC_Status="A"

Output-
Green lines represents the output, i.e., All Details of all routes having ABC_Status=”A”



Query Output (Continued)- ABC routes having ABC_status-'A'

SQL Output :: Features Total: 505, Filtered: 505, Selected: 0

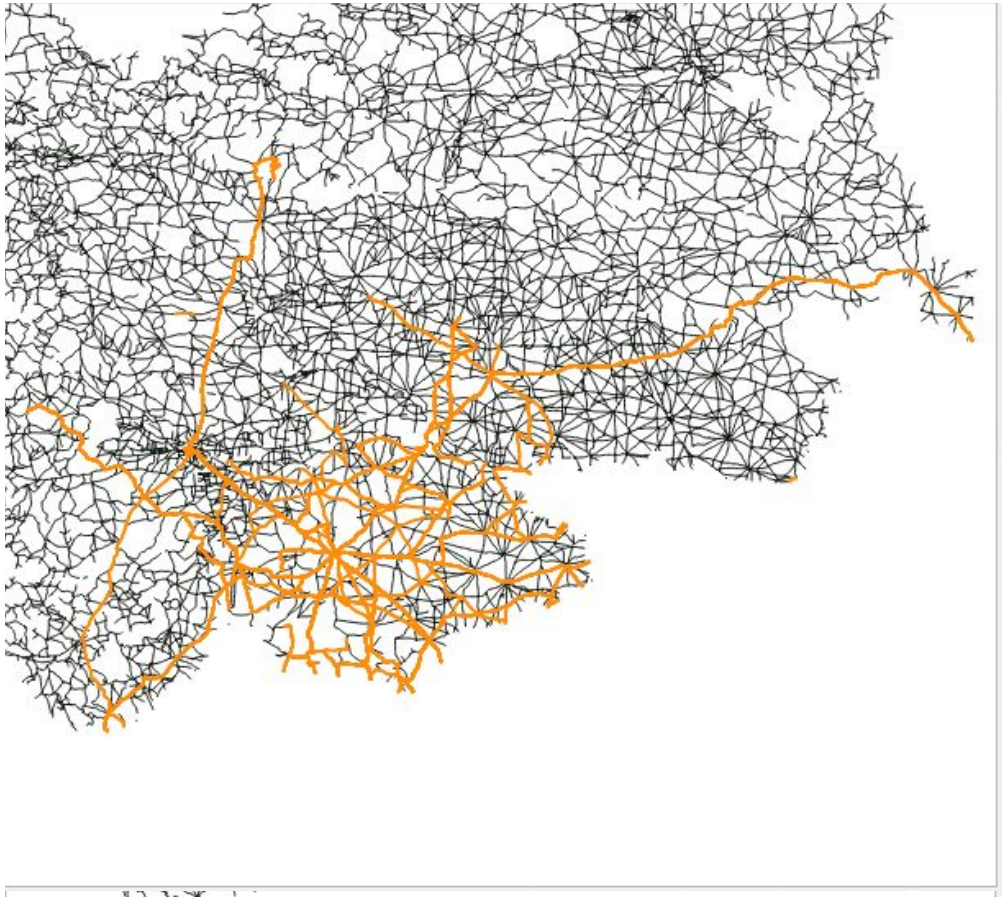
	Route_no	Orgin	Destinatio	Sr No	Trip_Numbe	Route_Name	From	From_Code	To	To_Code	Bus Servic	Dept Time	Kilo-mete
1	2130	MUSON	MSLSNK	114	S228065	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	9.45	90.2
2	2130	SNNR	MUSON	649	S228915	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.45	90.2
3	2130	MUSON	MSLSNK	582	S228809	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	15.3	90.2
4	2130	MUSON	MSLSNK	293	S228293	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.3	90.2
5	2130	MSLSNK	MSLSN	114	S228065	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	9.45	90.2
6	2130	MUSON	MSLSNK	649	S228915	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.45	90.2
7	2130	MSLSNK	MSLSN	582	S228809	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	15.3	90.2
8	2130	MSLSNK	MSLSN	293	S228293	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.3	90.2
9	2130	MSLSN	DTL	114	S228065	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	9.45	90.2
10	2130	MSLSNK	MSLSN	649	S228915	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.45	90.2
11	2130	MSLSN	DTL	582	S228809	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	15.3	90.2
12	2130	MSLSN	DTL	293	S228293	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.3	90.2
13	2130	DTL	KPDH	114	S228065	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	9.45	90.2
14	2130	MSLSN	DTL	649	S228915	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.45	90.2
15	2130	DTL	KPDH	582	S228809	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	15.3	90.2
16	2130	DTL	KPDH	293	S228293	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.3	90.2
17	2130	KPDH	KADIBD	114	S228065	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	9.45	90.2
18	2130	DTL	KPDH	649	S228915	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.45	90.2
19	2130	KPDH	KADIBD	582	S228809	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	15.3	90.2
20	2130	KPDH	KADIBD	293	S228293	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	8.3	90.2

Query Output

Objective-To get all routes which has ABC_Status=”B”

Query-
Select * from ABC_July_final where ABC_Status="B"

Output-
Orange lines represents the output, i.e., All Details of all routes having ABC_Status=”B”



Query Output (Continued)- ABC routes having ABC_status-'B'

SQL Output :: Features Total: 3251, Filtered: 3251, Selected: 0

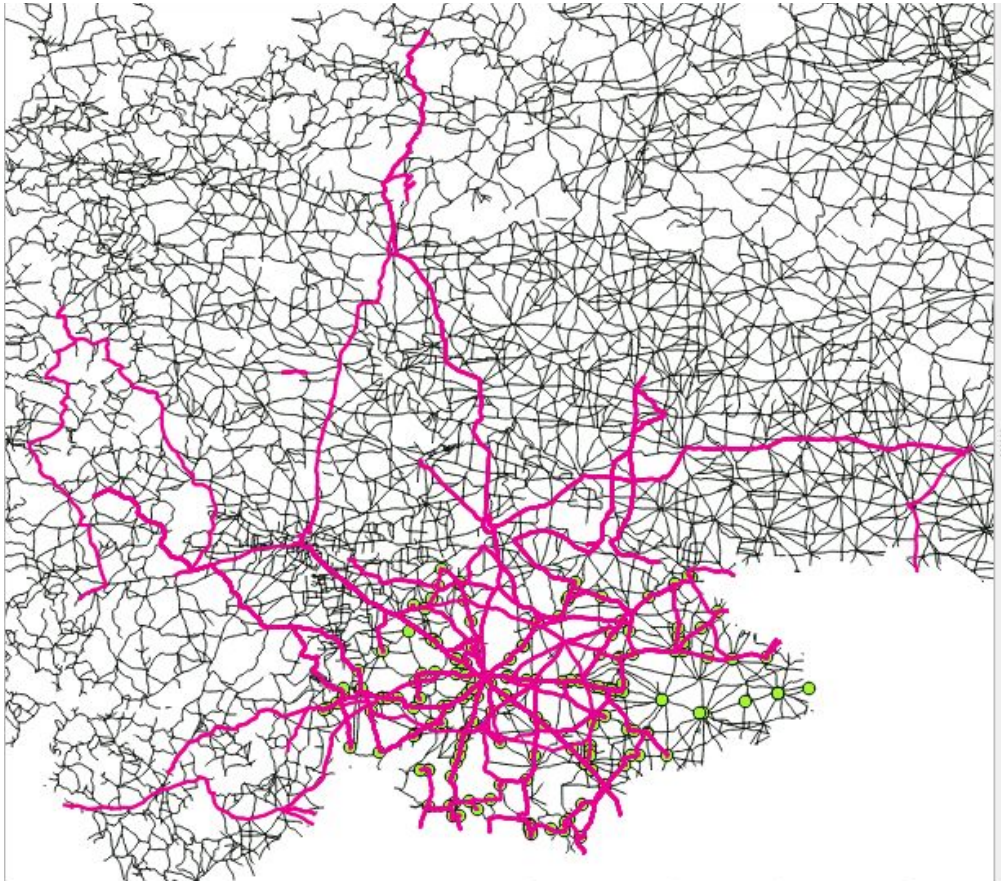
	Route_no	Orgin	Destinatio	Sr No	Trip_Numbe	Route_Name	From	From_Code	To	To_Code	Bus Servic	Dept Time	Kilo-mete
1	2130	CHOFS	MEARI	656	S228928	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	7.3	90.2
2	2130	MEARI	MLANF	656	S228928	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	7.3	90.2
3	2130	MEARI	MLANF	647	S228913	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	17.3	90.2
4	2130	MLANF	SNNR	647	S228913	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	17.3	90.2
5	2130	MLANF	SNNR	95	S228039	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	14.45	90.2
6	2130	SNNR	MUSON	95	S228039	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	14.45	90.2
7	2130	MLANF	SNNR	656	S228928	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	7.3	90.2
8	2130	SNNR	MUSON	656	S228928	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	7.3	90.2
9	2130	SNNR	MUSON	647	S228913	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	17.3	90.2
10	2130	MUSON	MSLSNK	647	S228913	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	17.3	90.2
11	2130	MUSON	MSLSNK	95	S228039	NASIK CBS to SHIRDI	NASIK CBS	NSKCBS	SHIRDI	SRDI	DO	14.45	90.2
12	2128	VNI	CKPR	518	S228693	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	14.3	75.5
13	2128	VNI	CKPR	514	S228687	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	8	75.5
14	2128	CKPR	MNNEFT	231	S228220	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	14.15	75.5
15	2128	VNI	CKPR	557	S228767	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	13.36	75.5
16	2128	CKPR	MNNEFT	518	S228693	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	14.3	75.5
17	2128	CKPR	MNNEFT	514	S228687	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	8	75.5
18	2128	MNNEFT	PYRDN	231	S228220	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	14.15	75.5
19	2128	CKPR	MNNEFT	557	S228767	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	13.36	75.5
20	2128	MNNEFT	PYRDN	518	S228693	NASIK CBS to SAPTASHRUNG...	NASIK CBS	NSKCBS	SAPTASHRUNG...	SPGD	DO	14.3	75.5

