9th Urban Mobility India Conference & Expo 2016
Planning Mobility for City's Sustainability

SUSTAINABLE TRANSPORTATION OPTIONS FOR A TOURIST HILL TOWN. CASE STUDY: DARJEELING

Paper Code: 04031

Dipanjan Nag[1]; Dr. Swati Saha[2]; Dr. Subrata Kumar Paul[3]

[1]Research Scholar, Indian Institute of Technology, Kharagpur
[2]Professor, Indian Institute of Engineering Science & Technology, Shibpur
[3]Assistant Professor, Indian Institute of Engineering Science & Technology, Shibpur

10th November, 2016

Presentation Outline

- Introduction
- Selection of Sustainability Indicators from existing literature.
- Sustainability Analysis
- Inferences and Strategies for Tourist Hill Town in the context of Sustainability

Introduction

- Darjeeling– small hill town in West Bengal– **major tourist destination** .
- **2014, 3 lakhs** of tourists visited Darjeeling. (Source: Dept. Of Tourism, Govt. of WB, 2014)
- Darjeeling—**intended population of 10,000** where **presently** there is a population of **1,18,805** (as per Census 2011) –**daily floating population =9,000 people** approximately.
- **1850—26 wards**; **1998—32 wards** with an area **of 7.43 sq. km.**

Roads leading to Darjeeling (Source: Google Images)

Kanchenjungha from Darjeeling(Source: Google Images)

Introduction

- The **rising population** results in stressing upon the **existing infrastructure.**
- **Infrastructural Capacity problem**—water supply , sanitation and sewerage, solid waste management, **transportation**
- There is **major traffic congestion** and long traffic jam during the **tourist season** (Mar-May and Sept-Nov).

Long Traffic Jam During the tourist Season (Source: Authors)

View of a street during the tourist season (Source: Authors)

Introduction

- **Tourism** (along with Tea) –major contributor of economy, congestion and such **problems** with the **transport** infrastructure would create a **negative impact on tourism.**
- **Economy directly linked with tourism**, the transportation system must be **sustainable** –caters to both the residents and the tourists **economically**, does not degrade the **environment** and be **socially** beneficial to the community.

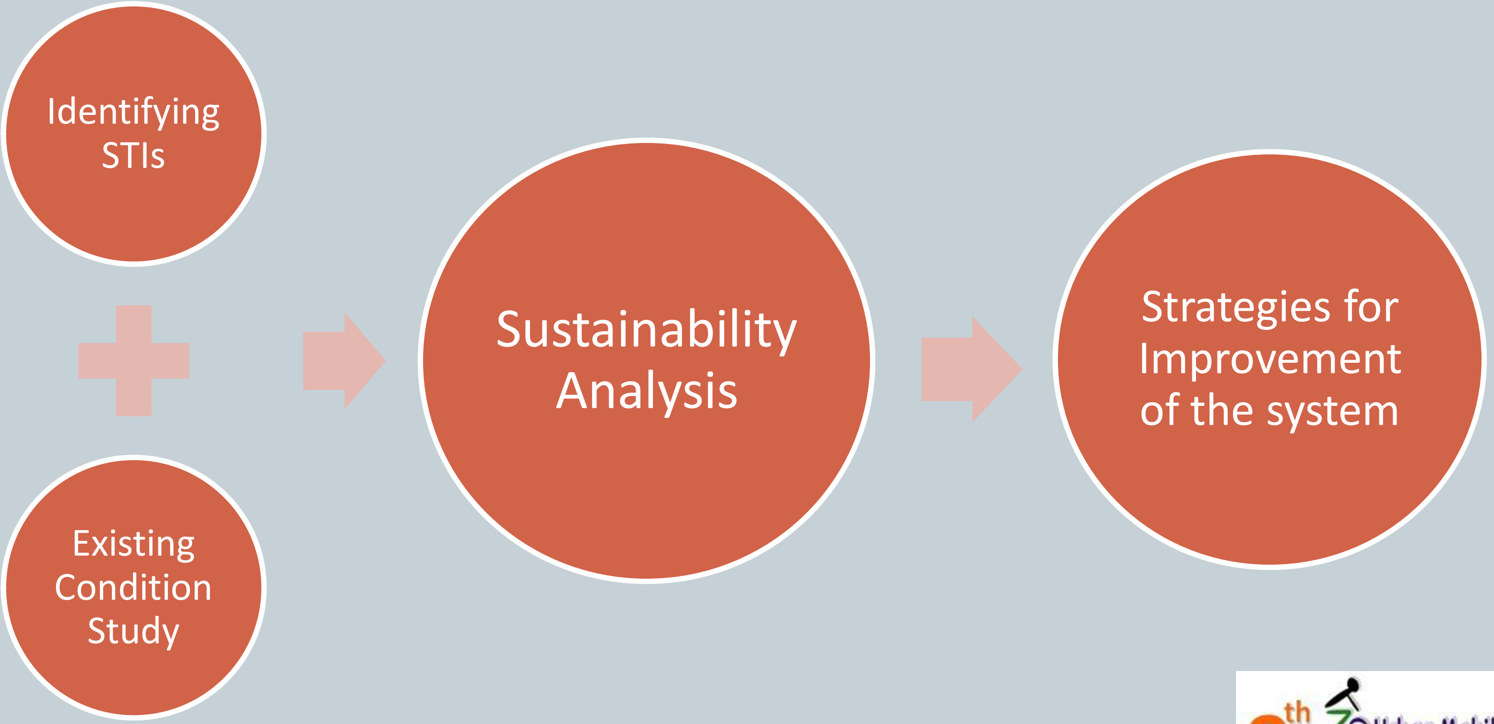
View of a street during the tourist season (Source: Authors)

Urbanisation along the hill slope Season (Source: Authors)

Introduction

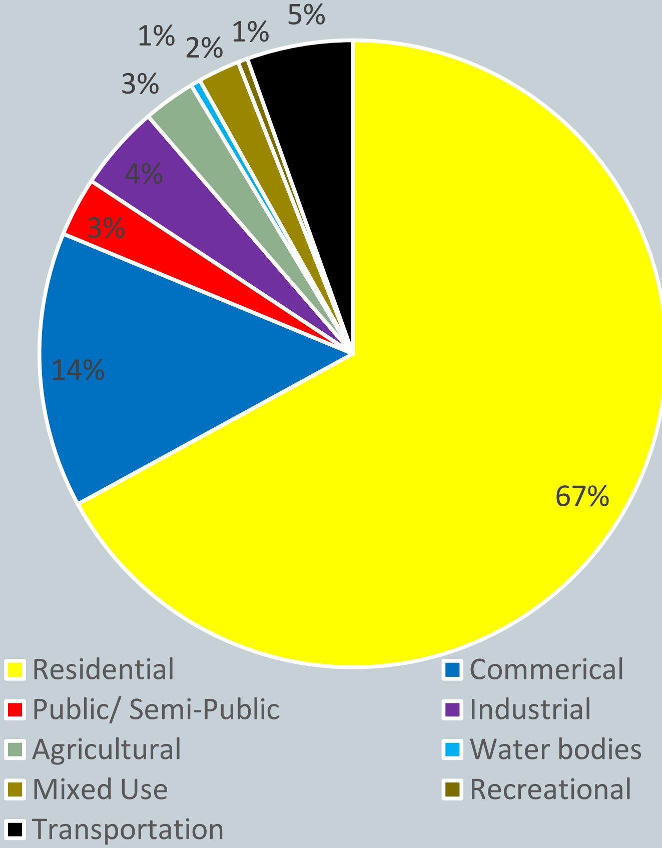
This Study:

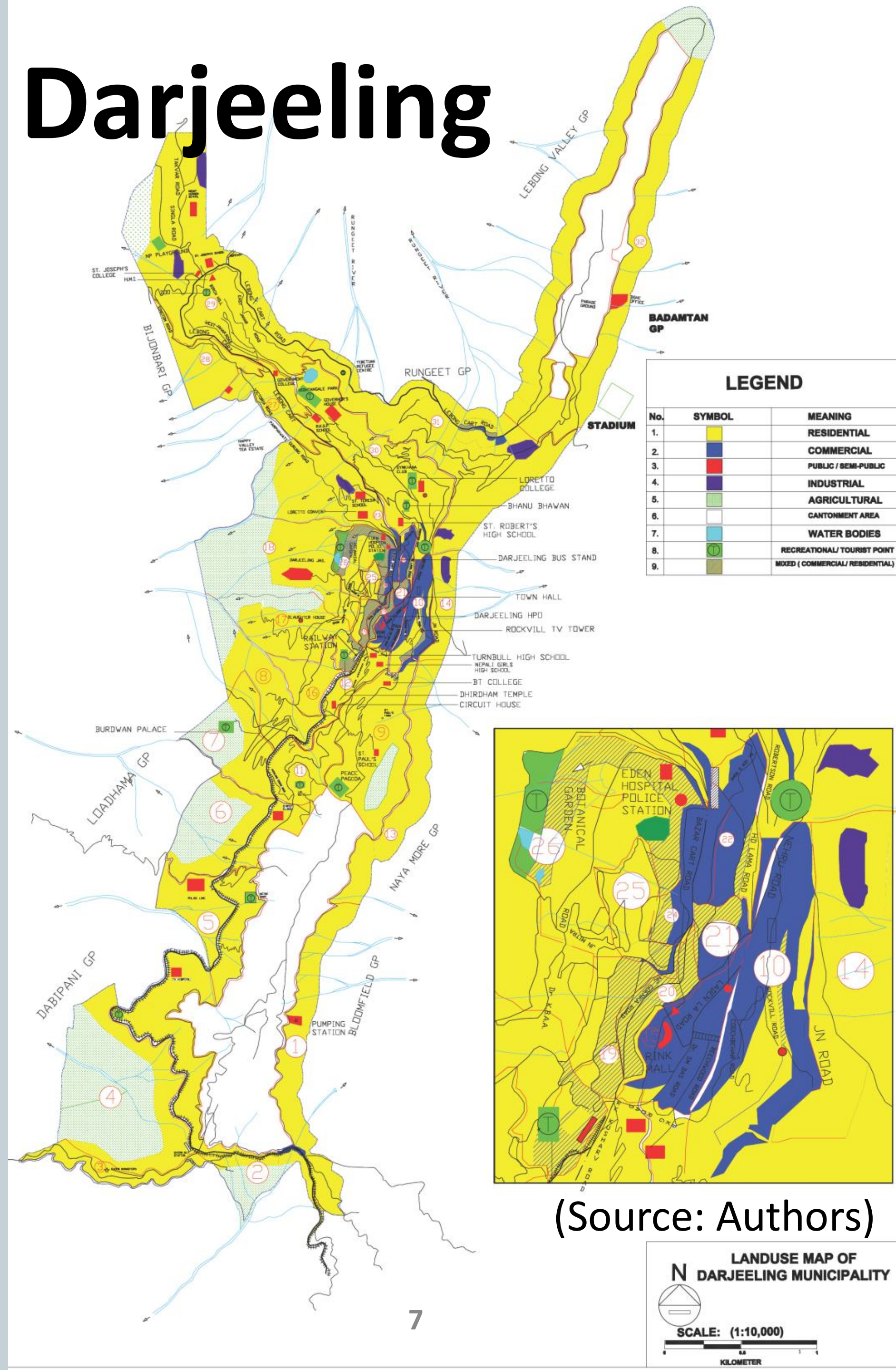
- providing a framework for assessing sustainability (using Sustainable Transport Indicators) of existing transport system
- suggest options to transform this transport system to a sustainable one



Study Area: Darjeeling

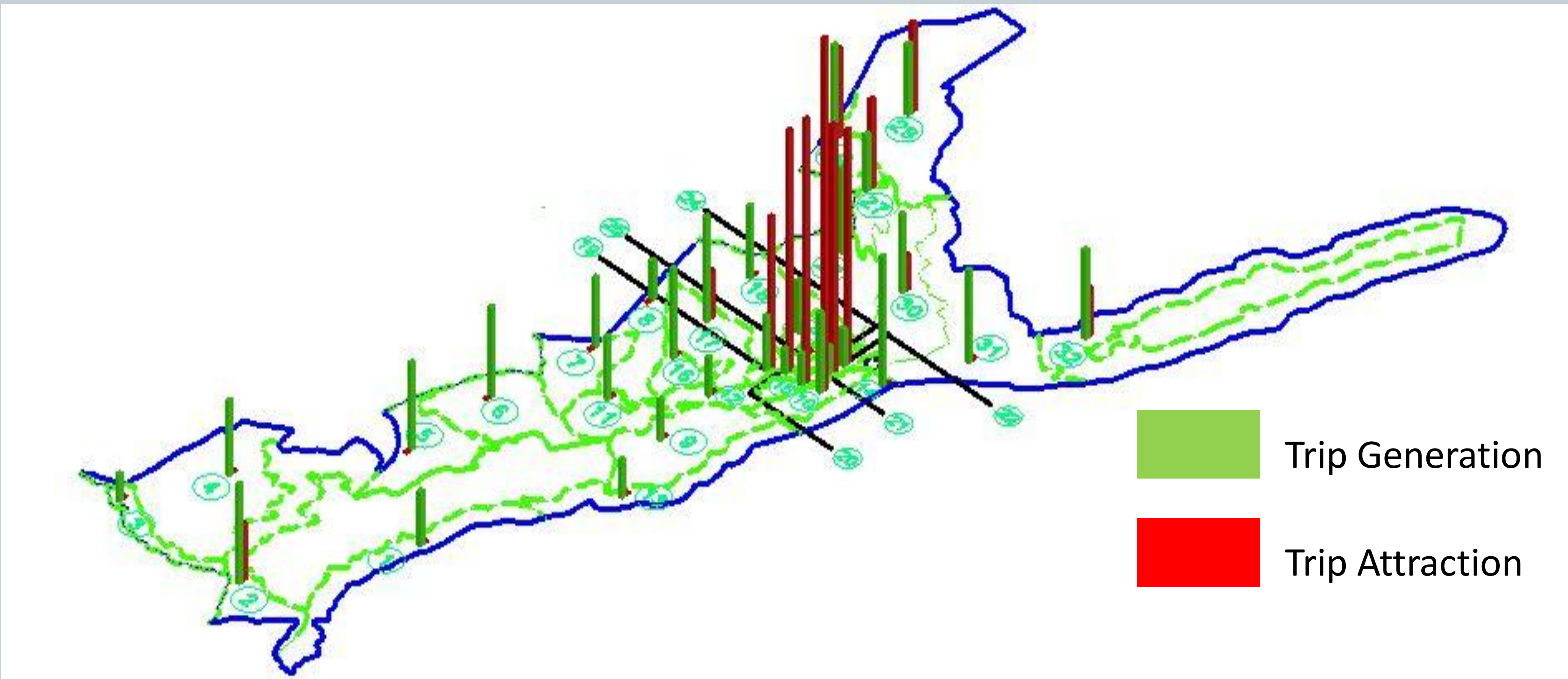
Land Use % break up
(Source: DDP, Darj. Muni.,2008-2013)





(Source: Authors)

Study Area: Darjeeling



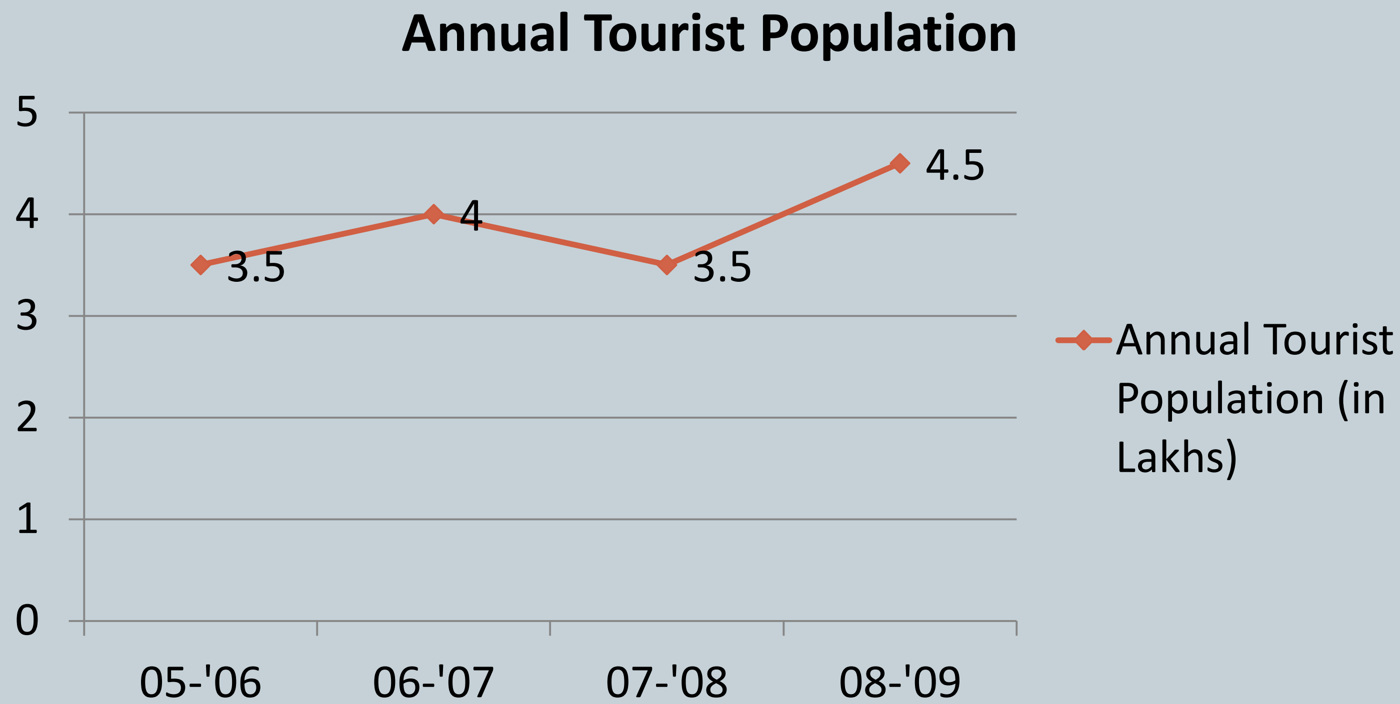
Trip Generating and Attracting zones (Source: Authors)

$$Y = \alpha X + \beta$$

Trip **Generating** models: Y= Trips/HH and X= **Household Size**

Trip **Attracting** model: Y= Trips/AL and X= **Sq. m. of attracting landuse**

Study Area: Darjeeling



(Source: DDP, Darj. Muni.,2008)

During tourist season the population of the town increases three folds.

