Research at IITB on MSRTC Operations and the Way Ahead

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Outline

- Public transport as a societal service
- Analysis of MSRTC Operations
- Digital Geography framework
- Data Analysis of Shahapur Depot
- Social Value Analysis
- Plan for Future Work
- Way ahead

Public Transport in Rural India

Mode Used to Travel to Work - Rural India (2011) (Figures in %)

Mode Used to Travel to Work - Rural India - Gender Wise (2011) (Figures in %)



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

What does the census say on transport



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

Repeated Losses

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Rising fuel costs compels corporation to increasing MSRTC bus fares by 18%

MSRTC counts its losses

THE Mur 28, 2010 02, 43 (57



KOLFIAPUR: The state transport corporation is finding it difficult to stay on course with a cumulative net loss of Rs 2712

A+

crore in last five years. The Manansitra Shike Road Transport Corporation (MSRTC) is one of the largest public transport utilities in India having fixet of 48.000 active buses and 60 lakh dally passengers. But It has been suffering from financial losses due to

Series 1013-0-01

presentation in the

expenditure on salaries, fuel and pessenger tax charged by the state government.

hindustantimes

PUC panel reports points out MSRTC's losses, blames e-ticketing system

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31.75./ Sr. No.	तपशील / Particulars	वाहतूर उपलब्ध खेडयांची Percen Villlage	क सेवा असलेल्या टक्केवारी/ tage of s served	वाहतूक सेवा उपलब्ध असलेल्या लोकसंख्येची टक्केवारी / Percentage of Population served		
		2015-16	2016-17	2015-16	2016-17	
1	2	3	4	5	6	
39/	थेट /	74.48	75.53	91.17	91.66	
A	Direct	(30906)	(31341)	(1099.66)	(1119.86)	
ब	३ कि.मी.पर्यत/	15.72	15.11	5.85	5.61	
/B	Upto 3 Kms.	(6524)	(6269)	(70.52)	(68.49)	
क	३ ते ५ कि.मी. दरम्यान/	5.61	5.42	1.68	1.59	
/c	Between 3 to 5 Kms.	(2328)	(2247)	(20.27)	(19.44)	
ड	५ ते ८ कि.मी.दरम्यान/	2.57	2.44	0.86	0.74 (8.98)	
/D	Between 5 to 8 Kms.	(1067)	(1014)	(10.33)		
Ş /E	८ कि.मी.पलिकडे / Beyond 8 Kms.	1.61 (668)	1.50 (622)	0.45 (5.38)	0.40 (4.92)	

corporation.

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Repeated Losses

Rising fuel costs compels corporation to increasing MSRTC bus fares by 18%	Waive taxes for MSRTC, Transport Minister urges CM							
MSRTC counts its losses	31.75./ Sr. No.	अ.क्र./ तपशील / Particulars वाहतूक सेवा वा Sr. उपलब्ध असलेल्या अस No. खेडयांची टक्केवारी/ टक्वे				हतूक सेवा उपलब्ध लेल्या लोकसंख्येची कवारी / Percentage		
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corporation.

Railway vs MSRTC

Criteria	Railway	MSRTC
People travelling	2%	10%
Connectivity	Main cities	75% villages
Charge per km	0.48	1.5
Subsidy by govt as a fraction of income	105%	18%

ST is responsible for more societal service than railway

Previous work: Analysing Regional Public Transport One Depot at a time

- Understanding the MSRTC operations
- Field visit to depots (Shahapur, Sinnar)
- GIS Analysis
- Analysis of ETIM and ABC data
- Connectivity to school (case of Dolkhamb, Shahapur)

Previous MoU and Data Agreement



The 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)



Analysis of MSRTC Operations (Traffic)

Datasets used

- Form 4
- Master data
- ETIM data
- ABC data
- Census data
- Schools UDISE data
- Socio-econom ic data

Questions to be addressed

- What are the current routes and trips? Can they be visualised in GIS format?
- How many passengers travel through a particular route? How many (on an avg) board at a particular stop?
- What is the time table at a given stop? Needs a framework to model the operational data
- Which services are essential for schools and colleges? Which services provide connectivity to remote villages?
- If a service is not generating any revenue and the depot decides to stop it, How to know if it is essential for school students or not? - Needs a method of social value accounting

Analysis of Data

Related to Operational Aspects of Depot

- Analysis 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
- Survey at the depot to understand the functioning

Related to Social value provided by ST

- Identifying the main Hubs in the region
- Identifying the points of social interests ie schools, weekly markets, govt offices, colleges, industry/MIDC etc.
- Surveying such points to understand the requirements of the passengers
- Maintaining standard OD pairs

MSRTC's GIS portal



The solution should integrate the current available data structure of MSRTC and provide extra features as per requirements

Available data

- National and state highways
- Locations of depot, terminal, offices
- Data useful for overall management and aggregated at the central, regional, depot level e.g. avg ridership, total km covered, avg km of tyres, pass numbers, total passengers etc

What is not available

- Actual MSRTC route network
- Locations of destinations
- Data required for local depot level analysis and planning e.g. locations of stops, avg passengers boarding at a stop, current running status/ location of the bus, locations of points of public interest like schools, weekly markets etc

How many trips pass through a given location? Do dense areas have more trips? How many villages and population is covered? Can riders know where is my bus? Requires connecting geography and schedule!