Query Output

Objective-To get all routes which has ABC_Status=”C”

Query-
Select * from ABC_July_final where ABC_Status="C"

Output-
Pink lines represents the output i.e., All Details of all routes having ABC_Status=”C”



Query Output (Continued)- ABC routes having ABC_status-'C'

SQL Output :: Features Total: 3042, Filtered: 3042, Selected: 0

	Route_no	Orgin	Destinatio	Sr No	Trip_Numbe	Route_Name	From	From_Code	To	To_Code	Bus Servic	Dept Time	Kilo-mete
1	7112	SINDAA	BNASN	687	S228974	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	12.45	31.3
2	7112	BNASN	CODAINSK	84	S228017	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.45	31.3
3	7112	BNASN	CODAINSK	72	S228001	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	SL	21.45	31.3
4	7112	BNASN	CODAINSK	94	S228037	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	13.3	31.3
5	7112	BNASN	CODAINSK	92	S228033	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.1	31.3
6	7112	BNASN	CODAINSK	147	S228107	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	20.3	31.3
7	7112	BNASN	CODAINSK	113	S228063	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	8.3	31.3
8	7112	BNASN	CODAINSK	288	S228287	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	19.3	31.3
9	7112	BNASN	CODAINSK	274	S228268	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.35	31.3
10	7112	BNASN	CODAINSK	422	S228495	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	14.15	31.3
11	7112	BNASN	CODAINSK	408	S228473	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.59	31.3
12	7112	SINDAA	CHOFS	288	S228287	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	19.3	31.3
13	7112	SINDAA	CHOFS	274	S228268	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.35	31.3
14	7112	SINDAA	CHOFS	422	S228495	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	14.15	31.3
15	7112	SINDAA	CHOFS	408	S228473	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.59	31.3
16	7112	SINDAA	CHOFS	585	S228815	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	13.1	31.3
17	7112	SINDAA	CHOFS	486	S228626	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.05	31.3
18	7112	SINDAA	CHOFS	648	S228914	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	8.45	31.3
19	7112	SINDAA	CHOFS	588	S228821	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	13.59	31.3
20	7112	SINDAA	CHOFS	664	S228944	SINNAR to NASIK CBS	SINNAR	SNNR	NASIK CBS	NSKCBS	DO	6.15	31.3

Physical Significance of Digital Geography:

Digital geography has geospatial properties which makes it ideal for transportation planning especially in rural areas. In Urban planning it will help the planners in estimating the probable demand and beneficiary analysis of any new infrastructure that's coming up for example like a metro station, railway station, electricity load distribution.

Analysing ETIM data and ABC data (Shahapur)

Analysing ETIM data and ABC data

Objectives:

- Analysing sanity of the routes
- Analysing ridership on routes
- Analysing ticket issue patterns on routes
- Analysing punctuality of trips
- Day-wise analysis for a month’s data

Sanity of the routes

- Sane route:
  - A route is said to be sane, if the tickets are issued for only those bus stops which are mentioned in the route master file.
- Insane stops:
  - There might be some exceptional bus stops on a route which are not mentioned in the route master file, but tickets are issued on that stop.
- Sanity Checking:
  - Checks the percentage of tickets which were issued on the bus stops already stated in the master file.

Sanity of the routes

Reasons for insanity:

- The bus stop on which the tickets were issued might not be in the master data (i.e. Not an official stop for that route), but the bus driver stopped the bus there.
- The bus stop might be in the official route because then only the ETIM machine could generate a ticket to that stop, but was not stored in the master data.
    - For route 65117- Tickets issued from/till BVD(BHIVANDI), KBF(KOKAN BHAVAN FATA), LALAFT(LONAVALA FATA), RABP(RABALE POLICE STN.) = 1020 (843 tickets, 1020 pass) out of 1701 passengers. Thus sanity is **40.03%**, which means that we cannot consider this route as fault free and we need to apply some data clearing algorithm to clean the data for this route.

Sanity of the routes

Resolutions for insanity:

- The bus stop can be permanently added to the master file, if a large number of tickets were issued on this stop all over the month.
    - For **route 3906(Shahapur- Mahuli)**, we added **Asangaon Fata** as stop sequence number 2, based on our analysis of other routes that have Shahapur and Asangaon as consecutive bus stops.
- Ignore the tickets issued on the bus stop if the number of tickets issued is less, as it might be an anomaly.

SHAHAPUR-MAHULI [Route 3906 - 16567]

- Sanity check:
  - For route 3906 is 85.37% [887 passenger tickets (674 tickets for 887 passengers) are issued from or till Asangaon fata, which is not a Bus stand in the master data for this route, out of 6064 passenger tickets (4284 tickets for 6064 passengers)]
  - For route 16567 is 87.36% [664 passenger tickets (447 tickets for 664 passengers) are issued from or till Asangaon fata, which is not a Bus stand in the master data for this route, out of 5252 passenger tickets (3789 tickets for 5252 passengers)]

Sanity of the routes

- Analysis:
  - We have a total of 265 routes for Shahapur for the month of July.
  - Out of these 265 routes, 66 routes are not sane routes.
  - So, we conclude that 75% routes out of total routes are sane routes.
  - The max count of the stops where tickets were issued but not in the route master file is 5 stops for a route.

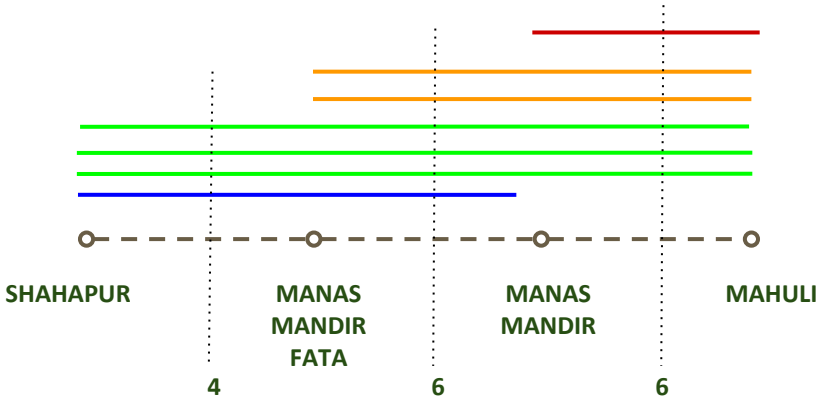
	route_no integer	no_of_stops integer	no_of_tickets bigint	no_of_lugg_tickets bigint	psgrs bigint	no_of_stops_from_etim bigint	stops_not_in_route text	no_of_insane_stops integer
1	18344	22	852	1	1043	15	MLGST, SHEVA, SHST, STHGN, UMARAI	5
2	65117	25	1440	2	1725	23	BVD, KBF, LALAFT, RABP, SBMD	5
3	17527	20	1707	28	2072	19	CGHAPD, KMBAM, KUGR, SLLIFT, SPDAE	5
4	3891	32	3281	11	4055	20	BHGTWDT, KHRDI, NSKCBS, PNDRGLT	4
5	13159	33	2959	5	3717	24	BHGTWDT, PWRHOS, RAHD, VINLI	4
6	107950	35	2005	15	2508	22	ATGO, OZR, VDLB, ZDGA	4
7	3856	18	380	110	361	17	CNWDI, DAAIFT, KUGR, SLLIFT	4
8	3905	11	2945	60	3881	11	AJNP, KOLIPDBT, UMEM	3
9	44351	34	4724	22	5776	24	ARVIDD, DHL, SONNE	3
10	102169	44	3078	16	3753	27	ATGO, KSBSST, RAHD	3
11	42722	21	2373	51	2954	21	OAGNN, VASD, ZDGA	3
12	203	44	4668	31	5849	41	LONADPS, SWR, VBLN	3
13	16555	11	2461	221	3032	11	AHAMBT, GLBHNBT, VACA	3
14	17520	20	4880	12	5897	13	GNDE, NSKCBS, WDVRE	3
15	13127	11	3208	150	3697	11	ABAKAR, KUGR	2
16	3606	13	427	0	545	5	RBP, SBBA	2

SHAHAPUR-MAHULI [Route 3906 - 16567]

- Route details:
  - 9 Kms
  - 8 round trips run daily
  - Extra bus stop ASAO - ASANGAON FATA is there in the ETIM data (i.e. tickets are issued from ASAO or till ASAO) but not in the Master route data.
- Route 3906:
  - Trips ran - 239 (13 extra)
  - First trip at 6:00.
  - Total earnings from passengers: ABC is Rs 45953 and ETIM is Rs 48613 (with extra trips)
- Route 16567:
  - Trips ran - 237 (7 extra)
  - Total earnings from passengers: ABC is Rs 42166 and ETIM is Rs 44394 (with extra trips)