Existing Literature

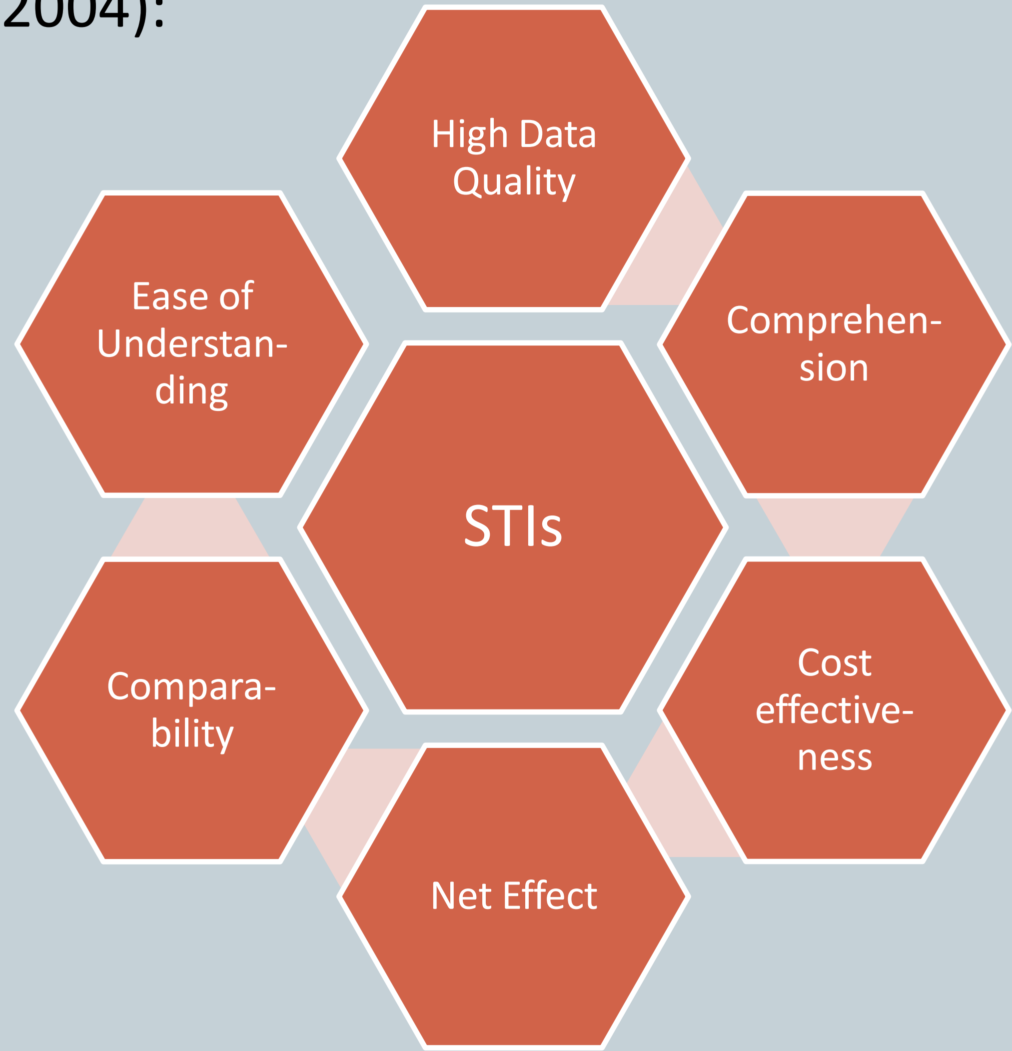
- Sustainable Transport System (Litman, 2007;Black et al., 2002):
  - ✓ Basic **access** to needs—individuals and societies—with equity within and between **generations**.
  - ✓ **Affordable**, **Efficient**, **choice** of mode, and supports a vibrant **economy**.
  - ✓ Limits **emissions**—minimizes & limits **consumption**—**reuses** and **recycles** its components—minimizes the use of **land** and the production of **noise.**

Existing Literature

- **Sustainable Transport Indicators(STIs)** (US-EPA, 2011; Litman, 2007):
  - ✓ *Sustainable Indicator:* a variable selected and defined to **measure progress** toward the common objective of **sustainability**.
  - ✓ *Indicator data:* **values** used in indicators.
  - ✓ *Indicator framework:* **conceptual structure** linking indicators to a theory, purpose or planning process.
  - ✓ *Indicator set:* a **group of indicators** selected to measure comprehensive progress toward goals.

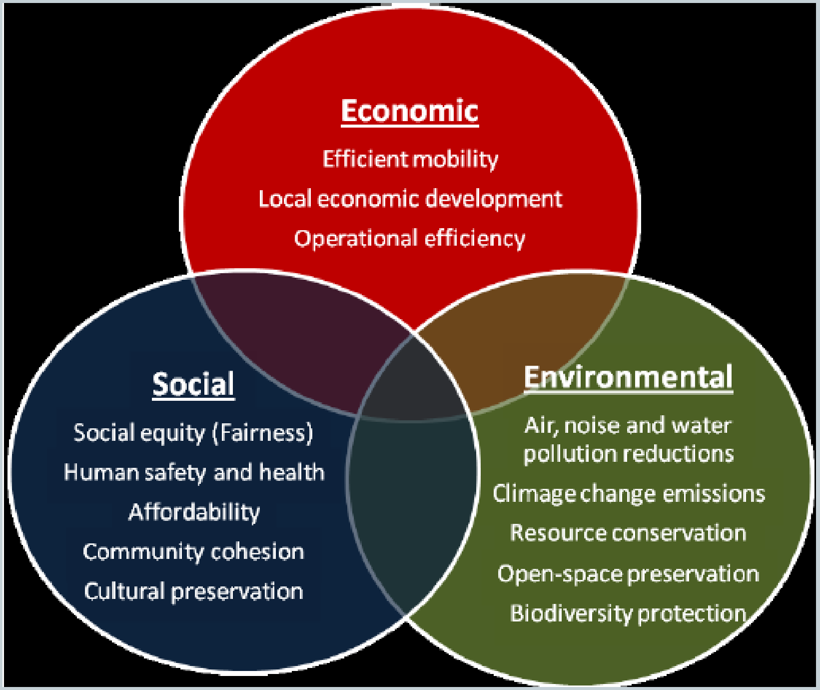
Existing Literature

- **Qualities of STIs** (Gilbert & Tanguay, 2000; Litman, 2007; ECMT, 2004):



Existing Literature

- Considering the triple bottom line of sustainability (Littman & Burwell, 2006) (OECD, 1999) (Dobranskyte-Niskota, Perujo, & Pregl, 2007), the indicators can be broadly classified as:
  - ✓ Social Indicators
  - ✓ Economic indicators
  - ✓ Environmental Indicators



"A balance must be created between all three parameters and an integrated planning approach to be drawn." (Schilleman & Gough, 2012)

Existing Literature

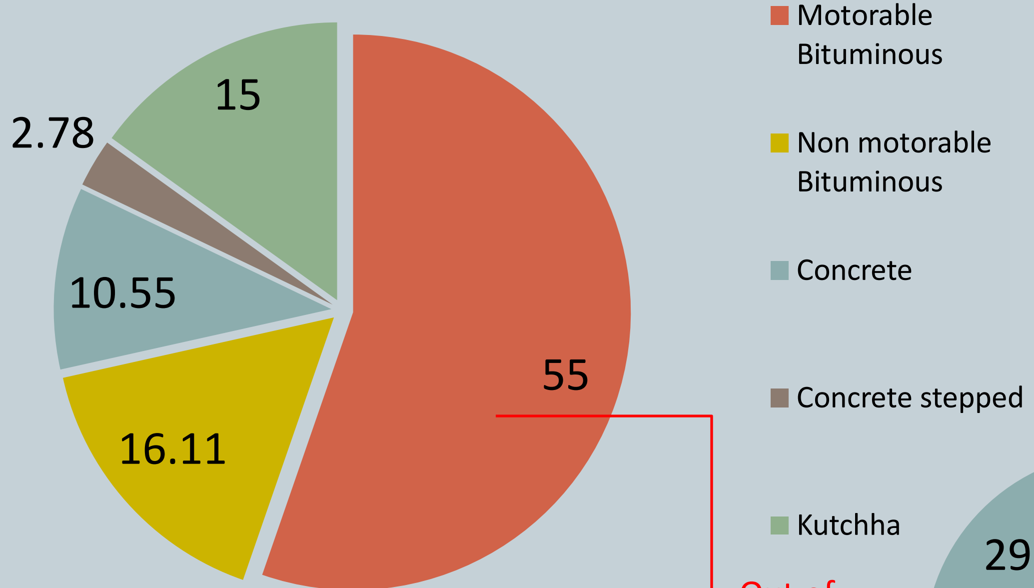
- **Selection of STIs:**

Dimension	Theme	Indicator	Literature
Economic	Infrastructure	Road Quality	(Dobranskyte-Niskota et. al., 2007)
		Parking Facilities	(Littman, 2007)
		Pedestrian facilities	**Area Specific**
	Affordability	Share of household income of transport	(Litman, 2007)(Dobranskyte-Niskota, Perujo, & Pregl, 2007)
Mobility	Congestion & Delay	LOS Value	(Litman, 2007)(US-EPA, 2011)
		Congestion and Encroachment	**Area Specific**
Social	Transit Preference	Modal Split	(Commission for Sustainable Development , 2005)
	Promoting Walking	Pedestrian Volume	(FHWA, 2010)(Littman & Burwell, 2006)
Environmental	Air Pollution	Emission of SO_x	(Littman, 2007)(Dobranskyte-Niskota, Perujo, & Pregl, 2007)(Gilbert & Tanguay, 2000)(FHWA, 2010)(ECMT, 2004)
		Emission of NO_x	
		Emission of PM_{10}	
		Emission of CO_2	
	Noise Pollution	Decibel(dB) Levels	

Sustainability Analysis

Scope of the analysis:

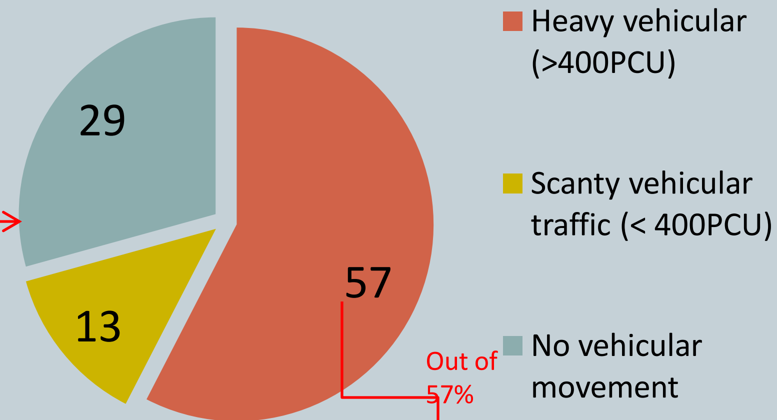
% of Total Road Length Based on Pavement material



Source: Darjeeling Municipality

Out of 55%

% Share of total Roads based on Vehicular Traffic



Source: Authors

13 Roads

9th Urban Mobility India Conference & Expo 2016
Planning Mobility for City's Sustainability

Sustainability Analysis

1. Infrastructure: Road quality

Parameters :

- Width of Carriage-way
- Number of lanes
- Black top condition
- Encroachment
- Footpath/ pedestrian walkway in areas with high pedestrian traffic
- User Rating

Good: Stretches which have less number of potholes, lesser amount of encroachment and their user rating is 3.5 and above

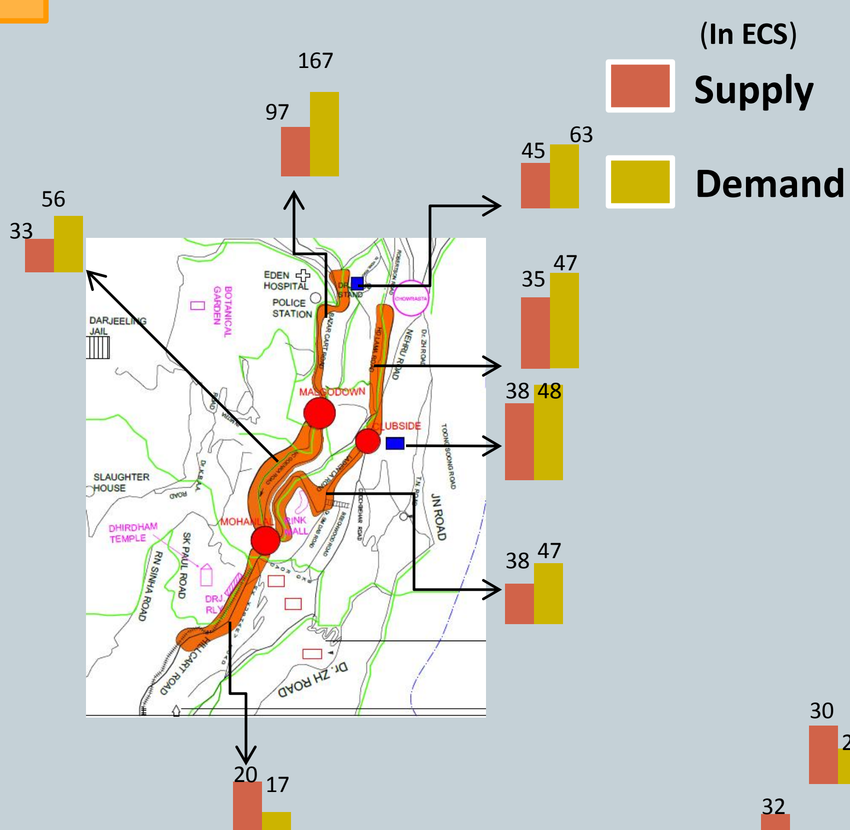
Medium: Stretches which have less number of potholes, but visible encroachment with user rating between 2.5 to 3.5.

