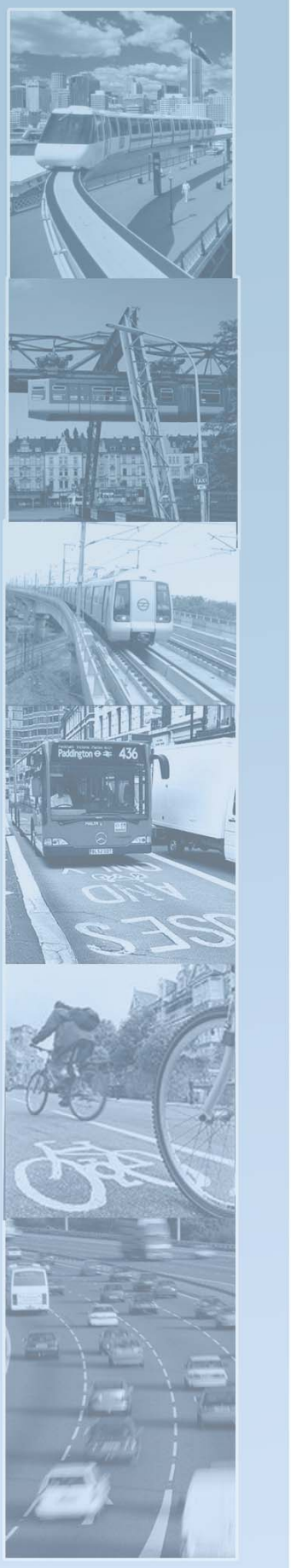
ANNEXURES

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

ANNEXURE 1.1. BASE DATA FOR 87 URBAN CENTERS IN INDIA



BASE DATA FOR 87 URBAN CENTERS IN INDIA

Category name	S.No	City Name	State	Population in Lakhs (1991)	Population in Lakhs (2001)	Area (Sq. Km)	Population Density (based on 2001 pop)	Capital City	PCI 1998-1999	PCI 2001-2002	Shape of the Town	Public Transport Details							Type
												Public Transport Availability	Bus	Local Train	Metro	Tram	Others	If others	
1a	1	Kavaratti	LAK	-	0.10	32	316	Y			Circular	N					✓	Mini buses,Tourist Taxis, Auto Rick-shaws	Tourist, Education
	2	Silvasa	DAD	0.117	0.22	491	45	Y			Linear	N					✓	Auto-rickshaws	Industrial
	3	Itanagar	ARU	0.165	0.35	110	318	Y			Linear	N					✓	Mini buses,Tourist Taxis, Cycle Rick-shaws	Administrative , Tourist
	4	Daman	DAM	-	0.36	122	293	Y			Linear	N					✓	Mini buses,Tourist Taxis, Auto Rick-shaws	Tourist, Education
1b	5	Kohima	NAG	0.514	0.79	20	3,929	Y			Hilly	N					✓	Taxis	Tourist, Administrative
	6	Gangtok	SIK	0.780	0.92	77	1,195	Y			Hilly	N					✓	Private Taxis, Jeeps and Landrovers	Administrative
1a	7	Panaji	GOA	0.722	0.97	23	4,217	Y			Semi Circular	Y	✓				✓	Two-Wheelers, Auto-Rickshaws, Cars, Taxis, Tourist Coaches,	Administrative , Tourist
	8	Port Blair	ANI	0.750	1.00	467	215	Y			Linear	Y	✓				✓	Taxis, Cycle-Rickshaws, Auto Rickshaws, Ferry	Administrative
1b	9	Shimla	HP	1.304	1.73	100	1,730	Y			Hilly	Y	✓				✓	Jeeps, Taxis	Tourist
1a	10	Agartala	TRI	1.574	1.89	58.84	3,218	Y			Linear	N					✓	Private Taxis	Tourist, Administrative
	11	Gandhinagar	GUJ	1.234	1.96	57	3,438	Y			Circular	Y	✓				✓	Auto-Rickshaws, Taxis	Administrative
1b	12	Aizawl	MIZ	1.552	2.28	572	399	Y			Hilly	Y	✓				✓	Taxis	Tourist, Administrative
1a	13	Imphal	MAN	2.028	2.50	30	8,341	Y			Linear	N					✓	Taxis	Tourist, Administrative
1b	14	Shillong	MEG	2.234	2.68	10.36	25,857	Y			Hilly	N					✓	Taxis	Tourist, Administrative
	15	Guntūr	AP	4.711	5.00		-	N	7416	10,590	Semi Circular	Y	✓				✓	Taxis, Cycle-Rickshaws	Industrial
	16	Belgaum	KAR	4.024	5.06		-	N	7838	11,516	Linear	Y	✓				✓	Auto-rickshaws	Administrative
	17	Pondicherry	PON	3.991	5.08	290	1,752	Y	9781	23,178	Semi Circular	Y	✓				✓	Two types of rickshaws are available, the pedalled and the	Tourist, Education
	18	Bhāvnagar	GUJ	4.052	5.18		-	N	9796	13,684	Circular	Y	✓				✓	Auto-Rickshaws	Industrial
	19	Dehra Dūn	UAR	3.681	5.28		-	Y	6755	7,937	Circular	Y	✓				✓	Taxis, Cycle-Rickshaws	Tourist, Education
	20	Mangalore	KAR	4.263	5.39	111	4,844	N	7838	11,516	Circular	Y	✓				✓	Taxis, Auto-rickshaws	Industrial
	21	Tiruppur	TN	3.062	5.43		-	N	8955	12,717	Linear	Y	✓				✓	Auto-rickshaws	Industrial
	22	Amrāvati	MAH	4.216	5.50	59	9,345	N	12183	14,892	Linear	Y	✓				✓	Taxis, Auto-rickshaws, Tongas	Tourist, Education
	23	Jamnagar	GUJ	3.260	5.58		-	N	9796	13,684	Semi Circular	Y	✓				✓	Taxis, Auto-rickshaws	Industrial
	24	Warangal	AP	4.678	5.77		-	N	7416	10,590	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Industrial
	25	Cuttack	ORI	4.403	5.88	60	9,865	N	4896	5,927	Linear	N					✓	Taxis, Auto-rickshaws	Tourist
	26	Jammu	J&K	3.000	6.08		-	N	6543	7,541	Semi Circular	Y	✓				✓	Mini buses,Tourist Taxis	Tourist
	27	Bhiwandi	MAH	3.922	6.21	300	2,071	N	12183	14,892	Linear	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Industrial
	28	Gorakhpur	UP	5.056	6.23		-	N	5066	5,687	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Industrial
	29	Bīkāner	RAJ	4.963	6.40	270	2,370	N	6182	8,571	Circular	N					✓	Taxis, Auto-rickshaws, Tongas	Tourist
	30	Morādābād	UP	4.437	6.41		-	N	5066	5,687	Linear	Y	✓				✓	Taxis	Administrative

Category name	S.No	City Name	State	Population in Lakhs (1991)	Population in Lakhs (2001)	Area (Sq. Km)	Population Density (based on 2001 pop)	Capital City	PCI 1998-1999	PCI 2001-2002	Shape of the Town	Public Transport Details							Type
												Public Transport Availability	Bus	Local Train	Metro	Tram	Others	If others	
2	31	Alīgarh	UP	4.805	6.68		-	N	5066	5,687	Circular	Y	✓				✓	Taxis	Administrative
	32	Kota	RAJ	5.374	7.05		-	N	6182	8,571	Linear	N					✓	Taxis, Auto-rickshaws, Tongas, Cycle-rickshaws, Tempos	Inudstrial, Education
	33	Jalandhar	PUN	5.095	7.09		-	N	12710	15,210	Linear	Y	✓				✓	Taxis	Administrative
	34	Raipur	CHH	4.913	7.19	188	3,824	Y	6539	7,303	Linear	N					✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative, Agriculture
	35	Bareilly	UP	6.174	7.30		-	N	5066	5,687	Circular	N					✓	Taxis	Administrative, Agriculture
	36	Salem	TN	5.783	7.49	94	7,963	N	8955	12,717	Semi Circular	Y	✓				✓	Taxis, Autorickshaws	Industrial
	37	Mysore	KAR	6.533	7.86	81	9,761	N	7838	11,516	Circular	Y	✓				✓	Taxis, Autorickshaws	Tourist
	38	Dispur	ASS	0.000	8.19		-	Y				N					✓	Mini buses,Tourist Taxis, Auto Rick-shaws	Tourist, Administrative
	39	Bhubaneswar	ORI	6.431	8.44	233	3,622	Y	4896	5,927	Semi Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Tourist, Pilgrim
	40	Tiruchchirappalli	TN	7.119	8.47		-	N	8955	12,717	Semi Circular	Y	✓				✓	Taxis, Autorickshaws	Industrial, Trade & Commercial
	41	Jodhpur	RAJ	6.663	8.56	76	11,338	N	6182	8,571	Semi Circular	N					✓	Taxis, Auto-rickshaws, Tongas, Bi- Cycles	Tourist
	42	Ranchi	JHA	6.148	8.63		-	Y	N/A	N/A	Circular	Y	✓				✓	Taxis, Scooters, Cycle Rickshaws	Administrative, industrial
	43	Gwalior	MP	7.178	8.66		-	N	6584	7,699	Semi Circular	N					✓	Local taxis, Auto rickshaws, and Six - seater Tempos	Administrative
	44	Sholapur	MAH	6.208	8.73	178	4,905	N	12183	14,892	Semi Circular	Y	✓	✓			✓	Taxis, Autorickshaws	Administrative
	45	Calicut	KER	8.012	8.80		-	N	7938	10,709	Semi Circular	Y	✓				✓	Taxis, Autorickshaws	Administrative
	46	Bhilai (Bhilai Nagar)	CHH	6.855	9.24		-	N	18166	26,550	Semi Circular	N					✓	Taxis, Autorickshaws,Cycle-rickshaws	Administrative
	47	Chandigarh	HAR	7.162	9.66	264	3,659	Y	19761	28,271	Circular	Y	✓				✓	Taxis, Autorickshaws,Cycle-rickshaws	Adninistrative
	48	Hubli-Dharwar	KAR	6.483	9.68	150	6,453	N	7838	11,516	Linear	Y	✓				✓	Taxis, Autorickshaws,Cycle-rickshaws,Tongas	Education & Commercial
	49	Ghaziabad	UP	5.118	9.69		-	N	5066	5,687	Semi Circular	N					✓	Taxis, Autorickshaws,Cycle-rickshaws	Administrative
	50	Rajkot	GUJ	6.545	10.00		-	N	9796	13684	Linear	N					✓	Unmetered taxis, Auto rickshaws, Tongas and few private cars.	Administrative
	51	Vijayawada	AP	8.458	10.34	110.44	9,359	N	7416	10590	Semi Circular	Y	✓				✓	Tourist Taxis, Metered Taxis, Auto rickshaws, and Cycle Rickshaws	Commercial
	52	Faridabad	HAR	6.177	10.50		-	N	11079	14250	Linear	Y	✓				✓	Tourist Taxis, Metered Taxis, Auto rickshaws, and Cycle Rickshaws	Industrial
	53	Allahabad	UP	8.445	10.50	63	16,648	N	5066	5687	Linear	Y	✓				✓	Tourist Taxis, Metered Taxis, Auto rickshaws, and Cycle Rickshaws	
	54	Dhanbad	JHA	8.150	10.60		-	N	N/A	N/A	Linear	N					✓	Taxis, Scooters, Cycle Rickshaws	Mining
	55	Gauhati	ASS	7.284	10.60	200	5,300	N	5715	6,059	Semi Circular	Y	✓				✓	Mini bus, Taxis	Administrative, Trade & Commercial
	56	Amritsar	PUN	7.088	10.85	150	7,233	N	12710	15,210	Linear	N					✓	Cycle Rickshaws, Taxis	Piligrim, Administrative
	57	Asansol	WB	7.639	10.90		-	Y	6756	10375	Linear	N					✓	Taxis	Industrial
	58	Jamshedpur	JHA	8.292	11.00	64	17,188	N	N/A	N/A	Linear	N					✓	Taxis, Scooters, Cycle Rickshaws	Industrial
	59	Srinagar	J&K	7.400	11.10	105	10,571	Y	6543	7,541	Semi Circular	Y	✓				✓	Mini buses,Tourist Taxis	Toruist
	60	Jabalpur	MP	8.889	11.20		-	N	6584	7699	Linear	Y	✓				✓	Mini buses,Tourist Taxis	Administrative, Education

Category name	S.No	City Name	State	Population in Lakhs (1991)	Population in Lakhs (2001)	Area (Sq. Km)	Population Density (based on 2001 pop)	Capital City	PCI 1998-1999	PCI 2001-2002	Shape of the Town	Public Transport Details							Type
												Public Transport Availability	Bus	Local Train	Metro	Tram	Others	If others	
3	61	Trivandrum	KER	10.352	11.22	310	3,619	Y	7938	10,709	Semi Circular	Y	✓				✓	Taxis, Autorickshaws, two wheelers	Administrative & Education
	62	Nashik	MAH	7.253	11.52		-	N	12183	14892	Linear	Y	✓	✓			✓	Taxis	Piligrim
	63	Meerut	UP	8.498	11.61		-	N	5066	5687	Linear	N					✓	Taxis, cycle rickshaws, auto-rickshaws	Industrial
	64	Madurai	TN	9.412	11.85	732	1,619	N	8955	12,717	Linear	Y	✓				✓	Taxis	Tourst, Education
	65	Visakhapatnam	AP	10.571	13.46		-	N	7416	10590	Semi Circular	Y	✓				✓	Taxis and Auto-rickshaws	Administrative, Industrial
	66	Agra	UP	10.280	13.69	200	6,845	N	5066	5,687	Linear	N					✓	Taxi, tempo, auto-rickshaw and cycle rickshaw	Tourist
	67	Ludhiana	PUN	10.427	14.00	159	8,785	N	12710	15210	Linear	Y	✓				✓	Taxis and Auto-rickshaws	Industrial
	68	Bhopal	MP	10.628	14.58	320	4,556	Y	6584	7,699	Linear	Y	✓				✓	Taxis, Mini Buses and Auto-rickshaws	Administrative & Industrial
	69	Vadodara	GUJ	11.268	14.93	148	10,073	N	9796	13684	Semi Circular	Y	✓				✓	Taxis, Mini Buses and Auto-rickshaws	Industrial
	70	Indore	MP	11.091	16.93		-	N	6584	7699	Linear	Y	✓				✓	Taxis, Mini Buses and Auto-rickshaws	Industrial, Commercial
	71	Coimbatore	TN	11.007	16.95	106	16,066	N	8955	12717	Linear	Y	✓				✓	Taxis,Auto-rickshaws	Industrial, Educational
	72	Kochi	KER	16.6	18.18	730	2490.41096	N	7938	10709	Linear	Y	✓				✓	Ferry, Auto -rickshaws	Industrial
	73	Patna	BIH	12.865	18.36	136	13,500	Y	3037	3,554	Linear	Y	✓				✓	Tempos, Cycle Rickshaws	Administrative
	74	Varanasi	UP	15.309	18.95	85	22,294	N	5066	5,687	Linear	N					✓	Cycle-rickshaws, Auto-rickshaws	Piligrim
4	75	Nagpur	MAH	16.210	21.13	270	7,826	N	12183	14,892	Circular	Y	✓				✓	Share cabs and Autos	Commercial & Administration
	76	Lucknow	UP	16.692	22.46	338	6,655	Y	5066	5687	Circular	Y					✓	Share cabs and Jeeps	Administrative
	77	Jaipur	RAJ	18.182	26.80	544	4,926	Y	6182	8,571	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Tourist
	78	Kanpur	UP	19.940	27.16	597	4,549	N	5066	5,687	Linear	Y	✓				✓	Tempos, Cycle Rickshaws	Industrial, Commercial
	79	Surat	GUJ	17.172	30.90	680	4,544	N	9796	13,684	Linear	N					✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Industrial
5	80	Pune	MAH	30.660	42.00	700	6,000	N	12183	14,892	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Industrial & Education
	81	Ahmadabad	GUJ	43.462	59.34	1,330	4,462	N	9796	13,684	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative, Industrial & Commercial
	82	Hyderabad	AP	46.444	63.83	900	7,092	Y	7416	10,590	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative
	83	Chennai	TN	58.190	70.14	1,189	5,899	Y	8955	12,717	Circular	Y	✓	✓	✓		✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative, industrial
6	84	Bangalore	KAR	63.303	86.25	1,279	6,744	Y	7838	11,516	Circular	Y	✓				✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative and Commercial
	85	Delhi	DEL	94.191	138.50	1,758	7,878	Y	18166	26,550	Circular	Y	✓	✓	✓		✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative and Commercial
	86	Kolkata	WES	126.492	147.38	1,851	7,962	Y	6756	10,375	Linear	Y	✓		✓	✓	✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative and Commercial
	87	Greater Mumbai	MAH	145.262	177.02	4,355	4,065	Y	5811	6,715	Linear	Y	✓	✓			✓	Taxis, Auto-rickshaws, Cycle-rickshaws	Administrative, Industrial & Commercial

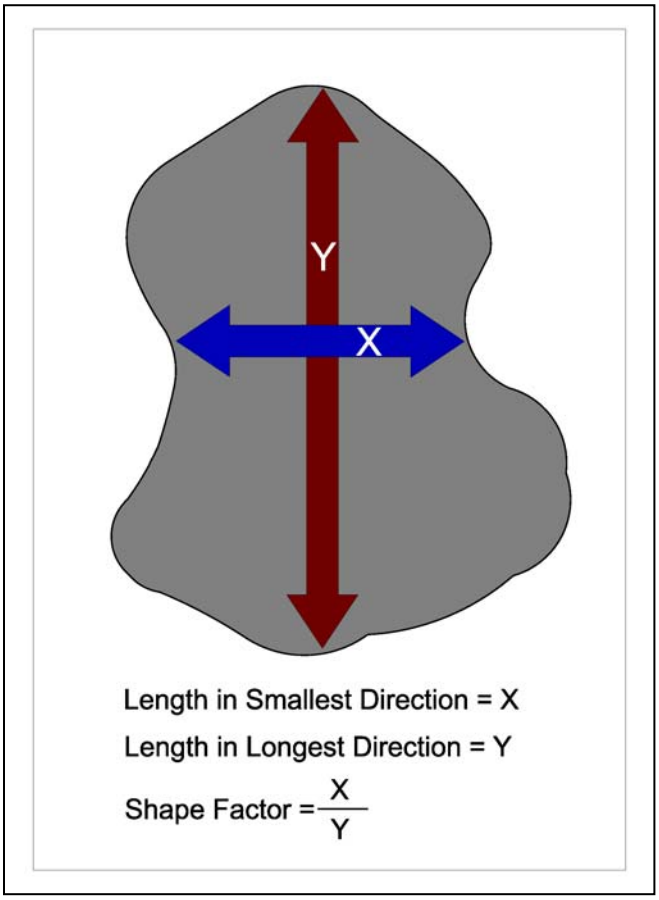
ANNEXURE 1.2. CITY SHAPE ASSUMPTION

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

CITY SHAPE ASSUMPTION

Shape factor is derived as the ratio of the length of the city in the smallest direction (X) to the length to the longest direction (Y).

Shape factor = X/Y



The shape assumed for the selected cities is presented in Table given below.

Shape of the selected cities

Sl. No	Name of the city	Shape	Shape Factor (Minimum spread / maximum spread)
1	Hubli- Dharward	Linear	0.30
2	Patna	Linear	0.35
3	Kanpur	Linear	0.37
4	Kolkata	Linear	0.37
5	TVM	Linear	0.43
6	Varanasi	Linear	0.47
7	Shimla*	Hilly	-
8	Panaji	Linear	0.50
9	Mumbai	Linear	0.57
10	Guwahati	Linear	0.57
11	Amritsar	Linear	0.58
12	Chennai	Semi-Circular	0.64
13	Kochi	Semi-Circular	0.73
14	Pondicherry	Semi circular	0.74
15	Gangtok*	Hilly	-
16	Bhuvaneshwar	Circular	0.75
17	Raipur	Circular	0.78
18	Agra	Circular	0.78
19	Madurai	Circular	0.80
20	Bhopal	Circular	0.82
21	Bangalore	Circular	0.89
22	Ahmedabad	Circular	0.83
23	Chandigarh	Circular	0.83
24	Delhi	Circular	0.85
25	Bikaner	Circular	0.86
26	Hyderabad	Circular	0.89
27	Surat	Circular	0.93
28	Nagpur	Circular	0.95
29	Pune	Circular	0.96
30	Jaipur	Circular	1.00

*(Note: *- Gangtok and Shimla are hilly terrain cities and hence not classified into any category based on shape)*

From the above table, the range of shape factor assumed for the three groups of cities are given in Table given below.

Range of Shape Factor assumed for different shapes of cities

Sl. No.	City Shape	Range of Shape factor assumed
1	Linear	< 0.6
2	Semi-circular	0.61 - 0.74
3	Circular	0.75 - 1.0

ANNEXURE 2.1. PRIMARY SURVEY FINDINGS

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

PRIMARY SURVEY FINDINGS

Traffic Characteristics at Inner City Locations during Peak Hour				
S no	**City**	**Average Share of Fast Traffic (%)**	**Average Share of Slow Traffic (%)**	**Total (%)**
1	Gangok	100	0	100
2	Panaji	83	17	100
3	Shimla	100	0	100
4	Pondicherry	85	15	100
5	Bikaner	84	16	100
6	Raipur	81	19	100
7	Bhuvaneshwar	83	17	100
8	Chandigarh	85	15	100
9	Hubli-Dharwad	83	17	100
10	Guahati	89	11	100
11	Amritsar	79	21	100
12	Trivandrum	97	3	100
13	Madurai	94	6	100
14	Agra	81	19	100
15	Bhopal	94	6	100
16	Kochi	97	3	100
17	Patna	68	32	100
18	Varanasi	73	27	100
19	Nagpur	83	17	100
20	Jaipur	88	12	100
21	Kanpur	86	14	100
22	Surat	91	9	100
23	Pune	89	11	100
24	Ahemadabad	92	8	100
25	Hyderabad	97	3	100
26	Chennai	94	6	100
27	Bangalore	100	0	100
28	Delhi	97	3	100
29	Kolkata	88	12	100
30	Mumbai	98	2	100

Peak Hour Traffic Composition on interior city locations (%)									
Sl. No.	City Name	Std. Bus (incl. tourist and educational bus)	Mini bus	Cars/Jeep /Van	Two Wheelers	Auto Rickshaws	Commercial Vehicles	SMVs	Total
1	Gangok	0%	13%	49%	36%	0%	2%	0%	100%
2	Panaji	9%	4%	17%	30%	14%	9%	17%	100%
3	Shimla	12%	17%	30%	31%	0%	9%	0%	100%
4	Pondicherry	10%	2%	22%	33%	14%	5%	15%	100%
5	Bikaner	4%	1%	16%	25%	30%	8%	16%	100%
6	Raipur	1%	2%	11%	30%	31%	7%	19%	100%
7	Bhuvaneshwar	2%	1%	13%	42%	20%	5%	17%	100%
8	Chandigarh	9%	2%	27%	33%	10%	5%	15%	100%
9	Hubli-Dharwad	19%	5%	12%	28%	15%	4%	17%	100%
10	Guahati	5%	4%	22%	37%	18%	3%	11%	100%
11	Amritsar	2%	4%	18%	18%	31%	6%	21%	100%
12	Trivandrum	8%	3%	21%	44%	16%	5%	3%	100%
13	Madurai	13%	4%	21%	40%	12%	5%	6%	100%
14	Agra	4%	4%	15%	28%	23%	7%	19%	100%
15	Bhopal	4%	6%	19%	41%	20%	4%	6%	100%
16	Kochi	11%	2%	23%	46%	12%	4%	3%	100%
17	Patna	1%	3%	14%	25%	21%	5%	32%	100%
18	Varanasi	1%	5%	17%	18%	27%	4%	27%	100%
19	Nagpur	6%	1%	22%	38%	11%	5%	17%	100%
20	Jaipur	7%	4%	25%	43%	6%	3%	12%	100%
21	Kanpur	8%	2%	22%	28%	21%	5%	14%	100%
22	Surat	2%	1%	23%	35%	26%	4%	9%	100%
23	Pune	6%	1%	13%	38%	26%	5%	11%	100%
24	Ahemadabad	8%	1%	21%	40%	20%	3%	8%	100%
25	Hyderabad	15%	3%	27%	29%	19%	4%	3%	100%
26	Chennai	8%	3%	20%	40%	18%	4%	6%	100%
27	Bangalore	13%	2%	30%	28%	24%	2%	0%	100%
28	Delhi	12%	4%	37%	23%	19%	2%	3%	100%
29	Kolkata	17%	4%	29%	24%	11%	3%	12%	100%
30	Mumbai	7%	3%	39%	29%	18%	3%	2%	100%

Commercial Vehicles (Trucks & MAV) movement at Outer Cordon Points (8 hours during day time)			
Sl. No.	**City**	**Total Nos.**	**Share of total vehicles crossing the cordon points (%)**
1	Gangtok	1086	5
2	Panaji	3650	10
3	Shimla	3800	13
4	Pondichery	7679	13
5	Bikaner	7623	12
6	Raipur	10408	23
7	Bhuvaneshwar	13884	22
8	Chandigarh	10994	15
9	Hubli-Dharwad	8411	19
10	Guwahati	2858	6
11	Amritsar	7046	11
12	Trivandrum	8518	18
13	Madurai	21891	26
14	Agra	11190	15
15	Bhopal	16088	29
16	Kochi	21676	32
17	Patna	7946	14
18	Varanasi	7704	12
19	Nagpur	17674	21
20	Jaipur	18896	20
21	Kanpur	18209	29
22	Surat	21778	34
23	Pune	20267	21
24	Ahmedabad	24784	19
25	Hyderabad	22705	15
26	Chennai	42306	25
27	Bangalore	36617	24
28	Delhi	43006	19
29	Kolkata	40321	22
30	Mumbai	47683	22