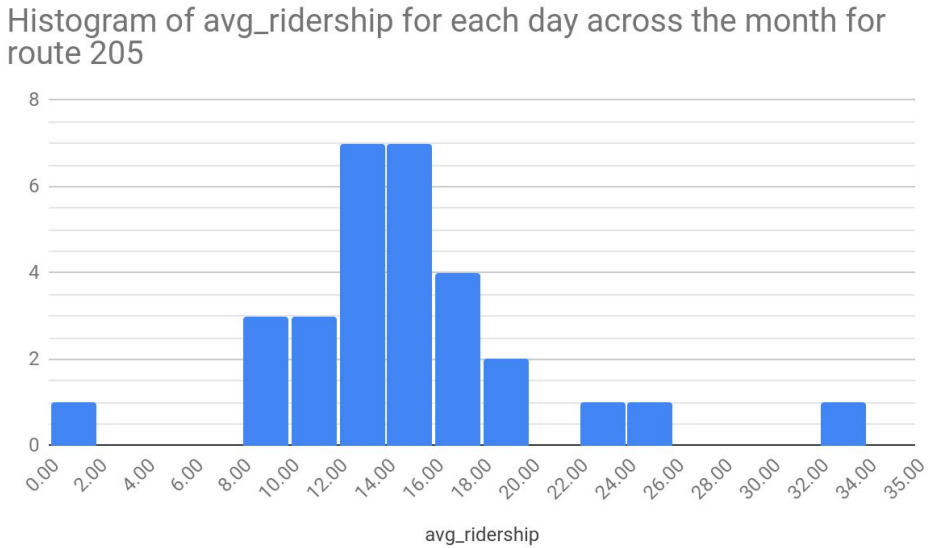
Analysing ridership on routes

- Ridership:
  - Defines at a time how many passengers are travelling in a bus between consecutive stops.
  - For example, here is the Ridership on 3rd July, 2019 for a trip 00S81428 on route SHAHAPUR-MAHULI:



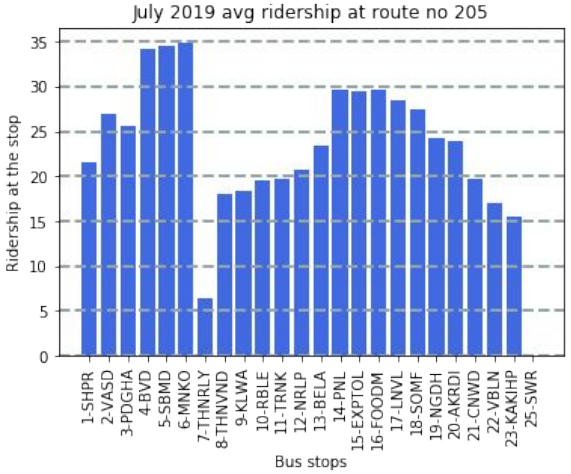
Final Ridership analysis

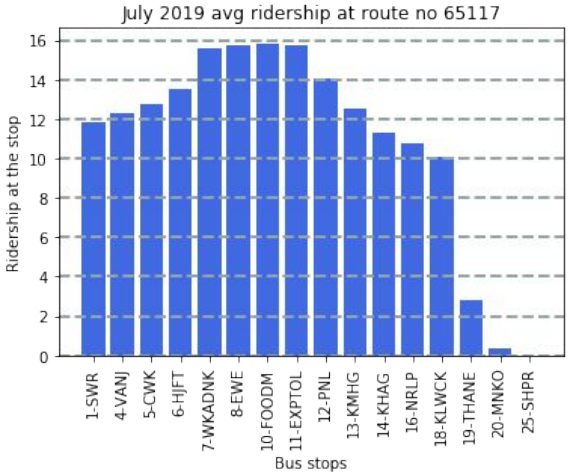
- Weighted Average ridership frequency distribution across the month for route 205:



SHAHAPUR - SWARGATE [Route 205 - 65117]

- Average Ridership for the month of July, 2019:





Final Ridership analysis

- Max ridership - the maximum ridership observed across the entire month.
- Weighted avg ridership - The weighted average ridership calculated with distance as weights across all the month.
- Std dev - The standard deviation across the weighted average ridership per day across the entire month.
- Sitting ridership - Expected number of people (with 82% probability, mean + 1 std dev) who will be sitting in the bus.
- Standing ridership - Expected number of people (with 97.5% probability, mean + 2 std dev) who will be standing or sitting in the bus.
- Utilization - Categorization on the basis of what % of bus was occupied:
  - α (alpha) : sitting_ridership>=80% capacity
  - β (beta) : 50%<= sitting_ridership < 80%
  - γ (gamma) : sitting_ridership < 50%

Final Ridership analysis

route_no	trip_no	max_ridership	weighted_avg_ridership	std_dev	sitting_ridership	standing_ridership	dept_time	from_cd	till_cd	kilometer	abc_status	utilization
205	000M4971	61	18.19	6.60	24.79	31.38	8:50:00	SHAHAPUR	SWARGATE	212.1	B	β
65117	000M4972	49	10.36	6.55	16.92	23.47	17:00:00	SWARGATE	SHAHAPUR	211.1	C	γ
3906	00S81665	4	1.74	1.19	2.93	4.13	6:00:00	SHAHAPUR	MAHULI	9	C	γ
3906	00S81428	22	9.20	4.07	13.27	17.33	8:00:00	SHAHAPUR	MAHULI	9	C	γ
3906	00S81433	71	17.99	13.86	31.85	45.71	10:20:00	SHAHAPUR	MAHULI	9	C	β
3906	00S81435	33	17.89	7.49	25.38	32.86	11:20:00	SHAHAPUR	MAHULI	9	C	β
3906	00S81437	66	35.00	15.56	50.55	66.11	12:40:00	SHAHAPUR	MAHULI	9	B	α
3906	00S81439	51	26.20	11.47	37.67	49.14	14:15:00	SHAHAPUR	MAHULI	9	C	α
3906	00S81720	42	23.05	8.40	31.45	39.85	16:30:00	SHAHAPUR	MAHULI	9	C	β
3906	00S81448	33	19.01	7.82	26.83	34.65	18:05:00	SHAHAPUR	MAHULI	9	C	β
16567	00S81427	35	17.12	9.49	26.61	36.09	6:40:00	MAHULI	SHAHAPUR	9	C	β
16567	00S81429	87	44.30	17.21	61.51	78.72	8:35:00	MAHULI	SHAHAPUR	9	B	α
16567	00S81434	61	30.62	14.57	45.19	59.75	10:45:00	MAHULI	SHAHAPUR	9	B	α
16567	00S81436	29	9.70	7.46	17.16	24.62	12:00:00	MAHULI	SHAHAPUR	9	C	γ
16567	00S81438	20	9.60	5.01	14.61	19.62	13:15:00	MAHULI	SHAHAPUR	9	C	γ
16567	00S81440	32	13.64	6.98	20.62	27.61	14:50:00	MAHULI	SHAHAPUR	9	C	γ
16567	00S81446	67	12.12	17.62	29.74	47.36	17:05:00	MAHULI	SHAHAPUR	9	C	β
16567	00S81721	25	5.79	5.92	11.71	17.63	18:40:00	MAHULI	SHAHAPUR	9	C	γ

Final Ridership analysis

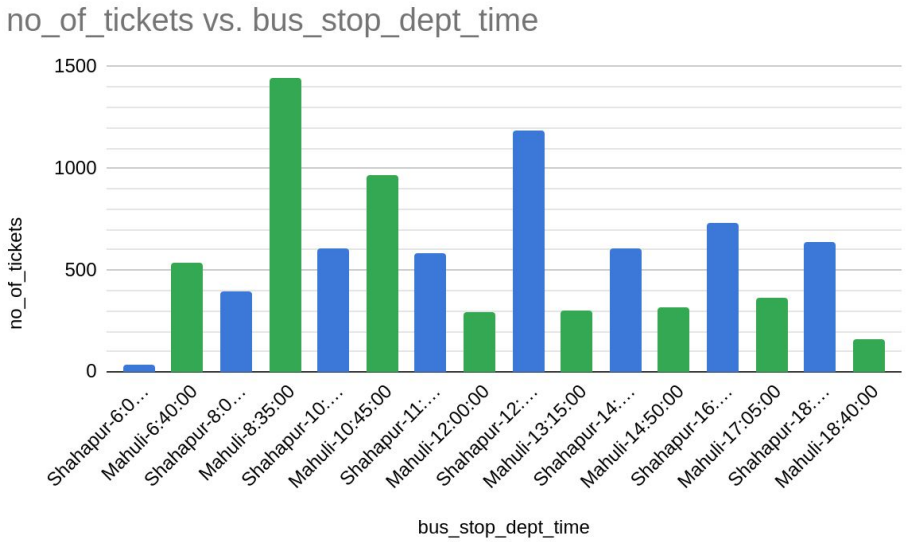
route_no	trip_no	max_ridership	weighted_avg_ridership	std_dev	sitting_ridership	standing_ridership	dept_time	from_cd	till_cd	kilometer	abc_status	utilization
17526	00S81143	58	22.70	5.20	27.90	33.11	8:40:00	ASANGAON	GUNDE	41.8	B	β
17526	00S81998	65	9.47	4.25	13.72	17.97	19:15:00	ASANGAON	GUNDE	41.8	C	γ
75002	00S81310	69	14.96	7.35	22.30	29.65	19:20:00	ASANGAON	JUNAVANI	28.8	C	β
75003	00S81311	54	17.99	7.32	25.30	32.62	5:50:00	JUNAVANI	ASANGAON	28.8	C	β
75003	00S81234	29	11.26	4.69	15.94	20.63	18:05:00	JUNAVANI	ASANGAON	28.8	C	γ
92740	00S81868	73	19.92	11.21	31.12	42.33	16:30:00	GUNDE	ASANGAON	41.8	C	β

Final Ridership analysis

- We can see that out of 24 trips which ran across the month, 9 were categorized as gamma. Thus, mini buses can be run on these trips with low load.