Bad: Stretches which have a poor black top condition, visible encroachment with user rating below 2.5.

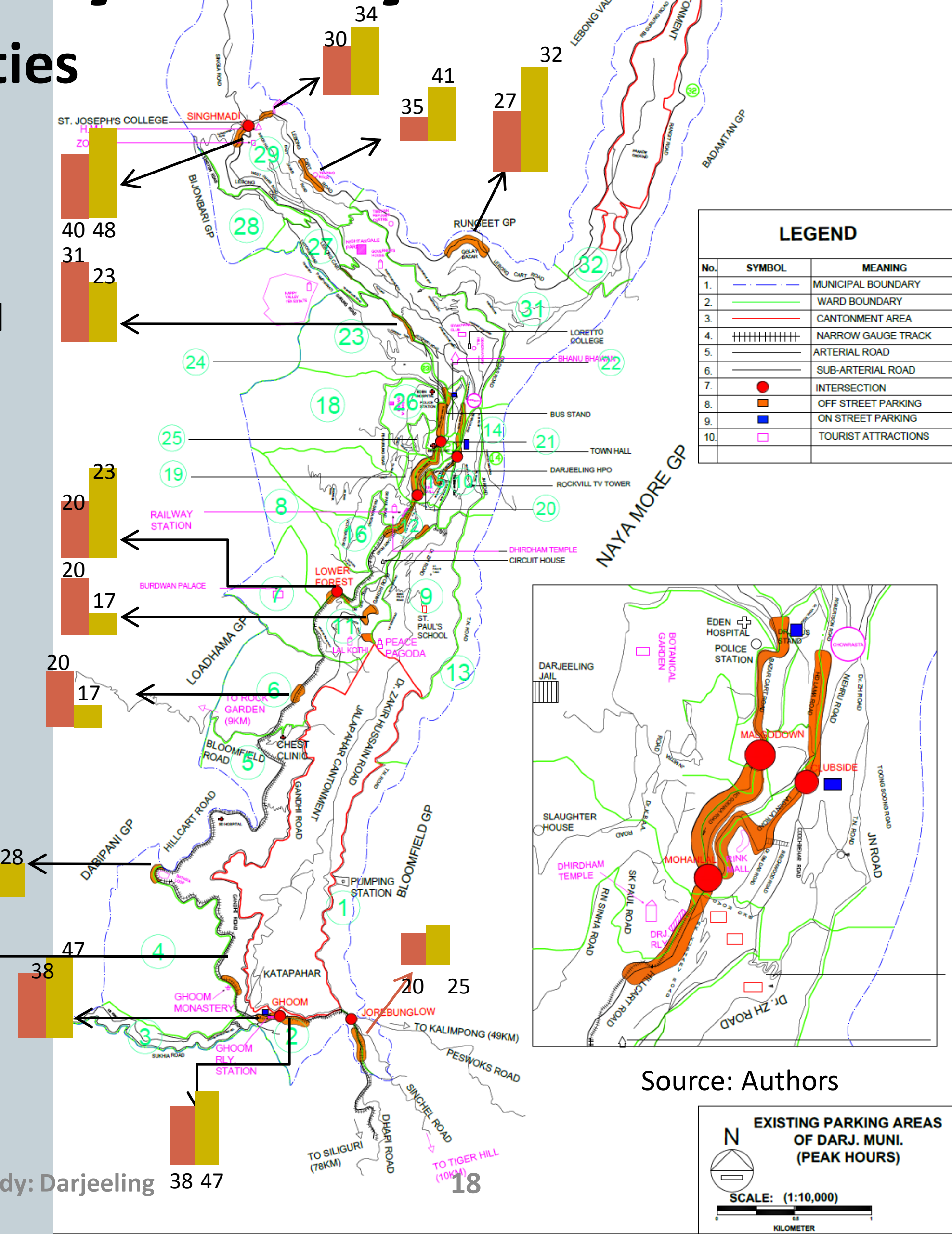
S/ No	Road Name	Road Type	No of Lanes	Divided/ undivided	Avg. Width of Carriage way	Length Within Municipal Limit	Paved/ Unpaved	Condition of black top	Encroachment	Footpath	User Rating (Out of 5)	Overall Quality
1	Hill Cart	Arterial (NH)	Single	undivided	7.0m	6.1km	Paved	Potholes exists at some stretches	None	Yes;1.5m width, one sided	3.5	
2	Lebong Cart	Arterial	Single	undivided	7.0m	10.36km	Paved	None	Yes, due to on-street parking at some stretches	Yes;2.1m width, one sided	4	
3	Laden La	Arterial	Single	undivided	5.0m	0.65km	Paved	None	Yes, due to on-street parking	No	2.5	
4	NC Goenka	Arterial	Single	undivided	5.0 m	0.3km	Paved	Potholes exists at some stretches	Yes, due to on-street parking	Yes; 1m on one side	2	
5	Bazar Cart	Arterial	Single	undivided	5.5m	0.95km	Paved	Potholes exists at some stretches	Yes, due to on-street parking	No	2.5	
6	AJC Bose	Sub-Arterial	Single	undivided	4.0m	0.73km	Paved	Potholes exists at majority stretches	None	No	2.5	
7	Dr. Zakir Hussain	Sub-Arterial	Single	undivided	4.5m	4.06km	Paved	Potholes exists at some stretches	Yes, due to on-street parking	No	3.5	
8	Robertson	Sub-Arterial	Single	undivided	5m	0.7km	Paved	Potholes exists at some stretches	None	No	3.5	
9	RK Ksharv	Collector	Single	undivided	3.5m	0.34km	Paved	Potholes exists at some stretches	None	No	3	
10	Nehru	Sub-Arterial	Single	undivided	4.5m	0.4km	Paved	None	Yes, due to on-street shops	No	4	
11	Collington	Collector	Single	undivided	3.5m	0.55km	Paved	Potholes exists at some stretches	None	No	2	
12	Auckland Zigzag	Collector	Single	undivided	3.75m	0.46km	Paved	None	None	No	3.5	
13	K. Lama	Collector	Single	undivided	3.5m	0.56km	Paved	None	None	No	3	

Sustainability Analysis

2. Infrastructure: Parking facilities



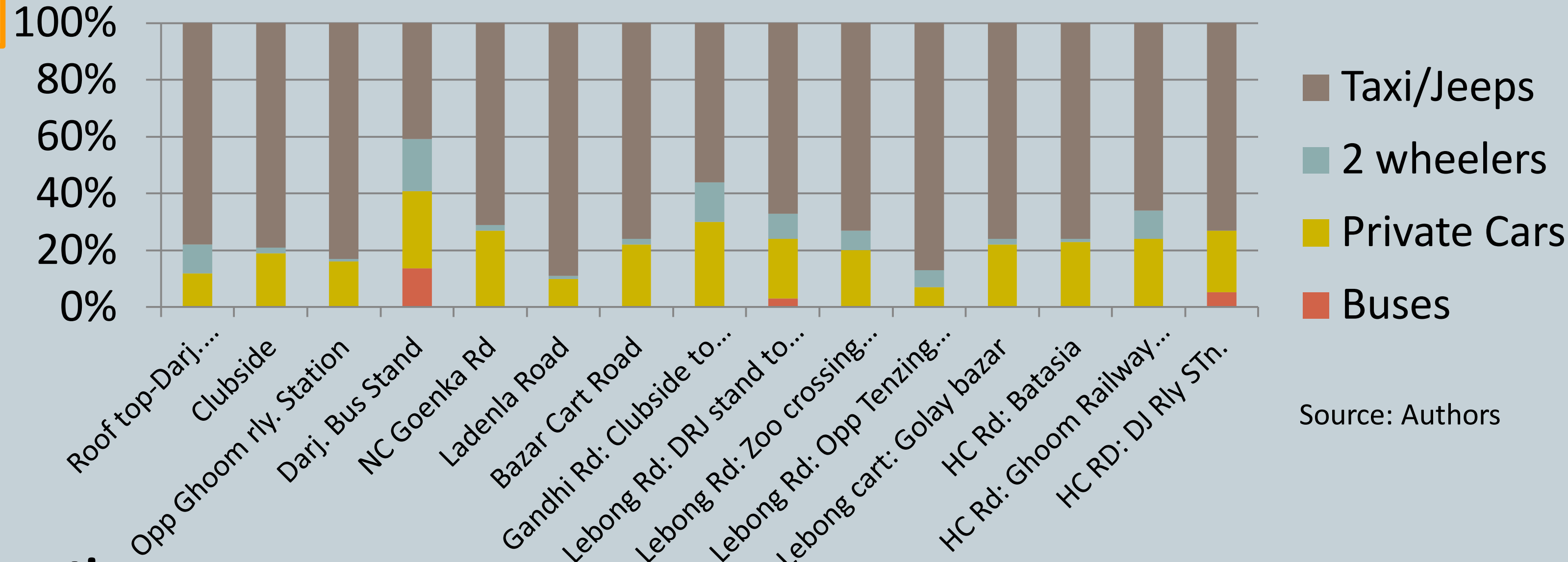
Parking data are recorded in the peak hours of the day (10 am to 1 pm) during the peak tourist season (Sept-Oct '14).



Source: Authors

Sustainability Analysis

2. Infrastructure: Parking facilities



Source: Authors

Observations:

1. Vehicle owners—park close by, hence disregards basic parking rules.
2. The parked vehicles which have a long term demand (2hrs or more) are tourist vehicles.

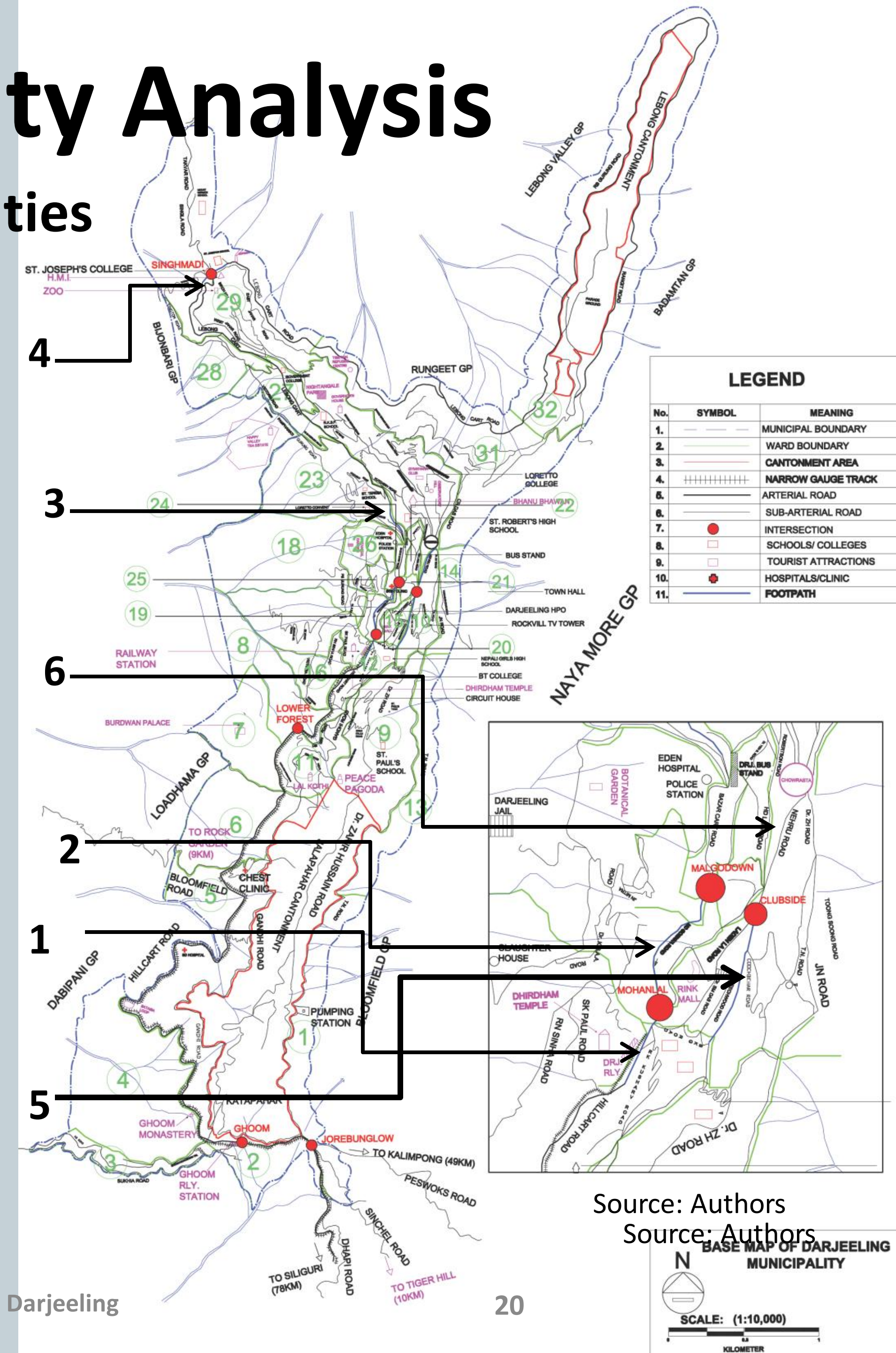
Conclusions:

1. Demand> Supply.
2. Average of 70% of tourist vehicles.

Sustainability Analysis

3. Infrastructure: Pedestrian facilities

Sl. No.	Stretch Name	Width	Number of Commuters	Capacity (IRC 103: 2012)	LOS
1.	Darj. Rly. Stn. To Malgodown	2.1m	2541	2400	LOS D
2.	Malgodown to Darj. Bus Stand	1.8m	2031	1890	Los E
3.	Darj. Bus Stand to DM's Office	2.0m	2234	2400	LOS D
4.	Singmadi to St. Joseph's School	2.1m	1765	2400	LOS B
5.	Clubside-Union Church	2.0m	2876	2400	LOS D
6.	Clubside-Chowrasta	4.5m	4351	5040	LOS C

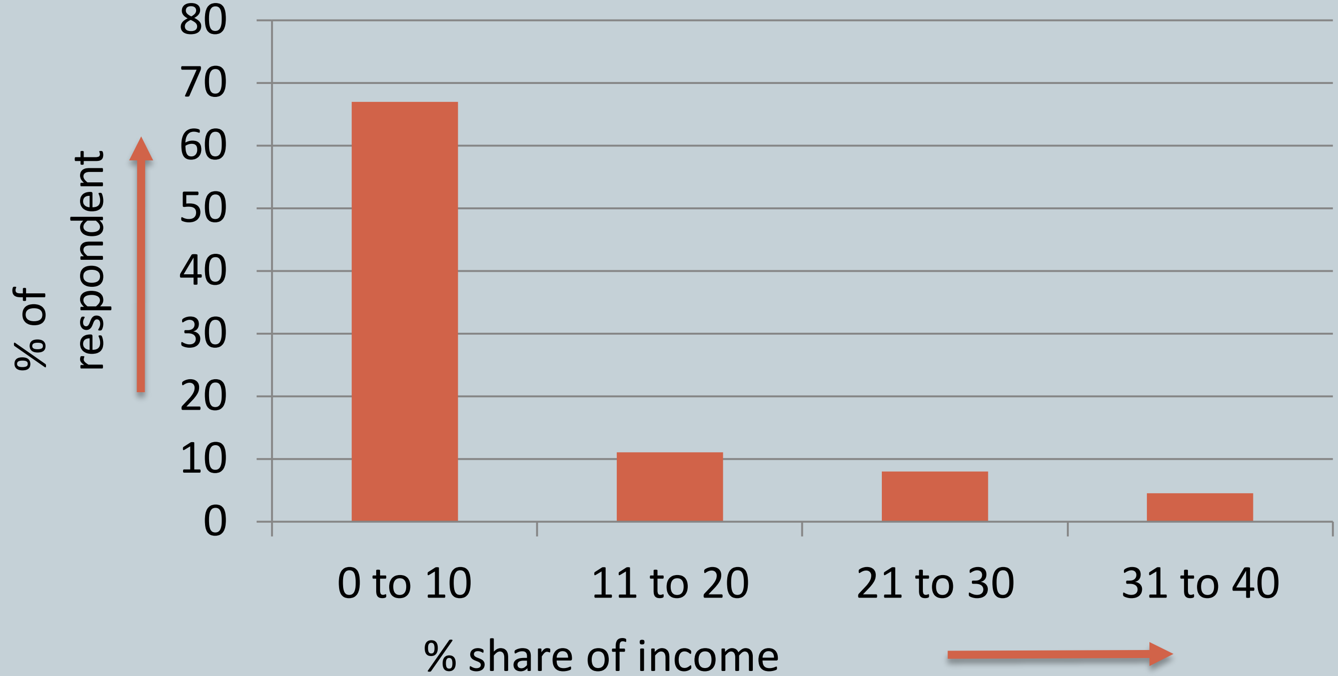


Source: Authors
Source: Authors

Sustainability Analysis

4. Portion of Household income on expenditure

Data is collected from 78 tourist responses and 206 HH responses during the peak tourist season (Sept-Oct ‘14).