Commercial Vehicles Movement Crossing the Cordon Points (during 8 hours of daytime)								
Sl.no	City	Total Vehicles (8 hrs)	Total Commercial Vehicles (8 hrs)		Ext- Ext Commercial (8 hrs)		Int- Ext & Ext- Int Commercial (8 hrs)	
		Nos.	Nos.	% of Total Vehicles crossing the cordon points	Nos.	% of Total Vehicles crossing the cordon points	Nos.	% of Total Vehicles crossing the cordon points
1	Gangtok	24124	1086	5	391	2	695	3
2	Panaji	37905	3650	10	1497	4	2154	6
3	Shimla	28570	3800	13	1479	5	2321	8
4	Pondicherry	60443	7679	13	2995	5	4684	8
5	Bikaner	65831	7623	12	3354	5	4269	6
6	Raipur	46016	10408	23	3469	8	6939	15
7	Bhuvaneshwar	63406	13884	22	5692	9	8192	13
8	Chandigarh	71492	10994	15	3987	6	7007	10
9	Hubli Dharwad	44214	8411	19	3701	8	4710	11
10	Guahati	45618	2858	6	1086	2	1772	4
11	Amritsar	63357	7046	11	3079	5	3967	6
13	Madurai	48443	8518	18	2896	6	5622	12
14	Agra	85458	21891	26	11310	13	10581	12
14	Trivandrum	77162	11190	15	4588	6	6602	9
15	Bhopal	55144	16088	29	4022	7	12066	22
16	Kochi	67638	21676	32	6720	10	14956	22
17	Patna	56372	7946	14	3337	6	4609	8
18	Varanasi	63416	7704	12	3698	6	4006	6
19	Nagpur	83485	17674	21	4552	5	13122	16
20	Jaipur	92845	18896	20	7369	8	11527	12
21	Kanpur	63472	18209	29	9468	15	8741	14
22	Surat	64479	21778	34	5959	9	15819	25
23	Pune	97558	20267	21	6485	7	13782	14
24	Ahmedabad	129767	24784	19	7661	6	17123	13
25	Hyderabad	155312	22705	15	15137	10	7568	5
26	Chennai	167117	42306	25	13538	8	28768	17
27	Bangalore	152965	36617	24	16111	11	20506	13
28	Delhi	224131	43006	19	15912	7	27094	12
29	Kolkata	181847	40321	22	13306	7	27015	15
30	Mumbai	213975	47683	22	16212	8	31471	15

Peak Hour Journey Speed on Major Road Network		
Sl. No.	**City**	**Average Journey Speed (KMPH) on major corridors**
1	Gangtok	23.8
2	Panaji	28
3	Shimla	26
4	Pondicherry	24.1
5	Bikaner	24
6	Raipur	21
7	Bhuvaneshwar	20
8	Chandigarh	30
9	Hubli-Dharwad	23
10	Guahati	20
11	Amritsar	24
12	Trivandrum	23
13	Madurai	27
14	Agra	28
15	Bhopal	24
16	Kochi	25
17	Patna	23
18	Varanasi	17.7
19	Nagpur	23
20	Jaipur	20.9
21	Kanpur	20
22	Surat	24.2
23	Pune	24
24	Ahemadabad	21
25	Hyderabad	19
26	Chennai	19
27	Bangalore	18
28	Delhi	16
29	Kolkata	18
30	Mumbai	16

On -Street Parking Availability o Major Road Corridors for the Selected Cities		
S.No	**City**	**Major Roads Length used for Parking (%)**
1	Gangtok	31%
2	Panaji	41%
3	Shimla	48%
4	Pondicherry	45%
5	Bikaner	35%
6	Raipur	32%
7	Bhuvaneshwar	36%
8	Chandigarh	36%
9	Hubli-Dharwad	35%
10	Guahati	45%
11	Amritsar	49%
12	Trivandrum	47%
13	Madurai	52%
14	Agra	53%
15	Bhopal	51%
16	Kochi	56%
17	Patna	56%
18	Varanasi	50%
19	Nagpur	61%
20	Jaipur	58%
21	Kanpur	48%
22	Surat	60%
23	Pune	53%
24	Ahemadabad	43%
25	Hyderabad	29%
26	Chennai	27%
27	Bangalore	17%
28	Delhi	14%
29	Kolkata	19%
30	Mumbai	16%

Pedestrian Opinion Ranking on Pedestrian Facilities		
S.No	**City**	**Rank**
1	Gangok	1.1
2	Panaji	1.3
3	Shimla	1.2
4	Pondicherry	1.3
5	Bikaner	1.2
6	Raipur	1.4
7	Bhuvaneshwar	1.5
8	Chandigarh	4.1
9	Hubli-Dharwad	1.8
10	Guahati	2.1
11	Amritsar	2.4
12	Trivandrum	1.9
13	Madurai	2.3
14	Agra	2.7
15	Bhopal	2.4
16	Kochi	2.6
17	Patna	1.8
18	Varanasi	2.3
19	Nagpur	3.4
20	Jaipur	3.6
21	Kanpur	1.7
22	Surat	2.4
23	Pune	3.1
24	Ahemadabad	3.5
25	Hyderabad	3.0
26	Chennai	3.4
27	Bangalore	3.5
28	Delhi	3.7
29	Kolkata	3.9
30	Mumbai	3.9

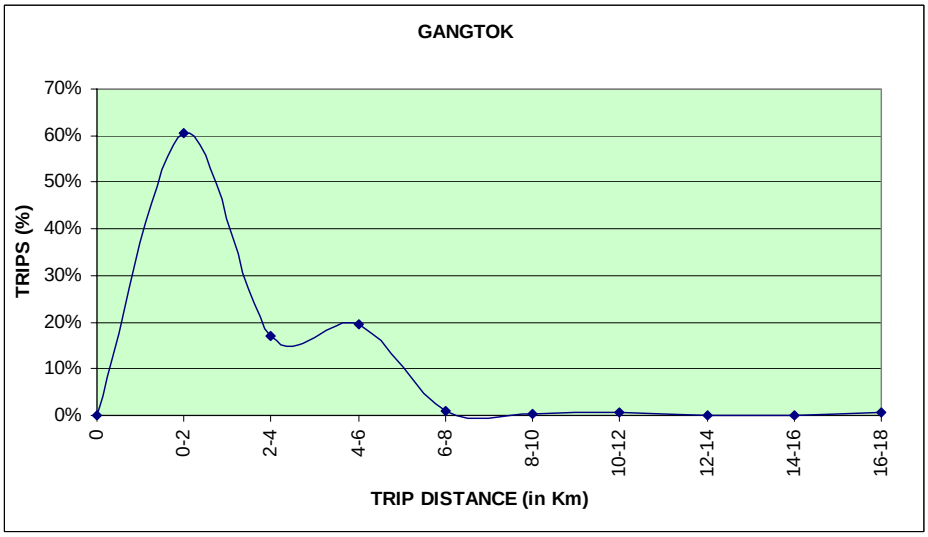
(Note: Rank 1- lowest and 5- best)

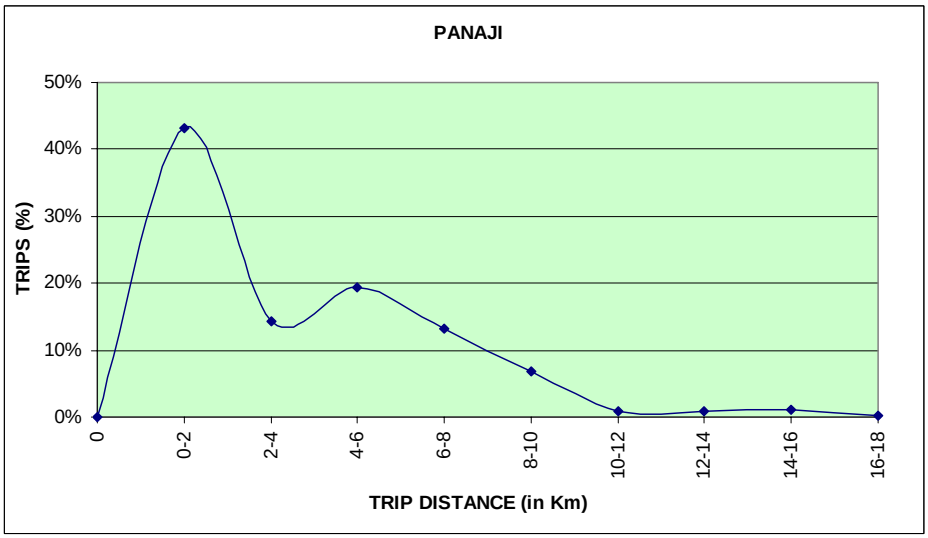
% of Major Roads with Lane Configuration*					
Sl.no	**City**	**2 Lane**	**4 Lane**	**6 and above**	**Total**
1	Gangtok	92	8	0	100
2	Panaji	59	41	0	100
3	Shimla	85	15	0	100
4	Pondicherry	84	16	0	100
5	Raipur	90	10	0	100
6	Chandigarh	12	84	4	100
7	Gauhati	39	61	0	100
8	Amritsar	49	40	11	100
9	Trivandrum	84	16	0	100
10	Madurai	75	25	0	100
11	Agra	64	36	0	100
12	Bhopal	68	32	0	100
13	Cochin	73	27	0	100
14	Jaipur	58	37	6	100
15	Pune	68	28	4	100
16	Ahmedabad	50	41	9	100
17	Hyderabad	54	42	4	100
18	Bangalore	12	81	7	100
19	Delhi	8	89	3	100
20	Kolkata	62	31	7	100
21	Mumbai	27	57	17	100
*Note *- Includes only major roads with 2 lane and above width)*					

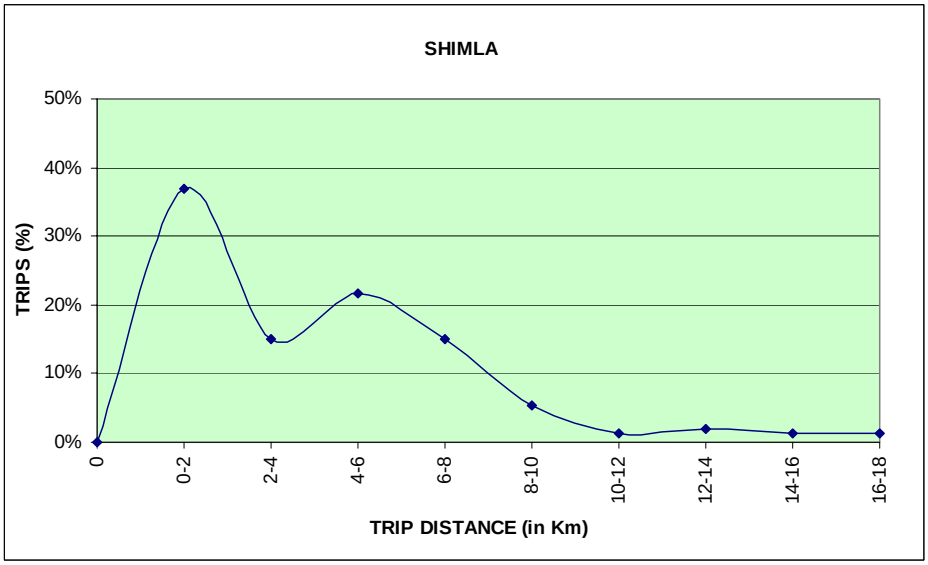
ANNEXURE 2.2. TRIP LENGTH FREQUENCY DISTRIBUTION

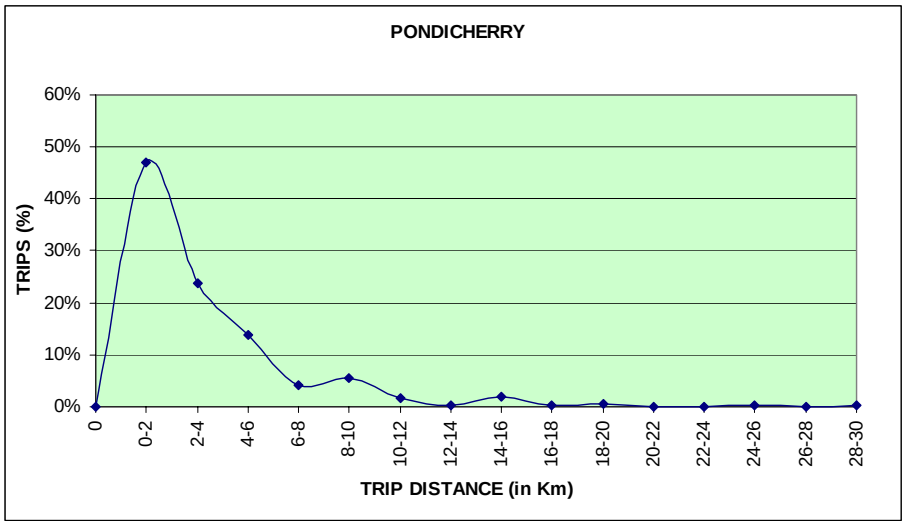
Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

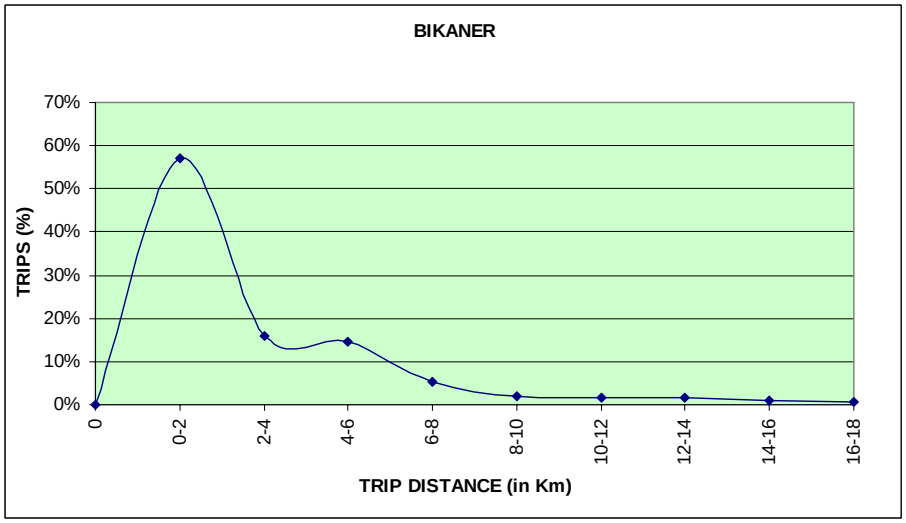
TRIP LENGTH FREQUENCY DISTRIBUTION

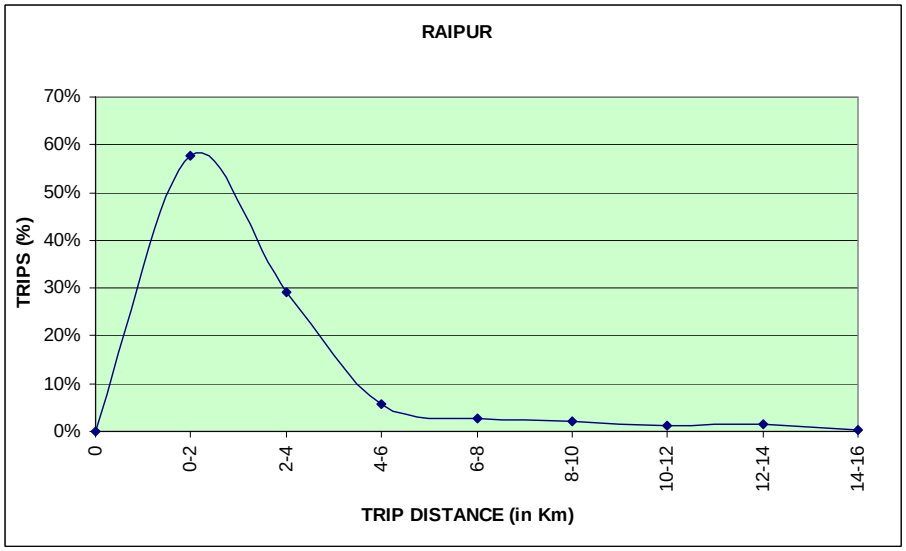


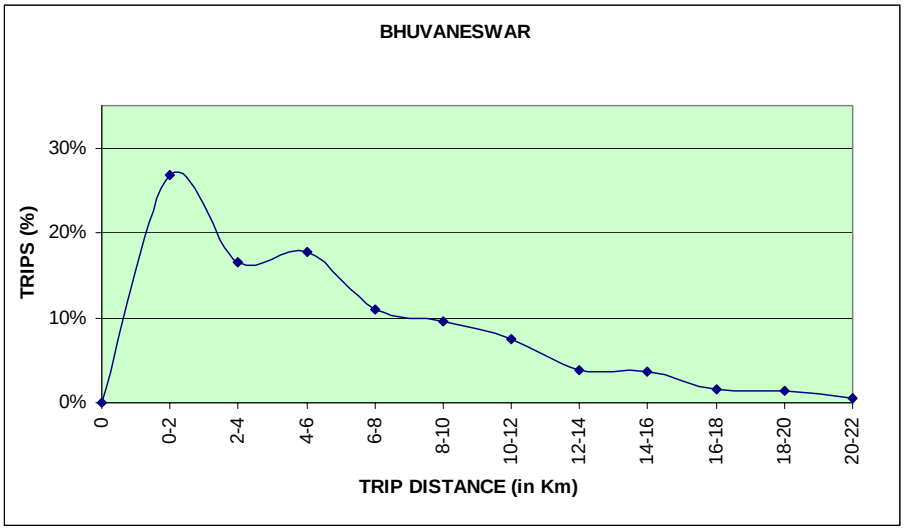


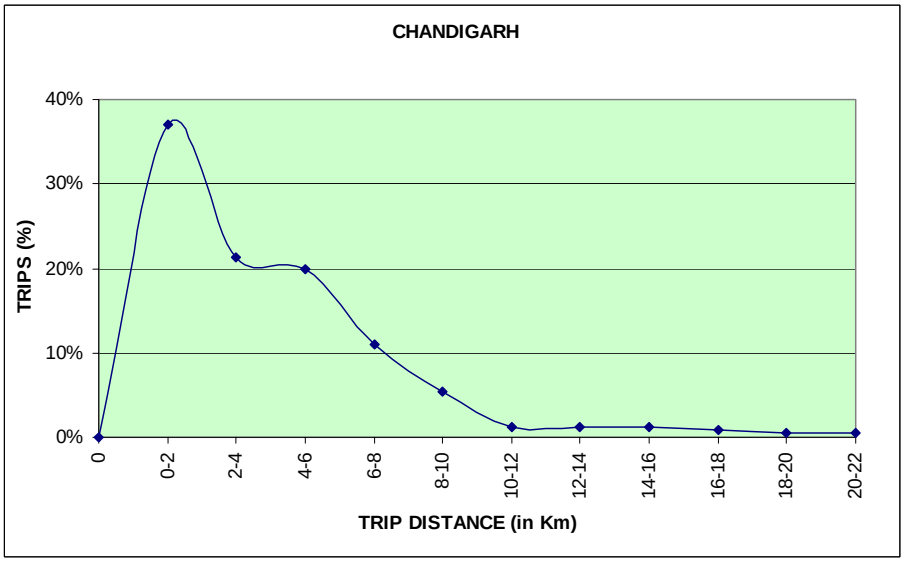


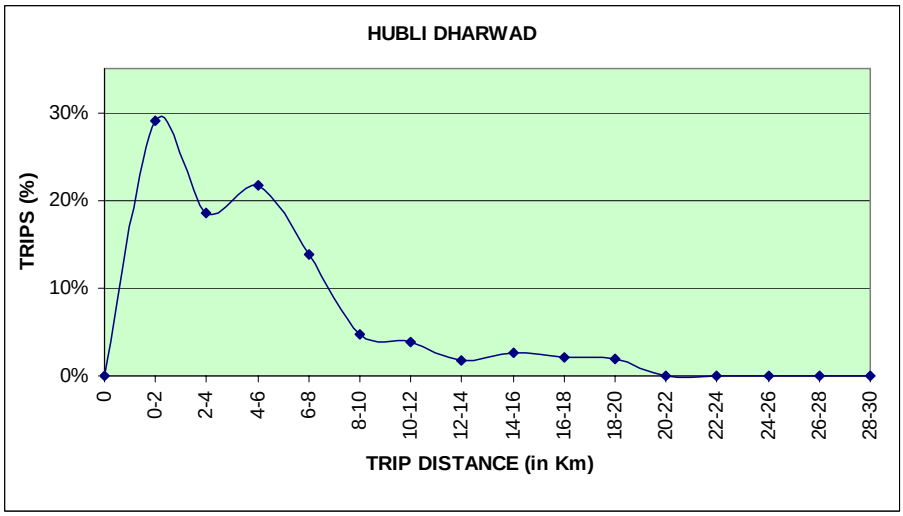

PONDICHERRY
60%
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)

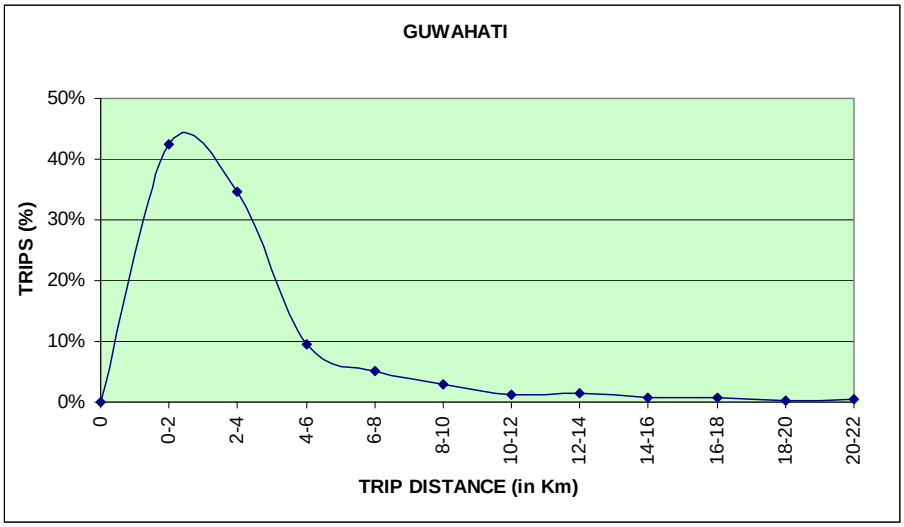

BIKANER
70%
60%
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
TRIP DISTANCE (in Km)

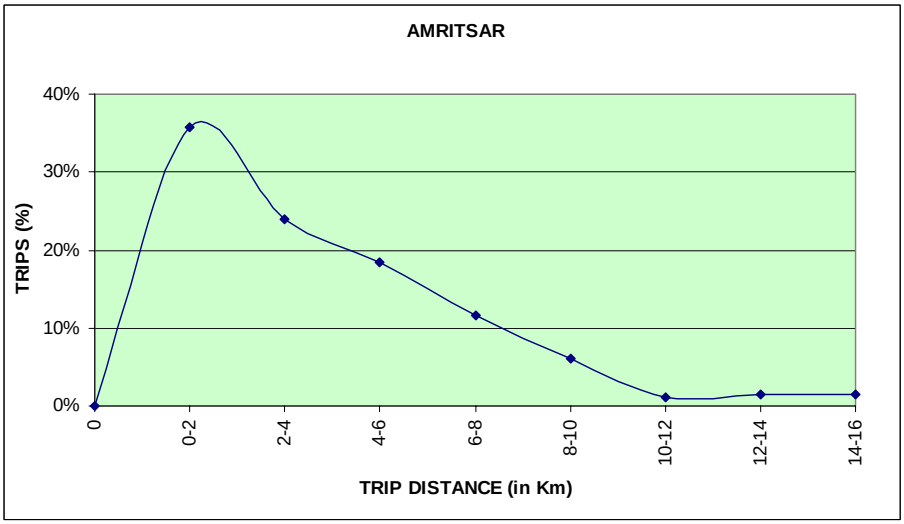

RAIPUR
70%
60%
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
TRIP DISTANCE (in Km)