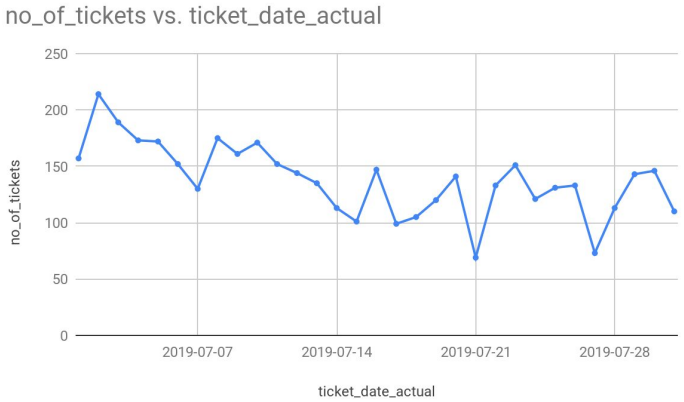
SHAHAPUR-MAHULI [Route 3906 - 16567]

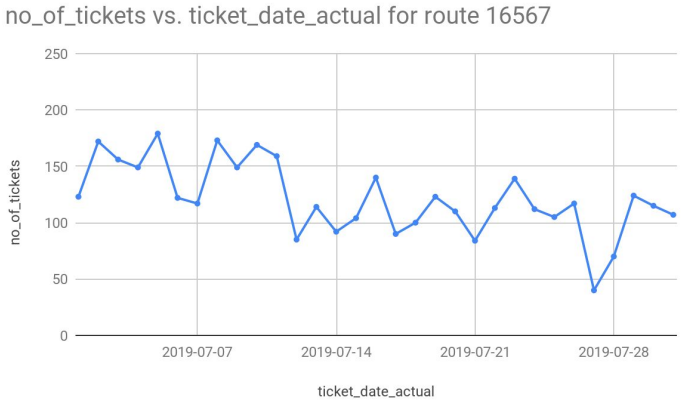
- Ticket issue pattern according to timings:
  - We observed the number of tickets issued per trip for an entire month and have displayed those tickets arranged by the trips' departure time.



SHAHAPUR-MAHULI [Route 3906 - 16567]

- Number of tickets issued on all the trips per day across the entire month:
  - Less number of tickets issued on weekends, thus we can reduce the number of trips on weekends. **Needs more analysis.**



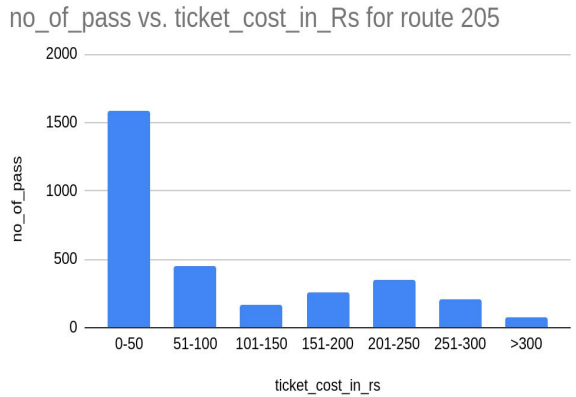


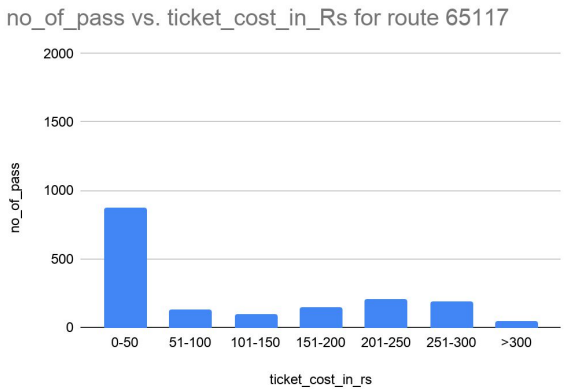
SHAHAPUR - SWARGATE [Route 205 - 65117]

- Route details:
  - 212.1 Kms
  - Bus stop SNGFTH(SHIVAJI NAGAR FATA) missing from route 205 in master data, but tickets were issued in ETIM data.
  - Bus stop BVD(BHIVANDI), KBF(KOKAN BHAVAN FATA), LALAFT(LONAVALA FATA), RABP(RABALE POLICE STN.) missing from route no 65117 in master data, but tickets were issued in ETIM data.
- Route 205:
  - Only 1 trip [ABC status: 'C'].
  - Trips ran - 37 (with 7 extra)
  - Total earnings from passengers: ABC is Rs 297744 and ETIM is Rs 325220, a difference of Rs 27476 between the two.
- Route 65117:
  - Only 1 trip [ABC status: 'C'].
  - Trips ran - 37 (with 8 extra)
  - Total earnings from passengers: ABC is Rs 190692 and ETIM is Rs 215127, a difference of Rs 24435 between the two.

SHAHAPUR - SWARGATE [Route 205 - 65117]

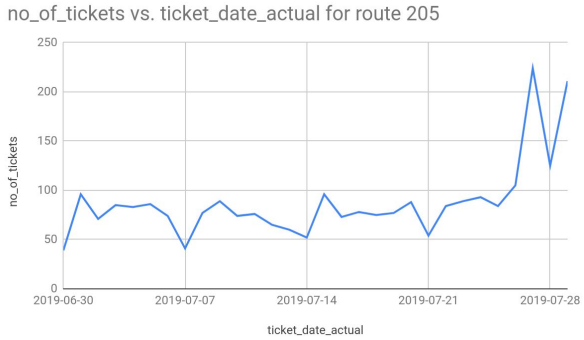
- Number of passengers and the amount of tickets issued for them:

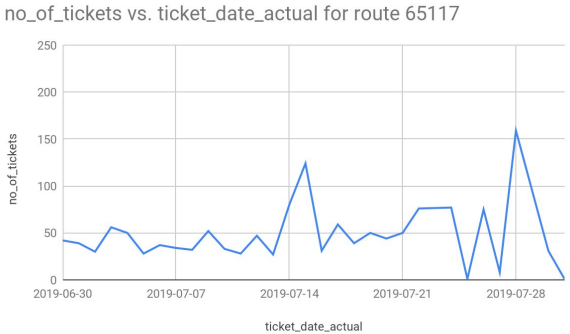




SHAHAPUR - SWARGATE [Route 205 - 65117]

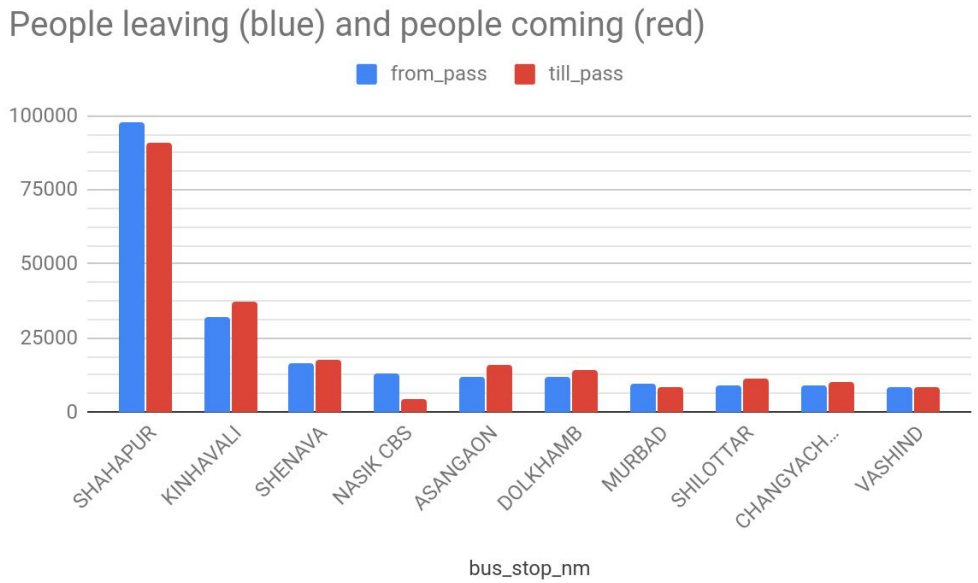
- Tickets issued per day on the route across the month:
  - The number of tickets issued on route 205 decreases during weekends, but the same is not observed on route 65117. Rather, the no of tickets for route 65117 seem to be rising during weekends.





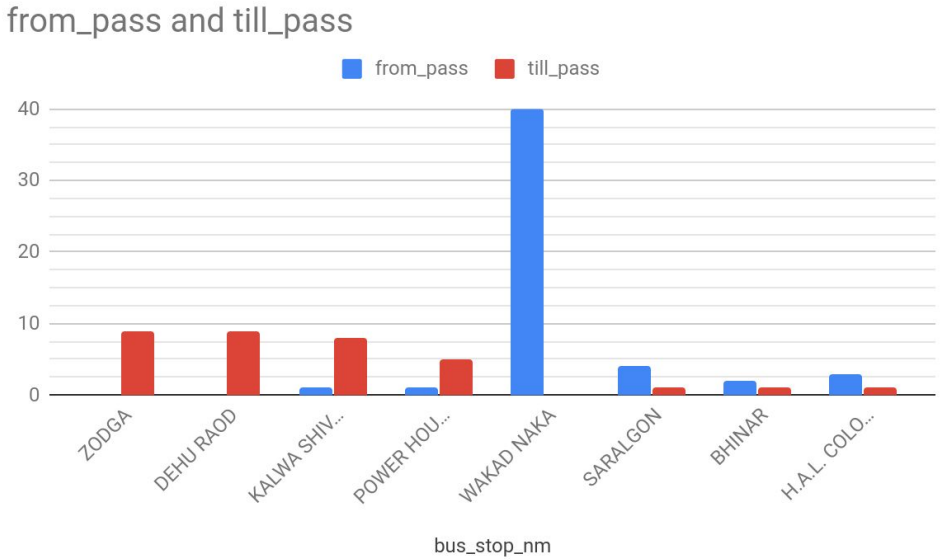
Bus traffic analysis

This graph represents bus stands with the highest traffic in shahapur bus data:



Bus traffic analysis

This graph represents bus stands with the lowest traffic in shahapur bus data:



Findings

- ABC data is not synchronous with ETIM data:
  - Operated number of trips in ETIM may not match the number of trips stated in ABC data.
  - The number of trips operated in ABC varies from what is observed in ETIM (eg 224 trips in ABC data for route 3906, but the total run trips (with extras) is 239).
  - The EPKM criteria for ABC status is not defined (for 3 trips in route 3906 the EPKM according to ETIM data is 27.59, 26.54 and 27.67 which might qualify for ‘B’ ABC status). The given criteria states that for ‘B’ status the EPKM > 22.1 (although in the ABC data this does not seem to apply) .
  - The earnings from extra trips are not added in the ABC data, which leads to high amount if the route is long. (eg. for route 65117, ABC earnings are Rs 190692 , while ETIM earnings with extra trips are Rs 215127, a difference of Rs 24,435. Similarly, for route 205 ABC earnings are Rs 2,97,744 , while ETIM earnings with extra trips are Rs 3,25,220, a difference of Rs 27,476.) This difference remains unaccounted?