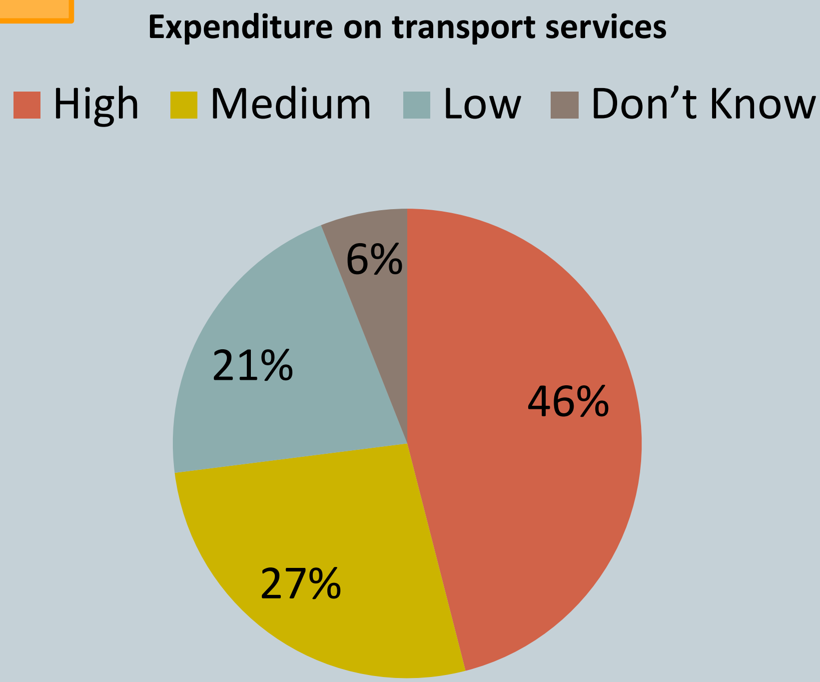


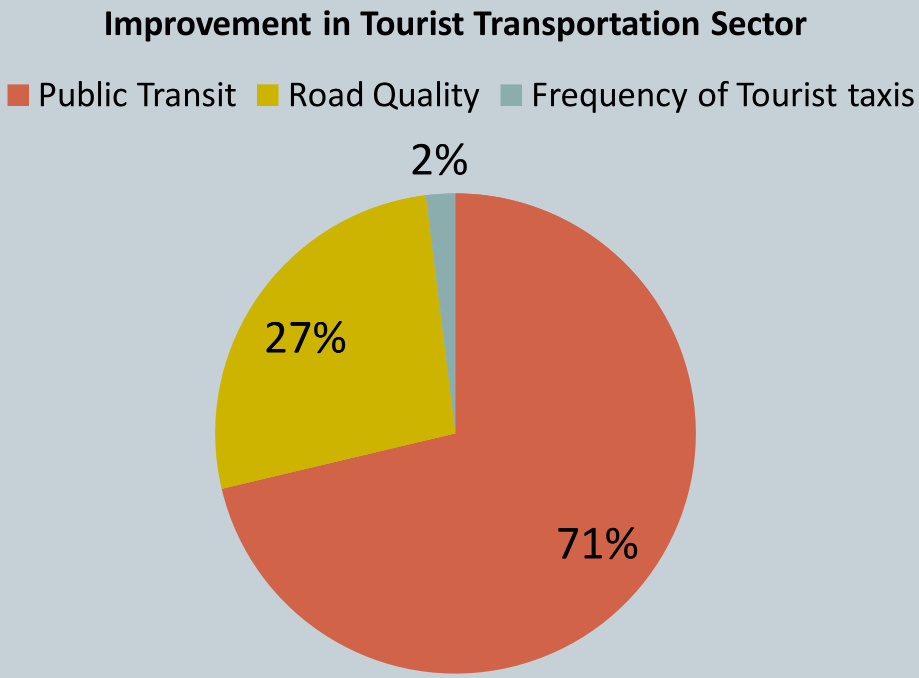
Benchmark/Standard/ Reference: According to VTPI, transport expenditure should not cross 20% of the share of income.

Conclusion: Does not cross the benchmark as majority of the households lies in the 0 to 10% range of expenditure.

Sustainability Analysis

4. Portion of Household income on expenditure





Conclusion: 46% of the tourists feel that the transport cost is high in Darjeeling, this could be due to the dynamic rise of prices during tourist season.
The dynamic rise of prices is due to a disorganised tourist taxi service and an absence of a proper public transport.

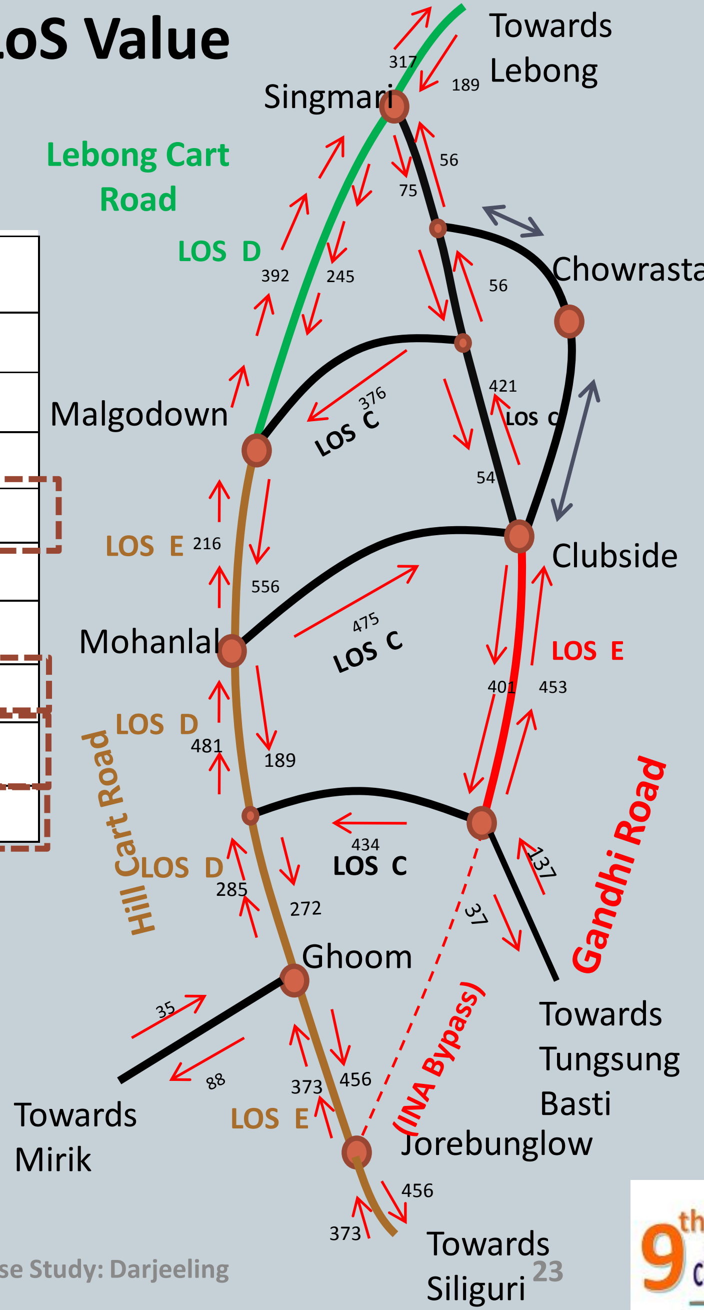
Sustainability Analysis

5. Congestion and Delay: LoS Value

Road name	Stretch	Observed Peak Hourly	Suggested PCU Capacity	V/C Ratio	LoS
HC Road	Jorebunglow - Ghoom	830 PCU	750	1.1	E
HC Road	Ghoom-Batasia	712 PCU	750	0.95	D
HC Road	Batasia-Mohanlal	946 PCU	750	1.26	E
NC Goenka	Mohanlal TP-	412 PCU (5m)	750	0.54	C
Lebong Cart	Malgodown-Darj. Bus	759 PCU	750	1.01	E
Lebong Cart	Bus Stand-Singmari TP	623 PCU	750	0.83	D
Ladenla Road	Mohanlal-Clubside	475 PCU (5.5m)	750	0.63	C
Robertson	Clubside-Bhanu	435 PCU (5.5m)	750	0.58	C
DB Giri	INA-Lower Forest Road	434 PCU (5m)	750	0.57	C

Benchmark/ reference/ Standard:
IRC 86:1983

Source: Authors



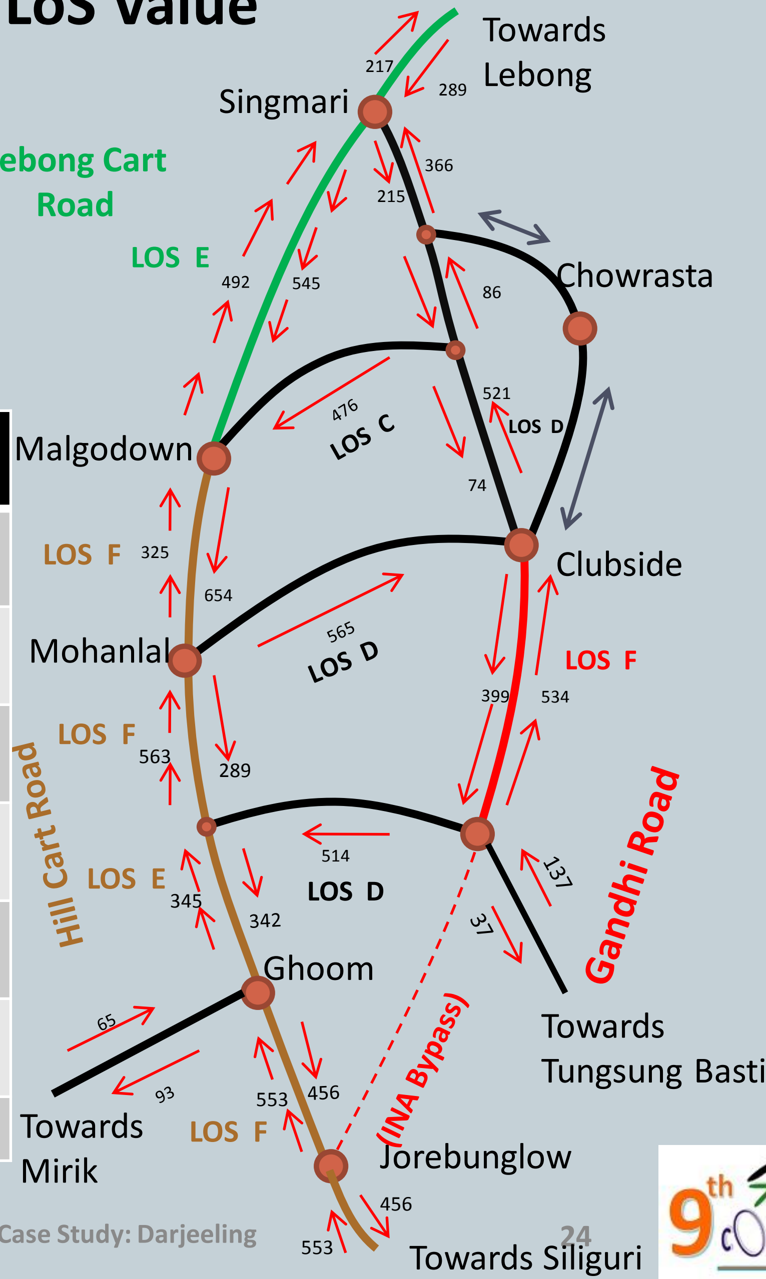
Sustainability Analysis

5. Congestion and Delay: LoS Value

Estimated Link Volumes for the year 2031:

All the links have poorer LoS rating

Stretch	Estimated Volume	Capacity	V/C	LOS
Jore-ghoom	1009	750	1.34	LOS F
Ghoom-Lower forest	687	750	0.9	LOS E
Lower forest - mohanlal	852	750	1.13	LOS F
Mohanlal-malgodown	979	750	1.3	LOS F
Mohanlal-Singmadi	1037	750	1.38	LOS F
Mohanlal – clubside	565	750	0.85	LOS D
Gandhi Road	933	750	1.1	LOS F



Source: Authors

Sustainability Analysis

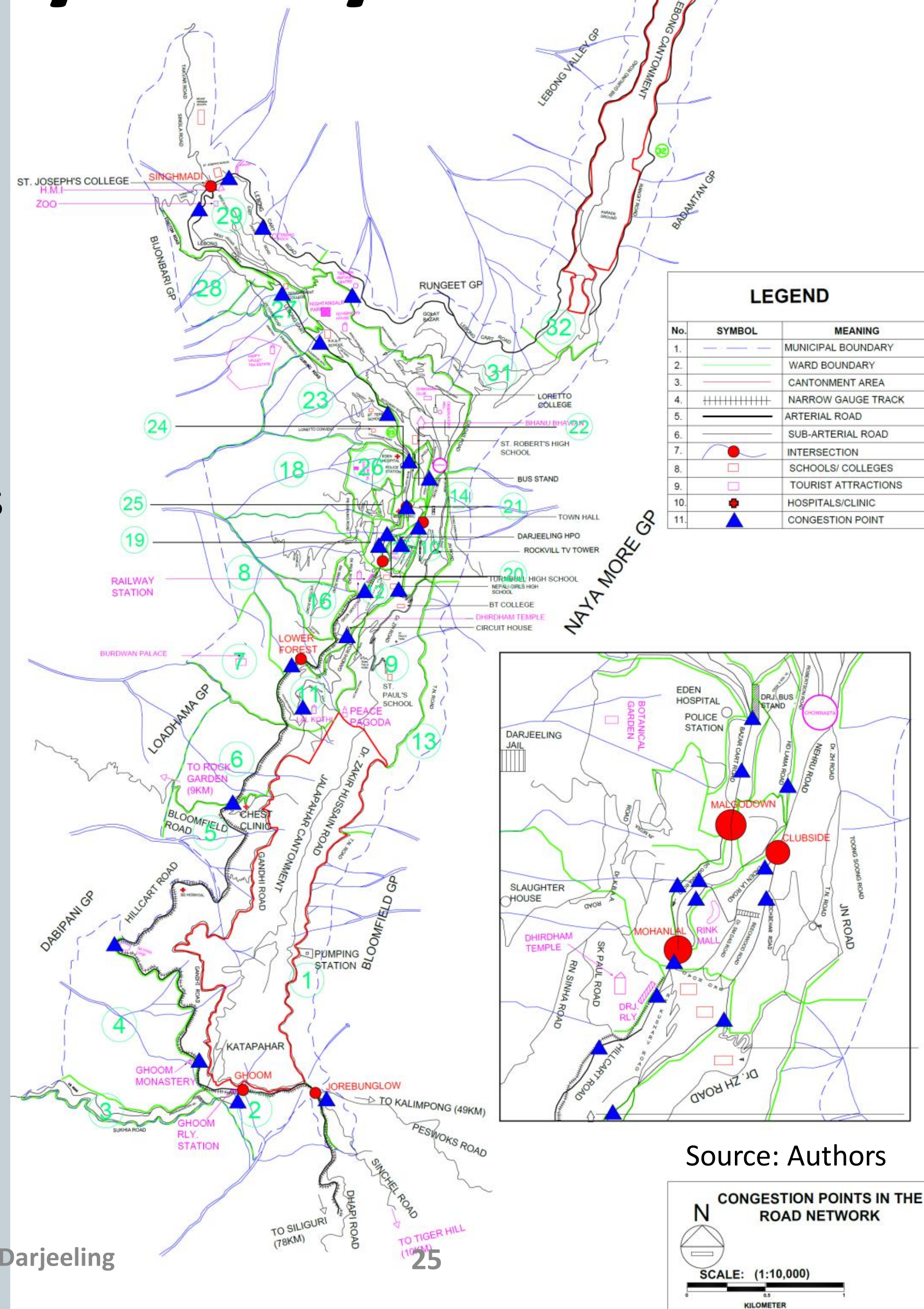
6. Congestion and Delay: Congestion Points & Encroachment

Impact of Congestion Points:

•27 congestion points –9 are at Traffic Points

•As per KS Nesamani (2002), the number of congestion point was 19 in 2002 which she said was “unsustainable for future traffic movement”.