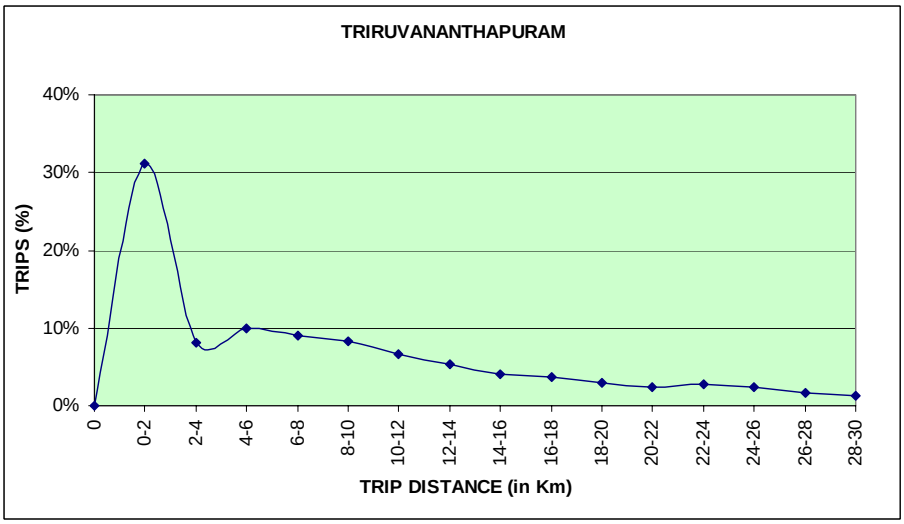

BHUVANESWAR
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

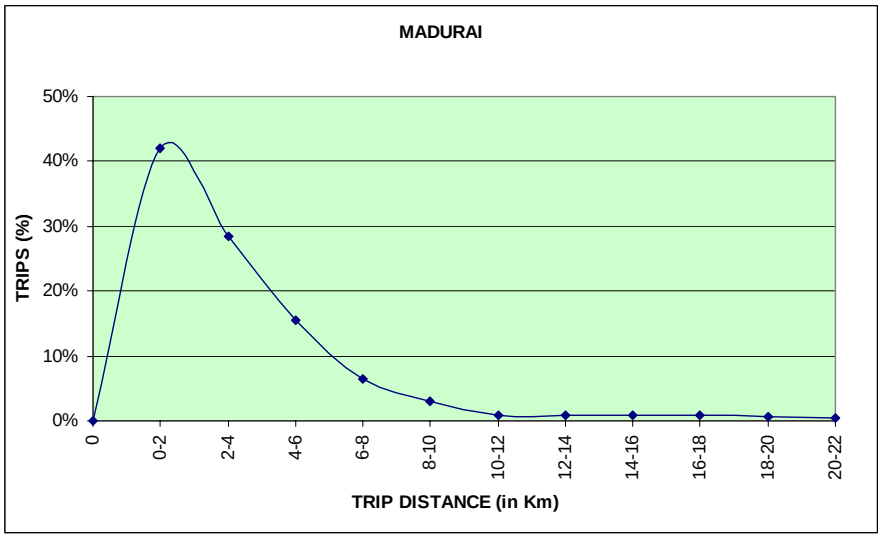

CHANDIGARH
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

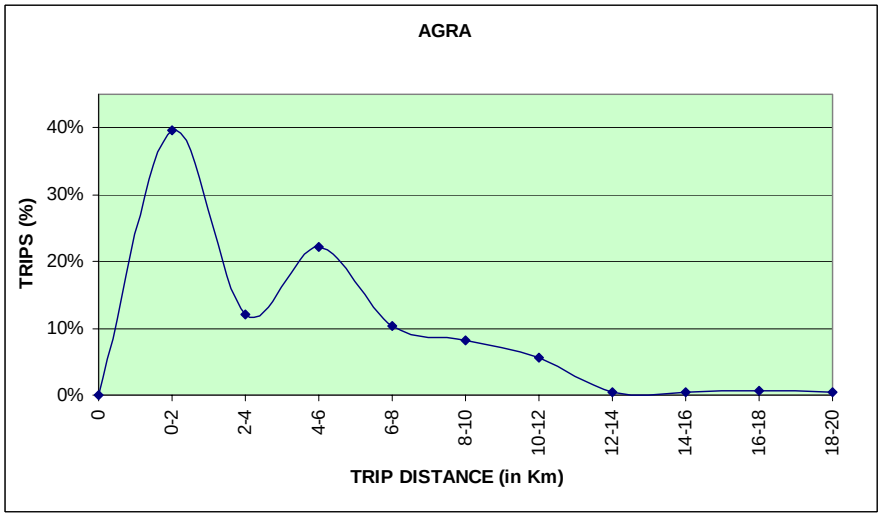

HUBLI DHARWAD
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)

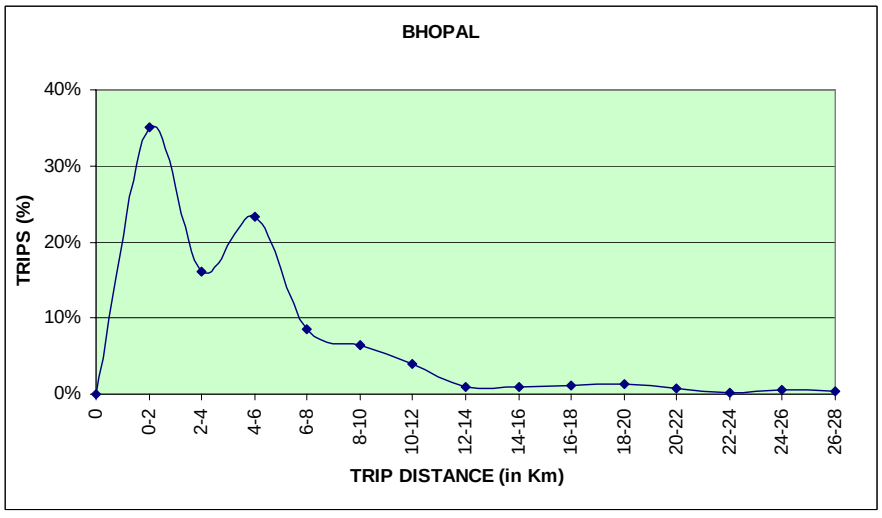

GUWAHATI
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

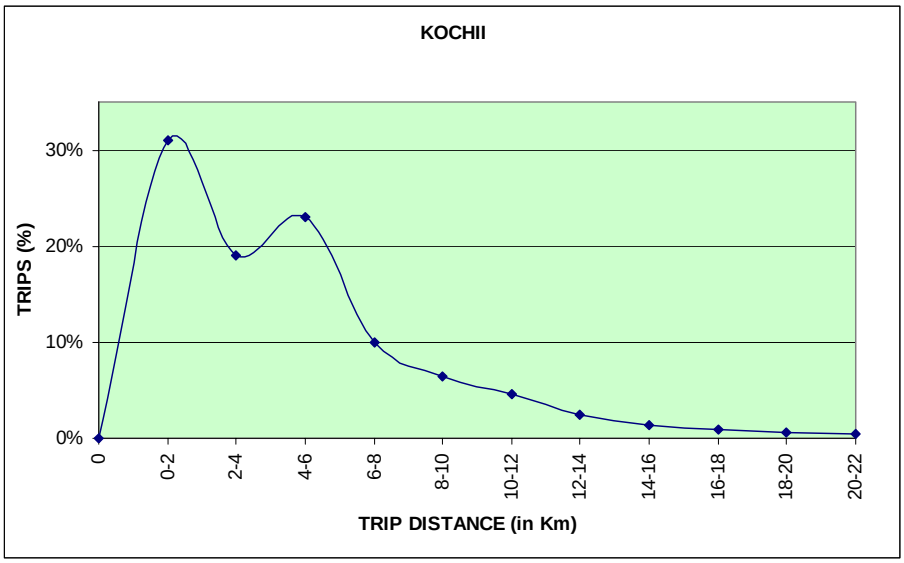

AMRITSAR
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
TRIP DISTANCE (in Km)

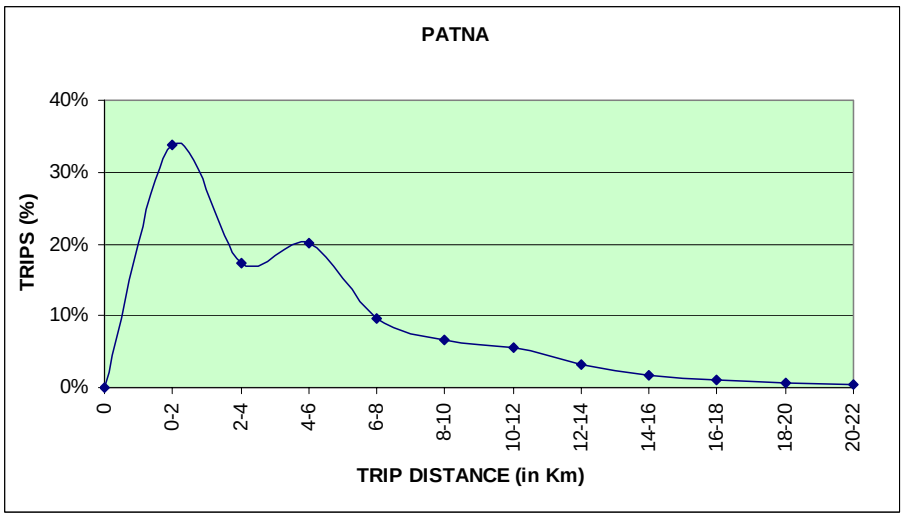

TRIRUVANANTHAPURAM
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)

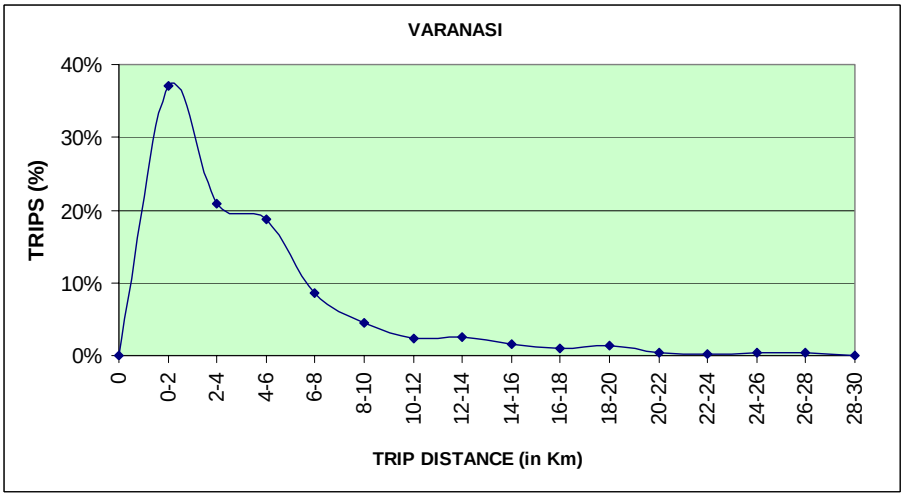

MADURAI
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

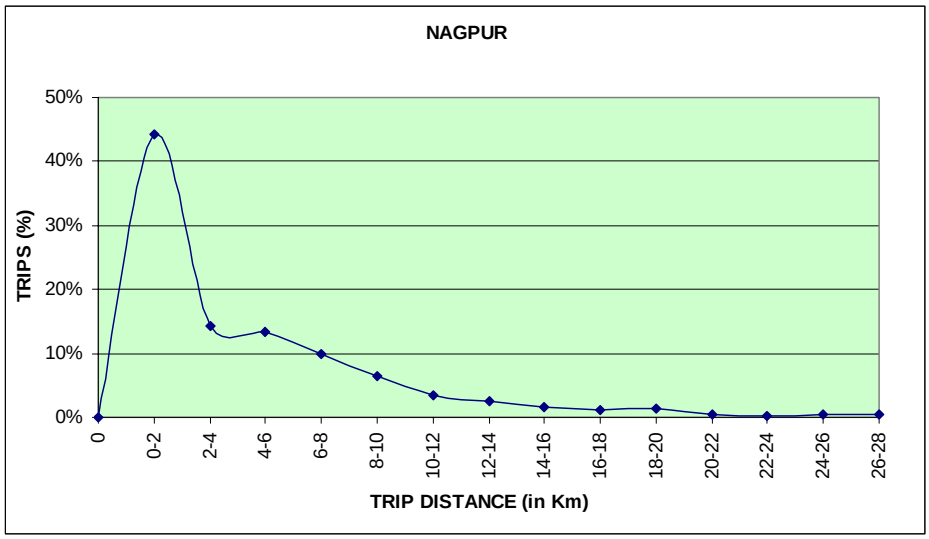

AGRA
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
TRIP DISTANCE (in Km)

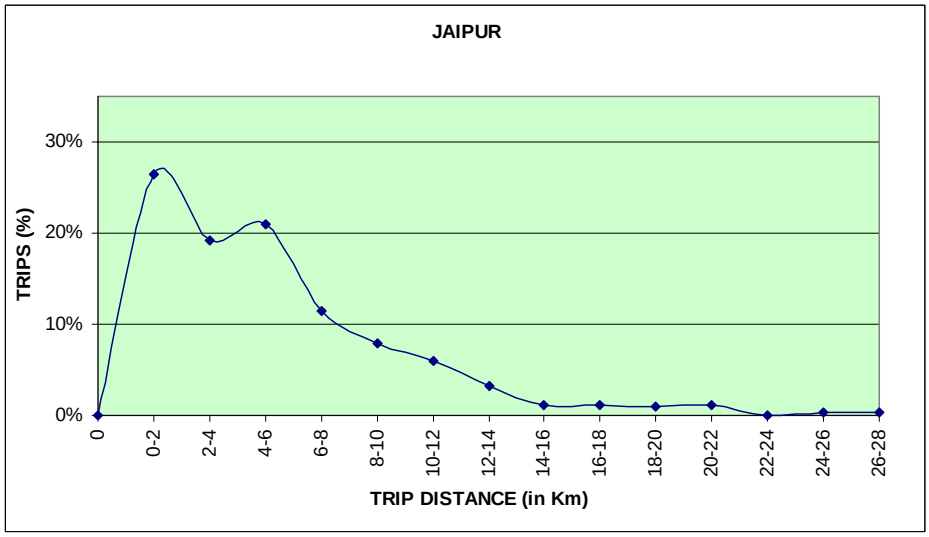

BHOPAL
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
TRIP DISTANCE (in Km)

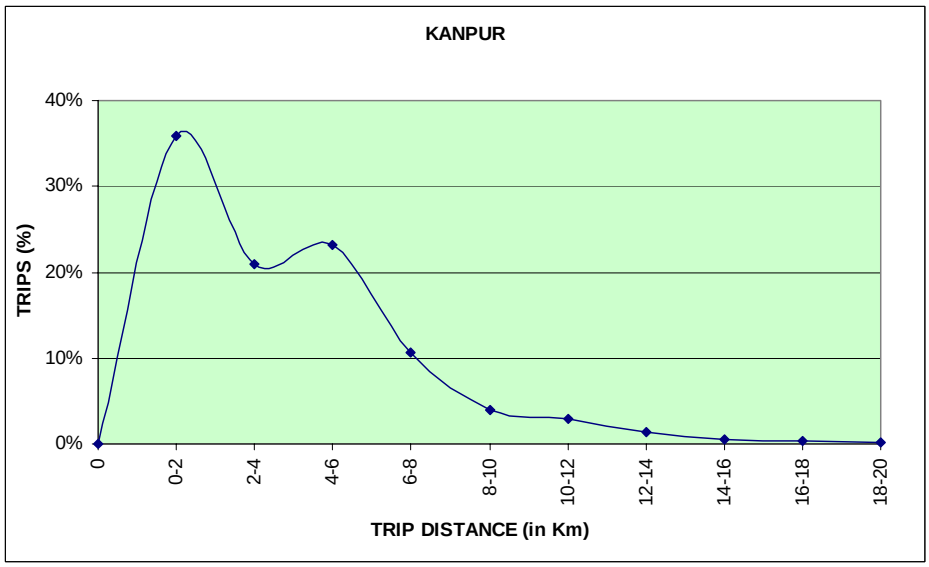

KOCHII
TRIPS (%)
30%
20%
10%
0%
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

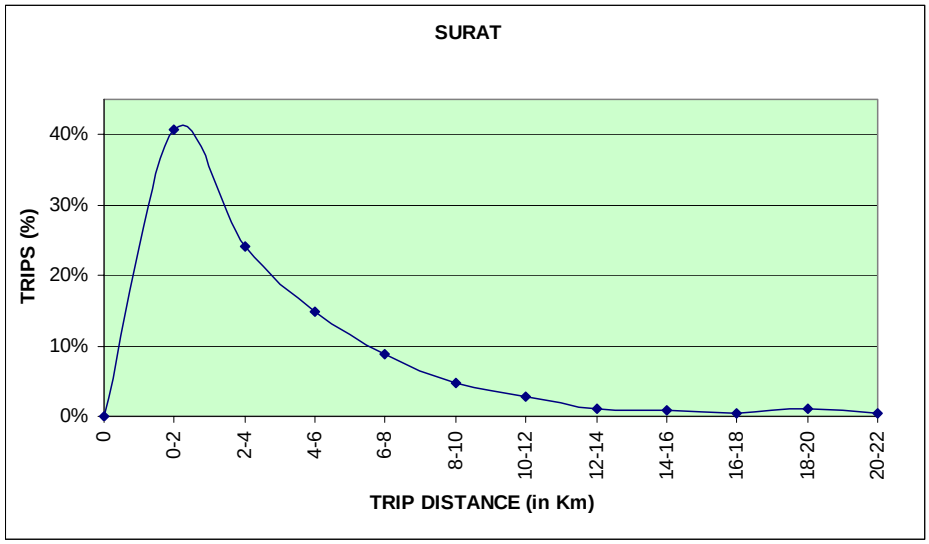

PATNA
TRIPS (%)
40%
30%
20%
10%
0%
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

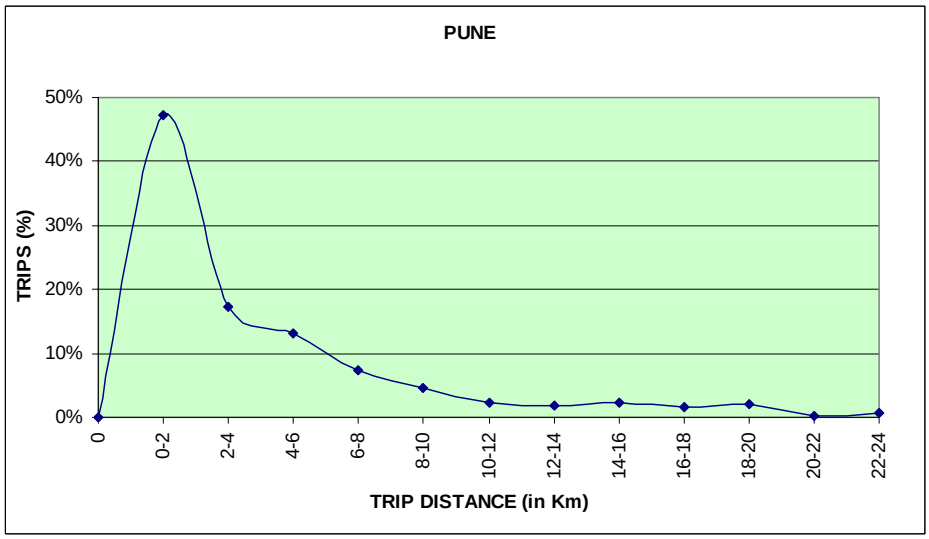

VARANASI
TRIPS (%)
40%
30%
20%
10%
0%
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)

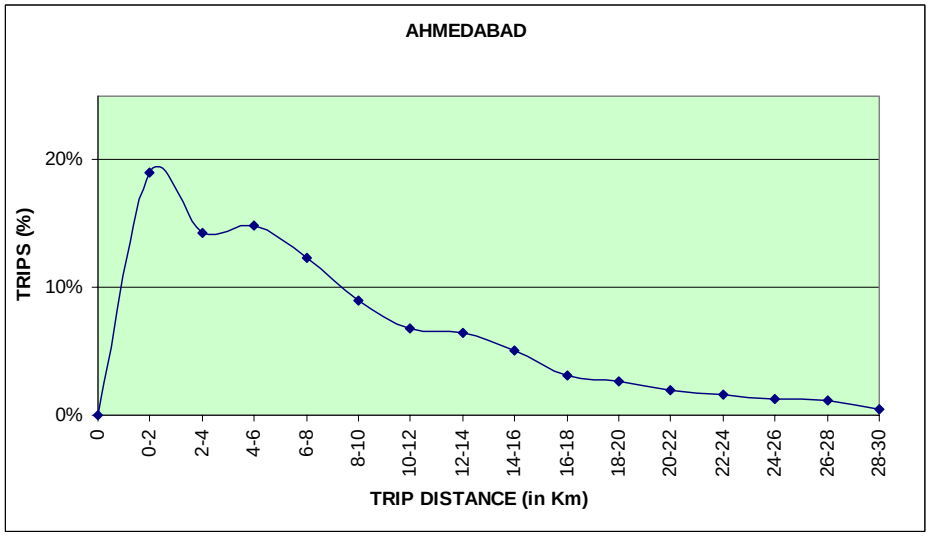

NAGPUR
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
TRIP DISTANCE (in Km)

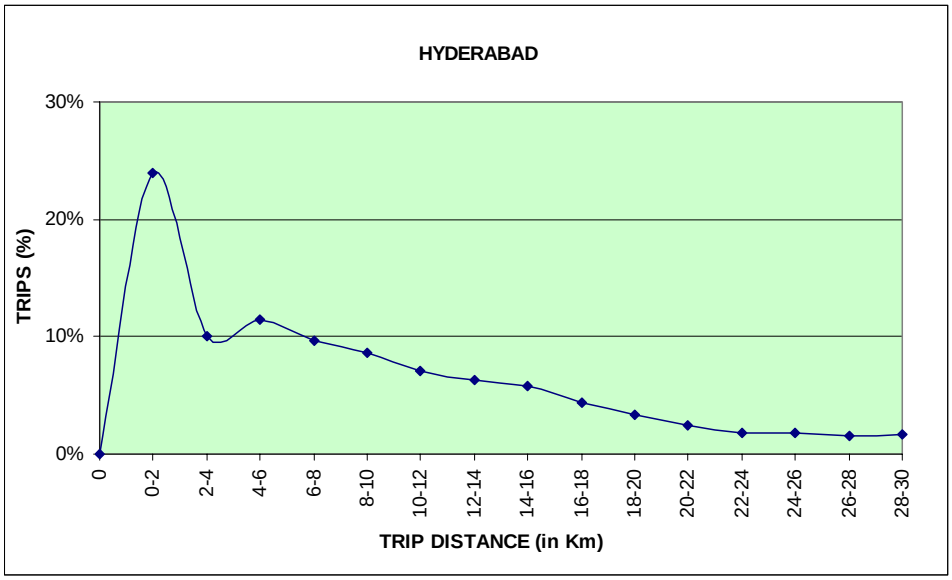

JAIPUR
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
TRIP DISTANCE (in Km)

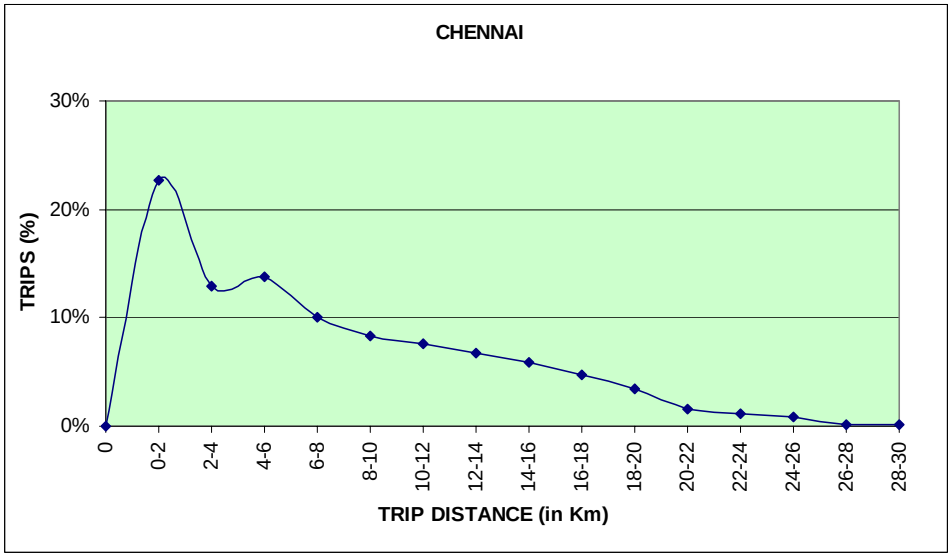

KANPUR
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
TRIP DISTANCE (in Km)

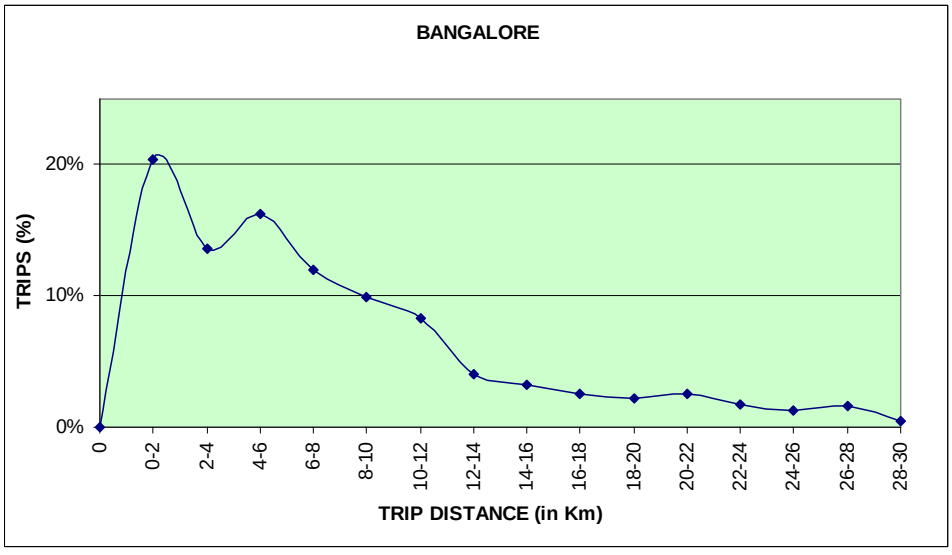

SURAT
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
TRIP DISTANCE (in Km)

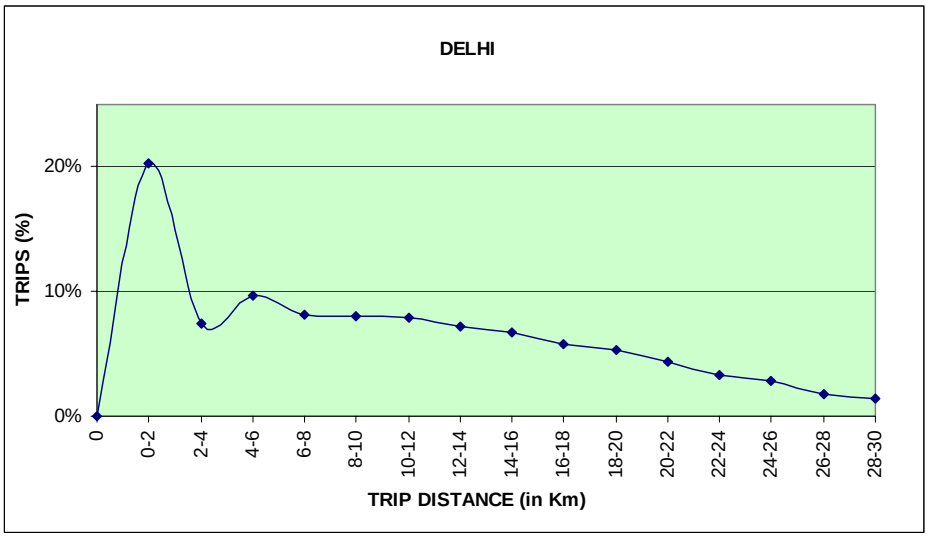

PUNE
50%
40%
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
TRIP DISTANCE (in Km)