Findings

- ETIM data is not synchronous with the Master data:
  - For some routes, tickets are issued on the bus stops which are not present in the master route data. (For example, on route 3906, 887 passenger tickets (674 tickets for 887 passengers) are issued from or till Asangaon fata, which is not a Bus stand in the master data for this route, out of 6064 passenger tickets (4284 tickets for 6064 passengers). This means that 14.63% of the tickets are not sane for this route and might be discarded.

Findings

- Form 4 data is not synchronous with any other data:
  - The Form 4 data can not be mapped to any other data table as the attributes do not match. The service id is different than given as trip numbers, the timings are different. Form4 data is basically obsolete if we want to use it for observational purposes.

Issues

- Right now we do not have a way to confirm if a bus ran empty (i.e. no tickets were issued) or the trip did not run at all on a day through etim data.
- As an example, you can see that trip 00S81081 apparently did not run on 2019-07-01, but the tickets were issued from NASIK CBS to KASARA and then again from NASIK CBS to SHAHAPUR. No explanation of how the bus got back at NASIK CBS.

1	etim_no	ticket_date_actual	route_no	trip_no	waybill_no	first_ticket_time	no_of_pass	from_cd	till_cd	kilometer	dept_time
2	SHP05001	2019-06-30	18326	00S81078	198583	16:30:44	36	NASIK CBS	KASARA	64.4	16:00:00
3	SHP05001	2019-06-30	17520	00S81079	198583	20:03:37	0	KASARA	NASIK CBS	64.4	19:30:00
4	SHP05001	2019-07-01	18326	00S81080	198583	05:03:44	39	NASIK CBS	KASARA	64.4	05:15:00
5	SHP05001	2019-07-01	13159	00S81082	198583	10:05:18	24	NASIK CBS	SHAHAPUR	96.5	10:15:00
6	SHP05001	2019-07-02	3859	00S81298	198698	17:28:14	60	ASANGAON	SHIRGAON	11.7	17:40:00
7	SHP05001	2019-07-02	12723	00S81757	198698	17:59:49	12	SHIRGAON	ASANGAON	11.7	18:12:00

Issues

- While on 2019-07-05, you can see that in between NASIK CBS to KASARA and NASIK CBS to SHAHAPUR, there is a trip number 00S81081 which ran from KASARA to NASIK CBS, thus explaining the schedule.
- For trip number 00S81081, 11 trips are reported in the ETIM data but in ABC data 26 trips are reported. Thus there is a lack of consistency in the data.

1	etim_no	ticket_date_actual	route_no	trip_no	waybill_no	first_ticket_time	no_of_pass	from_cd	till_cd	kilometer	dept_time
1587	SHP05020	2019-07-04	3891	00S81076	198787	13:16:08	1	SHAHAPUR	NASIK CBS	96.5	12:45:00
1588	SHP05020	2019-07-04	18326	00S81078	198787	16:41:08	21	NASIK CBS	KASARA	64.4	16:00:00
1589	SHP05020	2019-07-04	17520	00S81079	198787	18:37:30	2	KASARA	NASIK CBS	64.4	19:30:00
1590	SHP05020	2019-07-05	18326	00S81080	198787	05:29:30	20	NASIK CBS	KASARA	64.4	05:15:00
1591	SHP05020	2019-07-05	17520	00S81081	198787	07:52:24	1	KASARA	NASIK CBS	64.4	08:15:00
1592	SHP05020	2019-07-05	13159	00S81082	198787	10:10:14	28	NASIK CBS	SHAHAPUR	96.5	10:15:00
1593	SHP05020	2019-07-05	16781	00S81268	198857	16:03:40	1	SHAHAPUR	ASANGAON	2.7	15:35:00
1594	SHP05020	2019-07-05	3870	00S81269	198857	16:14:03	15	ASANGAON	ASNOLI	26.2	16:10:00

Issues

- Our solution:
  - If a trip runs empty, issue a ***null*** ticket at start and end of the trip to signify the empty trip.
  - This ***null*** ticket may be an empty luggage ticket of 0 cost or an ***inspection*** ticket, so no additional changes will be done to the original software of trimax.
  - Addition of these start/end trip tickets will help in punctuality calculations later on, giving precise details about how many trips were delayed, what was the average delay and did the lateness of one trip led to cumulative lateness of another trip.

Punctuality of the trips

- A bus is said to be on time, if it starts within 20 mins of its departure time as mentioned in the ABC data.
- A bus is said to be running late, if it exceeds the 20 mins span.
- A bus is said to be cancelled if it has exceeded the total duration of that trip and is delayed by 5-8 hrs.

While analyzing the routes with source or destination as Shahapur depot, the following are the inferences:
1. **65%** of the trips were **as per the schedule.**
2. The **punctuality is more for trips leaving out of Shahapur (i.e. 53%)** when compared with the trips coming back to Shahapur (47%).

Punctuality of the trips

- Assumptions
    - Cumulative delay of the bus trips, due to which the upcoming trips of the day gets delayed.
    - A bus should not be early by an hour or so, but if it, then this may be because for the first one or two stops, passengers did not board the bus and then finally the first ticket is issued on the third stop or so.
      The reason for not boarding the bus can be assumed that for some instances the timings of the bus trip are not suitable for the commuters.

Findings

- 68% trips are on time i.e, as per the schedule.
- Infact, 45% trips starts within the span of 10 mins.

route_no integer	trip_no character varying	trip_no_etim character varying	from_stop_cd character varying	till_stop_cd character varying	route_kms numeric	day date	abc_start_time time without time zone	first_issued_ticket time without time zone	diff_mins time without time zone	trip_status character varying
18329	00S81134	00S81134	KTHRAT	SHPR	21.7	2019-07-29	13:55:00	14:13:03	00:18:03	as scheduled(10-20mins)
70223	00S81153	00S81153	KLPSN	KSRA		2019-07-26	16:15:00	16:26:42	00:11:42	as scheduled(10-20mins)
70223	00S81205	00S81205	KLPSN	KSRA		2019-07-02	05:30:00	05:42:04	00:12:04	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-05	07:45:00	07:58:07	00:13:07	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-06	07:45:00	08:01:44	00:16:44	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-08	07:45:00	08:00:36	00:15:36	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-10	07:45:00	08:03:59	00:18:59	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-14	07:45:00	08:03:15	00:18:15	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-21	07:45:00	07:55:16	00:10:16	as scheduled(10-20mins)
129583	00S81896	00S81896	RASTHN	SHPR		2019-07-24	07:45:00	07:56:59	00:11:59	as scheduled(10-20mins)
129583	00S81915	00S81915	RASTHN	SHPR		2019-07-01	19:45:00	19:58:38	00:13:38	as scheduled(10-20mins)
75482	00S81862	00S81862	SHPR	KHYS	17.8	2019-07-12	15:15:00	15:30:42	00:15:42	as scheduled(10-20mins)
75482	00S81862	00S81862	SHPR	KHYS	17.8	2019-07-15	15:15:00	15:34:43	00:19:43	as scheduled(10-20mins)
129582	00S81895	00S81895	SHPR	RASTHN	10.3	2019-07-30	07:15:00	07:27:56	00:12:56	as scheduled(10-20mins)
129582	00S81914	00S81914	SHPR	RASTHN	10.3	2019-07-07	19:15:00	19:26:35	00:11:35	as scheduled(10-20mins)
129582	00S81936	00S81936	SHPR	RASTHN	10.3	2019-07-14	09:40:00	09:53:31	00:13:31	as scheduled(10-20mins)
129582	00S81936	00S81936	SHPR	RASTHN	10.3	2019-07-17	09:40:00	09:50:19	00:10:19	as scheduled(10-20mins)
129582	00S81936	00S81936	SHPR	RASTHN	10.3	2019-07-21	09:40:00	09:52:34	00:12:34	as scheduled(10-20mins)
16567	00S81427	00S81427	MLIBT	SHPR	9	2019-07-02	06:40:00	06:43:17	00:03:17	as scheduled(within 10mins)
13972	00S81499	00S81499	MRBD	SHPR	42.7	2019-07-21	08:45:00	08:45:00	00:00:00	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-07	06:55:00	07:04:55	00:09:55	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-09	06:55:00	06:59:35	00:04:35	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-12	06:55:00	07:02:46	00:07:46	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-13	06:55:00	06:59:49	00:04:49	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-17	06:55:00	07:03:39	00:08:39	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-21	06:55:00	07:01:38	00:06:38	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-22	06:55:00	07:03:01	00:08:01	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-24	06:55:00	07:01:46	00:06:46	as scheduled(within 10mins)
77574	00S81392	00S81392	SHPR	KKBBT	23.3	2019-07-27	06:55:00	07:01:58	00:06:58	as scheduled(within 10mins)