•Congestions are due to Encroachment (i.e due to parking and commercial shops)



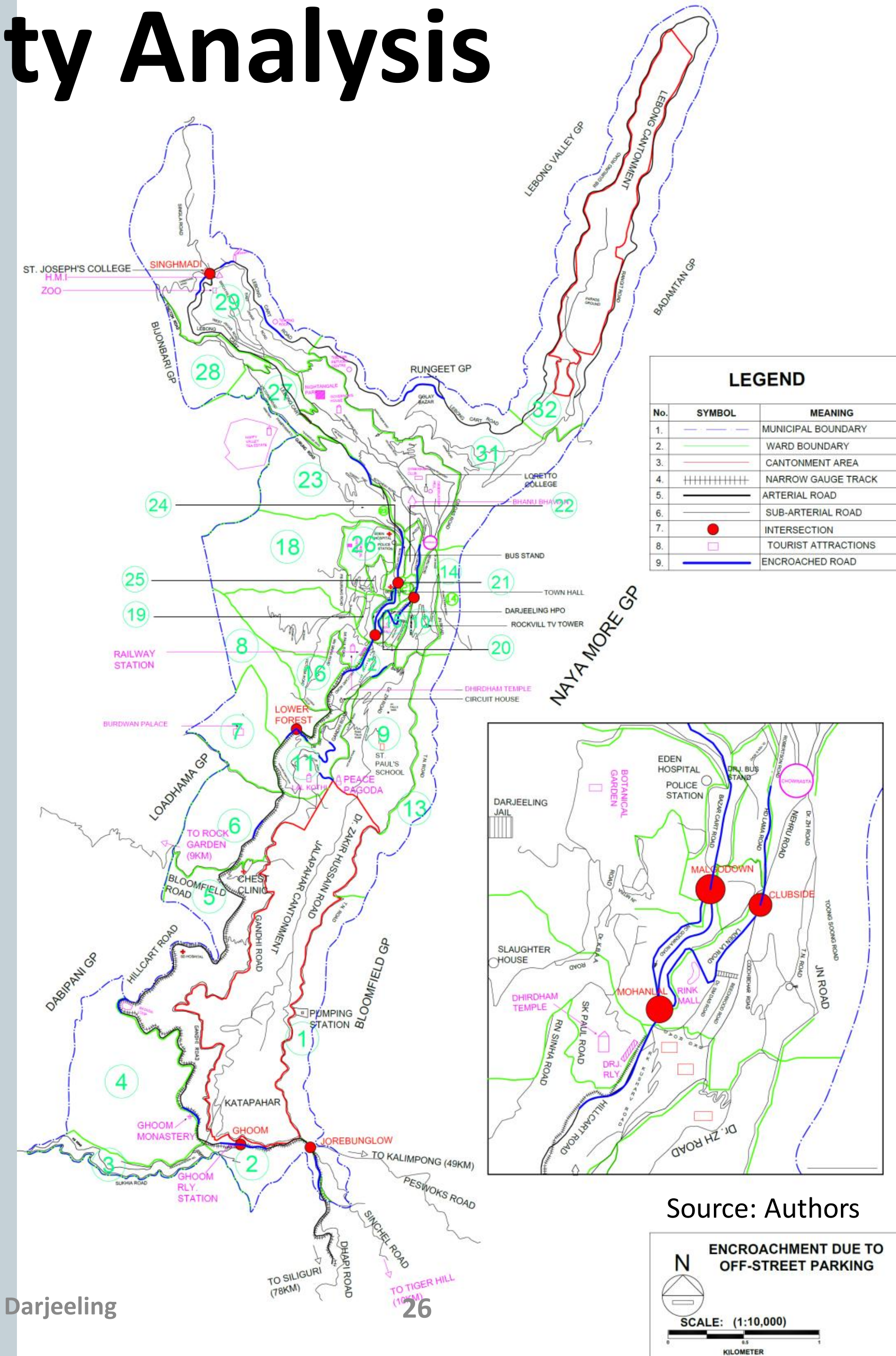
Source: Authors

Sustainability Analysis

6. Congestion and Delay: Congestion Points & Encroachment

Encroached Ratio:

$$= \frac{Length\ of\ the\ road\ stretch\ encroached}{Total\ length\ of\ the\ stretch}$$

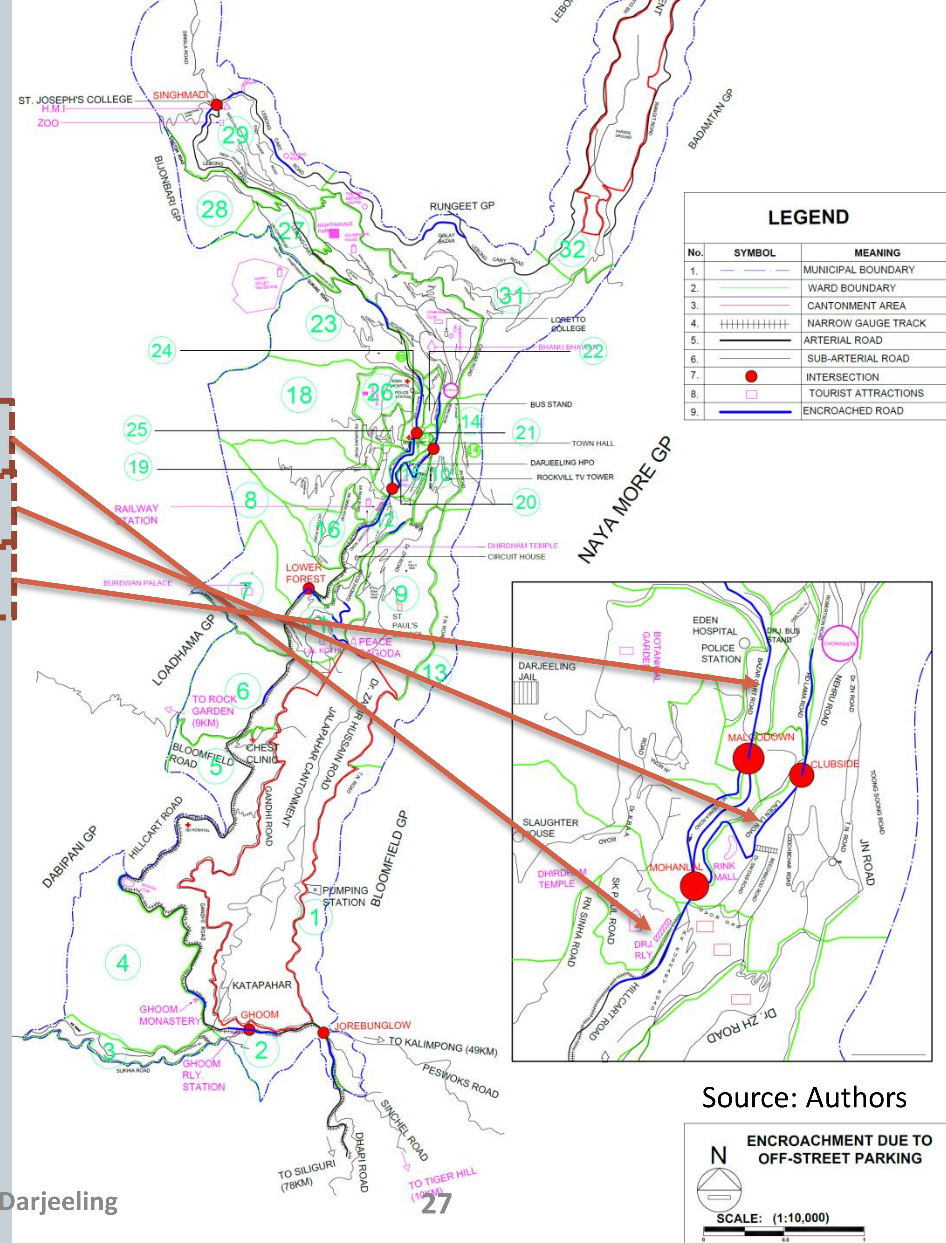


Source: Authors

Sustainability Analysis

6. Congestion and Delay: Congestion Points & Encroachment

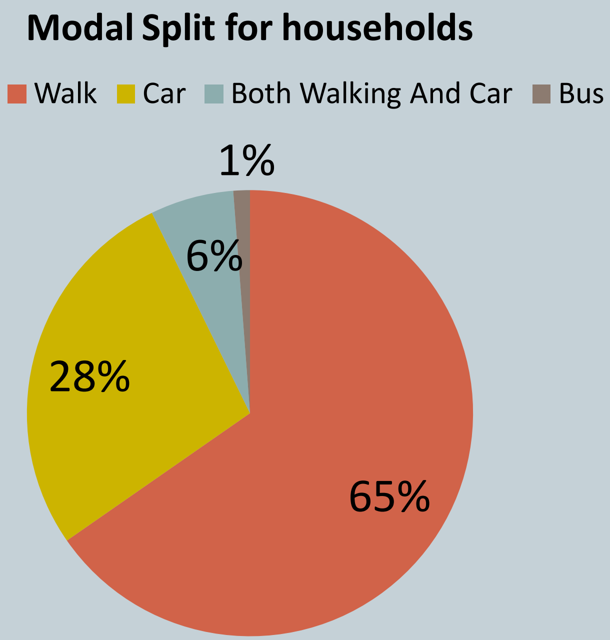
Stretch	Road Name	Length of Stretch	Length of encroachment	Type	% encroached
Jorebunglow-Ghoom	HC Road	0.51km	0.38km	Parking	0.745
Ghoom-Batasia	HC Road	1.74km	0.92km	Parking	0.5287
Batsia-Ava Art Gallery	HC Road	2.06km	0.98km	Parking+Shops	0.4757
Ava Art-Darj. Rly.	HC Road	1.31km	0.54km	Parking	0.4122
Darj. Rly. Stn.-	HC Road	0.42km	0.42km	Parking+Shops	1
Darj. Rly. Stn.-Clubside	Laden La Road	0.53km	0.53km	Parking	1
Malgodown-Darj. Bus	Lebong Road	0.27km	0.27km	Parking	1
Darj. Bus Stand-DM's office	Lebong Road	0.76km	0.56km	Parking	0.7368
Dn's Office-Singmari	Lebong Road	1.54km	0.67km	Parking	0.435
Singmari-Lebong	Lebong Road	3.17km	0.34km	Parking	0.108
Clubside-Lower	DB Giri	1.31km	0.45km	Parking	0.3435
Clubside-Darj. Bus	Robertson	0.55km	0.38km	Parking	0.6909
Singmari-Bhanu	Jawahar	2.67km	0.74km	Parking	0.2771
Clubside-Bhanu Bhavan	Robertson	0.62km	0.13km	Parking	0.2096

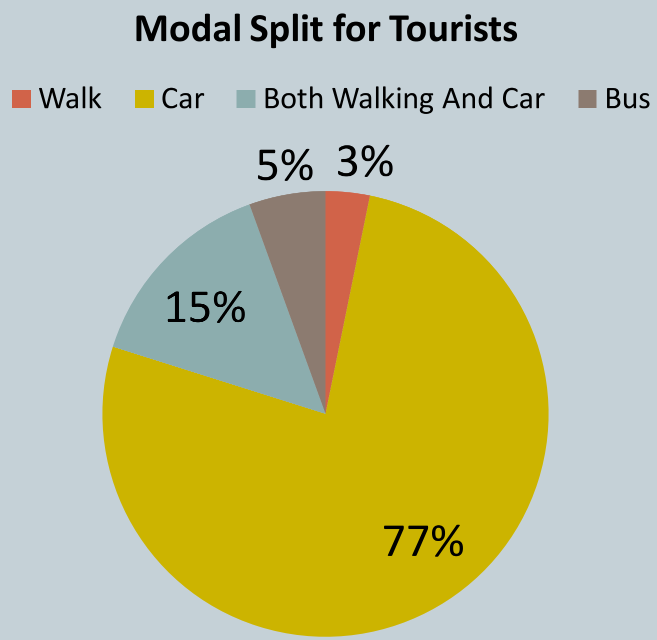


Source: Authors

Sustainability Analysis

7. Transit preference: Modal split





Source: Authors

Conclusion: Shows extremely low share of bus– indicating improper public transport system.

Sustainability Analysis

8. Promoting Walking: Pedestrian Volume

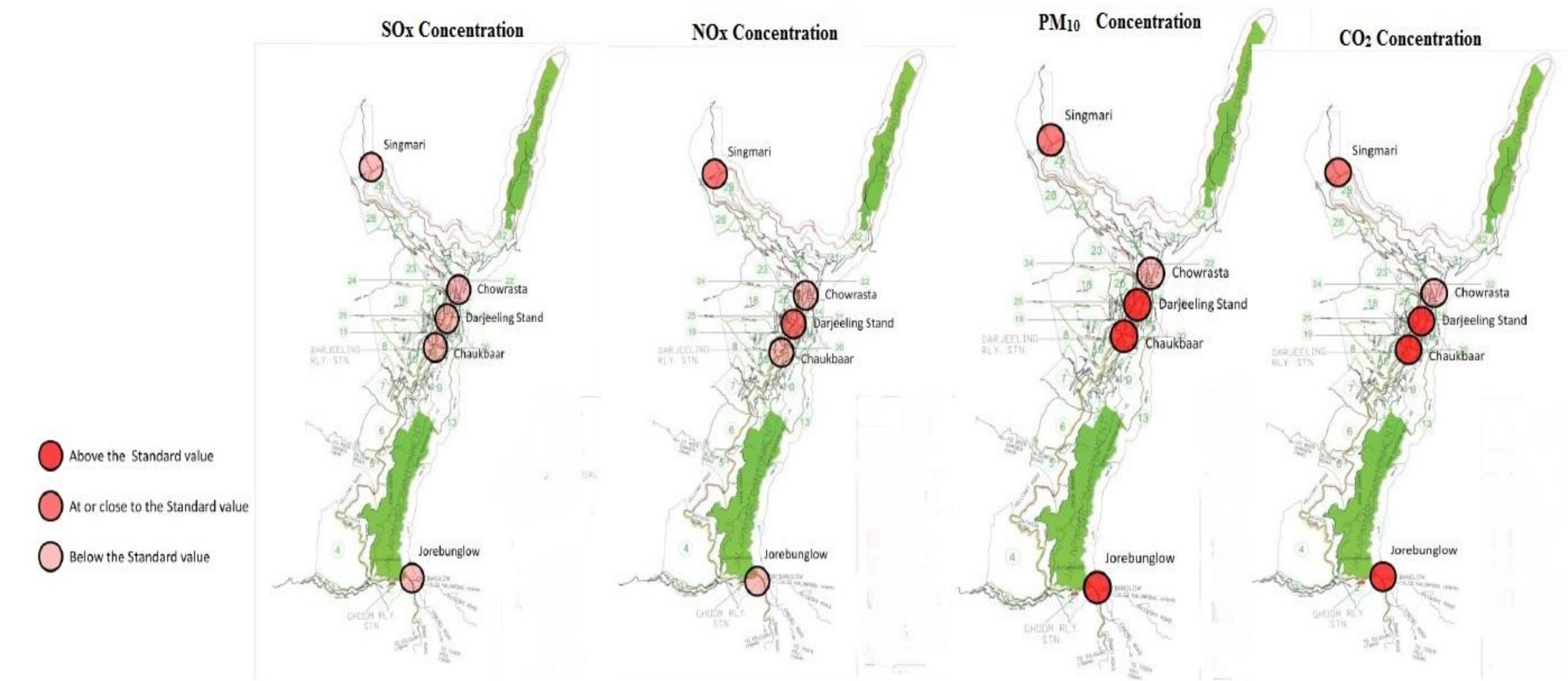
Recorded in Sept- Oct 2014 (peak tourist season)
Peak hours of the day (between10.00 am to 3 pm)

No entry zone (only pedestrian movement)

Recorded in Dec 2014 (off-for peak tourist season)
Peak hours of the day (between 10.00 am to 1 pm and between 4pm to 5pm)

Sustainability Analysis

9. Air Quality: Emission of SO_x, NO_x, PM_{10}, CO_2



The central part of Darjeeling (Darjeeling Stand, Chaukbazar) is most affected due to emission of CO_2 and PM_{10}; this can be attributed to the high vehicular movement here.