- Digital Geography is a 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.

Typical problems faced in management of transport operations



Solution: We use a Graph Structure. Digital Geography!

Details of Digital Geography

- Edges and nodes from OSM data
- MSRTC stops and route network mapped on the OSM data
- Details of service in form 4 mapped on the stops and routes network
- ETIM data to understand profitability of a route



Network Layer of Shahapur using Digital Geography Framework

Route Timings



Timings for each node on the route. Estimated time to reach the node and other details.

All-route timetables at all points : (Kinhavli)

serviceid	route_no	s_eng	s_s_eng	d_eng	s_d_eng	arrival 🔺
S-81557	54239	KINHAVALI	KINV	SHAHAPUR	SHPR	10:25:00
S-81252	87915	KINHAVALI	KINV	ASNOLI	ASNLIN	10:40:00
S-81253	17536	KINHAVALI	KINV	APATE	APTE	11:35:00
S-81605	54236	KINHAVALI	KINV	SHAHAPUR	SHPR	12:20:00
S-81255	17536	KINHAVALI	KINV	APATE	APTE	12:30:00
S-81365	83073	KINHAVALI	KINV	SOGAON	SOGAONST	12:30:00
S-81952	54240	KINHAVALI	KINV	SHAHAPUR	SHPR	15:05:00
S-81843	83037	KINHAVALI	KINV	KHARPAT	KHRPTA	16:30:00
S-81016	54235	KINHAVALI	KINV	SHAHAPUR	SHPR	16:40:00
S-81460	12720	KINHAVALI	KINV	AASANGAON	ASNGN	18:20:00
S-81563	12720	KINHAVALI	KINV	AASANGAON	ASNGN	19:00:00
S-81387	54241	KINHAVALI	KINV	SHAHAPUR	SHPR	19:55:00
S-81658	54237	KINHAVALI	KINV	SHAHAPUR	SHPR	21:35:00

Dynamic Tracking and evaluation





Classification of Routes

- Based on economic outcomes/ revenue
 - Type ABC classification of MSRTC
- Based on number of currently running Trips
- Based on Social importance
 - Last mile connectivity for remote villages
 - Routes for schools (Manav Vikas Buses and other school routes)
 - Routes that connect facilities like Bank, Mandi, Weekly Market, colleges, hospitals etc



Classification of Hubs



Hubs based on presence of social points of interest



Khardi village falls in level 0 hub but it has a secondary school, college, hospital and railway station. There is a scope for more trips between Khardi and neighbouring villages.

Punctuality

	Α			В		C
	trip_status	no	of	etim	july trip	percentage
2	as scheduled(10-20mins)				2767	23.04
L	as scheduled(within 10mins)				5359	44.63
E	cannot say late/early(9-12hrs)				63	0.52
	cannot say late/early(more than 12hrs				25	0.2
	early				830	6.91
8	early by 1-2hrs				118	0.98
E.	early by 2-4hrs				58	0.48
15	early by 5-8hrs				125	1.04
0	late				2254	18.77
1	late by 1-2hrs				306	2.54
2	late by 2-4hrs				81	0.67
3	late by 5-8hrs				21	0.17
4	total				12007	
-						

- No record when the trip started or ended.
- Based on ETIM time-stamps.
- Analysis for starting stops!

GPS Based Time-Stamping Essential. Guidance to passengers too!

Ridership - Path Analysis



Shahapur-Pune service

- 1. Empties at Thane. Very few passengers take the longer journey.
- 2. Serves Padgha and intermediate people to reach Thane railway station. Serves as a Thane -Pune service thereafter
- 3. Average ridership at 22 is not GOOD.

Bus stops

Trip-wise occupancy

route_no	trip_no	max_ridershi p	weighted_avg _ridership	std_dev	sitting_riders hip	standing_ride rship	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	в	β
17526	00S81998	65	9.47	4.25	13.72	17.97	19:15:00	ASANGAON	GUNDE	41.8	С	γ
75002	00S81310	69	14.96	7.35	22.30	29.65	19:20:00	ASANGAON	JUNAVANI	28.8	с	β
75003	00S81311	54	17.99	7.32	25.30	32.62	5:50:00	JUNAVANI	ASANGAON	28.8	с	β
75003	00S81234	29	11.26	4.69	15.94	20.63	18:05:00	JUNAVANI	ASANGAON	28.8	с	γ
92740	00S81868	73	19.92	11.21	31.12	42.33	16:30:00	GUNDE	ASANGAON	41.8	с	β

Guide discrepancy between ABC and ridership - pass-holders?