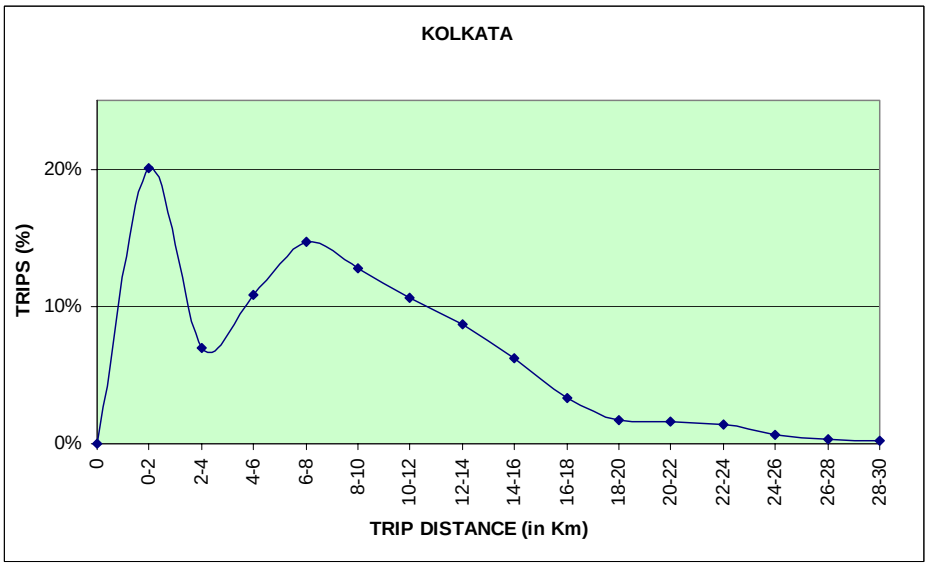

AHMEDABAD
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)

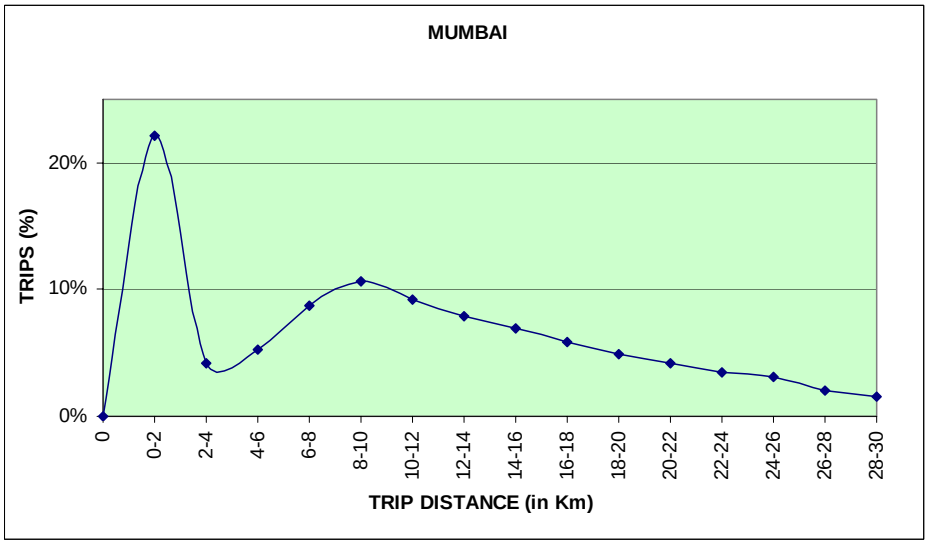

HYDERABAD
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)


CHENNAI
30%
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)


BANGALORE
20%
10%
0%
TRIPS (%)
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)


DELHI
TRIPS (%)
20%
10%
0%
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)


KOLKATA
TRIPS (%)
20%
10%
0%
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)


MUMBAI
TRIPS (%)
20%
10%
0%
0
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
26-28
28-30
TRIP DISTANCE (in Km)

ANNEXURE 3.1. TRANSPORT CHARACTERISTICS OF 30 STUDY CITIES

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

Name of the City	GANGTOK

Gangtok, the capital city of Sikkim is located in the East District and situated in the lower Himalayas. Gangtok is simply a great place for tourism, especially for people who like to explore the wonderful Buddhist Monasteries and surroundings are beautiful and appealing. The study area is the Gangtok Development Area comprising about 76.95 sq. kms. and about 0.92 lakh population as per 2001 census. The population of Gangtok city is 0.59 lakhs covering the area 25 Sq.Km as per Census 2001 with a decadal growth rate of 17 per cent. Vehicle population of the city is very less. The total number of registered vehicles in Gangtok city in 2005 is 3977. The vehicle population has experienced an annual growth rate of 16% during the past 5 years. National Highway No. 31-A connects the city with other places. The road network is comprised mainly by 2 lane roads. The city does not have a proper public transport system.

I. General:

Study Area	**:** 76. 95 Sq.Km
Administrative Boundary	**:** Gangtok Development Area
Population (2001)	: 0.92 lakhs
2007 Population (estimated)	**:** 1.12 lakhs
2007 Employment (estimated)	: 0.31 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 1b
Shape Category	: 1
Terrain	: Hilly Terrain
Availability of City Bus service	: Absent
Average Travel speed (KMPH) on major corridors	: 23.8

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 0.87
Daily Trips (Lakhs) : 0.83
Average Trip Length (Km) : 2.11

Mode	Share (%)	Trips(Lakhs)
Two Wheeler	4	0.03
Car	40	0.33
Auto	0	0.00
Public Transport	0	0.00
Walk	56	0.47
Cycle	0	0.00

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
172.8	1.0552	0.06852

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1388	-0.4104
Car	-0.03258	-0.0359
Auto	-	-
Public Transport	-	-

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos.)	0.520	45.84	0.904	53.44	1.497	61.98
PT (in Nos.)*	0.0	0.0	0.0	0	0.0	0.0
NMT *(In nos.)**	0.614	54.16	0.788	46.56	0.958	39.02

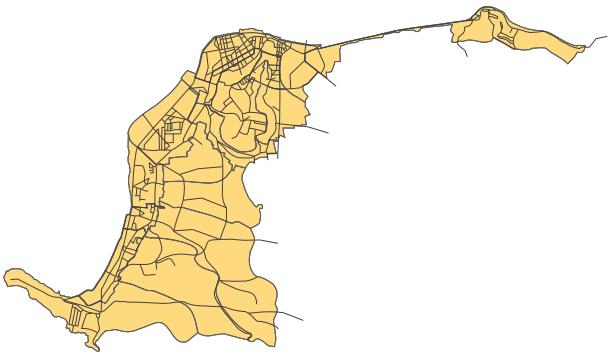
(Note:- model output, **-estimated)*

Name of the City	PANAJI

Panaji is a capital of Goa State and is situated along the river Mandovi, on Island of Tiswadi. Panaji is spotted as one of the most attractive tourist destination centers in India, and it attracts around 2.0 Lacs National tourists and 0.35 lacs international tourist annually. The study area is the area within the Panaji Development Area comprising about 22.63sq. kms. and about 0.97 lakh population as per 2001 census. The population of Panaji city is 0.58 lakhs covering an area of 8.12 Sq.km as per Census 2001 with a decadal growth rate of 38.3 per cent. The total number of registered vehicles in Panaji city in 2005 is 7151. The vehicle population has experienced an annual growth rate of 6.7% during the past 5 years. Two National Highways NH 17 and NH 4 A is connecting the city with other places.

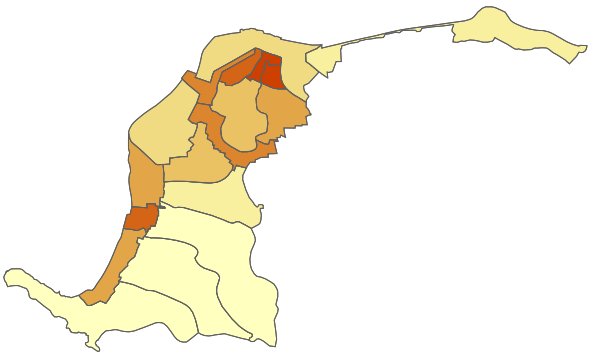
I. General:

Study Area	**:** 22.63 Sq .Km
Administrative Boundary	**:** Panaji Development Area
Population (2001)	**:** 0.97 lakhs
2007 Population (estimated)	**:** 1.05 lakhs
2007 Employment (estimated)	**:** 0.40 lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: Yes
Population Category	: 1(a)
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 28



Network Map

Network Length	: 89Km
Number of Links	: 603
Number of Nodes	: 417



Zoning Map

Number Of Zones	: 22
Internal Zones	: 18
External Zones	: 4

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 0.76
Daily Trips	: 0.80
Average Trip Length (Km)	: 2.41

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	26	0.21
Car	27	0.21
Auto	5	0.04
Public Transport	5	0.04
Walk	34	0.27
Cycle	3	0.03

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values are as follows

Calibration Functions

a	b	c
175.0	1.0680	0.06931

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1358	-0.1792
Car	0.17291	-0.0347
Auto	0.1747	-0.0694
Public Transport	-0.4559	0.71865

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	Value (Lakhs)	**%**	**Value (Lakhs)**	**%**	**Value (Lakhs)**	**%**
PV+ IPT (In Nos.)*	0.520	61.83	0.784	66.68	1.140	72.35
PT (in Nos.)*	0.025	2.83	0.026	2.25	0.025	1.61
NMT *(In nos.)**	0.324	36.14	0.365	31.07	0.410	26.04

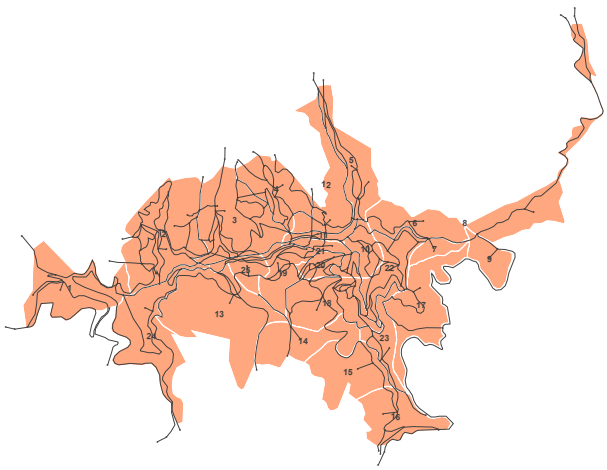
(Note:- model output, **-estimated)*

Name of the City	SHIMLA

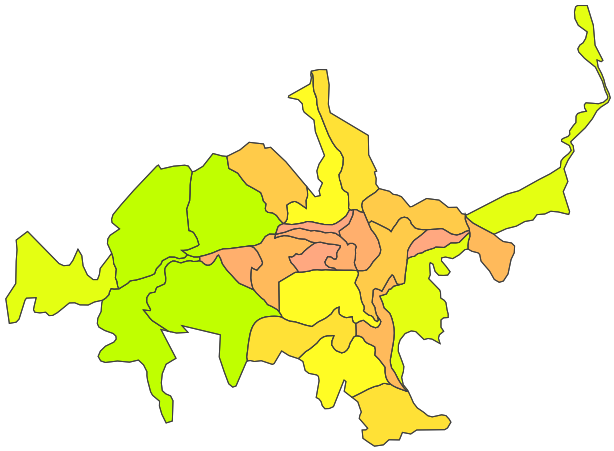
Shimla, the State capital of Himachal Pradesh, is known as the "Queen of Hill Stations" and the former summer capital of British Government and Punjab State has got unique privilege of being a hill station. It is situated on a range of hills which forms the last traverse of the central Himalayas south of the river Sutlej. The study area is the Shimla Planning Area (SPA) comprising about 100 sq. kms. The population of SPA is 1.73 lakhs as per Census 2001 with a decadal growth rate of 33 per cent. The total number of registered vehicles in Shimla city in 2005 is 19,849. The vehicle population has experienced an annual growth rate of 5.43% during the past 5 years. The city is developed in linear shape. National highway No. 22 and National Highway No. 88 connects Shimla with other places in the State and outside. Public transport in Shimla Planning Area is through bus transport provided by HRTC and mini buses operated on selected routes by the licensed private operators.

I. General:

Study Area	**:** 100 Sq.Km
Administrative Boundary	**:** Shimla Planning Area
Population (2001)	**:** 1.73 lakhs
2007 Population (estimated)	**:** 1.8 Lakhs
2007 Employment (estimated)	**:** 0.64 lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: Yes
Population Category	: 1(b)
Shape Category	: 3
Terrain	: Hilly
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 26



Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 0.78
Daily Trips (Lakhs) :1.45
Average Trip Length (Km) : 3.0

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	8	0.12
Car	17	0.25
Auto	0.0	0.0
Public Transport	16	0.23
Walk	58	0.84
Cycle	1	0.01

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and the values as follows

Calibration Functions

a	b	c
155.9	0.9546	0.06223

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1401	0.0000
Car	0.00000	-0.0343
Auto	-	-
Public Transport	-0.0100	0.04195

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	Value (Lakhs)	%	**Value (Lakhs)**	%	**Value (Lakhs)**	%
PV+ IPT (In Nos)*	0.636	37.05	1.059	45.79	1.628	54.94
PT (in Nos.)*	0.105	6.10	0.123	5.33	0.121	4.09
NMT *(In nos.)**	0.976	56.86	1.130	48.88	1.214	40.97

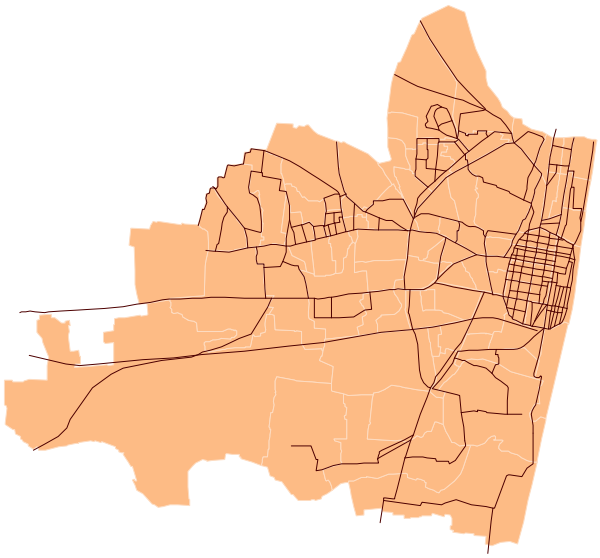
(Note:- model output, **-estimated)*

Name of the City	PONDICHERRY

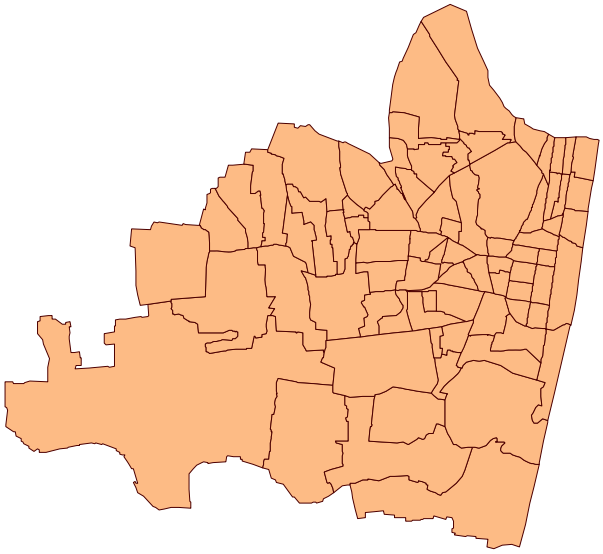
Union Territory of Pondicherry is situated on the Coromandel Coast about 162 kms south of Chennai and 22 kms north of Cuddalore. Pondicherry encompasses many tourist attractive places. The bulk of Pondicherry region is an irregular stretch of land consisting, the municipalities of Pondicherry & Oulgaret and five panchayats. The study area is the Pondicherry Development Area which is about 290 Sq. km, with the total population of 5.08 lakhs according to the 2001 census. Pondicherry is grown in semi circular shape. NH 45- A connects Pondicherry with other places. Public Transport need of the city is performed by buses operated by Pondicherry Road Transport Corporation (PRTC) and Private Operators.

I. General:

Study Area	**:** 290 Sq. km
Administrative Boundary	**:** Pondicherry Development Area
Population (2001)	**:** 5.08 lakhs
2007 Population (estimated)	**:** 5.68 Lakhs
2007 Employment (estimated)	**:** 1.80 Lakhs
Shape of the city	**:** Semi-circular
Capital City (Yes/No)	: yes
Population Category	: 2
Shape Category	: 2
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 24.1



Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate : 0.96
Daily Trips (Lakhs) : 4.88
Average Trip Length (Km) : 3.0

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	30	1.48
Car	4	0.19
Auto	4	0.18
Public Transport	7	0.32
Walk	40	1.97
Cycle	15	0.75

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where,
'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function

Calibration Functions

a	b	c
117.1	0.7244	0.04784

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1325	0.4410
Car	0.23109	-0.0331
Auto	0.2076	-0.0367
Public Transport	-0.0268	0.12700

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	Value (Lakhs)	**%**	**Value (Lakhs)**	**%**	**Value (Lakhs)**	**%**
PV+ IPT (In Nos)*	2.636	43.78	4.014	51.68	6.035	59.27
PT (in Nos.)*	0.173	2.87	0.191	2.46	0.233	2.28
NMT *(In nos.)**	3.213	53.35	3.563	45.87	3.915	38.44

(Note:- model output, **-estimated)*

Name of the City	BIKANER

Bikaner is situated in the north part of Rajasthan. The city, just like Jodhpur, is surrounded by great walls. It has Ganganagar and Hanumannagar in its northern side whereas Churu lies in its eastern side. The study area is the Bikaner Planning Area with area of 270 Sq. Km. As per 2001 census the population is 6.40 lakhs. National Highway No. 11 connects the city with other places. The road network is comprised by 38% of 2 lane roads, 58% of 4 lane, etc. The city does not have a formal public transport system.

I. General:

Study Area : 270 Sq.Km

Administrative Boundary **:** Bikaner Planning Area

Population (2001) **:** 6.4 lakhs

2007 Population (estimated) **:** 7.6 lakhs

2007 Employment(estimated) **:** 2.2 Lakhs

Shape of the city **:** Circular

Capital City (Yes/No) : No

Population Category : 2

Shape Category : 1

Terrain : Plain

Availability of City Bus service : Absent

Average Travel speed (KMPH) on major corridors : 24

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 0.81
Daily Trips : 6.21
Average Trip Length (Km) : 2.60

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	21.5	1.34
Car	8.28	0.51
Auto	5.23	0.33
Public Transport	0.0	0.0
Walk	45.83	2.85
Cycle	19.16	1.19

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
113.4	0.7028	0.04648

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.2230	0.0784
Car	0.14109	-0.0513
Auto	0.0903	0.0000
Public Transport	-	-

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	Value (Lakhs)	%	**Value (Lakhs)**	%	**Value (Lakhs)**	%
PV+ IPT (In Nos)*	2.761	37.57	4.585	46.33	6.98	55.02
PT (in Nos.)*	0.0	0.0	0.0	0.0	0.0	0.0
NMT *(In nos.)**	4.588	62.43	5.311	53.67	5.707	44.98

(Note:- model output, **-estimated)*

Name of the City	RAIPUR

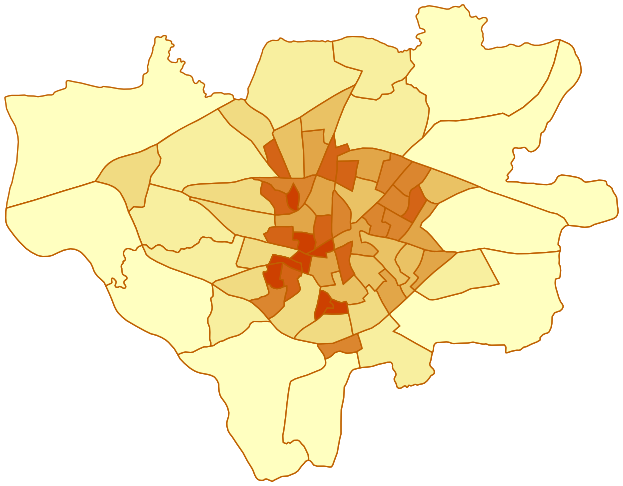
Raipur is the capital city of the recently formed State of Chhattisgarh, carved out of the erstwhile State of Madhya Pradesh. The city is also the head quarter of Raipur District. Raipur, being the capital of Chattisgarh, is positioned to support the mineral based industries. The study area is the Raipur planning area covering 188 sq. km. As per 2001 census the planning area covers a population of 7.19 lakhs, in which the city population is 6.70 lakhs. Raipur is developed in linear shape. Three National Highways such as NH 6, NH 43 and NH 200 connects city with other places. The road network is comprised by 37% of 2 lane roads, 60% of 4 lane, etc. There is no organized public transportation system present in Raipur.

I. General:

Study Area	**:** 188 Sq. km
Administrative Boundary	**:** Raipur Planning Area
Population (2001)	: 7.19 lakhs
2007 Population (estimated)	**:** 8.80 Lakhs
2007 Employment (estimated)	**:** 2.11 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: No
Population Category	: 2
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Absent
Average Travel speed (KMPH) on major corridors	: 21

Network Map

Number of Links : 1700
Number of Nodes : 1248



Zoning Map

Number Of Zones : 74
Internal Zones : 70
External Zones : 4

II. Base year Trip Characteristics

Per capita Trip Rate : 0.94
Daily Trips : 8.07
Average Trip Length (Km) : 3.03

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	25	2.04
Car	9	0.71
Auto	4	0.31
Public Transport	0	0.0
Walk	35	2.79
Cycle	28	2.22

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
102.1	0.6355	0.04228

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.0864	0.1651
Car	0.16313	-0.0237
Auto	0.1186	0.0000
Public Transport	-	-

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	4.03	40.32	7.56	48.69	13.29	56.99
PT (in Nos.)*	0.0	0.0	0.0	0.0	0.0	0.0
NMT *(In nos.)**	5.96	59.68	7.97	51.31	10.03	43.01

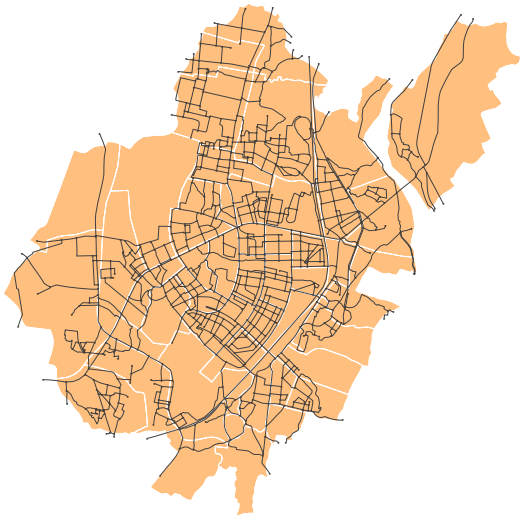
(Note:- model output, **-estimated)*

Name of the City	BHUBANESWAR

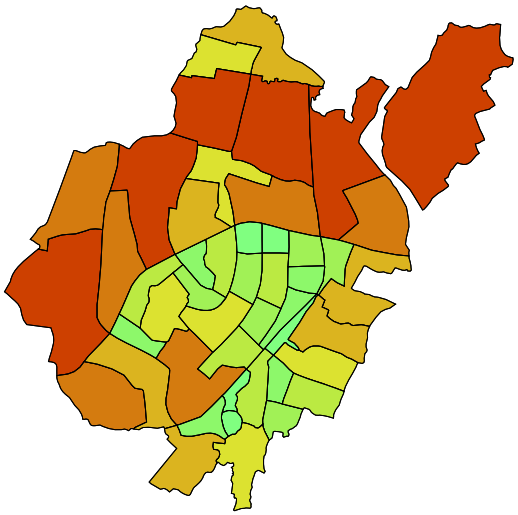
Bhubaneswar is the capital city of East Indian State of Orissa located in Khorda district at a distance of about 64 km from Puri. The city boasts of majestic temples and shrines, which form a major part of its tourist attractions. The study area is the Bhubaneswar Development Area comprising about 233 sq. kms. and about 8.44 lakh population as per 2001 census. The population of Bhubaneswar city is 6.48 lakhs covering 135 sq. kms as per Census 2001 with a decadal growth rate of 50 per cent. The total number of registered vehicles in Bhubaneswar city in 2001 is 26,244. The vehicle population has experienced an annual growth rate of 14% during the period between 1991 and 2001. Two national highways, NH 5 (Kolkatta- Chennai) and NH 203 (Bhubaneswar – Puri) traverse through the city. The road network is comprised by 38% of 2 lane roads, 56% of 4 lane, etc. Public transport need of the city is performed through buses operated by the Orissa government.