Source: Compiled from WBPCB, 2009

Sustainability Analysis

9. Air Quality: Emission of SO_x, NO_x, PM_{10}, CO_2

Emission Calculation of NO_x, PM_{10}, CO_2 Stretch wise

- The total air pollutant emitted per Km as per Kaur(2009) is,

$= \boldsymbol{n} \times \boldsymbol{e} \times \boldsymbol{y}$

Where,

$\boldsymbol{n}$ = no of vehicle of single type running on that road

$\boldsymbol{e}$= Emission factor i.e. pollutant emitted in kg by that particular vehicle when it run a distance of 1 Km.

$\boldsymbol{y}$= age of the vehicle in year

- Since the emission of **SOx does not violate** the reference value in any area its calculation stretch wise is **omitted**.
- Emission Factors ($\boldsymbol{e}$) calculated from Gilani (2012), **Emission Factor Ready Reckoner, India.**

	Car	Bus/trucks	Motorized two
For CO_2	0.29 kg/km	0.99 kg/km	0.04 kg/km
For PM_{10}	5.6mg/km	200mg/km	1.9mg/km
For NO_x	2089 μg/km	121456 μg/km	457 μg/km

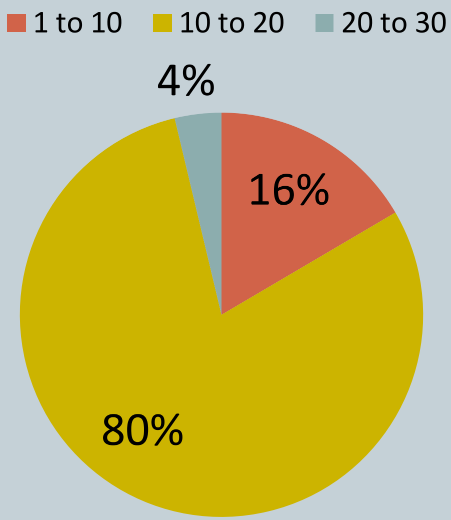
Sustainability Analysis

9. Air Quality: Emission of SO_x, NO_x, PM_{10}, CO_2

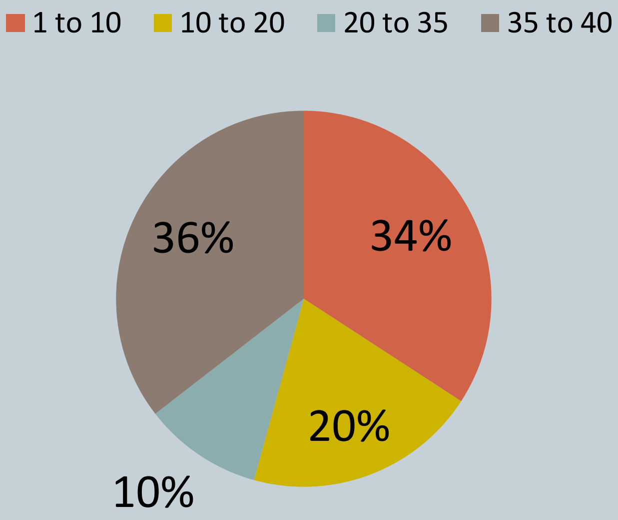
Emission Calculation of NO_x, PM_{10}, CO_2 Stretch wise

- **Age of vehicles(y)** Not obtained so calculated based on primary surveys households and establishments. Following is the summary of the data collected:

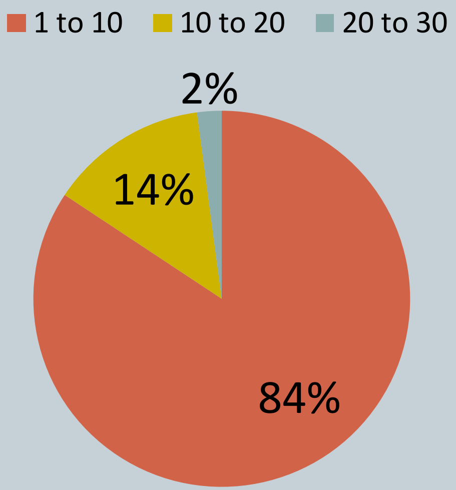
Bus



Car



Bikes

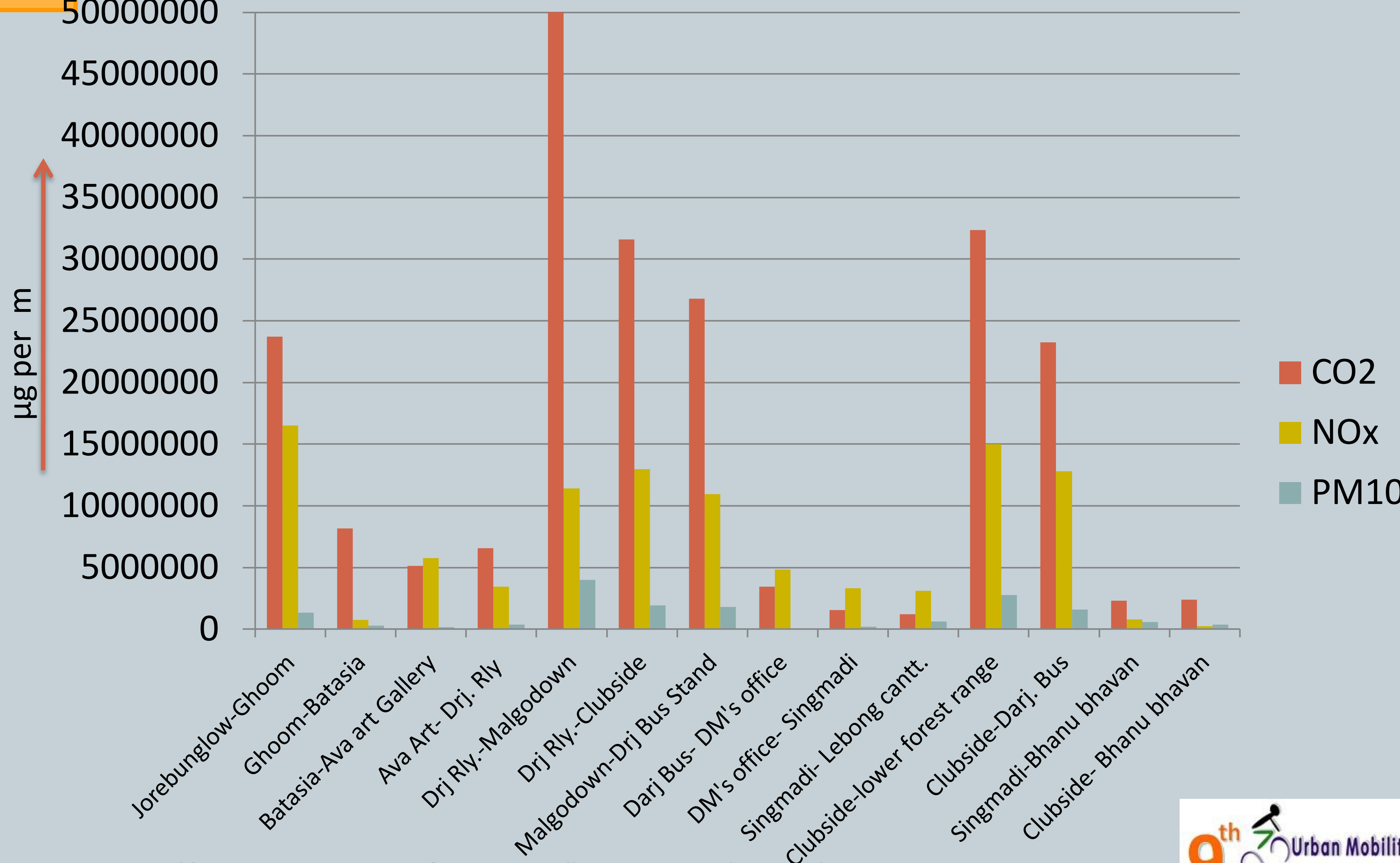


Source: Authors

Sustainability Analysis

9. Air Quality: Emission of SO_x, NO_x, PM_{10}, CO_2

Emission Calculation of NO_x, PM_{10}, CO_2 Stretch wise



9th Urban Mobility India Conference & Expo 2016
Planning Mobility for City's Sustainability

Sustainability Analysis

9. Air Quality: Emission of SO_x, NO_x, PM_{10}, CO_2

Estimation of desirable reference level of NO_x, PM_{10}, CO_2

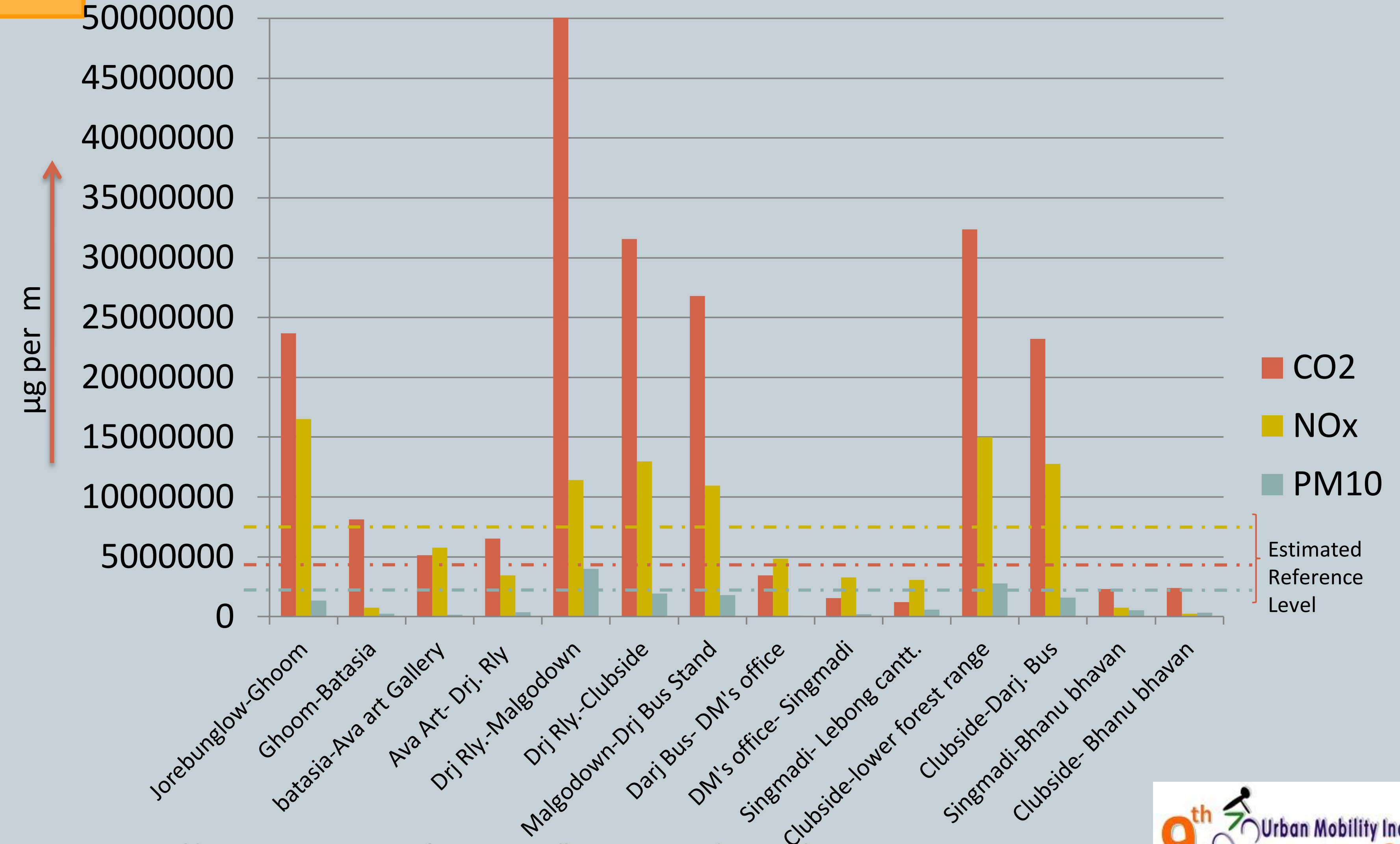
- Assumptions
  - The vehicular volume is taken in PCU with no distinction in the mode of travel.
  - For a desirable condition, traffic volumes at stretches are taken to be 750 PCU.
  - The emission factor for each pollutant is taken as a average of the three vehicular modes taken.
  - Ages of vehicles are assumed to be 15 years which is the tolerable age of a motor vehicle as per the Motor Vehicle Act, 1988.

- Emission of CO_2 = 60,07,870 µg /m
- Emission of NO_x= 1,17,23,870 µg/m
- Emission of PM_{10} = 43,870 µg /m

Sustainability Analysis

9. Air Quality: Emission of SO_x, NO_x, PM_{10}, CO_2

Estimation of desirable reference level of NO_x, PM_{10}, CO_2



Sustainability Analysis

10. Noise Pollution : Decibel Level

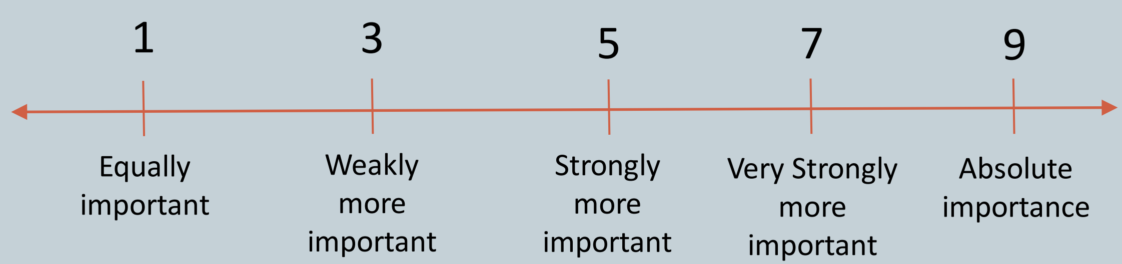
Locations	Residential (R)/ Commercial (C)/ Tourist Spot (T)	Noise level (in dB)	Reference	Inference
Jorebunglow	R/C	75 dB	65 dB	More than specified
Batasia Loop	T	63dB	55 dB	More than specified
Ghoom Monastery	T	57dB	55dB	More than specified
Chowrasta	T/C	47dB	65dB	Less than specified
Mall Road	T	43dB	55 dB	Less than specified
Bazar Area	C/R	82dB	65dB	More than specified
Darjeeling Railway Station	C/R	71dB	65 dB	More than specified
Zoo Crossing	T	77dB	55 dB	More than specified
Darjeeling Bus Stand	C	74dB	65 dB	More than specified

Source: Authors

Sustainability Analysis

11. Priority Matrix of stretches using group consensus & Analytical Hierarchy Process(AHP)

- A **group decision making technique like AHP** –assign **weightage** to the indicators– weightages to **prioritize the road stretches:**
  - A total of **34 experts** –various **government organization** (NHAI, PWD, Darj. Muni.) –**researchers** from educational institutes (IIEST, IITs)– Online survey questionnaire.
  - Number of indicators were reduced from **13 to 8**—only those indicators are used which could be easily quantified on a 3-point scale.
  - Relative **importance** of the indicators were marked by Saaty’s (2008) Gradation scale for quantitative comparison of alternatives.