Issue

- Some trips are starting before the start time, those trips are marked as early trips.
- Infact, some trips were early by 40 mins to 1 hour.
- What could be the possible reason for this?

route_no integer	trip_no character varying	trip_no_etim character varying	from_stop_cd character varying	till_stop_cd character varying	route_kms numeric	day date	abc_start_time time without time zone	first_issued_ticket time without time zone	diff_mins time without time zone	trip_status character varying
12708	00S81500	00S81500	SHPR	MRBD	42.7	2019-07-27	10:45:00	09:59:33	00:45:27	early
12708	00S81504	00S81504	SHPR	MRBD	42.7	2019-07-04	18:45:00	18:23:11	00:21:49	early
12708	00S81508	00S81508	SHPR	MRBD	42.7	2019-07-02	11:15:00	10:45:07	00:29:53	early
12708	00S81508	00S81508	SHPR	MRBD	42.7	2019-07-20	11:15:00	10:15:56	00:59:04	early
12712	00S81000	00S81000	SHPR	GKLGN	14.2	2019-07-07	13:45:00	13:11:15	00:33:45	early
12713	00S81358	00S81358	SHPR	NEALIST	13	2019-07-20	20:30:00	19:46:03	00:43:57	early
12714	00S81017	00S81017	SHPR	TMBRA	17.2	2019-07-07	18:15:00	17:54:30	00:20:30	early
12714	00S81183	00S81183	SHPR	TMBRA	17.2	2019-07-29	16:00:00	15:32:17	00:27:43	early
12721	00S81040	00S81040	KNGNA	SHPR	34.1	2019-07-31	08:45:00	07:48:27	00:56:33	early
12721	00S81049	00S81049	KNGNA	SHPR	34.1	2019-06-30	16:00:00	15:23:09	00:36:51	early
12721	00S81049	00S81049	KNGNA	SHPR	34.1	2019-07-20	16:00:00	15:28:11	00:31:49	early
12721	00S81049	00S81049	KNGNA	SHPR	34.1	2019-07-22	16:00:00	15:02:07	00:57:53	early
12721	00S81049	00S81049	KNGNA	SHPR	34.1	2019-07-25	16:00:00	15:26:18	00:33:42	early
12723	00S81676	00S81676	SHRGNI	ASNGN		2019-07-30	08:00:00	07:33:43	00:26:17	early
12725	00S81359	00S81359	NEALIST	ASNGN	15.7	2019-07-20	21:00:00	20:24:54	00:35:06	early
12726	00S81018	00S81018	TMBRA	SHPR	17.2	2019-07-07	19:00:00	18:38:28	00:21:32	early
12726	00S81662	00S81662	TMBRA	SHPR	17.2	2019-07-15	17:05:00	16:44:17	00:20:43	early
12726	00S81662	00S81662	TMBRA	SHPR	17.2	2019-07-18	17:05:00	16:43:04	00:21:56	early
12726	00S81662	00S81662	TMBRA	SHPR	17.2	2019-07-19	17:05:00	16:42:22	00:22:38	early
12726	00S81662	00S81662	TMBRA	SHPR	17.2	2019-07-23	17:05:00	16:39:43	00:25:17	early
12726	00S81662	00S81662	TMBRA	SHPR	17.2	2019-07-29	17:05:00	16:21:18	00:43:42	early
13132	00S81086	00S81086	ASHTEST	SHPR	20.8	2019-07-01	16:45:00	16:16:20	00:28:40	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-03	12:20:00	11:53:36	00:26:24	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-04	12:20:00	11:59:36	00:20:24	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-05	12:20:00	11:56:27	00:23:33	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-06	12:20:00	11:55:43	00:24:17	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-09	12:20:00	11:50:44	00:29:16	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-10	12:20:00	11:52:57	00:27:03	early
13137	00S81042	00S81042	BASACL	SHPR		2019-07-12	12:20:00	11:51:25	00:28:35	early

Summary Table for Punctuality: (July,2019)

	trip_status	no_of_etim_july_trip	percentage
1	**as scheduled(10-20mins)**	**2767**	**23.04**
2	**as scheduled(within 10mins)**	**5359**	**44.63**
3	cannot say late/early(9-12hrs)	63	0.52
4	cannot say late/early(more than 12hrs	25	0.2
5	**early**	**830**	**6.91**
6	early by 1-2hrs	118	0.98
7	early by 2-4hrs	58	0.48
8	early by 5-8hrs	125	1.04
9	**late**	**2254**	**18.77**
10	late by 1-2hrs	306	2.54
11	late by 2-4hrs	81	0.67
12	late by 5-8hrs	21	0.17
13	**total**	**12007**	
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Early by 20 mins to 1 hr

Late by 20 mins to 1 hr

Day wise analysis of monthly data

Analysis for daily basis is done for the month of July.

- Attributes for a day:
  - Number of routes
  - Number of trips
  - Number of trips covered from ABC
  - Number of trips on time
  - Number of passengers
  - Total Revenue
  - Cancelled trips
  - Extra trips performed
  - Revenue from extra trips
  - Revenue from regular ABC trips

	day	total_routes	total_trips	regular_trips	on_time_trip	% on_time_trip	no_of_psgr	total_amt_rs	cancelled_trip	% cancelled_trip	extra_trips	% extra_trips	psgrs_on_extra_trip	total_amt_from_extra_	total_amt_from_reg_rs
1	2019-07-01	194	379	344	219	57.78	16618	389432	5	1.32	35	9.23	1479	37442	351990
2	2019-07-02	201	386	348	251	65.03	16350	390715	2	0.52	38	9.84	1636	54613	336102
3	2019-07-03	198	396	374	287	72.47	17357	375306	1	0.25	22	5.56	997	12846	362460
4	2019-07-04	196	396	371	262	66.16	15950	333995	6	1.52	25	6.31	1199	27990	306005
5	2019-07-05	196	402	375	270	67.16	16582	351910	2	0.5	27	6.72	1085	15662	336248
6	2019-07-06	197	408	380	278	68.14	16360	379201	8	1.96	28	6.86	965	13038	366163
7	2019-07-07	174	375	338	233	62.13	14036	340003	0	0	37	9.87	1281	33340	306663
8	2019-07-08	191	408	383	264	64.71	18348	390492	2	0.49	25	6.13	870	11366	379126
9	2019-07-09	197	407	371	275	67.57	17154	377381	6	1.47	36	8.85	964	26988	350393
10	2019-07-10	183	379	334	232	61.21	17515	374198	0	0	45	11.87	1702	57530	316668
11	2019-07-11	176	350	314	212	60.57	14084	358272	1	0.29	36	10.29	1292	99057	259215
12	2019-07-12	157	326	301	239	73.31	12807	357872	0	0	25	7.67	1383	90390	267482
13	2019-07-13	179	366	328	246	67.21	14401	400795	4	1.09	38	10.38	1280	140075	260720
14	2019-07-14	162	342	299	239	69.88	11844	311011.5	3	0.88	43	12.57	1751	72536.5	238475
15	2019-07-15	201	410	379	277	67.56	16968	397976	4	0.98	31	7.56	1492	54112	343864
16	2019-07-16	198	406	377	284	69.95	15952	356662	0	0	29	7.14	1070	15976	340686
17	2019-07-17	194	417	391	275	65.95	14874	335194	1	0.24	26	6.24	644	7953	327241
18	2019-07-18	200	439	419	323	73.58	14186	314537	5	1.14	20	4.56	552	6068	308469
19	2019-07-19	198	421	404	313	74.35	14586	322746	8	1.9	17	4.04	494	12422	310324
20	2019-07-20	192	401	369	272	67.83	14383	336614	17	4.24	32	7.98	1030	18350	318264
21	2019-07-21	169	354	322	256	72.32	11518	315177	4	1.13	32	9.04	1094	26118	289059
22	2019-07-22	204	440	423	290	65.91	16615	366655	20	4.55	17	3.86	460	6342	360313
23	2019-07-23	206	450	427	309	68.67	16305	331347	0	0	23	5.11	749	9876	321471
24	2019-07-24	201	436	409	283	64.91	17173	353785	3	0.69	27	6.19	1384	23680	330105
25	2019-07-25	203	420	401	298	70.95	14487	321900	3	0.71	19	4.52	491	7458	314442
26	2019-07-26	204	439	422	285	64.92	16117	370468	7	1.59	17	3.87	498	6771	363697
27	2019-07-27	180	369	338	221	59.89	11187	335077	3	0.81	31	8.4	850	56257	278820
28	2019-07-28	152	315	282	200	63.49	11116	338042	9	2.86	33	10.48	1112	45865	292177
29	2019-07-29	195	405	379	247	60.99	17439	376238	9	2.22	26	6.42	1246	32822	343416
30	2019-07-30	188	387	350	238	61.5	15206	303586	3	0.78	37	9.56	1269	21855	281731
31	2019-07-31	139	244	219	170	69.67	9268	152366	3	1.23	25	10.25	841	11473	140893
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*analysis such as number of trips covered from ABC, number of pass tickets in trips throughout a day, etc. is to be done.