I. General:

Study Area	**:** 233 Sq.km
Administrative Boundary	**:** Bhubaneswar Development Area
Population (2001)	**:** 8.44 lakhs
2007 Population (estimated)	**:** 10.94 lakhs
2007 Employment(estimated)	**:** 2.77 lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 2
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 20



Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 0.96
Daily Trips : 10.46
Average Trip Length (Km) : 3.92

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	30	3.17
Car	12	1.26
Auto	4	0.42
Public Transport	4	0.44
Walk	28	2.96
Cycle	21	2.21

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
94.7	0.5913	0.03952

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1401	-0.3670
Car	0.01330	-0.0347
Auto	-0.0630	-0.0141
Public Transport	-0.0408	0.23618

V. Travel demand Forecast

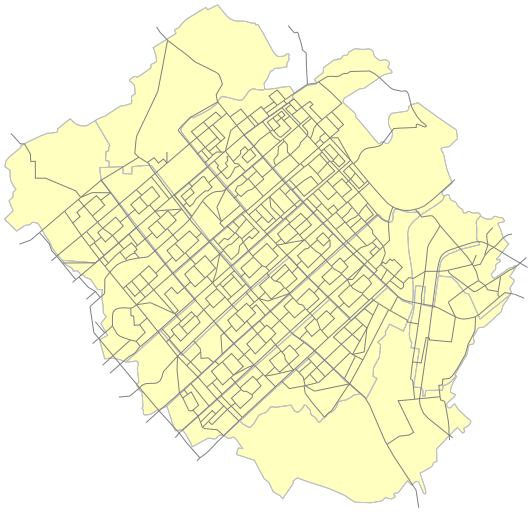
Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	6.413	50.60	11.611	57.42	20.10	64.01
PT (in Nos.)*	0.245	1.93	0.359	1.78	0.56	1.79
NMT *(In nos.)**	6.015	47.47	8.252	40.81	10.74	34.20

(Note:- model output, **-estimated*

Name of the City	CHANDIGARH

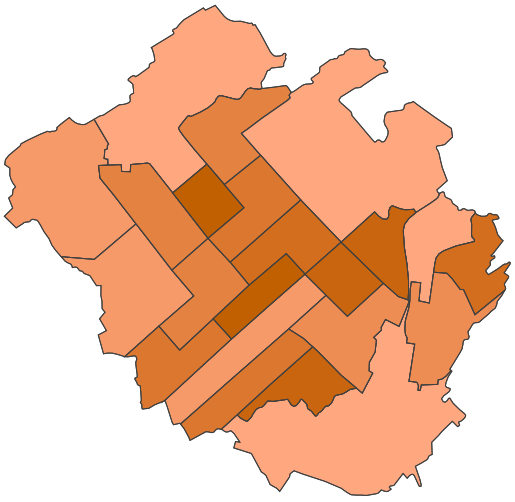
Chandigarh is located in western side of river Ghaggar and Shimla National highway, is the capital city of both Punjab and Haryana. The study area considered for the study is the Chandigarh Planning Area including Municipal corporation area having 114 sq. Km. As per 2001 census, the population of the study area is 9.66 lakhs with a decadal growth rate of 50 per cent. At present about 6,00,000 vehicles are plying in the city roads of Chandigarh. The average yearly growth rate of vehicle population in the city is about 6%. Two National Highways, NH 21 and NH 22 traverse through the city. The city is developed in Semi circular shape. The road network is comprised by 58% of 4 lane roads, 42% of 6 lanes. Chandigarh city is a planned city with wide roads and other facilities. Public transport need of the city is performed through bus operated by Chandigarh Transport Undertaking (CTU).

Study Area	**:** 150 Sq.Km
Administrative Boundary	**:** Chandigarh Planning Area
Population (2001)	**:** 9.66 lakhs
2007 Population (estimated)	**:** 11.2 Lakhs
2007 Employment (estimated)	**:** 2.44 lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 2
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 30



Network Map

Network Length	: 393Km
Number of Links	: 1050
Number of Nodes	: 670



Zoning Map

Number Of Zones	: 24
Internal Zones	: 20
External Zones	: 4

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.18
Daily Trips	: 11.49
Average Trip Length (Km)	: 4.50

Mode	Share (%)	Trips
Two Wheeler	10	1.14
Car	28	3.17
Auto	3	0.4
Public Transport	18	2.10
Walk	23	2.62
Cycle	18	2.06

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $\quad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
96.6	0.6026	0.04023

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.3849	-0.2002
Car	0.76875	-0.1514
Auto	0.4194	-0.1387
Public Transport	-0.0271	0.23445

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	value	**%**	**value**	**%**	**value**	**%**
PV+ IPT (In Nos)*	8.241	51.26	15.237	57.80	27.392	63.42
PT (in Nos.)*	1.550	9.64	2.264	8.59	3.630	8.40
NMT *(In nos.)**	6.286	39.10	8.862	33.62	12.169	28.17

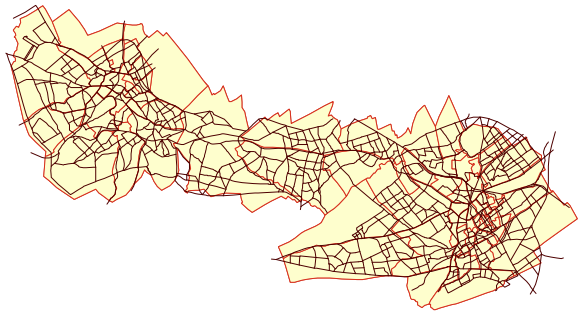
(Note:- model output, **-estimated)*

Name of the City	Hubli- Dharwad

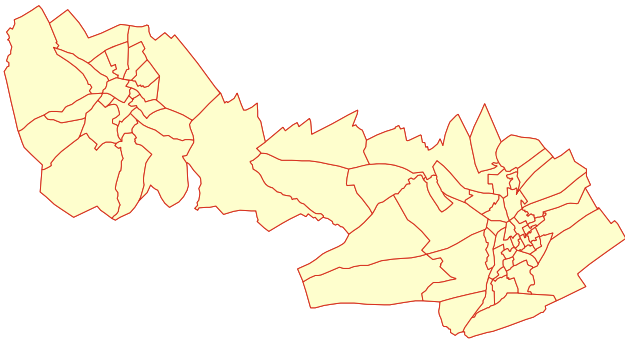
Hubli, situated 428 kms from Bangalore, is a twin city with Dharwad which is 16 km away and is a major town located in the northern part of Karnataka. Hubli City is the commercial centre of the district. It is also an important city for the Indian Railways, being the zonal headquarters of South Western Railway and the Hubli Division. Dharwad is the cultural capital of Northern Karnataka. Due to extremely favorable climatic conditions and because of the aesthetic people, it is often called the 'paradise of pensioners'. The study area is the Hubli -Dharward planning area including the two Municipal corporations and suburbs with an area of 200 Sq. Km. As per 2001 census the Population is 9.86 lakhs. National Highway No 4 passes through the city. Public Transport need of the city is performed by buses operated by Karnataka State Road Transport Corporation (KSRTC).

I. General:

Study Area	**:** 200 sq.km
Administrative Boundary	**:** Hubli -Dharward Planning Area
Population (2001)	**:** 9.68 lakhs
2007 Population (estimated)	**:** 11.17 lakhs
2007 Employment (estimated)	**:** 2.64lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: No
Population Category	: 2
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 23



Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 0.92
Daily Trips : 10.23
Average Trip Length (Km) : 3.95

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	25	2.57
Car	10	0.99
Auto	0.5	0.04
Public Transport	22	2.30
Walk	22.5	2.37
Cycle	19	1.96

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai, Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj - Trip Attractions to zone j,
'Fij- Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
102.2	0.6358	0.04230

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.3077	1.0696
Car	0.37884	-0.0681
Auto	0.4065	-0.0619
Public Transport	-0.0324	0.19253

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	5.385	47.75	8.005	54.66	11.269	60.50
PT (in Nos.)*	1.302	11.54	1.514	10.34	1.893	10.16
NMT *(In nos.)**	4.591	40.71	5.126	35.00	5.464	29.33

(Note:- model output, **-estimated)*

Name of the City	GUWAHATI

Guwahati, the capital city of Assam, is recognized to be the most critical city in the Northeast India. The city has a well-developed connectivity with the rest of the country and acts as the gateway to the entire North Eastern India. Guwahati is a part of Kamrup District and located on the banks of the Brahamaputra River. The study focuses on the Guwahati Metropolitan Development Authority jurisdiction, comprising of Guwahati Municipal Corporation Area (GMCA), North Guwahati Town Committee area, Amingaon and some revenue villages. The area is known as the Guwahati metropolitan area (GMA) and covers an area of 264 Sq.km. As per 2001 census the population is 10.60 lakhs with a decadal growth rate of 38.6 per cent. The city is developed in semi circular shape. Three National Highways NH 31, NH 37 and NH 40 connect the city with other places. Public Transport needs are performed by buses operated by Assam State Transport Corporation (ASTC) and by Private operators.

I. General:

Study Area	**:** 264 Sq.Km
Administrative Boundary	**:** Guwahati metropolitan area
Population (2001)	**:** 10.60 lakhs
2007 Population (estimated)	**:** 11.9 Lakhs
2007 Employment (estimated)	**:** 2.64 lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: Yes
Population Category	: 3
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 20

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 0.98
Daily Trips : 11.62
Average Trip Length (Km) : 4.14

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	20	2.35
Car	18	2.10
Auto	12	1.39
Public Transport	8	0.94
Walk	21	2.39
Cycle	21	2.45

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	b	c
99.0	0.6168	0.04111

IV. Mode Choice

$$V_M = \alpha\ TT_M + \beta\ TC_M$$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1120	-0.1248
Car	0.08727	-0.0290
Auto	0.0227	-0.0287
Public Transport	-0.0383	0.21015

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	7.710	55.83	10.626	61.88	14.412	67.5
PT (in Nos.)*	0.591	4.28	0.657	3.82	0.801	3.75
NMT *(In nos.)**	5.510	39.89	5.890	34.3	6.138	28.75

(Note:- model output, **-estimated)*

Name of the City	AMRITSAR

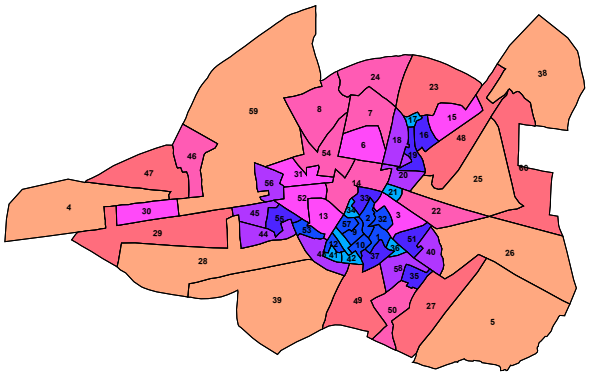
Amritsar is a border city located in the northern western part of Punjab. It is 228 km west of State capital of Chandigarh, 82 km from Jalandhar. The study area is the development area comprised by the city and the suburban areas. The area covered by the Municipal Corporation of Amritsar is taken as the study area is 139.58 sq. km, out of which 105.86 sq. km is developed and 33.72 sq. km is undeveloped. The study area has a population of 10.85 as per 2001 census. The city is developed in linear shape. National highway No. 1 and National Highway No. 15 connects the city with other region. The road network is comprised by 37% of 2 lane roads, 55% of 4 lane, etc. The city of Amritsar does not possess any public transport system for intra city movements.

I. General:

Study Area	**:** 150 Sq. km
Administrative Boundary	**:** Amritsar Planning Area
Population (2001)	**:** 10.85 lakhs
2007 Population (estimated)	**:** 11.08 Lakhs
2007 Employment (estimated)	**:** 4.06 Lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: No
Population Category	: 3
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Absent
Average Travel speed (KMPH) on major corridors	: 24

Network Map

Network Length	: 469Km
Number of Links	: 1839
Number of Nodes	: 1239



Zoning Map

Number Of Zones	: 67
Internal Zones	: 64
External Zones	: 3

II. Base year Trip Characteristics

Per capita Trip Rate	: 1.08
Daily Trips (Lakhs)	: 12.38
Average Trip Length (Km)	: 4.50

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	31	3.84
Car	14	1.67
Auto	4	0.51
Public Transport	0	0.00
Walk	27	3.32
Cycle	25	3.04

III. Base year Calibrated Model Functions

Trip Distribution

$$T_{ij} = A_i O_i B_j D_j F_{ij}, \qquad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	C
94.2	0.5886	0.03935

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	B
Two Wheeler	-0.1788	1.3190
Car	-0.00750	0.0621
Auto	0.2020	-0.1850
Public Transport	-	-

V. Travel demand Forecast

Mode	Horizon Year Trips / Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In PCU)*	6.951	50.68	10.23	57.60	14.49	64.46
PT (in Nos.)*	0.0	0.0	0.0	0.0	0.0	0.0
NMT *(In nos.)**	6.76	49.32	7.53	42.40	7.99	35.54

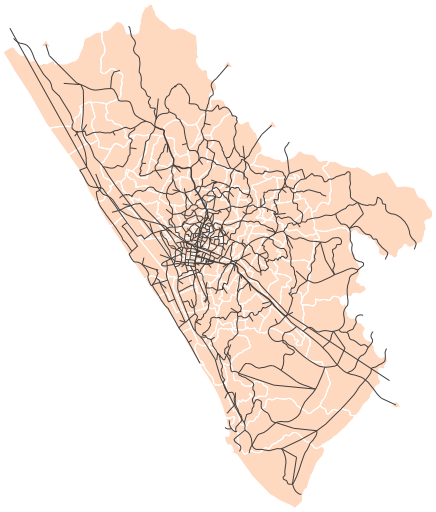
(Note:- model output, **-estimated)*

Name of the City	THIRUVANANTHAPURAM

Thiruvananthapuram is the State capital of Kerala and is one of the major tourist destinations in India. Thiruvananthapuram is a strategically important city in southern India as the city is very close to the international shipping route and East-West shipping axis. Being close to Tamil Nadu Border, the city provides a key link in movement of goods and passengers to and from southern Tamil Nadu into Kerala. The study area for the purposes of this study is the Thiruvananthapuram Development Authority (TRIDA) area that constitutes the city and the adjoining 10 gram panchayats including the upcoming 3 satellite towns. The Thiruvananthapuram Development Authority (TRIDA) area spreads over 310 Sq Kms. As per 2001 census the population is 11.22 lakhs. The city is developed in semi circular shape. National Highway 47 connects the city with Tamil nadu and other places. The road network is comprised by 21% of 2 lane roads, 70% of 4 lane, etc. Public Transport need of the city is performed by buses operated by Kerala State Road Transport Corporation (KSRTC) and private operators.

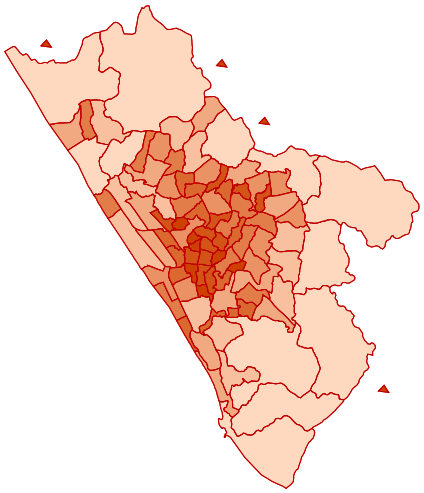
I. General:

Study Area	**:** 310 Sq. Km
Administrative Boundary	**:** Thiruvananthapuram Development Area
Population (2001)	**:** 11.22 lakhs
2007 Population (estimated)	**:** 13.83 Lakhs
2007 Employment (estimated)	**:** 3.71 Lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: Yes
Population Category	: 3
Shape Category	: 2
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) On major corridors	: 23



Network Map

Network Length	:562Km
Number of Links	: 806
Number of Nodes	: 575



Zoning Map

Number Of Zones	: 94
Internal Zones	: 91
External Zones	: 3

II. Base year Trip Characteristics

Per capita Trip Rate	: 1.03
Daily Trips	: 12.47
Average Trip Length (Km)	: 4.7

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	19	2.39
Car	10	1.27
Auto	10	1.22
Public Transport	22	2.69
Walk	20	2.53
Cycle	19	2.37

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
86.6	0.5436	0.03654

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.0131	0.1402
Car	0.15684	-0.0026
Auto	0.1105	-0.0592
Public Transport	-0.0440	0.29271

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	6.879	50.09	9.732	56.76	13.315	62.32
PT (in Nos.)*	1.619	11.79	1.792	10.46	2.181	10.21
NMT *(In nos.)**	5.236	38.13	5.615	32.78	5.870	27.47

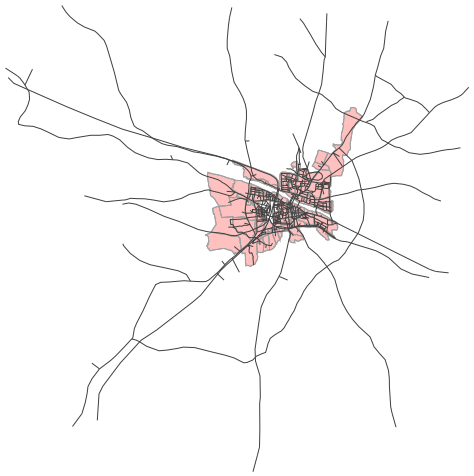
(Note:- model output, **-estimated)*

Name of the City	MADURAI

The temple town of Madurai, situated on the bank of river Vaigai and 500 km southwest of Chennai, is the third largest city in Tamil Nadu and the district headquarters of Madurai District. It is a famous pilgrim centre and gateway to south Tamil Nadu having the famous Meenakshi temple at its core. Madurai is a town and a municipal corporation. The study area is the Local Planning area of Madurai covering 732 Sq. Km. As per 2001 census the population is 11.85 lakhs. The city is developed in linear shape. Two National Highways, namely, NH 7 and NH 49 provide regional connectivity to Madurai. The Public Transport needs of the city are performed by the bus operated by State Transport Corporation (STC).

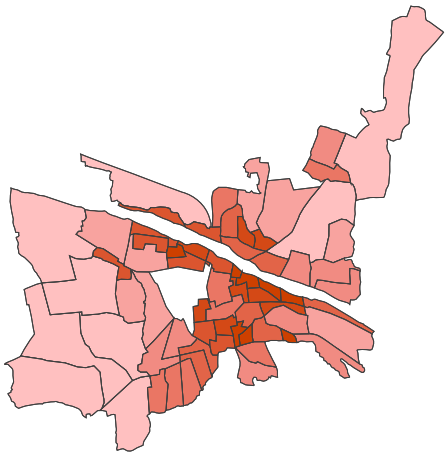
I. General:

Study Area	**:** 732 Sq. km
Administrative Boundary	**:** Madurai Local Planning Area
Population (2001)	**:** 11.85 lakhs
2007 Population (estimated)	**:** 14.24 Lakhs
2007 Employment (estimated)	**:** 3.61 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: No
Population Category	: 3
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 27



Network Map

Network Length	:405 Km
Number of Links	: 973
Number of Nodes	: 661



Zoning Map

Number Of Zones	: 94
Internal Zones	: 81
External Zones	: 13

II. Base year Trip Characteristics

Per capita Trip Rate	: 1.14
Daily Trips	: 16.23
Average Trip Length (Km)	: 5.20

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	15	2.46
Car	7	1.20
Auto	9	1.40
Public Transport	16	2.64
Walk	34	5.54
Cycle	18	2.99

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	b	c
85.6	0.5377	0.03617

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.0046	-0.0009
Car	0.02579	-0.0445
Auto	0.0598	-0.1018
Public Transport	-0.0017	-0.10334

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	7.751	41.98	11.508	49.58	16.234	56.55
PT (in Nos.)*	1.298	7.03	1.528	6.58	1.925	6.7
NMT *(In nos.)**	9.413	50.99	10.174	43.83	10.546	36.74

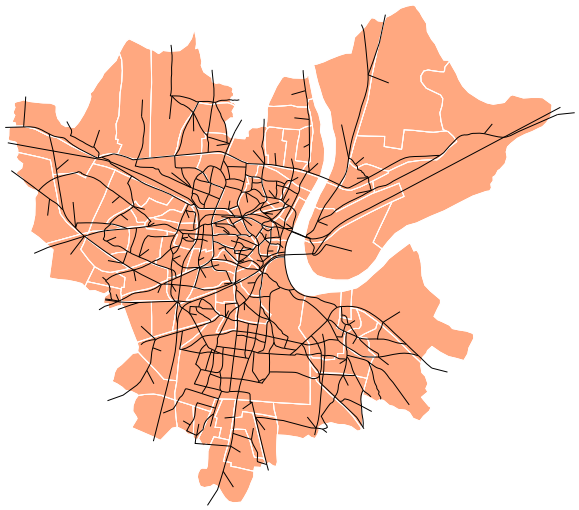
(Note:- model output, **-estimated)*

Name of the City	AGRA

Agra is situated on the Western Bank of river Yamuna at about 200 Kms from Delhi in the State of Uttar Pradesh. Agra is one of the key tourist destinations attracting tourists from all over the world. The study area is the Agra Development Area comprising about 200 sq. kms. and about 13.69 lakh population as per 2001 census. The population of Agra city is 12.75 lakhs as per Census 2001 with a decadal growth rate of 30.37 per cent. The total number of registered vehicles in Agra city in 2006 is 4, 75,700. The vehicle population has experienced an annual growth rate of 10% during the past 10 years. Agra at present does not offer good intra-city public transportation to local and floating population.

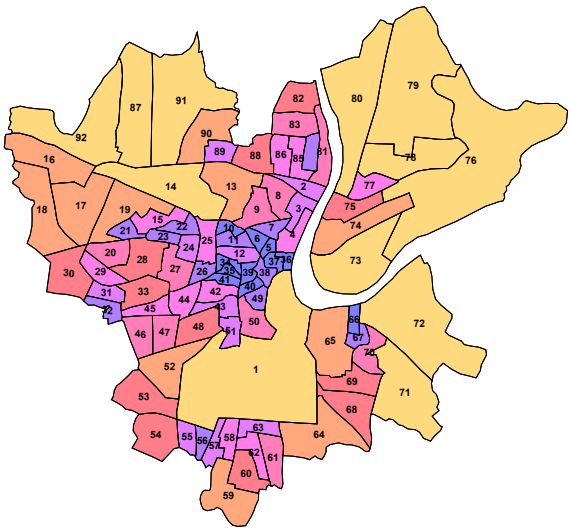
I. General:

Study Area	**:** 200 Sq.Km
Administrative Boundary	**:** Agra Development Area
Population (2001)	**:** 13.69 lakhs
2007 Population (estimated)	**:** 16.77 Lakhs
2007 Employment (estimated)	**:** 3.69 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: No
Population Category	: 3
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 28



Network Map

Network Length	: 269Km
Number of Links	: 693
Number of Nodes	: 500



Zone Map

Number Of Zones	: 95
Internal Zones	: 90
External Zones	: 5

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.06
Daily Trips	: 17.81
Average Trip Length (Km)	: 4.40

Mode	Share (%)	Trips (lakhs)
Two Wheeler	31	5.45
Car	17	2.95
Auto	3	0.54
Public Transport	2	0.32
Walk	27	4.83
Cycle	21	3.72

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $\quad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	b	c
80.0	0.5044	0.03409

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1601	-0.4333
Car	-0.02374	-0.0387
Auto	-0.0955	-0.0059
Public Transport	-0.0441	0.34771

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	11.053	52.60	17.785	59.20	24.647	65.67
PT (in Nos.)*	0.178	0.85	0.234	0.78	0.293	0.78
NMT *(In nos.)**	9.783	46.56	12.025	40.03	12.59	33.55

(Note:- model output, **-estimated)*

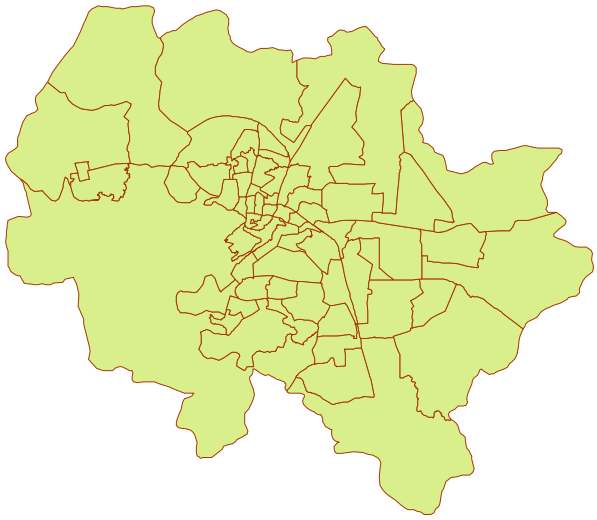
Name of the City	BHOPAL

Bhopal, the capital city of Madhya Pradesh, is the second largest city of the State. Bhopal Development Area comprising the city and the suburban areas, covering a gross area of 320 sq. km. is taken as the study area. As per 2001 census, the population of Bhopal district is 18.38 lakhs out of which 14.58 lakhs live in Bhopal city, covering a gross area of 285 sq. km. including the lakes and hills. National Highway 12 (Beora – Jabalpur road), which links the city to many major cities in the north – west and the south – east. The city is developed in linear shape. The road network is comprised by 26% of 2 lane roads, 65% of 4 lane, etc. Public transport need of the city is performed by city buses.