Sustainability Analysis

11. Priority Matrix of stretches using group consensus & Analytical Hierarchy Process(AHP)

Relative Importance Matrix of indicators

	LoS Value	Encroachment	Congestion Points	Pedestrian Volume	Concentration of CO_2	Concentration of NO_x	Concentration of PM_{10}	Noise dB Level	Weightages
LoS Value	1	5	1/3	1	4	3	1/4	1/2	0.3
Encroachment	1/5	1	1/5	1/5	1/4	2	2	2	0.175
Congestion Points	3	5	1	2	5	4	1/6	4	0.09
Pedestrian Volume	1	5	1/2	1	5	2	5	5	0.05
Concentration of CO_2	1/4	4	1/5	1/5	1	1	1/3	4	0.09
Concentration of NO_x	1/3	1/2	1/4	1/2	1	1	1/2	3	0.1
Concentration of PM_{10}	4	1/2	6	1/5	3	2	1	3	0.185
Noise dB Level	2	1/2	1/4	1/5	1/4	1/3	1/3	1	0.01

Sustainability Analysis

11. Priority Matrix of stretches using group consensus & Analytical Hierarchy Process(AHP)

Weightage and Criteria in the "3-point Scale"

Indicator	Weightage	Criteria	Scale
LoS Value	0.3	LoS E (LoS C with roadwith >7m)	3
		LoS D	2
		LoS C or above	1
Encroachment	0.175	0-40%	1
		40.1-60%	2
		60.1-100%	3
Congestion Points	0.09	0 to1	1
		2 to 4	2
		5 and above	3
Pedestrian Volume	0.05	2000-3000	1
		3001-4500	2
		>4600	3
		No demand	0
Concentration of CO_2	0.09	1000000-9000000μg/m	1
		9000001-30000000μg/m	2
		30000001-60000000μg/m	3
Concentration of NO_x	0.1	2000000-8000000μg/m	1
		8000001-60000000μg/m	2
		60000001-200000000μg/m	3
Concentration of PM_{10}	0.185	70000-600000 μg/m	1
		600001-1300000μg/m	2
		1300001-4500000μg/m	3
Noise dB Level	0.01	40-55dB	1
		55-65dB	2
		>65 dB	3

Sustainability Analysis

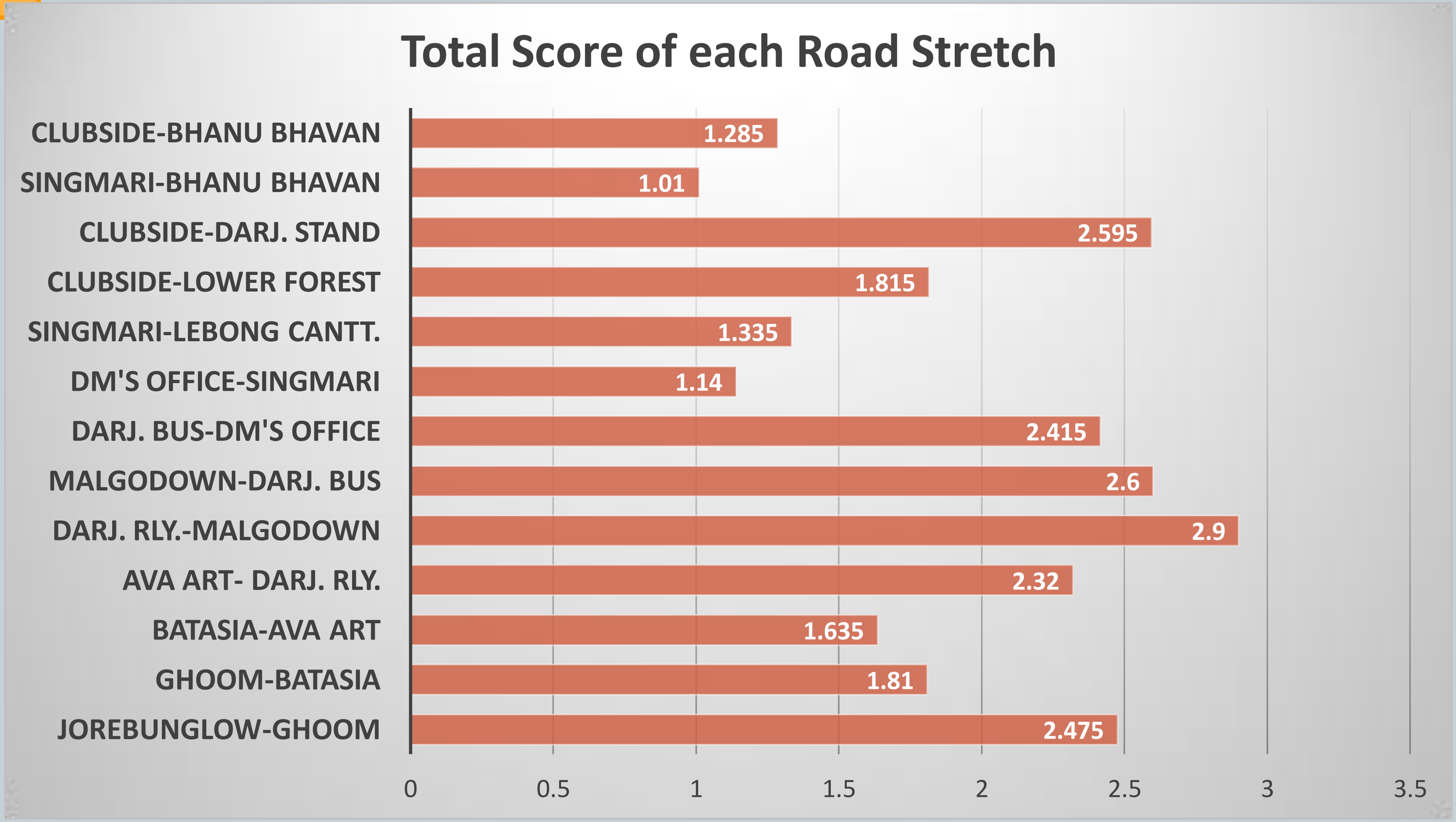
11. Priority Matrix of stretches using group consensus & Analytical Hierarchy Process (AHP)

A Sample of Total Score Calculation of each Road Stretches

	Jorebunglow-Ghoom		Ghoom-Batasia		Batasia-Ava Art		Ava Art- Darj. Rly.		Darj. Rly.-Malgodown		Malgodown-Darj. Bus		Darj. Bus-DM's Office	
	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score
LoS Value	3	0.9	2	0.6	2	0.6	3	0.9	3	0.9	2	0.6	2	0.6
Encroachment	3	0.525	2	0.35	1	0.175	1	0.175	3	0.525	3	0.525	2	0.35
Congestion Points	2	0.18	1	0.09	1	0.09	2	0.18	3	0.27	3	0.27	3	0.27
Pedestrian Volume	0	0	0	0	0	0	2	0.1	1	0.05	1	0.05	3	0.15
Concentration of CO_2	2	0.18	2	0.18	2	0.18	2	0.18	3	0.27	3	0.27	3	0.27
Concentration of NO_x	3	0.3	2	0.2	2	0.2	2	0.2	3	0.3	3	0.3	2	0.2
Concentration of PM_{10}	2	0.37	2	0.37	2	0.37	3	0.555	3	0.555	3	0.555	3	0.555
Noise dB Level	2	0.02	2	0.02	2	0.02	3	0.03	3	0.03	3	0.03	2	0.02
Total Score		2.475		1.81		1.635		2.32		2.9		2.6		2.415

Sustainability Analysis

11. Priority Matrix of stretches using group consensus & Analytical Hierarchy Process (AHP)



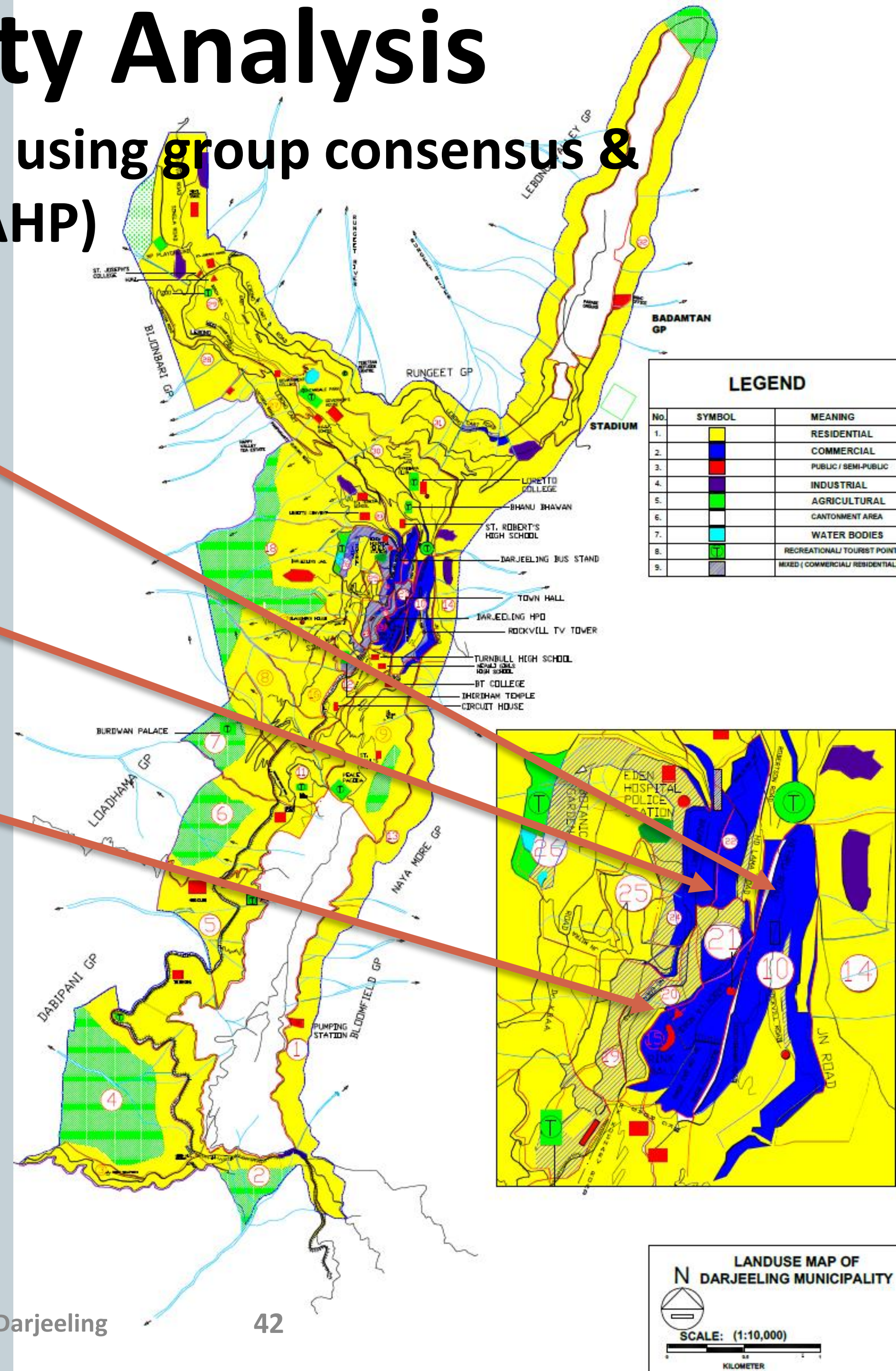
Sustainability Analysis

11. Priority Matrix of stretches using group consensus & Analytical Hierarchy Process (AHP)

Some conclusions:

Central Darjeeling

- **Clubside To Darjeeling Bus Stand**
- **Malgodown To Darjeeling Bus Stand**
- **Darjeeling Rly. Stn. To Malgodown**



<u>More weightage:</u>

Delay

- LoS Value (0.3)
- Encroachment (0.175)

Air quality

- Concentration of PM_{10} (0.185)

Inferences and Strategies

Inferences:

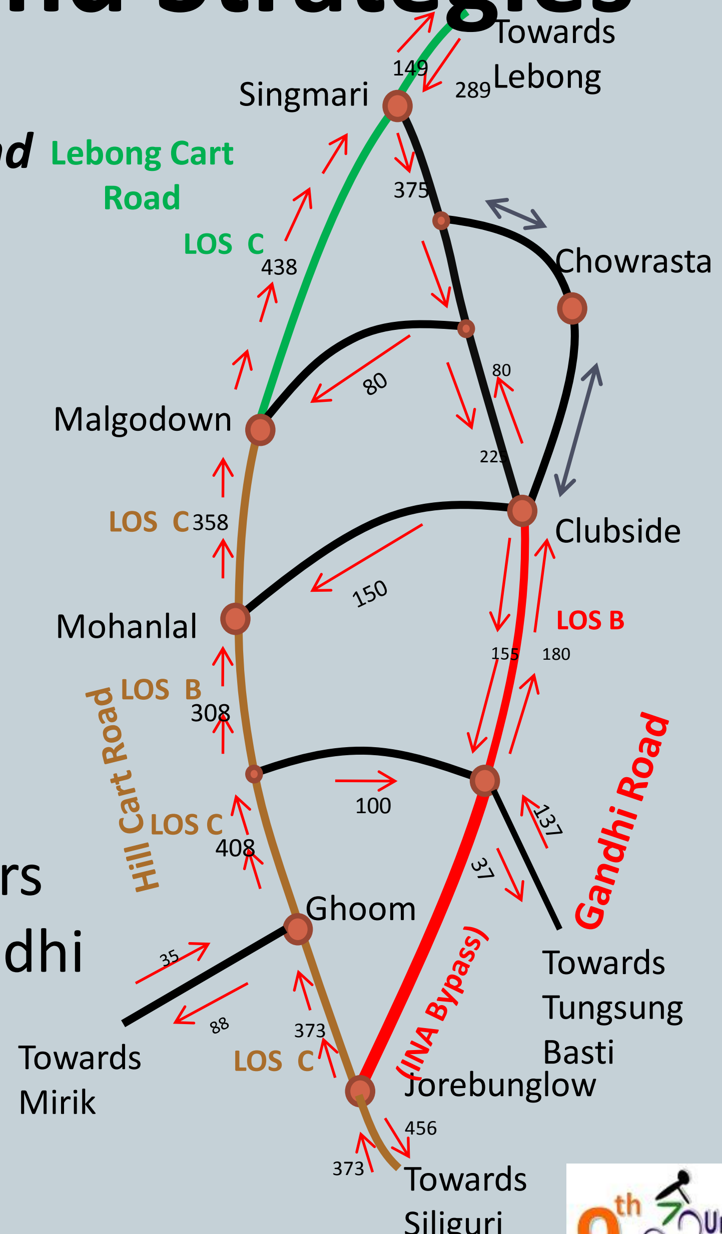
- Congestion is due to **High Link Volumes** and **Encroachment** Due to On Street Parking.
- The **Central Darjeeling**—dense development, **concentration** of commercial and mixed land use—**high numbers of trips** are attracted—both residents and tourists.
- Acute crisis of **parking space.**
- **Environmental** degradation due to **high number of cars;** majority of the shared taxi are old in age (>15 years).
- trip-makers in **absence of a proper public transit** have to avail smaller shared taxi—both pollution and congestion

Inferences and Strategies

Broad Strategies:

1. Re-opening of Gandhi Road and Circulation Plan for intra-city movement

- Traffic Circulation plan
- Improved LoS rating compared to the existing scenario.
- Strengthening of connectors between HC Road and Gandhi Road