Drive bus size and capacity utilization

New datasets formed, many

corrections attempted.

New tables:

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

For example, here is the Ridership on 3rd July, 2019 for a trip 00S81428 on route SHAHAPUR-MAHULI:



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. Accuracy of a route





Social Value Analysis



Analysing a school at Dolkhamb



Brown lines indicate road network, yellow lines show ST routes



- Dolkhamb is level1 hub (11 trips per day)
- There is a road connecting Chondhe kh., Gandulwad, Talwade to Dolkhamb but it has no bus service
- There are 4 services between Shahapur -Chondha



- What is the catchment of school?
- Are there buses to suit the school schedule?

Not too good!

	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

So how are students coming to school?

Village Name	Distance (Village Centroid to School) (in km)			Tra			
						Distance	
						from	
			Distance from	Village		bus/road	
	Village centroid to		bus/road network	centroid	Bus/road	network to	
	bus/road network	Bus/road network	to school	to road	network	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	
							Road is
							there but
Malad	1.887	6.981	0.103	Walk	Walk	Walk	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	

Case study at Chiplun depot and DBJ college



village	karambavane	tivare	chiveli	talsar	tamhan mala	
Distance from chiplun depot	24.7	27.7	37.7	20.7	33.1	
Reach village bus stop by	5:50	5:50	6:35	6:50	6:35	
Bus travel	6 to 6:45	6 to 7:20	6:45 to 8:15	7 to 7:50	6:45 to 8:15	
walk time to reach college	20 min	NA	20 min	NA	20 min	
reach college by	7:05	7:25	8:35	7:55	8:35	
lecture starts at	7:30	7:30	7:30	7:30	7:30	
NA as college lies on the road towards depot						

Students from chiveli, talsar and tamhan mala use other modes of transport as ST does not reach on time

Improving Ridership

- Standard O-D pairs field surveys
 - Educational trips, trips for work, trips for markets
- Focus on institutions schedule, volumes, institutional analysis
- Where is my bus improving information and punctuality
- Improving operational matters roads, depot amenities, analysing competition

Social Value Accounting

- Development of a standard demand-side map
 - census, population, institutions, hubs
- Route classification and ridership analysis
- Incorporation of concessions into CB analysis
- Responsive schedules and timetables
- Improving standard communication with stakeholders

Plan for future work

Improving Routine Analytics

• Depot and Route analysis - Coverage and profitability

Improving Ridership

Starting on Social Value Accounting

Mapping Operational Problems of MSRTC using the DG framework

• Longer-term Optimization and Support

Core Data Backbone

- GIS representation of network and operations
- Supplementary data census, socio-economic, education etc.

Scaling up for Multiple Depots

Mapping Operational Problems

How many buses are needed to serve a time-table? How can these be clubbed into schedules?

Converting MSRTC's optimisation and management decisions into the Network Layer framework of Digital Geography

- Affects both Quality of Service as well as efficiency
- How much is the gap between trips? Can that be reduced?
- Can trip-links be done dynamically in case of delay?

Scaling Up

Example for Rajapur (Ratnagiri)

Understanding the inter-depot/ long route services

Considering all the Depot and a few important towns in each tehsil as hubs

Addition of inter-tehsil routes and trips

Separate optimising methods with these inter-tehsil/ inter-depot routes

Resource allocation (i.e. allocation of bus services and crews) between depot level services and long route services



Way Ahead

- Detailed analysis of 4-6 medium and small bus depots
- Standard case-study format, accessible to regional colleges (Unnat Maharashtra Abhiyan, HTE)
- New analytic frameworks for accounting
- IT support to operations side integration of separate IT systems
- Immediate permission to visit depots, gather data and conduct surveys, Point of Contact, renewal of data MoU, renewal of collaboration MoU

Resources (1 year MoU)

	Task	Charges	Total
1.	Analysis of 3 bus depots	8 person-months/depot (Rs. 12 lakh per depot)	Rs. 36L
2.	Standard case study development and Training program	Rs. 4 lakh + Rs. 3L per workshop (2 workshops)	Rs. 10L
3.	Routine IT support and analytics	Rs. 5L per month (2 full-time and 2 students)	Rs. 60L
4.	Big Ticket Items - Two M.Tech. Project Fellowships, with 1 year support in year 3.	Rs. 15L*2	Rs. 30L

+ 20% IITB overheads + applicable 18% GST (?)

Thank you