I. General:

Study Area	**:** 320 Sq. km
Administrative Boundary	**:** Bhopal Development Area
Population (2001)	**:** 14.58 lakhs
2007 Population (estimated)	**:** 18.73 Lakhs
2007 Employment (estimated)	**:** 4.83 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 3
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 24

Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate : 1.14
Daily Trips : 21.39
Average Trip Length (Km) : 4.40

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	31	6.56
Car	9	1.82
Auto	3	0.55
Public Transport	15	3.29
Walk	26	5.5
Cycle	17	3.66

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
76.3	0.4820	0.03269

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1910	0.1583
Car	0.16141	-0.0449
Auto	0.1164	-0.0493
Public Transport	-0.0423	0.38297

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	12.773	50.52	19.220	57.15	27.379	63.07
PT (in Nos.)*	2.008	7.94	2.40	7.14	3.055	7.03
NMT *(In nos.)**	10.502	41.54	12.010	35.71	13.001	29.93

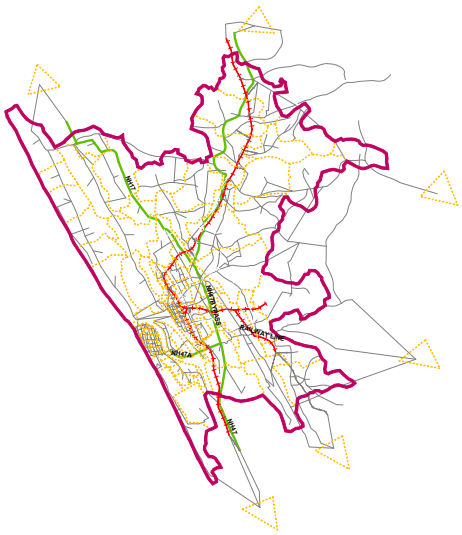
(Note:- model output, **-estimated)*

Name of the City	KOCHI

Kochi is the commercial and trade capital of Kerala, situated on the Malabar Coast at about 350 Kms from the State capital of Kerala. The study area is the Greater Cochin Area comprising about 730 sq. kms. with 18.189 lakh population as per 2001 census. The population of Kochi city alone is 5.96 lakhs as per Census 2001 with a decadal growth rate of 50 per cent (1991-2001). The total number of registered vehicles in the district in 2004-05 is 5, 25,204, which is experiencing an annual growth rate of 13% during the past 15 years.

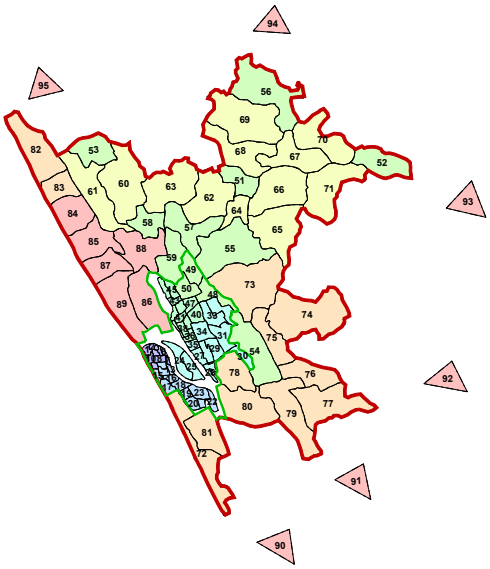
I. General:

Study Area	**:** 730 Sq.Km
Administrative Boundary	**:** Greater Cochin Area
Population (2001)	**:** 18.18 Lakhs
2007 Population (estimated)	**:** 21.8 Lakhs
2007 Employment (estimated)	**:** 6.72 Lakhs
Shape of the city	**:** Semi Circular
Capital City (Yes/No)	: No
Population Category	: 3
Shape Category	: 2
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major roads	: 25



Network Map

Network Length	: 940Km
Number of Links	: 1232
Number of Nodes	: 822



Zoning Map

Number Of Zones	: 95
Internal Zones	: 89
External Zones	: 6

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.21
Daily Trips	: 26.34
Average Trip Length (Km)	: 5.5

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	14	3.64
Car	9	2.33
Auto	6	1.49
Public Transport	51	13.37
Walk	16	4.10
Cycle	5	1.40

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	b	c
71.1	0.4513	0.0308

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.0041	-0.0563
Car	-0.03317	0.0048
Auto	0.0073	-0.0579
Public Transport	-0.0112	0.42232

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	12.771	40.90	18.899	44.95	26.24	48.68
PT (in Nos.)*	12.121	13.82	14.872	35.37	17.367	32.22
NMT *(In nos.)**	6.332	20.28	8.273	19.68	10.291	19.09

(Note:- model output, **-estimated)*

Name of the City	PATNA

Patna, the capital city of Bihar, is situated on the South bank of Ganga River. The study area is the Development Area of Patna comprising about 135.79 sq. kms. with 18.36 lakh population as per 2001 census. The population of Patna Corporation is 13.66 lakhs as per Census 2001. The total number of registered vehicles in Patna city in 2001 is 2, 89,844. The vehicle population has experienced an annual growth rate of 5.7% during the past 5 years. Patna does not have proper public transport system.

I. General:

Study Area	**:** 135.79 Sq.Km
Administrative Boundary	**:** Patna Development Area
Population (2001)	**:** 18.36 lakhs
2007 Population (estimated)	**:** 22.67 Lakhs
2007 Employment (estimated)	**:** 6.03 Lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: Yes
Population Category	: 3
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Absent
Average Travel speed (KMPH) on major corridors	: 23

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 1.25
Daily Trips : 28.25
Average Trip Length (Km) : 4.51

Mode	Share (%)	Trips(Lakhs)
Two Wheeler	20	5.76
Car	12	3.49
Auto	10	2.70
Public Transport	0.0	0.0
Walk	26	7.43
Cycle	31	8.87

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values are as follows

Calibration Functions

a	b	c
69.7	0.4432	0.03026

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.0306	0.6074
Car	0.27093	0.0016
Auto	0.2606	0.0000
Public Transport	-	-

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	14.46	44	24.57	45.66	35.45	46.20
PT (in Nos.)*	0.0	0.0	0.0	0.0	0.0	0.0
NMT *(In nos.)**	18.40	56	29.24	54.34	41.27	53.80

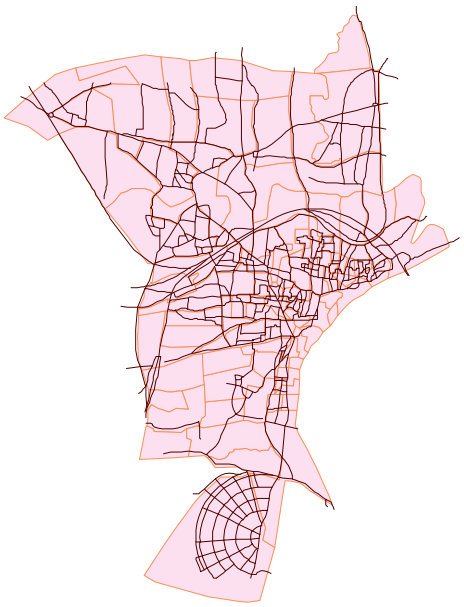
(Note:- model output, **-estimated)*

Name of the City	VARANASI

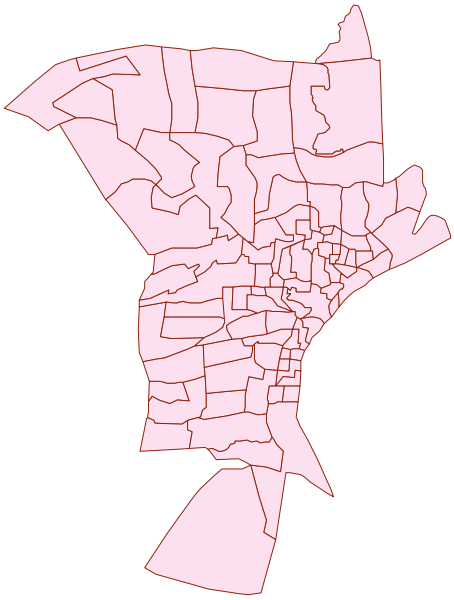
Varanasi is situated on the Bank of river Ganga and is an important city in Uttar Pradesh. It is known as the cultural capital of India, is predominantly a Hindu city. The study area is the Varanasi Development Area comprising about 84.55 sq. kms. with 18.95 lakh population as per 2001 census. The population of Varanasi city is 12.02 lakhs as per Census 2001. The total number of registered vehicles in Ernakulam District in 2004 is 3, 88,725. The vehicle population has experienced an annual growth rate of 9.96% during the 1995-02. There is no proper public transport facility available in Varanasi.

I. General:

Study Area	**:** 84.55 Sq.Km
Administrative Boundary	**:** Varanasi Development Area
Population (2001)	**:** 18.95 lakhs
2007 Population (estimated)	: 21.37 Lakhs
2007 Employment (estimated)	**:** 4.94 Lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: No
Population Category	: 3
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Absent
Average Travel speed (KMPH) on major corridors	: 17.7



Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 1.13
Daily Trips : 24.25
Average Trip Length (Km) : 4.91

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	34	8.14
Car	10	2.52
Auto	15	3.64
Public Transport	0.0	0.0
Walk	24	5.78
Cycle	17	4.16

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	b	c
71.8	0.4552	0.03102

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.0035	0.8069
Car	0.31793	-0.0047
Auto	0.3238	0.0000
Public Transport	-	-

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	value	%	**value**	%	**value**	%
PV+ IPT (In Nos)*	16.5	60.19	22.54	61.37	30.24	61.76
PT (in Nos.)*	0.0	0.0	0.0	0.0	0.0	0.0
NMT *(In nos.)**	10.91	39.81	14.19	38.63	18.73	38.24

(Note:- model output, **-estimated)*

Name of the City	NAGPUR

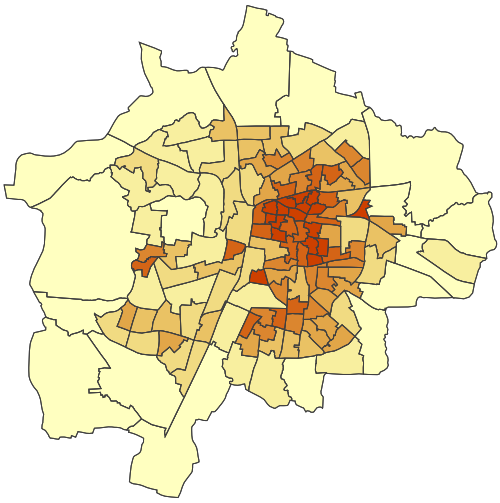
Nagpur, located in Maharashtra State, is at practically the geographical center of India; in fact, the Zero Milestone of India (a heritage monument) is in this city. Nagpur is bordered by Amravati and Wardha in the west, Bhandara in the east and Chandrapur in the south. Nagpur is situated 837 km from Mumbai, 1094 km south of Delhi, 1092 km north of Chennai and 1140 km west of Kolkata. The study area is the planning Area comprising about 270 sq. kms. comprising 21.13 lakh population as per 2001 census. The total number of registered vehicles in Nagpur city as in 2005 is 4, 59,000.

I. General:

Study Area	**:** 270 Sq.Km
Administrative Boundary	**:** Nagpur Planning Area
Population (2001)	**:** 21.13 lakhs
2007 Population (estimated)	**:** 23.61 Lakhs
2007 Employment (estimated)	**:** 7.19 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: No
Population Category	: 4
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 23

Network Map

Network Length	: 632Km
Number of Links	: 2161
Number of Nodes	: 1379



Zone Map

Number Of Zones	: 141
Internal Zones	: 136
External Zones	: 5

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.29
Daily Trips	: 30.38
Average Trip Length (Km)	: 5.01

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	35	10.57
Car	7	2.06
Auto	7	1.98
Public Transport	8	2.49
Walk	21	6.34
Cycle	23	6.93

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	B	c
68.3	0.4349	0.02975

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.3051	-0.3669
Car	0.01334	-0.0676
Auto	-0.0630	-0.0419
Public Transport	-0.0315	0.46586

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	17.645	53.07	23.672	54.67	31.623	55.45
PT (in Nos.)*	1.504	4.52	1.811	4.18	2.172	3.81
NMT *(In nos.)**	14.099	42.41	17.817	41.15	23.230	40.74

(Note:- model output, **-estimated)*

Name of the City	JAIPUR

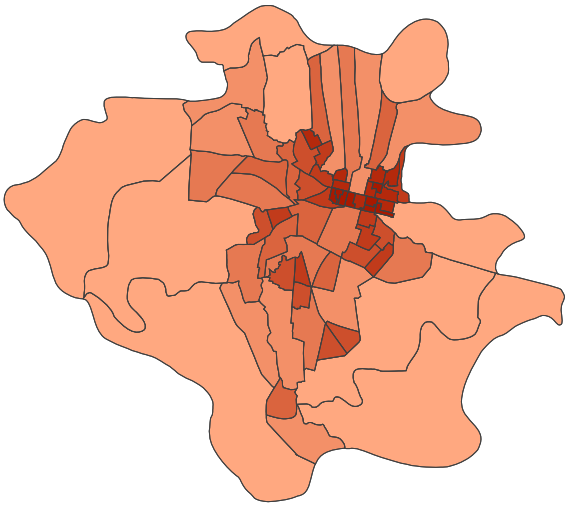
Jaipur, the capital of Rajasthan State, is popularly called the 'Pink City'. Jaipur is known as one of the first planned cities of India. The study area is the Jaipur Development Area comprising about 544 sq. kms. with about 26.8 lakh population as per 2001 census. The Jaipur Municipal Corporation has the Population of 23.2 lakhs with a decadal growth rate of 52%. The total number of registered vehicles in Jaipur city in 2004-05 is 72,248.

I. General:

Study Area	**:** 544 Sq.Km
Administrative Boundary	**:** Jaipur Developement Area
Population (2001)	**:** 26.8 lakhs
2007 Population (estimated)	: 29.4 Lakhs
2007 Employment (estimated)	**:** 9.78 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 4
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 20.9

Network Map

Network Length	: 557Km
Number of Links	: 1067
Number of Nodes	: 715



Zoning Map

Number Of Zones	: 75
Internal Zones	: 70
External Zones	: 5

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.26
Daily Trips	: 37.11
Average Trip Length (Km)	: 6.02

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	26	9.80
Car	8	3.04
Auto	4	1.60
Public Transport	22	8.22
Walk	26	9.53
Cycle	13	4.92

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values are as follows

Calibration Functions

a	B	c
60.5	0.3886	0.02685

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.2848	-0.3417
Car	-0.13616	-0.0293
Auto	-0.2991	0.0245
Public Transport	-0.0248	-0.05562

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	19.973	48.99	36.124	51.16	61.937	52.62
PT (in Nos.)*	5.389	13.22	8.594	12.17	13.029	11.07
NMT *(In nos.)**	15.410	37.80	25.898	36.67	42.737	36.31

(Note:- model output, **-estimated)*

Name of the City	KANPUR

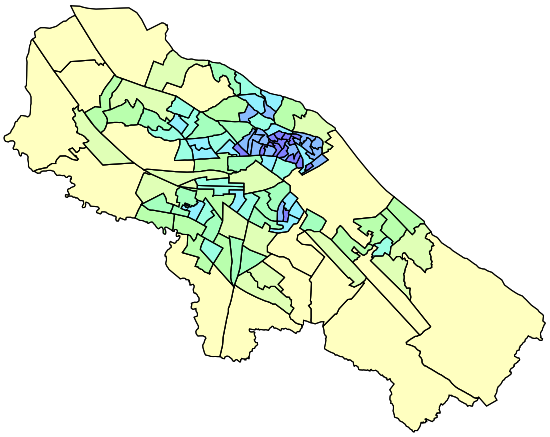
Kanpur is a metropolitan city, situated on the southern bank of Ganga River and has been an important place in the history of modern India. Kanpur is the biggest city of the State of Uttar Pradesh and is main centre of commercial and industrial activities. The study area is the Kanpur Development Area comprising about 597 sq. kms. comprising 27.16 lakh population as per 2001 census. The Kanpur Municipal Corporation has the Population of 25.32 lakhs with a decadal growth rate of 36%. The total number of registered vehicles in Kanpur city in 2005-06 is 49,468, which has increased nearly 63% during 1999-06.

I. General:

Study Area	**:** 597 Sq.Km
Administrative Boundary	**:** Kanpur Development Area
Population (2001)	**:** 27.16 lakhs
2007 Population (estimated)	**:** 31.22 Lakhs
2007 Employment (estimated)	**:** 11.13 Lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: No
Population Category	: 4
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 20

Network Map

Network Length : 885Km
Number of Links : 1360
Number of Nodes : 904



Zoning Map

Number Of Zones : 116
Internal Zones : 111
External Zones : 5

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 1.20
Daily Trips : 37.60
Average Trip Length (Km) : 5.56

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	21	8.01
Car	16	5.94
Auto	7	2.51
Public Transport	9	3.21
Walk	29	10.80
Cycle	19	7.14

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	B	c
58.8	0.3782	0.02620

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.0279	-0.3398
Car	-0.03313	0.0009
Auto	-0.0826	-0.0256
Public Transport	0.0033	0.58119

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	21.076	49.31	30.633	51.00	40.659	51.81
PT (in Nos.)*	1.880	4.40	2.450	4.08	2.919	3.72
NMT *(In nos.)**	19.785	46.29	26.977	44.92	34.897	44.47

(Note:- model output, **-estimated)*

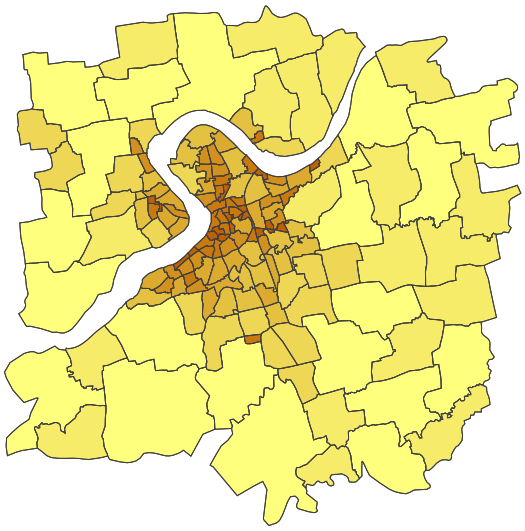
Name of the City	SURAT

Surat is India's twelfth and Gujarat's second most populous city (2001). The city is the commercial capital of Gujarat State and is of significant importance to the country. The study area is the Surat Urban Development Area covering about 892 sq. kms. and comprising 30.90 lakh population as per 2001 census. This includes Surat Municipal Corporation with the population of 24.33 lakhs. The total number of registered vehicles in Surat city in 2005 is about 9.84 lakhs. The vehicle population in Surat has an annual average growth of 9% during 1991-05.

I. General:

Study Area	**:** 680 Sq.Km
Administrative Boundary	**:** Surat Urban Development Area
Population (2001)	**:** 30.90 lakhs
2007 Population (estimated)	**:** 33.51 Lakhs
2007 Employment(estimated)	**:** 11.05 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: No
Population Category	: Category -4
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 24.2

Network Map



Zoning Map

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 1.28
Daily Trips : 47.38
Average Trip Length (Km) : 6.01

Mode	Share (%)	Trips
Two Wheeler	34	16.12
Car	16	7.56
Auto	7	3.50
Public Transport	0.0	0.10
Walk	27	12.64
Cycle	16	7.46

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	B	c
56.3	0.3638	0.02530

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.2916	-0.1181
Car	0.08912	-0.0649
Auto	0.0250	-0.0177
Public Transport	0.0181	0.6125

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	32.524	58.29	49.934	59.13	68.570	59.95
PT (in Nos.)*	0.066	0.12	0.091	0.11	0.114	0.10
NMT *(In nos.)**	23.205	41.59	34.425	40.76	45.703	39.95

(Note:- model output, **-estimated)*

Name of the City	PUNE

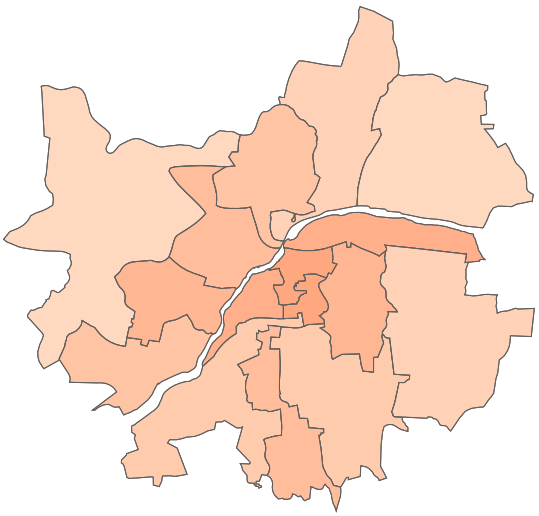
Pune is an important regional centre in the urbanized State of Maharashtra. It is situated 177 Km South East of Mumbai. Pune Metropolitan Area (PMA) is selected as the study area, with a population of 42 lakhs as per 2001 census. Pune is developed in circular shape. Three National Highways No. 4, 9 and 50 provides regional connectivity. The road network is comprised mainly by 4 lane roads. Public Transport need of the city is performed by buses operated by Pune Mahanagar Pravahan Mahamandal Limited (PMPML).

I. General:

Study Area	**:** 700 Sq. km
Administrative Boundary	**:** Pune Metropolitan Area
Population (2001)	**:** 42 lakhs
2007 Population (estimated)	**:** 50.2 Lakhs
2007 Employment (estimated)	**:** 17.80Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: No
Population Category	: 5
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 24

Network Map

Network Length : 484Km
Number of Links : 858
Number of Nodes : 589



Zoning Map

Number Of Zones : 20
Internal Zones : 16
External Zones : 4

II. Base year Trip Characteristics

Per capita Trip Rate : 1.30
Daily Trips : 65.05
Average Trip Length (Km) : 6.14

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	35	23.07
Car	12	7.88
Auto	7	4.87
Public Transport	12	7.64
Walk	22	14.36
Cycle	11	7.24

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and the values are as follows

Calibration Functions

a	b	c
46.4	0.3046	0.02160

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.3140	1.6220
Car	0.50429	-0.0693
Auto	0.5790	-0.0606
Public Transport	0.1202	0.74522

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	Value (Lakhs)	**%**	**Value (Lakhs)**	**%**	**Value (Lakhs)**	**%**
PV+ IPT (In Nos)*	52.560	47.85	73.825	50.22	98.980	51.85
PT (in Nos.)*	6.333	5.77	6.358	4.32	6.857	3.59
NMT *(In nos.)**	50.942	46.38	66.835	45.67	85.059	44.56

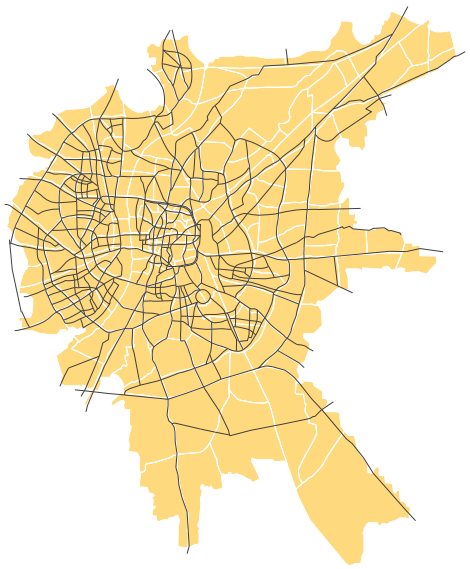
(Note:- model output, **-estimated)*

Name of the City	AHMEDABAD

Ahmedabad, the capital city of Gujarat State, located on the eastern bank of the river Sabarmati, now the seventh largest metropolis in India and the largest in Gujarat state. The city was once famous as the 'Manchester of India' on account of its textile industry. The study area is the Ahemadabad Urban Development Area comprising about 1330 sq. kms. comprising 59.34 lakh population as per 2001 census. The Ahmedabad Municipal Corporation has the Population of 35.15 lakhs with a decadal growth rate of 22%. The total number of registered vehicles in Ahemadabad in 2001 is 12, 10,278 lakhs. The vehicle population in Ahemadabad has an annual average growth of 8.5% during 1991-01.

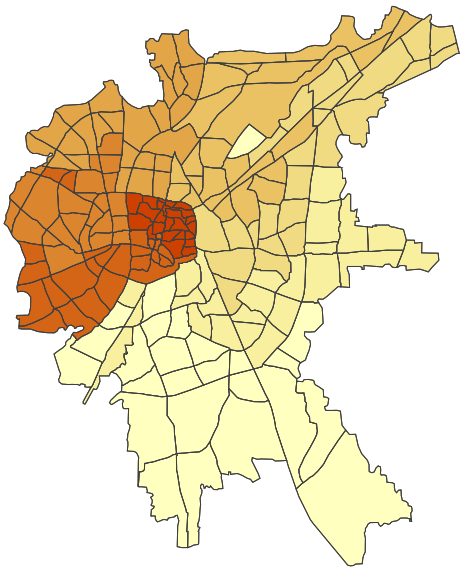
I. General:

Study Area	**:** 1330 Sq.Km
Administrative Boundary	**:** Ahemadabad Urban Development Area
Population (2001)	**:** 59.34 lakhs
2007 Population (estimated)	**:** 68.20 Lakhs
2007 Employment (estimated)	: 22.90 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 5
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 21



Network Map

Network Length	: 424.92Km
Number of Links	: 865
Number of Nodes	: 548



Zoning Map

Number Of Zones	: 203
Internal Zones	: 197
External Zones	: 6

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.41
Daily Trips	: 96.06
Average Trip Length (Km)	: 6.20

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	26	25.27
Car	8	7.65
Auto	7	6.85
Public Transport	11	10.78
Walk	32	30.88
Cycle	15	14.63

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $\quad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	B	c
32.0	0.2194	0.01627

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1211	0.6680
Car	0.28528	-0.0308
Auto	0.2799	-0.0497
Public Transport	0.4842	0.89992

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	47.08	42.87	68.53	45.46	93.47	48.96
PT (in Nos.)*	11.81	10.75	11.66	7.93	12.37	6.48
NMT *(In nos.)**	50.94	46.38	66.83	46.61	85.06	44.56

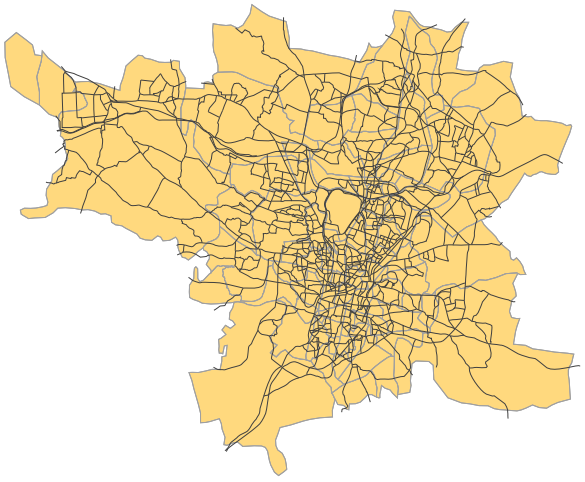
(Note:- model output, **-estimated)*

Name of the City	HYDERABAD

Hyderabad, the capital city of Andhra Pradesh, is located on the cross roads of the rivers, Krishna and Godavari are situated in the Telangana region of Andhra Pradesh. Hyderabad is not only the administrative capital but also the economic and financial capital of Andhra Pradesh. The study area is the Hyderabad Urban Development Area comprising about 900 sq. kms. with 63.83 lakh population as per 2001 census. Hyderabad is currently ranked as the sixth largest urban agglomeration in the country. The total number of registered vehicles in Hyderabad in 2001 is about 9.50 lakhs with an annual average growth of 8.5% during 1991-01.