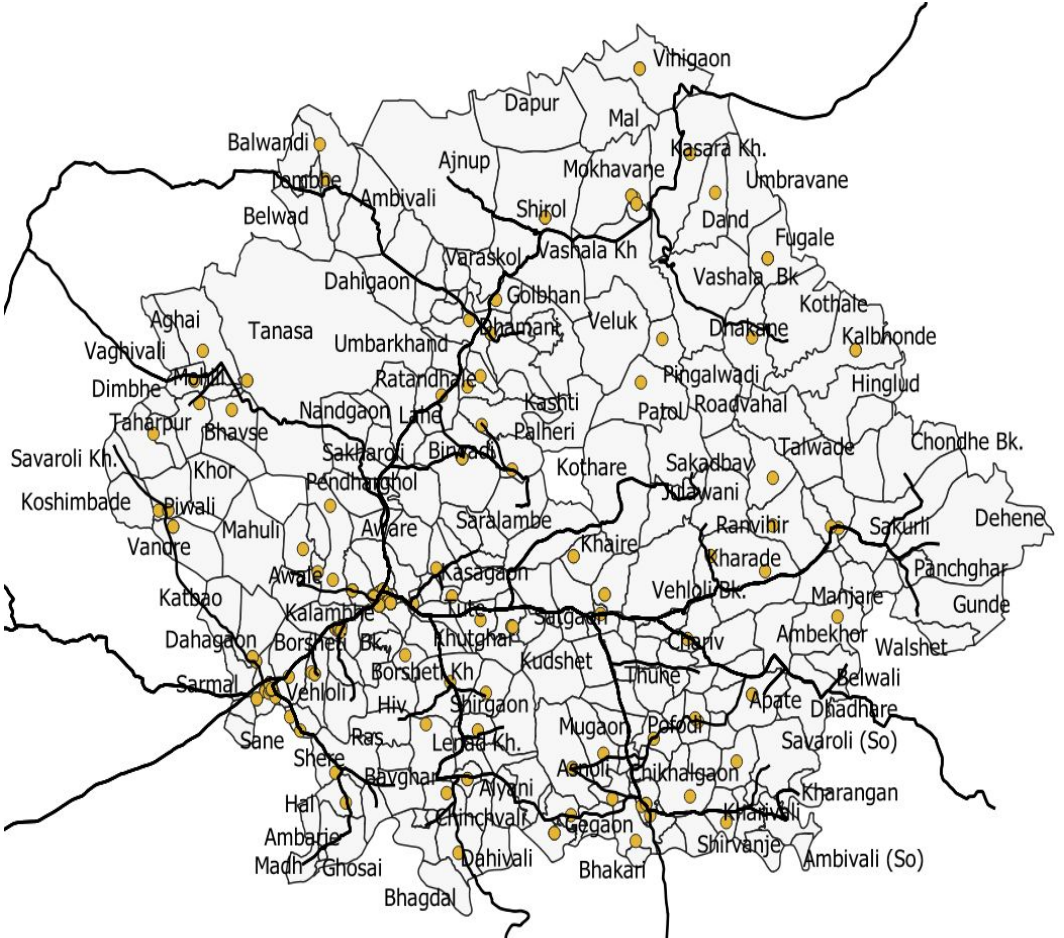
Education and Public transport

Objective

- Evaluating Transport planning and customising for Shahapur taluka
- To identify points for social coverage.
- To do social benefits accounting of services offered by Shahapur Taluka Bus depot.
- To do social impact cost-benefit analysis
- To maximize the profit for MSRTC by increasing ridership

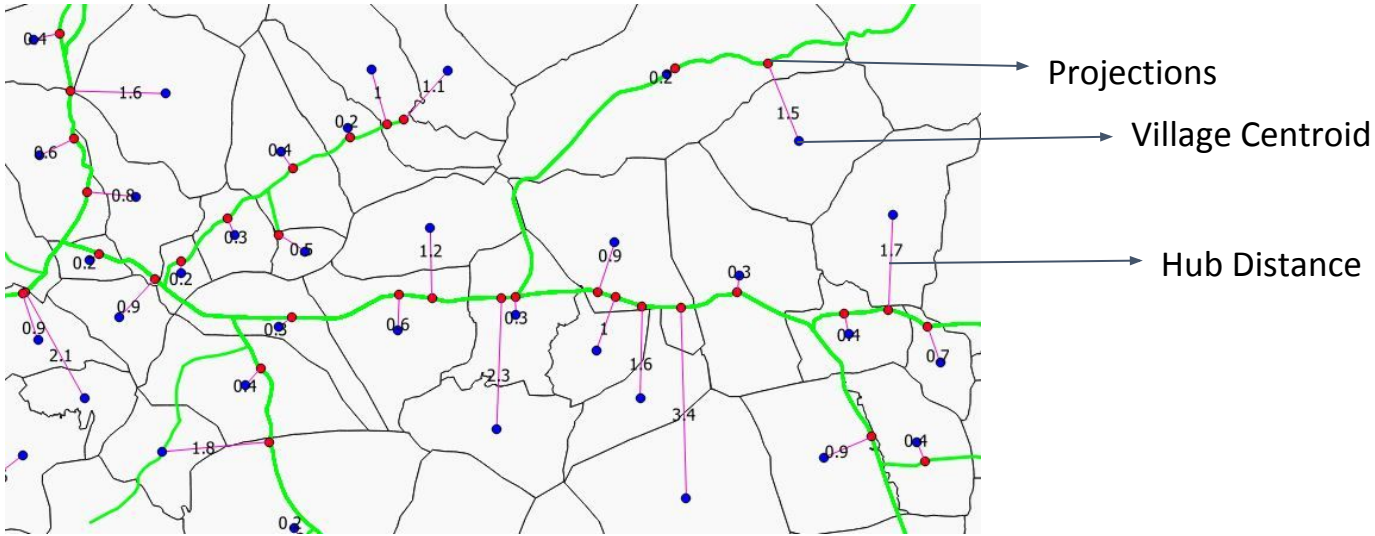
Secondary Data Used

- Shahapur Taluka Shapefile
- Route Segment (shortest path on two consecutive bus stops on a route based on road network)
- Road Network (Source: MRSAC)
- School Location data(Source: DISE (SchoolGIS))



Definitions

Projections (P): Point of shortest distance from village centroid
Hub distance: Euclidian distance from village centroid to nearest route segment



Method: measuring school accessibility

- First Centroid of each polygon/village has been taken out
- Perpendicular projections have been drawn from both centroid and schools to ST bus route.
- Origin-Destination pairs have been formed for both village centroid and its nearest school (Category-wise) taking bus routes and projections
- For Each category of School, we have located the closest school to the village and for each school, if there is a village, we have classified it when walking distance is more than 3 km.

Schools from all the category-wise (Primary School (Class 1-5), middle school (class 6-8), senior schools (class 9th and 10th) and senior secondary schools (Class 11th and 12th)

Analysis

- Total 30 schools have been identified in which walking distance is greater than 3 km (According to Right to education act the neighbourhood/nearest school should be within 3 km walking distance from student home)(we are considering that after reducing the bus route from shortest distance from village centroid to nearest schools (category-wise)).
- From that we have taken out 16 schools. Since we are only focusing on Middle schools and Secondary school in this project

List of 16 Schools

Schools	Total Villages Served	%pop Serve	%SCpop Serve	%STpop Serve	Distance From Main road(in meters)	Distance From ST road(in metres)
MOHILI	8	3.14	12.50	0.89	80.89	791.79
BIRWADI	7	2.01	0.00	2.51	31.63	95.02
KASARA BUDRUK	8	2.16	6.43	0.53	20.42	963.89
TEMBHE	4	5.98	6.78	6.05	670.75	2384.96
FUGALE	6	2.35	0.00	2.72	171.94	3629.26
SUSARWADI	4	11.06	1.01	16.94	21.56	2475.25
PENDHARGHOL	4	10.56	0.00	25.42	2371.30	2371.30
DOLKHAMB	17	6.33	5.88	2.44	92.88	103.46
SHIROL	21	1.42	0.29	2.09	103.58	662.53
PIVALI	5	3.78	20.00	5.53	48.94	165.99
VIHIGAON	2	6.16	6.49	5.73	347.57	2527.40
KHARDI	27	4.41	7.08	4.11	108.02	108.02
PIVALI	5	15.22	0.00	25.93	48.94	165.99
DHASAI	16	1.79	0.00	0.08	34.33	989.48
CHANDROTI	6	4.09	0.00	4.83	1005.76	1378.79
TEMBHURLI	3	5.40	12.50	0.87	75.82	2654.86

Primary Data Collected

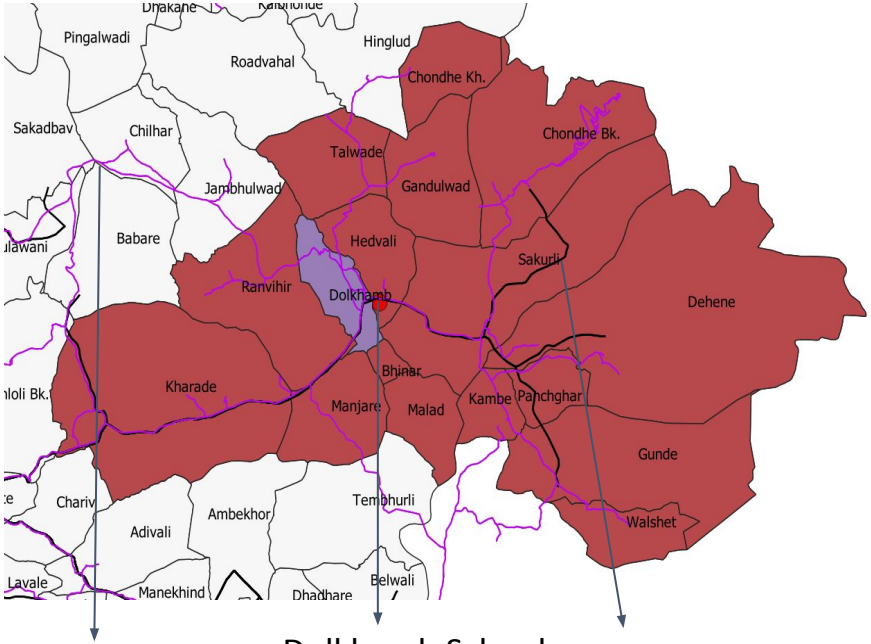
4 Schools, viz., Pendhargol, Piwali, Atgaon and Dolkhamb were visited in field visit, in which 100 surveys were done in Dolkhamb school and following data were collected from there:

- Point of origin and destination (for each mode of transport)
- Time taken for trip
- Fare of each trip
- Mode of transport for each trip
- Any vehicle owned or not
- Safest mode of transport (perception wise rating for each mode of transport)

Travel Mode Choice of Students (Pilot Survey of DolKhamb School)

Village Name	Distance (Village Centroid to School) (in km)			Travel Mode Choice			
	Village centroid to bus/road network	Bus/road network	Distance from bus/road network to school	Village centroid to road	Bus/road network	Distance from bus/road network to school	Remark
Jambulwad	0.408	7.203	0.103	Walk	Jeep/walk	Walk	
Ranvihir	2.482	2.085	0.103	Walk	Bus	Walk	
Bhinar	1.057	3.732	0.103	Walk	Walk	Walk	
Kharade	0.603	2.218	0.103	Walk	Walk	Walk	
Talwade	0.836	4.745	0.103	Walk	Jeep	Walk	
Malad	1.887	6.981	0.103	Walk	Walk	Walk	Road is there but no bus
Dehene	2.287	11.569	0.103	Walk	Bus	Walk	
Hinglud	1.042	7.219	0.103	Walk	Walk	Walk	
Panchghar	0.410	10.207	0.103	Walk	Bus	Walk	
Chondhe Bk.	1.250	13.303	0.103	Walk	Bus	Walk	
Chondhe Kh.	3.799	13.303	0.103	Walk	Bus	Walk	

Coverage Area of Dolkhamb School

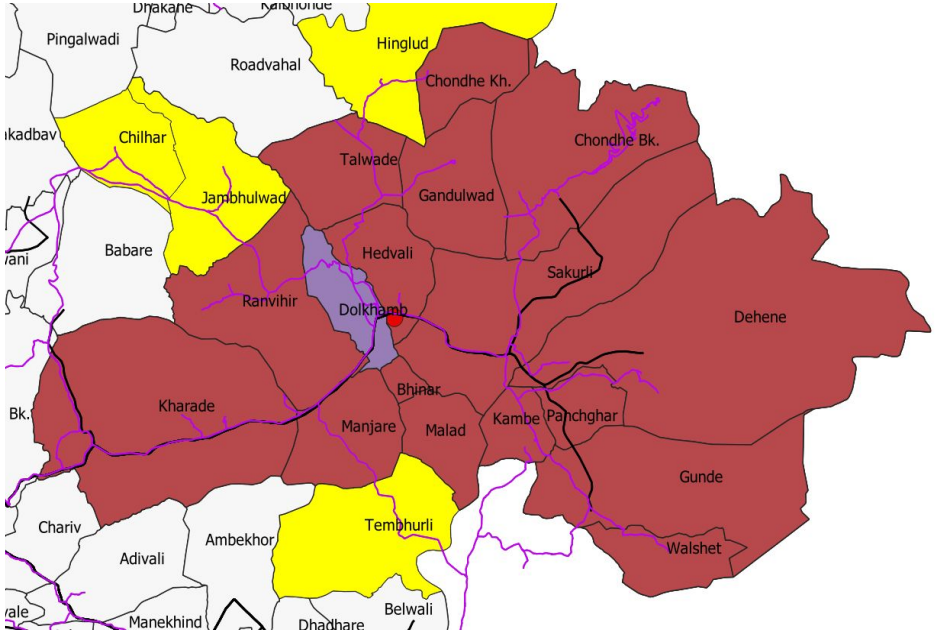


Road Network

Dolkhamb School

ST bus route network

Coverage area by data



Actual coverage area identified on field (from survey)

Bus Timings (Shahapur to Dolkhamb) vs School Timings *

Bus Timings					School TImings	
Start Timing	Origin	Destination	Station	Bus Service type	Start time	10:00 AM
08:30 AM-09:45 PM	Shahapur	Chonda	Dolkhamb	Manav Vikas		
12:00 PM-01.15 PM	Shahapur	Chonda	Dolkhamb	Day Ordinary		
03:30 PM- 04.45PM	Chonda	Shahapur	Dolkhamb	Day Ordinary		
04:15 PM-05.30 PM	Shahapur	Chonda	Dolkhamb	Manav Vikas	End time	5:00 AM

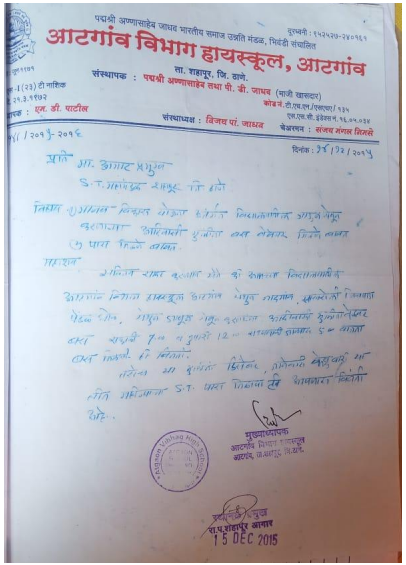
**All Time noted from survey as we don't have latest form 4 and ABC data*

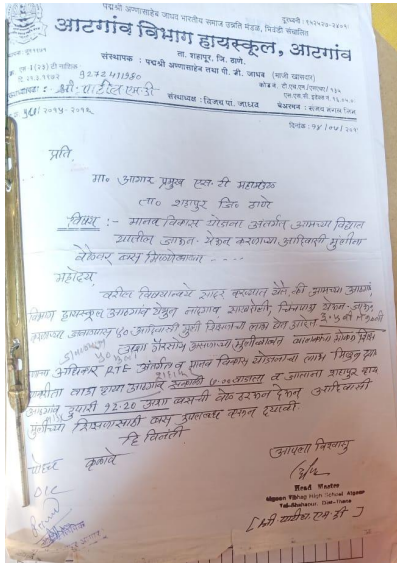
Findings from Field

- Main problem identified on the field associated with the public bus service is its late timings (4 times a week), which affects the student choice for travelling to school and consider alternate mode of transport such jeep/auto etc.
- Girls are more dependent on public transport as they were less likely to use bicycle or auto or jeep for traveling to school when schools are at a greater distance due to safety purpose.
- In a school in Atgaon, school administration has done a deal with BMC to take their children in their transport due to lack of public bus transport on this route, at school timings.
- Another problem identified with public bus transport is, breakdown of bus in midway (2 to 3 times a month) which compels students to take jeep/auto or sometimes go “to school”/”From school” by walking as depot have exact no. of vehicle according to form4 schedule.
- About 95% of the respondents chooses bus on any other mode, the main reason behind that is safety. This is sufficient to suggest that public buses have positive image.

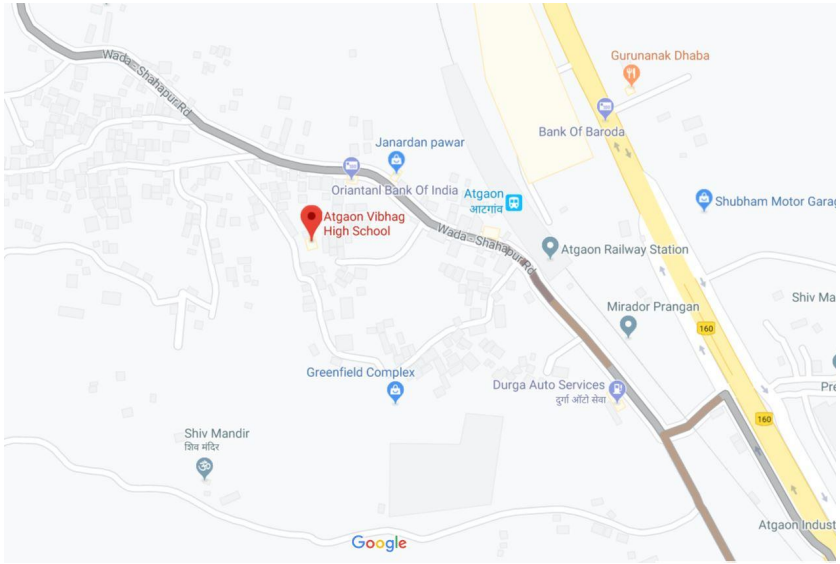
Issues and Questions raised

- A school in Atgaon where around 50 students out of 400 children comes from very far away from school, have written 2 letters to MSRTC in which they have requested to start Manav Vikas Bus on Shahapur to Wada route but it had been addressed yet.





Copy of Letters to MSRTC



Atgaon School

Recommendations

1. Repair of Master Files
    a. - missing routes
    b. - missing stops
2. Lat-long for stops
3. ETIM - start and ending of trips
4. Updation of Form 4, linking ABC and Form 4
5. Richer set of standard queries and data extensions

Future Work

1. Dashboard integrating GIS and operational data
2. Analysis of GPS data and preparation of time-tables
3. More analytics - correlations and other (and improved) data sets
4. Profitability and coverage analysis
5. Schedule analysis - fewer buses and better inventory utilization
6. Social Accounting - setting social goals and monetizing them
7. Engineering systems analysis

Future Mechanisms

- Rs. 20-25 lakhs annual support for IITB team.
  - Development of new models of knowledge transfer
  - New analytics and dashboard
- 2 fellowship for M.Tech. Students (at Rs. 15 lakhs per fellow)
  - Thesis, 1-year attachment with MSRTC, faculty time
- Management consultancy support to 2-3 depots. 1-2 % of revenues.
- Training workshop for 15 colleges on MSRTC analysis - data support and liaison

Thank you