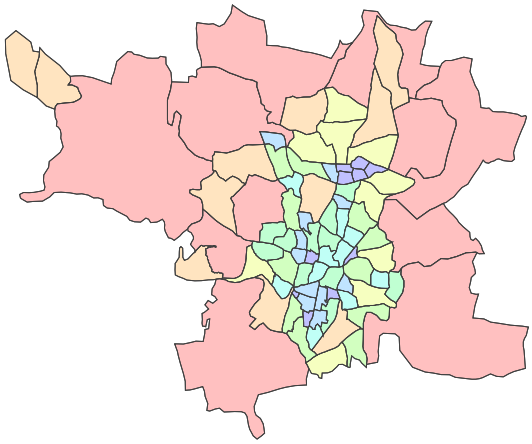
I. General:

Study Area	**:** 900 Sq.Km
Administrative Boundary	**:** Hyderabad Urban Development Area
Population (2001)	**:** 63.83 lakhs
2007 Population (estimated)	**:** 79.86 Lakhs
2007 Employment (estimated)	**:** 25.62 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: Category -5
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 19



Network Map

Network Length : 1239Km
Number of Links : 1787
Number of Nodes : 1179



Zoning Map

Number Of Zones : 91
Internal Zones : 85
External Zones : 6

II. Base year Trip Characteristics

Per capita Trip Rate (all modes) : 1.45
Daily Trips : 116.29
Average Trip Length (Km) : 7.90

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	22	25.67
Car	9	10.10
Auto	7	7.82
Public Transport	32	37.17
Walk	22	25.62
Cycle	9	9.91

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and the values are as follows

Calibration Functions

a	B	c
27.6	0.1930	0.01463

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.2559	0.3705
Car	0.21397	-0.0578
Auto	0.1850	-0.0617
Public Transport	0.6901	0.91706

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	65.612	48.45	122.974	54.56	167.482	57.96
PT (in Nos.)*	29.140	21.52	36.069	16.00	38.093	13.18
NMT *(In nos.)**	40.682	30.04	66.363	29.44	83.386	28.86

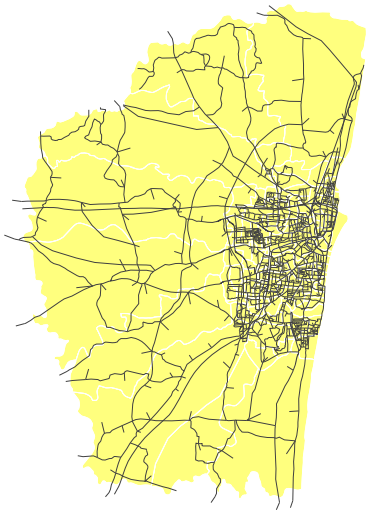
(Note:- model output, **-estimated)*

Name of the City	Chennai

Chennai is the oldest Municipal Corporation in India and is the capital city of Tamil Nadu. The city stretches its 19-km length along the Coromandel Coast and extends about 9 km towards inland. The study area is the Chennai Metropolitan Area (CMA) comprises the city of Chennai and its outlying urban and rural areas. The outlying area consists of one cantonment, 4 Townships, 16 Municipalities, 20 Special Village Panchayats and 213 Village Panchayats in 10 Panchayat Unions. The extent of CMA including St. Thomas Mount cantonment is 1189 Sq.km . The Chennai City area now covers 177 Sq.km. As per 2001 census, the study area has the population of 70.14 lakhs. Four National Highways such as NH 45, NH 4, NH 205 and NH 5 connects the city with other States and form the major arterials for the city. The city is developed in circular shape. Chennai has a road network length of 1183 km. The major road network is comprised by 83% of 4 lane, 14 % of 6 lane etc. Public Transport need of the city is performed by buses, Sub urban Trains and MRTS.

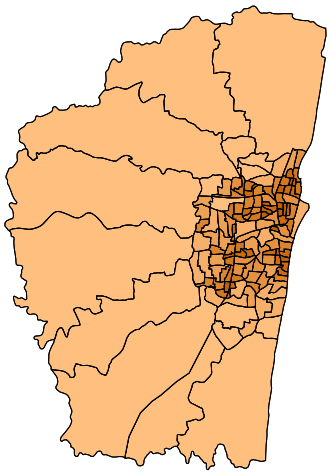
I. General:

Study Area	**:** 1189 Sq.Km
Administrative Boundary	**:** Chennai Metropolitan Area
Population (2001)	**:** 70.14 lakhs
2007 Population (estimated)	**:** 84.3 Lakhs
2007 Employment (estimated)	**:** 25.32 Lakhs
Shape of the city	**:** Semi Circular
Capital City (Yes/No)	: Yes
Population Category	: 5
Shape Category	: 2
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 19.0



Network Map

Network Length	:1183Km
Number of Links	: 2224
Number of Nodes	: 1517



Zoning Map

Number Of Zones	: 138
Internal Zones	: 130
External Zones	: 8

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.50
Daily Trips (Lakhs)	: 126.42
Average Trip Length (Km)	: 8.6

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	20	25.68
Car	10	12.14
Auto	8	10.51
Public Transport	31	38.64
Walk	22	27.84
Cycle	9	11.60

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $\quad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions and values as follows

Calibration Functions

a	b	c
28.0	0.1955	0.01478

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.0713	-0.1018
Car	0.09356	-0.0206
Auto	0.0305	-0.0549
Public Transport	0.6681	0.91653

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (lakhs)	%	Value (lakhs)	%	Value (lakhs)	%
PV+ IPT (In Nos.)*	73.505	49.06	110.721	54.88	150.372	58.14
PT (in Nos.)*	30.501	20.36	30.551	15.14	32.273	12.48
NMT (In nos.) **	45.835	30.59	60.493	29.98	76.010	29.39

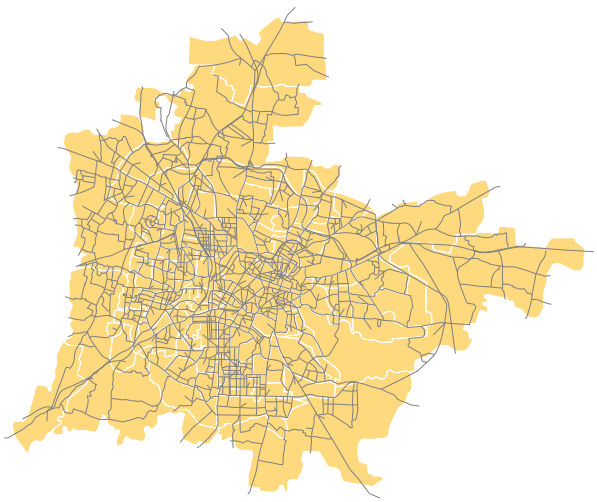
(Note:- model output, **-estimated)*

Name of the City	BANGALORE

Bangalore, the Capital of Karnataka situated in the southeast of the State, is the fifth largest metropolitan city in the country. It is well known – nationally and internationally – as a destination of choice for high-technology industries, particularly in the IT/ITES and Biotechnology sectors. The study area is the Bangalore Metropolitan Regional Development Area comprising about 1279 sq. kms. comprising 86.25 lakh population as per 2001 census. The Bangalore Municipal Corporation has the Population of 43.06 lakhs with a decadal growth rate of 37%. The total number of registered vehicles in Bangalore in 2006 is 25, 17, 365. The vehicle population in Bangalore has experienced an annual average growth of 17% during 1980-04.

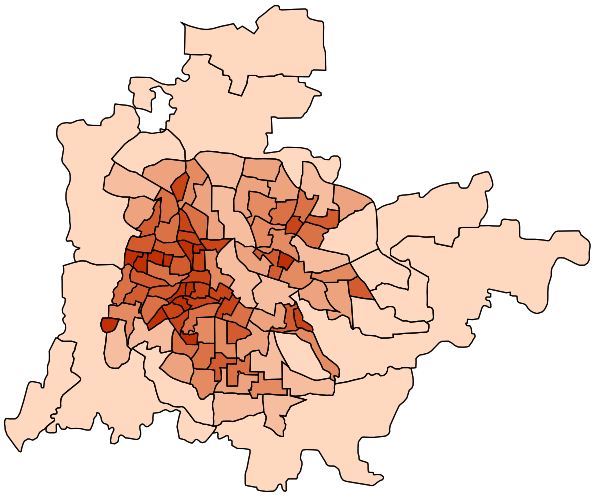
I. General:

Study Area	**:** 1279 Sq.Km
Administrative Boundary	**:** Bangalore Metropolitan Regional Development Area
Population (2001)	**:** 86.25 lakhs
2007 Population (estimated)	**:** 106.7 Lakhs
2007 Employment (estimated)	**:** 34.53 Lakhs
Shape of the city	**:** Circular
Capital City (Yes/No)	: Yes
Population Category	: 6
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 18



Network Map

Network Length	: 1206Km
Number of Links	: 2328
Number of Nodes	: 1565



Zoning Map

Number Of Zones	: 115
Internal Zones	: 108
External Zones	: 7

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.41
Daily Trips	: 150.44
Average Trip Length (Km)	: 9.60

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	21	32.10
Car	8	11.52
Auto	11	16.20
Public Transport	35	53.02
Walk	20	29.40
Cycle	5	8.21

III. Base year Calibrated Model Functions

Trip Distribution

$$T_{ij} = A_i O_i B_j D_j F_{ij}, \qquad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	B	c
32.2	0.2203	0.01633

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.1986	2.5819
Car	0.71696	-0.0464
Auto	0.8760	0.0587
Public Transport	0.4782	0.89895

V. Travel demand Forecast

Mode	**Horizon Year Trips/Day**					
	2011		**2021**		**2031**	
	Value (Lakhs)	**%**	**Value (Lakhs)**	**%**	**Value (Lakhs)**	**%**
PV+ IPT (In Nos)*	87.352	49.98	134.255	57.04	183.709	60.89
PT (in Nos.)*	44.610	25.52	44.582	18.94	46.990	15.57
NMT *(In nos.)**	42.828	24.50	56.525	24.02	71.024	23.54

(Note:- model output, **-estimated)*

Name of the City	Delhi

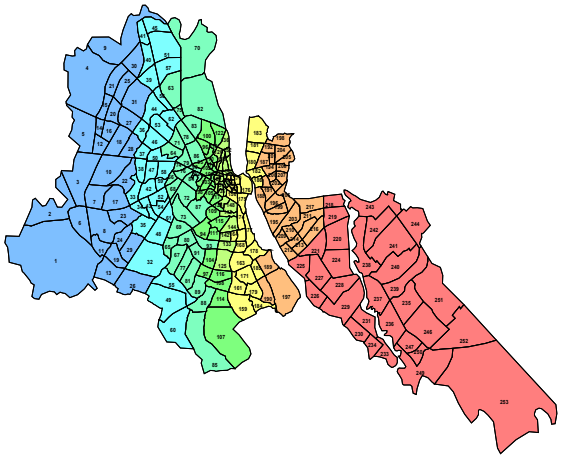
Delhi, the capital of India, shares borders with the States of Uttar Pradesh and Haryana. The Yamuna River and terminal part of the Aravali hill range are the two main geographical features of the city. The study area taken for the study is the National Capital Territory of Delhi, includes Municipal Corporation of Delhi, Noida, Greater Noida with the area of 1758 Sq. Km. As per 2001 census the population was 138.5 lakhs. The city is developed in semi circular shape. Seven National Highways such as NH 1, NH 2, NH 8, NH 10, NH 24, NH 57 and NH 58 connects the city with other states. Public Transport need of the city is performed by bus and metro.

I. General:

Study Area	**:** 1758 Sq.Km
Administrative Boundary	**:** National Capital Territory of Delhi
Population (2001)	**:** 138.5 lakhs
2007 Population (estimated)	**:** 157.44 Lakhs
2007 Employment (estimated)	**:** 64.02 Lakhs
Shape of the city	**:** circular
Capital City (Yes/No)	: Yes
Population Category	: 6
Shape Category	: 1
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 16.0

Network Map

Network Length	:2476Km
Number of Links	: 5875
Number of Nodes	: 3873



Zoning Map

Number Of Zones	: 256
Internal Zones	: 248
External Zones	: 8

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.55
Daily Trips (Lakhs)	: 245.61
Average Trip Length (Km)	: 10.20

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	5	12.61
Car	14	33.81
Auto	6	13.73
Public Transport	43	104.72
Walk	21	52.20
Cycle	12	28.55

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where,
'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function

Calibration Functions

a	b	c
1.0	-0.0152	0.01

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	0.0233	-0.0302
Car	0.02077	-0.0002
Auto	0.0221	-0.0233
Public Transport	0.0001	0.13819

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	107.574	40.06	199.981	47.78	315.619	52.03
PT (in Nos.)*	74.44	27.72	86.358	20.63	103.209	17.01
NMT (In nos.)**	86.535	32.22	132.184	31.58	187.786	30.96

(Note:- model output, **-estimated)*

Name of the City	KOLKATA

Located on the Eastern banks of river Ganges, Kolkata is the State capital of West Bengal and one of the major metropolises of India. It is the primate city in West Bengal which has been the British capital of India and a major port based trade city of this part of the world. Today it is the key business zone with an influence area reaching to the rest of the country. The study area is the Kolkata Metropolitan Area (KMA) that today extends over 1851 sq. km. KMA comprises of three municipal corporations, namely, Kolkata Municipal Corporation, the largest component of KMA with 197.54 sq. km. and Chandannagore and Howrah corporations and other outgrowths. As per 2001 census the KMA has the Population of 147.38 lakhs. The city is developed in linear shape. The public Transport System in KMA consists of the Buses, Trams and metro system.

I. General:

Study Area **:** 1851 Sq.Km

Administrative Boundary **:** Kolkata Metropolitan Area

Population (2001) **:** 147.38 lakhs

2007 Population (estimated) **:** 162.47 Lakhs

2007 Employment (estimated) **:** 53.62Lakhs

Shape of the city **:** Linear

Capital City (Yes/No) : Yes

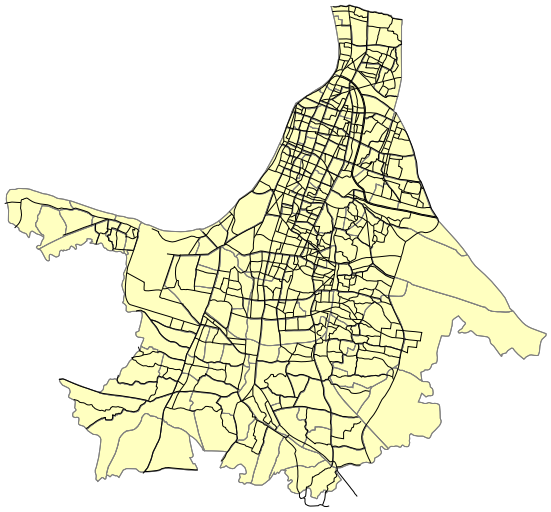
Population Category : 6

Shape Category : 3

Terrain : Plain

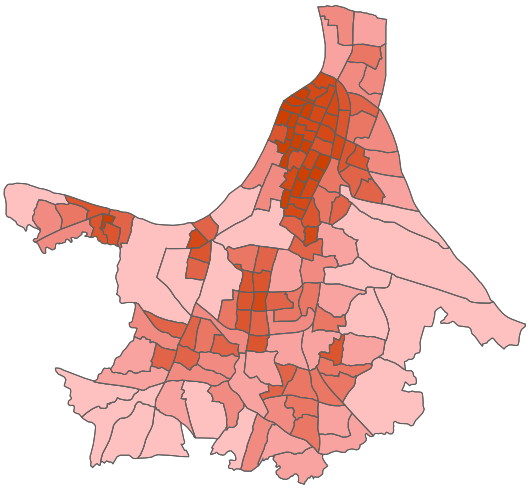
Availability of City Bus service : Present

Average Travel speed (KMPH) on major corridors : 18



Network Map

Network Length	:562Km
Number of Links	: 1448
Number of Nodes	: 936



Zoning Map

Number Of Zones	: 145
Internal Zones	: 141
External Zones	: 4

II. Base year Trip Characteristics

Per capita Trip Rate (all modes)	: 1.56
Daily Trips	: 253.35
Average Trip Length (Km)	: 10.00

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	4	10.08
Car	8	20.91
Auto	4	11.02
Public Transport	54	136.14
Walk	19	48.51
Cycle	11	26.70

III. Base year Calibrated Model Functions

Trip Distribution

$T_{ij} = A_i O_i B_j D_j F_{ij}$, $F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$

Where, 'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,
'Fij- ' Deterrence Function
a, b, c- Calibration functions

Calibration Functions

a	b	c
9.4	0.0850	0.00787

IV. Mode Choice

$V_M = \alpha\ TT_M + \beta\ TC_M$
where

V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.0277	-0.4235
Car	-0.03032	0.0009
Auto	-0.0971	-0.0624
Public Transport	2.5370	0.50486

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	93.896	34.11	155.374	44.09	221.136	49.47
PT (in Nos.)*	100.910	36.65	96.035	27.25	100.335	22.44
NMT *(In nos.)**	80.491	29.24	100.988	28.66	125.567	28.09

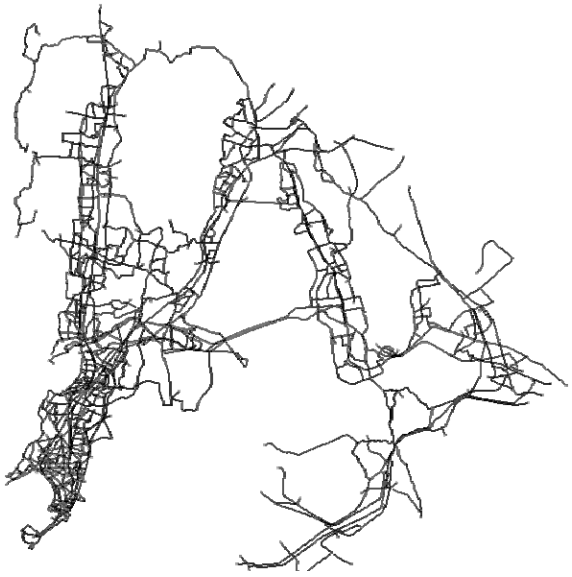
(Note:- model output, **-estimated)*

Name of the City	MUMBAI

Mumbai formerly known as Bombay, is the capital of the Maharashtra. It is the largest metropolis in India and one of the most populous cities in the world. Mumbai is one of the world's top 10 centers of commerce in terms of global financial flow. Mumbai is also the commercial and entertainment capital of India, and houses important financial institutions, such as the Reserve Bank of India (RBI), the Bombay Stock Exchange (BSE), the National Stock Exchange of India (NSE) and the corporate headquarters of many Indian companies and numerous multinational corporations. The study area is the Mumbai Metropolitan Region comprising about 4355 sq. kms. comprising 177.02 lakh population as per 2001 census. The Mumbai city, the main part of the MMR has the Population of 119.9 lakhs with a decadal growth rate of 20%. The total number of registered vehicles in Mumbai in 2001 is 10,29,563.

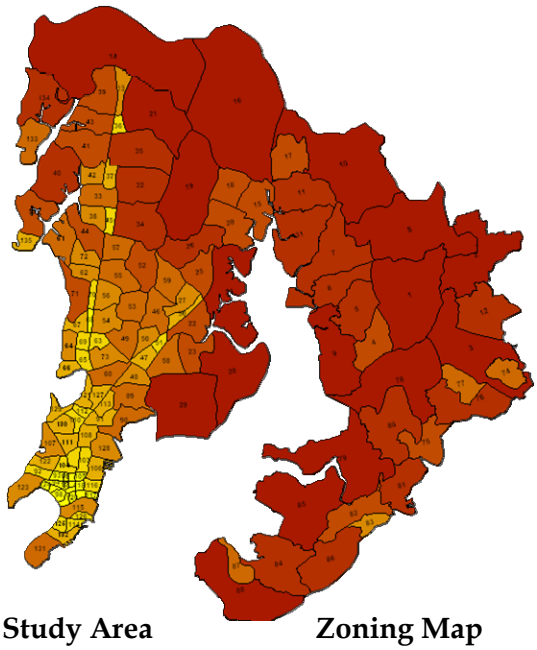
I. General:

Study Area	**:** 4355 Sq.Km
Administrative Boundary	**:** Mumbai Metropolitian Region
Population (2001)	**:** 177.02 lakhs
2007 Population (estimated)	**:** 205.9 Lakhs
2007 Employment (estimated)	: 78.24 Lakhs
Shape of the city	**:** Linear
Capital City (Yes/No)	: Yes
Population Category	: 6
Shape Category	: 3
Terrain	: Plain
Availability of City Bus service	: Present
Average Travel speed (KMPH) on major corridors	: 16



Transcad Network Map

Network Length	: 2100 Km
Number of Links	: 1106
Number of Nodes	: 1681



Study Area **Zoning Map**

Number Of Zones	: 142
Internal Zones	: 136
External Zones	: 6

II. Base year Trip Characteristics

Per capita Trip Rate	: 1.67
Daily Trips	: 343.85
Average Trip Length (Km)	: 11.91

Mode	Share (%)	Trips (Lakhs)
Two Wheeler	7	25.20
Car	8	28.93
Auto	7	22.40
Public Transport	45	154.01
Walk	27	92.93
Cycle	6	20.38

III. Base year Calibrated Model Function
Trip Distribution

$$T_{ij} = A_i O_i B_j D_j F_{ij}, \qquad F_{ij} = aC^{b}_{ij} e^{-cC_{ij}}$$

Where,

'C' is the generalized cost of travel from one zone to other.
Ai , Bj - Balancing Factors,
Oi - Trip Production from zone I,
Dj- Trip Attractions to zone j,

Calibration Functions

a	b	c
-4.0	0.0055	0.00290

IV. Mode Choice

$V_M = \alpha TT_M + \beta TC_M$

Where,
V_M - Utility function
TT_M - Travel Time by Mode M
TC_M - Travel Cost by Mode M
α and β are calibration parameters specific to each mode and values are as follows

Mode	α	β
Two Wheeler	-0.1232	-0.0888
Car	-0.03041	-0.0174
Auto	-0.0116	-0.0376
Public Transport	-0.0426	0.07180

V. Travel demand Forecast

Mode	Horizon Year Trips/Day					
	2011		2021		2031	
	Value (Lakhs)	%	Value (Lakhs)	%	Value (Lakhs)	%
PV+ IPT (In Nos)*	153.945	38.61	250.644	46.69	351.780	51.11
PT (in Nos.)*	115.966	29.09	116.240	21.65	122.876	17.85
NMT *(In nos.)**	128.779	32.30	169.92	31.66	213.560	31.03

(Note:- model output, **-estimated)*

ANNEXURE 3.2. POPULATION AND EMPLOYMENT FORECAST

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

METHODOLOGY ADOPTED FOR POPULATION & EMPLOYMENT PROJECTIONS

A. Population Projections

The population projections for the Project City are carried out by

(i) Understanding the past trend of population dynamics of the Project City;

(ii) Projections carried out by different analytical methods: Arithmetic Method, Incremental Increase Method, Linear Growth Method, and Geometric Increase Method;

(iii) Projections carried out by different agencies for different studies for the Project City.

The final projections and growth rates are arrived at after studying the above methods and past studies and accordingly projected to the Projected Period.

Projected population of the Project City is distributed over the Traffic Analysis Zones (TAZs). Some of the important factors considered for the distribution of population in the study are:

(i) Population Density. If the existing population density in the TAZ is high then in future, it is more likely that the population growth rate would come down. This is because the population in these TAZs is likely to attain saturation. In this regards, the following range for the population density is assumed (the range is arrived at from the support of various past demographic studies conducted for the cities in India):

- Population Density > 350 persons /Ha - Very High Density;
- Population Density 350 – 250 persons /Ha - High Density;
- Population Density 250 – 150 persons /Ha - Medium Density;
- Population Density < 150 persons /Ha - Low Density

(ii) Economic Growth Drivers. The predominant economic activity would influence the movement of people like industries, institutions, etc. Staying close to work place is the general preference. Hence, such TAZs (and their adjoining TAZs) would have more potential for people to reside and as a result, the potentiality of the population growth is high.

(iii) Spatial Growth Constraints. Presence of physical constraints like water body, hills, reserved forest, etc. restricts the growth of the population.

Migration of people from the neighboring towns/villages is also considered.

Projected population for the study cities is presented in the table given below.

Projected Population for the selected Cities

Sl. no	City Name	Population in Lakhs				
		2001	2007	2011	2021	2031
1	Gangtok	0.920	1.115	1.245	1.681	2.209
2	Panaji	0.970	1.047	1.149	1.365	1.657
3	Shimla	1.730	1.847	2.079	2.535	2.941
4	Pondicherry	5.080	5.681	6.079	7.099	8.425
5	Bikaner	6.400	7.642	8.601	10.485	12.168
6	Raipur	7.190	8.610	10.410	14.656	19.927
7	Bhuvaneshwar	8.440	10.939	12.605	18.211	25.600
8	Chandigarh	9.660	11.220	12.915	19.173	28.435
9	Hubli Dharward	9.680	11.167	11.946	14.042	16.168
10	Guwahati	10.600	11.916	13.412	15.096	16.992
11	Amritsar	10.850	11.482	12.322	14.442	16.547
12	Trivandrum	11.220	12.085	12.660	14.296	16.142
13	Madurai	11.850	14.239	15.833	18.020	20.175
14	Agra	13.690	16.773	18.826	24.365	27.554
15	Bhopal	14.580	18.726	21.487	25.873	30.252
16	Kochi	18.180	21.784	24.518	29.887	34.685
17	Patna	18.360	22.672	25.551	37.876	48.884
18	Varanasi	18.950	21.366	22.977	27.876	33.647
19	Nagpur	21.130	23.610	25.261	29.782	35.508
20	Jaipur	26.800	29.443	31.398	49.229	74.284
21	Kanpur	27.160	31.222	33.933	43.168	51.060
22	Surat	30.900	36.896	42.176	57.791	70.863
23	Pune	42.000	50.150	56.444	68.806	79.852
24	Ahmedabad	59.340	68.205	74.116	89.811	105.571
25	Hyderabad	63.830	79.862	90.549	136.430	158.332
26	Chennai	70.140	84.338	94.923	115.711	134.287
27	Bangalore	86.250	106.697	120.089	146.388	169.889
28	Delhi	86.250	157.444	164.658	232.308	304.820
29	Kolkata	147.380	162.466	172.520	199.920	229.590
30	Mumbai	177.020	205.891	231.732	282.480	327.829

(Note: Area includes planning area also)

B. Employment Projections

In the present context, employment refers to the number of jobs held within the TAZ. The past series of employment data (as per Census) was available under the following categories as given below:

(i) Primary Sector:

- Cultivators
- Agricultural Labor
- Livestock, Forestry, Fishing and Plantation
- Mining & Quarrying

(ii) Secondary Sector:

- Manufacturing and Processing in Household Industries
- Manufacturing and Processing in Other than Household Industries
- Construction

(iii) Tertiary Sector:

- Trade and Commerce
- Transport, Storage & Communication
- Other Services

The past trend of each of these categories is analyzed and the workforce participation rate for the entire town is calculated.

In addition, Industrial and Economic Policies of the State (or the City/Region) and Infrastructure Plan, is studied. These policies and studies assist in understanding the kind of investments and developments envisaged for the Project City. Master Plan prepared by the City Development Authority also plays a vital role in understanding the future spatial growth and locations of residential zones, industries, institutions, commercial establishments, etc.

Based on all above factors, the employment projections are carried out for the Project Period. The projected employment is, then re-distributed to the TAZs.

It should be noted that the methodology adopted for the projections are based on the assumptions and can change with City-to-City dynamics. Projection needs enormous and in depth database for each TAZ and especially in Indian context, the unavailability of such database makes projections difficult and hence, assumptions play key role for the exercise.

Projected employment details for the study cities are presented in the table given below.

Employment Projections for the selected Cities

Sl. no	City Name	Employment in Lakhs			
		2007	2011	2021	2031
1	Gangtok	0.31	0.31	0.31	0.32
2	Panaji	0.40	0.40	0.42	0.45
3	Shimla	0.64	0.65	0.67	0.70
4	Pondicherry	1.80	1.81	1.83	1.84
5	Bikaner	2.20	2.35	2.64	2.91
6	Raipur	2.11	2.35	3.03	3.63
7	Bhubaneswar	2.77	2.80	2.85	2.88
8	Guwahati	2.64	2.74	3.02	3.32
9	Chandigarh	2.44	2.53	2.79	3.07
10	Hubli Dharward	2.60	2.82	3.32	3.82
11	Amritsar	4.06	4.69	7.03	10.55
12	Trivandrum	3.71	3.90	4.42	5.01
13	Madurai	3.61	3.64	3.74	3.84
14	Agra	3.69	3.73	3.83	3.93
15	Bhopal	4.83	5.11	5.88	6.76
16	Cochin	6.72	6.99	8.93	9.38
17	Patna	6.04	6.08	6.18	6.25
18	Varanasi	4.94	4.99	5.10	5.16
19	Nagpur	7.19	7.67	8.42	8.44
20	Jaipur	9.78	10.42	12.07	13.85
21	Kanpur	11.13	11.27	11.66	12.09
22	Surat	11.06	12.71	16.00	17.66
23	Pune	17.80	19.19	22.82	25.97
24	Ahmedabad	22.91	25.15	30.39	35.62
25	Hyderabad	25.62	27.95	33.48	39.62
26	Chennai	25.32	28.27	35.84	43.69
27	Bangalore	34.53	37.67	45.83	54.68
28	Delhi	64.02	72.22	117.86	142.13
29	Kolkata	53.62	57.11	66.15	75.94
30	Mumbai	78.24	88.75	113.60	137.13

ANNEXURE 4.1. UNIT COST ESTIMATED FOR URBAN TRANSPORT INFRASTRUCTURE

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

Assumptions in Calculation of Transport Infrastructure Investment needs for various City Categories

Item	Unit	Quantity taken for each city category				Unit Rate (Rs. In crores)	Amount for each city category			
		<5 lakhs	5- 10 lakhs	10-40 lakhs	>40 akhs		<5 lakhs	5- 10 lakhs	10-40 lakhs	>40 akhs
Urban Roads										
Intra city road network	Km.	50	100	150	200	5	250	500	750	1000
Bypasses, developement of major arterials in the outer city area, outer ring road , etc	Km.	10	20	40	50	10	100	200	400	500
Corridor development for major roads in the city	Km.	10	20	40	100	8	80	160	320	800
Bridges	No.	2	4	6	10	25	50	100	150	250
Flyovers/Under passes	No.	0	10	15	20	25	0	250	375	500
RoB/RuB	No.	2	5	10	20	15	30	75	150	300
Traffic Improvements										
Junction Improvements	No.	10	20	40	50	0.25	2.5	5	10	12.5
Parking (on- street)	Km.	10	50	100	200	0.1	1	5	10	20
Parking (off- street)	No.		3	5	8	5	0	15	25	40
Signages and others	Km.	50	100	250	500	0.1	5	10	25	50
Traffic Management	LS						10	50	100	200
ITS	LS						0	100	200	300
NMT Management										
Pedestrian footpath	Km	50	200	300	400	0.5	25	100	150	200
Pedestrian Subways	No.	0	10	15	20	5	0	50	75	100
Cycle tracks	No.	20	50	100	200	0.5	10	25	50	100
Public/Mass transport systems										
Augmentation of Buses (including terminals/bays)	No.	50	250	500	1000	0.5	25	125	250	500
Metro	Km			0	30	150	0	0	0	4500
Monorail/LRT	Km			30	50	100	0	0	3000	5000
BRT/HCBS	Km		0	50	150	14	0	0	700	2100
Inland water transport	LS						50	100	200	300
Intermodal transfer facilities	No.			3	5	20	0	0	60	100
Terminals										
IPT stand	No.	5	10	20	50	0.1	0.5	1	2	5
Mofussil Bus terminals	No.		2	4	5	10	0	20	40	50
Truck terminals	No.		2	4	5	5	0	10	20	25
Others										
Road Safety	LS						5	10	20	50
Urban Transport Planning and Operation data	LS						50	100	150	200
Category-wise Unit Cost (Rs. In Crores)							**694**	**2011**	**7232**	**17203**
Category-wise Unit Cost Rounded off (Rs. In Crores)							**700**	**2020**	**7240**	**17210**
No. of cites in each category							14	35	30	8
Total Cost (Rs. In Crores)							**9,800**	**70,700**	**217,200**	**137,680**

ANNEXURE 4.2 PPP MODEL FOR INDORE BUS OPERATIONS

Wilbur Smith Associates
Private Limited
ENGINEERS & PLANNERS

PLANNING FOR URBAN TRANSPORT IN INDORE

Indore, the most prominent city of Madhya Pradesh and the headquarters of the district of the same name is situated in the western part of Malwa Plateau. Indore is 17th in terms of population among the 23 million plus cities in the country enumerated in the 2001 census. The area covered under the Indore Municipal Corporation (IMC) is almost 134 square kilometers. The total population in the jurisdiction of was around 1.65 Million according to the 2001 census. The only mode of transport within the city is road transport. The city has a dense network of intra city roads. At present the total road length within the city is around 1710 Km. The level of service on most of the major roads is quite low because the peak traffic far exceeds the prescribed load for the roads.

A. Planning authorities

The authorities in Indore with jurisdiction in the activity of planning for the urban transport sector include Indore Municipal Corporation (IMC), Indore Development Authority (IDA), State Public Works Department, Indore Development Fund and District Urban Development Authority.

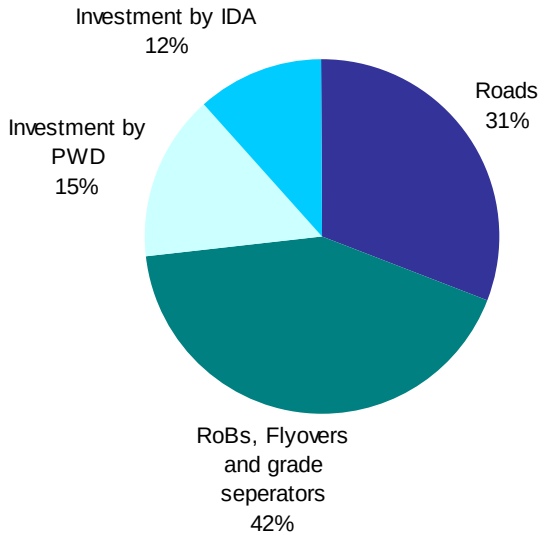
IMC has its origins in the Indore Municipality formed in 1870 under the royal charter of Holkar dynasty. It was converted into a municipal corporation in 1956. At present the IMC area is divided into 12 zones and 69 wards for effective decentralized planning and implementation. IDA is primarily responsible for the development of new residential areas of the city. During the early stages of development of these areas IDA is responsible for the provision of basic infrastructure. Apart from development of new areas, IDA has taken up a number of development schemes like construction of major roads, junction beautification etc.

Indore Development Fund Ltd. is a joint stock company formed for mobilizing funds for repair and construction of roads in the city. It is wholly owned by IMC. Indore City Transport Services Limited (ICTSL) is company formed jointly by the district administration and IMC to provide public transportation services in the city.

B. Investment planned for Urban Transport

The City Development Plan (CDP) prepared for Indore provides the framework for long term investments in traffic and transportation within the city. The CDP provides the investment needs in the sector for planning horizon of 2012. Accordingly the investments for the sector have been estimated to be Rs. 962 Crores. The chart indicates the total investments planned in the sector for the planning horizon of 2012 and the break up of the total investment:

Break up of Investments in Urban Transportation



The investments identified in the CDP are sourced from the comprehensive traffic and transportation master plan to identify the needs of the sector. This plan also assessed the quality of the public transportation situation in Indore and recommended solutions for improvement. In addition to these

investments identified in the CDP, Indore Municipal Corporation had identified a Bus Rapid Transit System project for improving the inadequate public transportation system in the city. A project plan of Rs. 868 Crores was submitted for funding had been submitted to the Central Government for funding under the JNNURM scheme. The central government has sanctioned around Rs. 100 Crores for this project at present.

C. *Investment Projects in Urban Transport*

Currently the investment projects in urban transport under implementation are:

1. Projects for the development of Physical Infrastructure in urban transport network as identified in the CDP

2. Projects for the development of public transportation service in the city, in the form of concurrent and overlapping activities of

    a. Creating and expanding the urban bus service under the aegis of ICTSL

    b. Creating the physical infrastructure for BRTS, so that ICTSL can operate its fleet more efficiently.

The development of the physical infrastructure is proposed to be funded under JNNURM. At this stage there are no private funds being planned for the development of physical infrastructure. The funding structure proposed for the BRTS project [1] is evident of this fact, as indicated in the

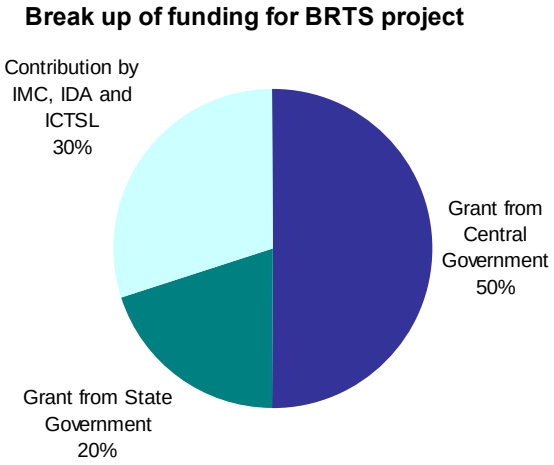


chart below:

However IMC, IDA and the District administration have jointly structured a Public Private Partnership initiative for creating and expanding the urban bus service under the aegis of ICTSL. This arrangement has been presented as a case study in the following sections.

[1] Source: ICTSL sources

Indore City Transport Services Limited: PPP for urban bus service

1. Creation of ICTSL

The World Bank in its note on *"India's Transport Sector, the Challenges Ahead (2002)"* stressed that cities exceeding population of one million should strive towards development of urban mass transport system. The note recommended a public private partnership model for managing the urban transport system. Guided by this model a special purpose vehicle called Indore City Transport Services Ltd (ICTSL) was registered in 2005, under the Companies Act 1956. The company was registered with a paid up share capital of Rs. 2.5 Million, jointly invested by the Indore Municipal Corporation (IMC) and Indore Development Authority (IDA). The stated objectives of the company were:

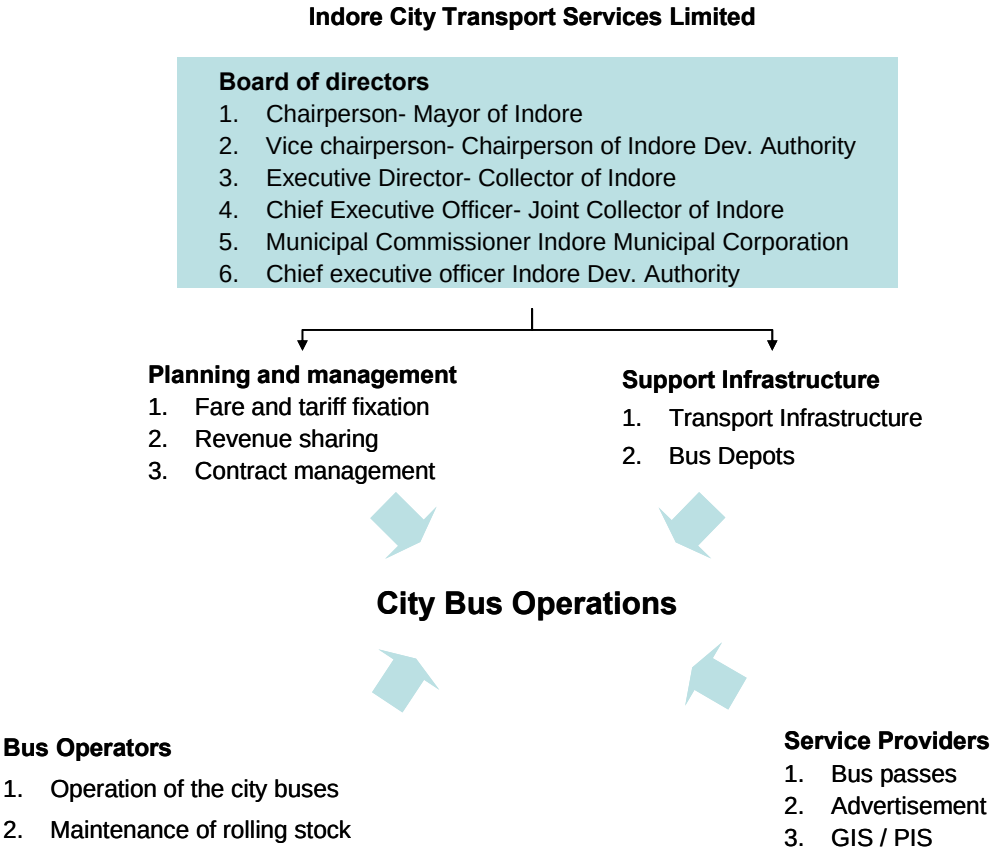
1. To create a specialized and effective regulatory agency to monitor the intra city public transport system

2. To establish and maintain line of passenger coaches to transport passengers

3. To develop support system for improving transport infrastructure

2. Implementation Structure

The structure for implementing urban bus transport system in Indore comprises of Indore City Transport Service Limited, bus operators and the service providers. The following schematic gives an overview of the implementation structure and the interrelationship between the components of the structure.



Indore City Transport Services Limited

The functions of Indore City Transport Services Limited (ICTSL) can be divided into two major heads, Planning and management of the urban bus transport system and provision of infrastructure for operation of the city bus system. The planning and management responsibilities of the company are:

- Fixation of fares and tariffs
- Establishing the revenue sharing arrangements
- Monitoring of quality of service
- Setting standards of performance
- Ensuring adherence to performance standards and environmental standards
- Network and route design
- Assessment of passenger demand
- Franchising and route allocation
- Planning and provisioning of services
- Contract monitoring

In addition to these activities, ICTSL is also responsible for the provision and management of common infrastructure.

2. Bus Operator

The responsibilities of the bus operators are:

- Operate the buses in the assigned routes
- Ensure that the operations conform to the performance standards laid down
- Ensure that the maintenance activities conform to the standards laid down in that regard
- Ensure proper collections, recording and reporting of fare

3. Service providers

The structure put in place by ICTSL envisages involvement of other private entities as vendors of services. These include advertising agency appointed as the sole franchisee for advertising rights in the buses.

3. Development through Public Private Partnership

Once Indore City Transport Services Limited was formed, it initiated the development of the city bus transport system on a PPP model. The steps in implementation are described below:

1. Need assessment and identification of routes for bus network

ICTSL identified the 18 high travel demand routes within the city. The routes were identified on the basis of traffic load on the existing roads. The identification of routes was not supported by an assessment of the circulation patterns in the city linked with its economic growth.

Once the routes were identified, ICTSL carried out complete route testing and time scheduling. Finally the permits for running buses on these routes were taken from the regional transport authority.

2. Definition of public private partnership arrangement

The basis of the public private partnership arrangement was the recommendation of World Bank in its note *"India's Transport Sector, The Challenges Ahead (2002)"*. According to the recommendations, the urban bus transport corporation should have a share of 30% in the total capital investment and 70% of the investment should be contributed by private investment.

Accordingly the investment in the urban bus transport system was shared between ICTSL and private operators and service providers. The investment in common infrastructure like bus stops, office space etc. was contributed by ICTSL while the investment in the rolling stock was made by the private bus operators.

The contractual arrangement between ICTSL and the bus operators is based on a franchise arrangement. Once the routes for operations of the city buses were identified, ICTSL initiated a tendering process inviting private bus operators to bid for operating buses on predefined routes. The bidding was a competitive process whereby the routes were awarded to the bidder quoting the highest amount of monthly premium to be paid by it to ICTSL. The contract between the successful bidder and ICTSL is for tenure of five years based on the following major conditions;

1. The operator would pay a fixed monthly premium to ICTSL against the right of plying the buses on the selected routes and using the shared infrastructure

2. All the operating and maintenance cost, daily running costs, and other cost required for operating the services will be born by the bus operators.

3. The operator will comply with the performance and maintenance standards issued by ICTSL for this purpose.

4. The fare collected by the operators from passengers would be based on tariffs prescribed by ICTSL

Currently there are four operators contracted by ICTSL for carrying out the city bus operations.

3. Public Private Partnership in support services

In addition to the Public Private Partnership arrangement in the operations of the buses, ICTSL involved private parties for provision of services supporting the main operations. These arrangements are listed below:

a) Bus Pass

ICTSL invited tenders from private agencies for establishing and operating a system of selling monthly passes to passengers. ICTSL has appointed a suitable agency for operating the monthly pass system.

b) Advertising

ICTSL invited tenders from private agency for appointment as franchisee for marketing the advertising rights on the buses. ICTSL has appointed a suitable agency as franchisee for marketing the advertising rights.

c) GIS/ PIS

ICTSL invited tenders from private agencies for installing and operating the GIS/ PIS in the city bus system. ICTSL has appointed a suitable agency for this purpose.

4. *Sharing of the risk and responsibility*

Roles/ Obligations/ Responsibilities	ICTSL	Bus Operator	Service Providers
Route Identification	√		
Route assessment and testing	√		
Construction of common facilities	√		
Prescribing specifications for the buses	√		
Prescribing performance standards	√		
Prescribing fares, tariffs and charges	√		
Investment in rolling stock (buses)		√	
Operating buses		√	
Maintaining buses		√	
Collection of fare		√	

Roles/ Obligations/ Responsibilities	ICTSL	Bus Operator	Service Providers
Sale of monthly passes			√
Sale of advertising rights			√
Provision of GIS/ PIS			√
Passenger traffic risk	√	√	
Operating risk	√	√	
Cost escalation risk		√	
Contract risk	√		

5. Financial Model

ICTSL has identified the following sources of revenue from the operations of the city bus system:

d) Fare box

The complete revenue from the fares collected from the passengers rest with the private operators of the bus.

e) Premium from bus operators

The bus operators pay a predetermined amount (amount bid by them at the time of the tendering process) per month to ICTSL for the right of operating buses.

f) Sale of monthly passes

20% of the revenue collected from sale of monthly passes is passed on to ICTSL. The remaining revenue from the sale of passes (80%) is shared between the private agency managing the sale of passes and the operator of the buses.

g) Sale of advertisement rights

40% of the revenue collected from sale of advertisement rights is passed on to ICTSL. The remaining revenue from sale of advertising rights is shared between the private agency functioning is the franchisee for sale of advertisement rights and the operator of the buses.

The bus operators are responsible for operating and maintaining the buses. This expenditure is financed from the revenue shared by them in the system. The operator's share of revenue includes the following;

a) Entire fare box collections

b) 60% of the revenue from sale of advertising rights

c) 80% of the revenue from sale of monthly passes

6. Performance parameters

The performance parameters for all the private entities are prescribed by ICTSL. These include;

a) Technical specifications for the rolling stock; dimensions of the bus, capacity of the bus

b) Specifications for operations; number of buses, frequency, number of trips, time of operations

c) Specifications for the operating staff

d) Standards for maintenance of the rolling stock

e) Standards for support services; Geographic Information System, Passenger Information System

The performance standards are supported by the supervision and monitoring by ICTSL. Additionally operational performance is based on Geographical Positioning System (GPS) based tracking system which monitors timely performance of the buses and adherence to the defined routes.

7. Capacity additions

The buses are operated on predefined capacities. At the initial stage, each operator is required to operate minimum two buses on the routes assigned to them. Once they exceed the capacity in terms of passenger Kms served by them, there is provision for increase in the number of buses. In case the number of buses on any route has to be increased, the first opportunity to deploy buses is given to the existing operator for that route. In case they refuse, opportunity will be given to a new entity.

4. Implementation status

Currently ICTSL has appointed four operators for running the city buses. The operators are running 84 buses on 18 predefined routes. ICTSL has appointed an agency as franchisee for marketing the advertisement rights on the buses. It has also appointed an agency for installing and operating the monthly bus pass system.

5. Other Public Private Partnership initiatives

ICTSL is extending the public private partnership model for operating 100 luxury taxis through out the city. These luxury taxis will be accessible to all citizens through a 24/7 call center.

6. Gap assessment

1. Structure of ICTSL

The corporate structure of ICTSL includes representation from Indore Development Authority, Indore Municipal Corporation and District Administration of Indore. Thus it includes all the stakeholders for the development of urban transport in Indore and facilitates real time coordination between them. A possible addition in the corporate structure would be representation of experts in transportation and urban planning, in advisory capacities.

Expansion of service

According to the terms of the contract between ICTSL and the bus operators, every operator would need to deploy minimum two buses on every route allotted. In case there is more demand on any route, ICTSL will invite the existing operator to deploy additional buses. If the existing operator declines the invitation, then ICTSL will extend the invitation to other private entities. The deployment is thus clearly linked with the demand for service on defined routes. This arrangement gives ICTSL an effective option of scalability of operations within the city.

The scalability of operations is not based on an overall estimation of demand. An estimation of demand for urban bus services within the city and the distribution of demand among the defined routes would have enabled ICTSL to determine the number of buses that need to be deployed and the phasing of deployment.

However this exercise would have required an extensive primary survey to estimate the demand for service and the demand on specific routes. The approach of ICTSL has enabled it to implement the bus service within a shorter planning period.

2. Extension of service to other routes

The Indore City Bus service is currently being provided on 22 routes. These routes were selected on the basis of the traffic load and potential passenger demand, so as to make the contractual arrangement more commercially attractive to private bus operators. As a result of the bus service, the existing transport operators running tempos and mini buses were marginalized. They moved to the lesser roads and started operating as feeders for the bus service.

To meet the need of urban transport in a more comprehensive manner, ICTSL will need to extend this service to other routes, which might not be as profitable as the current routes of the Indore Bus Service. In such a scenario, going forward, ICTSL will have the following imperatives:

- Planning the systematic integration of the tempo and mini bus operators into the system as feeders to the bus service
- Explore the option of cross subsidizing the urban bus services on less commercially attractive routes by working out a negative premium mechanism, where ICTSL pays the operator to run the service

7. Conclusion

The arrangement devised and implemented by ICTSL is a good model of urban bus system on PPP basis. The strategy of ICTSL to implement this system in the high passenger demand corridors and with limited buses to start with was a good decision as it tested the market and

showcased the operations of the system. Since the system is funded by private capital, it is very essential for the commercial viability of any project to be evident to investors before they commit their capital. The fact that ICTSL has been able to communicate the commercial viability of the project to potential operators before the operations has been the key success factor for its operations.

The other key success factor of this strategy was ICTSL managing the quality and safety of the urban bus service from the point of view of the end user. The existing users of bus service in the city would have used the new buses on their own. The challenge for ICTSL was to draw users who were not using the legacy bus service because of the poor quality and safety concerns. Drawing these users to the new bus service was important to draw the benefits of reduced congestion on roads, lesser pollution, reduction in accidents and overall change in travel patterns. The performance standards and the value added services implemented by ICTSL is an effective step towards providing a service attractive enough to draw the new users.