Inferences and Strategies

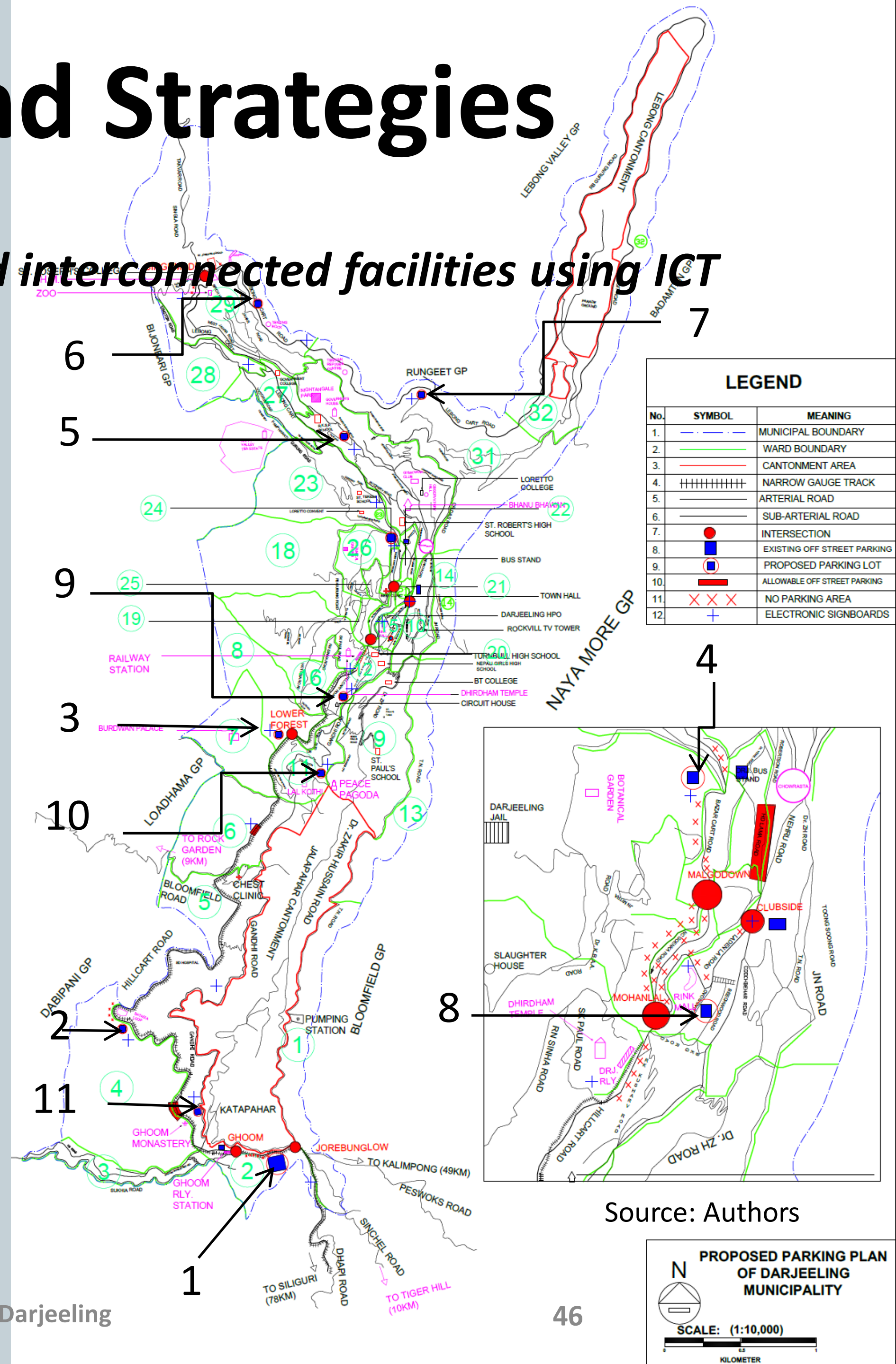
Broad Strategies:

2. Proposal of new parking areas and interconnected facilities using ICT

Sl. No	Parking Space	Level	Vehicle Type	Area Available (sq. m)
1	Jorebunglow	2	Buses/cars/Jeeps/2-wh	3740
2	Batasia Loop	1	Cars/ jeeps	1718
3	Lower Forest	1	c/j/2w	600
4	Bus Stand	3	b/c/j/2w	5500
5	RTO	1	c/2w	585
6	Singmadi	2	j/c/2w	2200
7	Golay Bazar	1	b/c/j/2w	1900
8	Behind Rink Mall	1	2w	200
9	Circuit House	2	j/c/2w	2200
10	Peace Pagoda	1	j/2w	700
11	Katapahar	1	j/c/2w	1500
Total Projected Parking area				25,843

- Existing off street parking demand= 3146 sq. m.
- Existing on street parking demand= 10,452 sq m.

Existing Total Demand= 13,598 sq m.



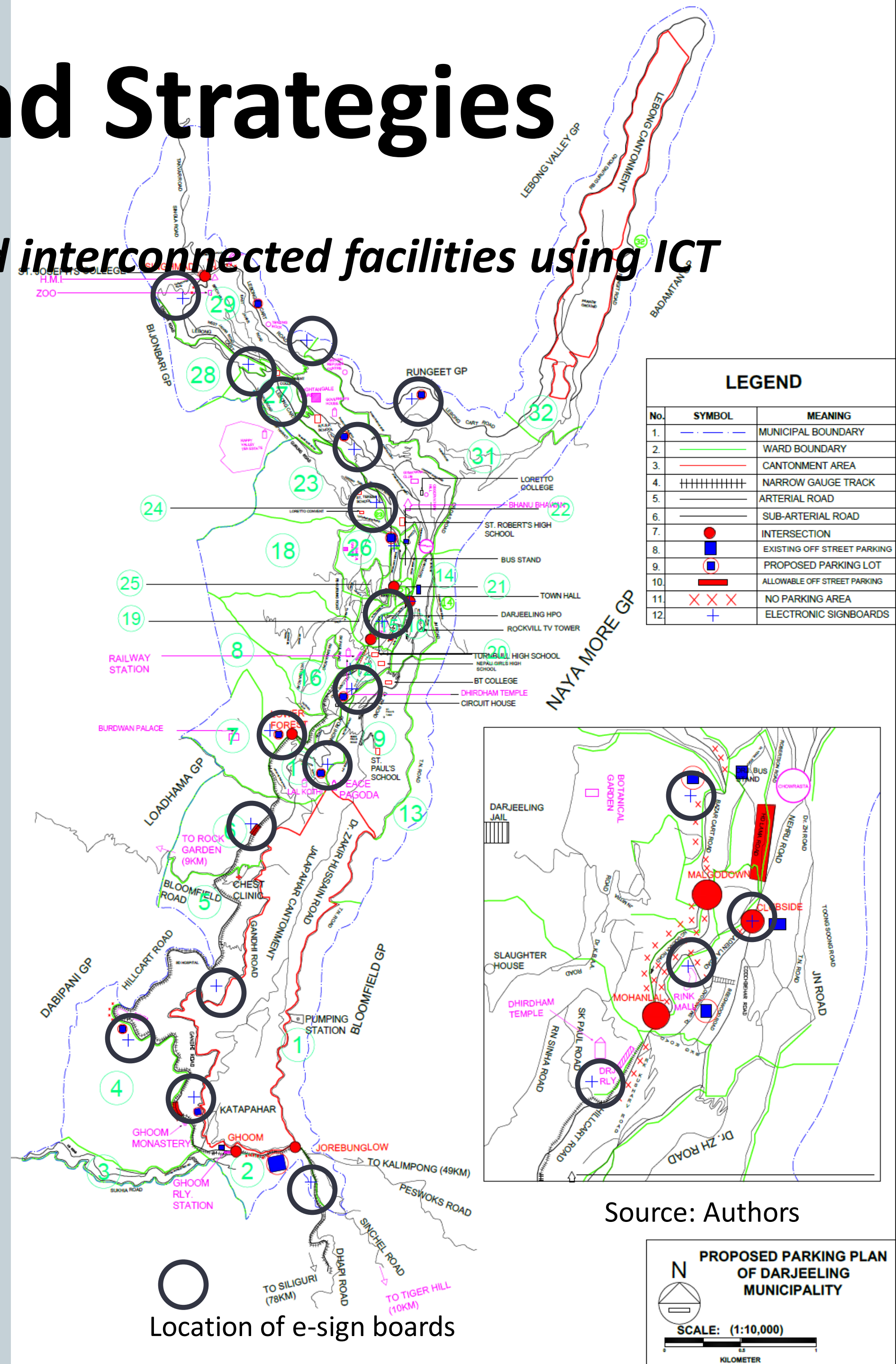
Source: Authors

Inferences and Strategies

Broad Strategies:

2. Proposal of new parking areas and interconnected facilities using ICT

- **Use of ICT-**
  - ✓ Existing-**Automated toll collection** system
  - ✓ Available parking spaces should be **real time connected to a central Information system** which is displayed to the drivers thorough **e-sign boards** at strategic locations along with the other parking lots.



Location of e-sign boards

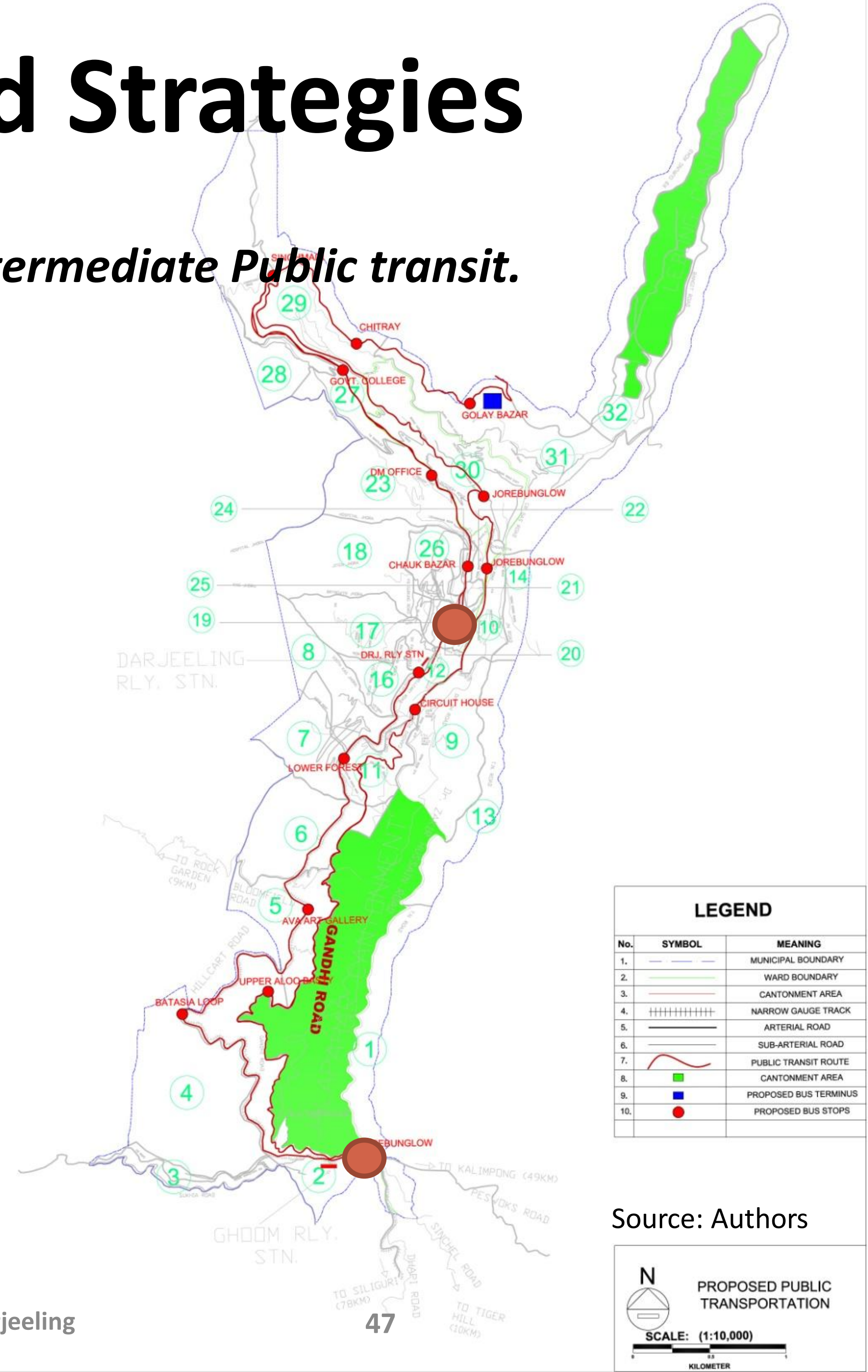
Source: Authors

Inferences and Strategies

Broad Strategies:

3. Introduction of Public transit and Intermediate Public transit.

- **Decentralisation** from Central Darjeeling
- **Circular Bus** route which goes via the proposed Gandhi Road route.
- **Battery Operated Vehicle –** discouraged due to terrain--run (as IPT) between Ghoom and Darjeeling railway station as the **slope is moderate** on this stretch.

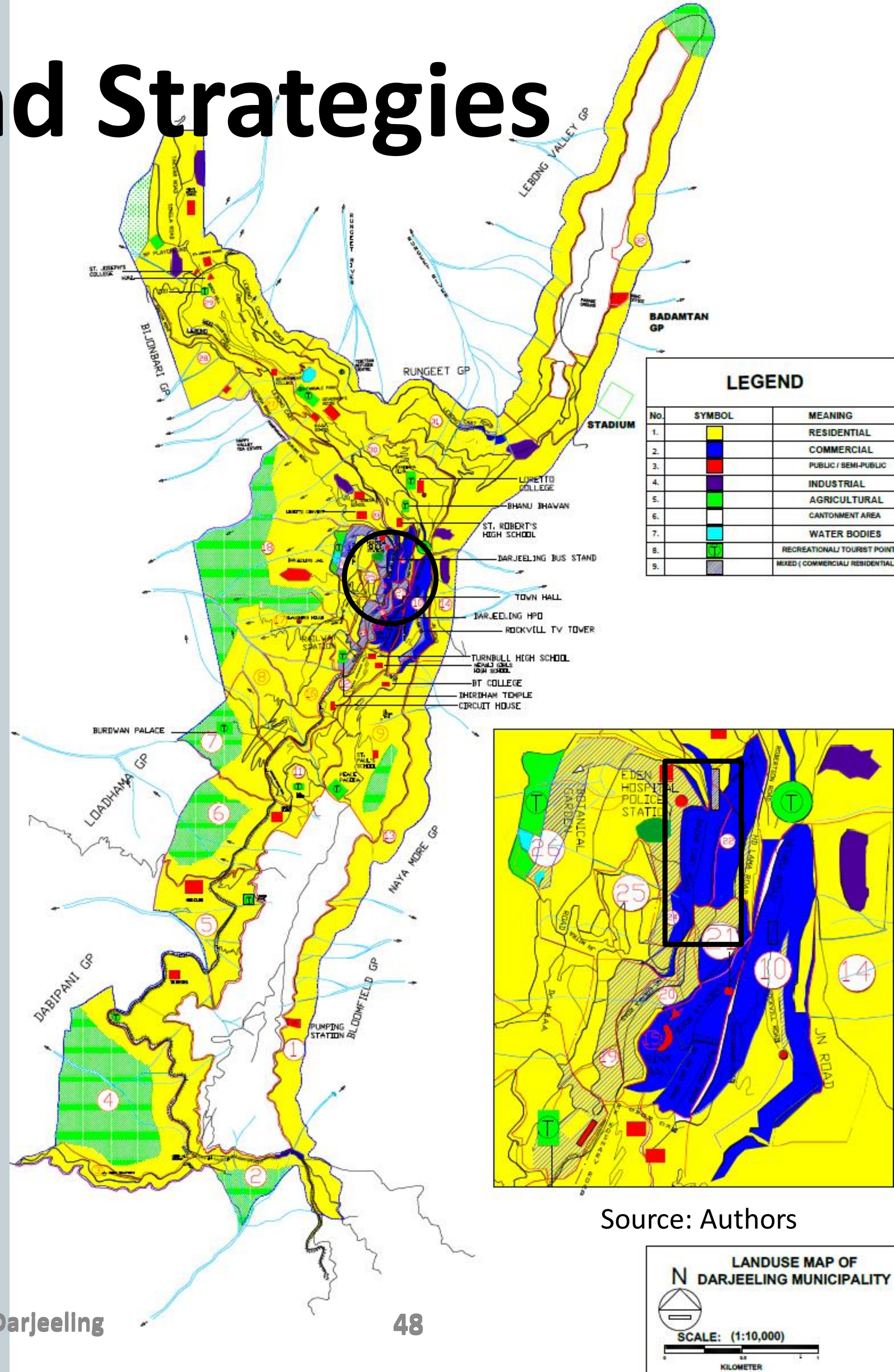


Source: Authors

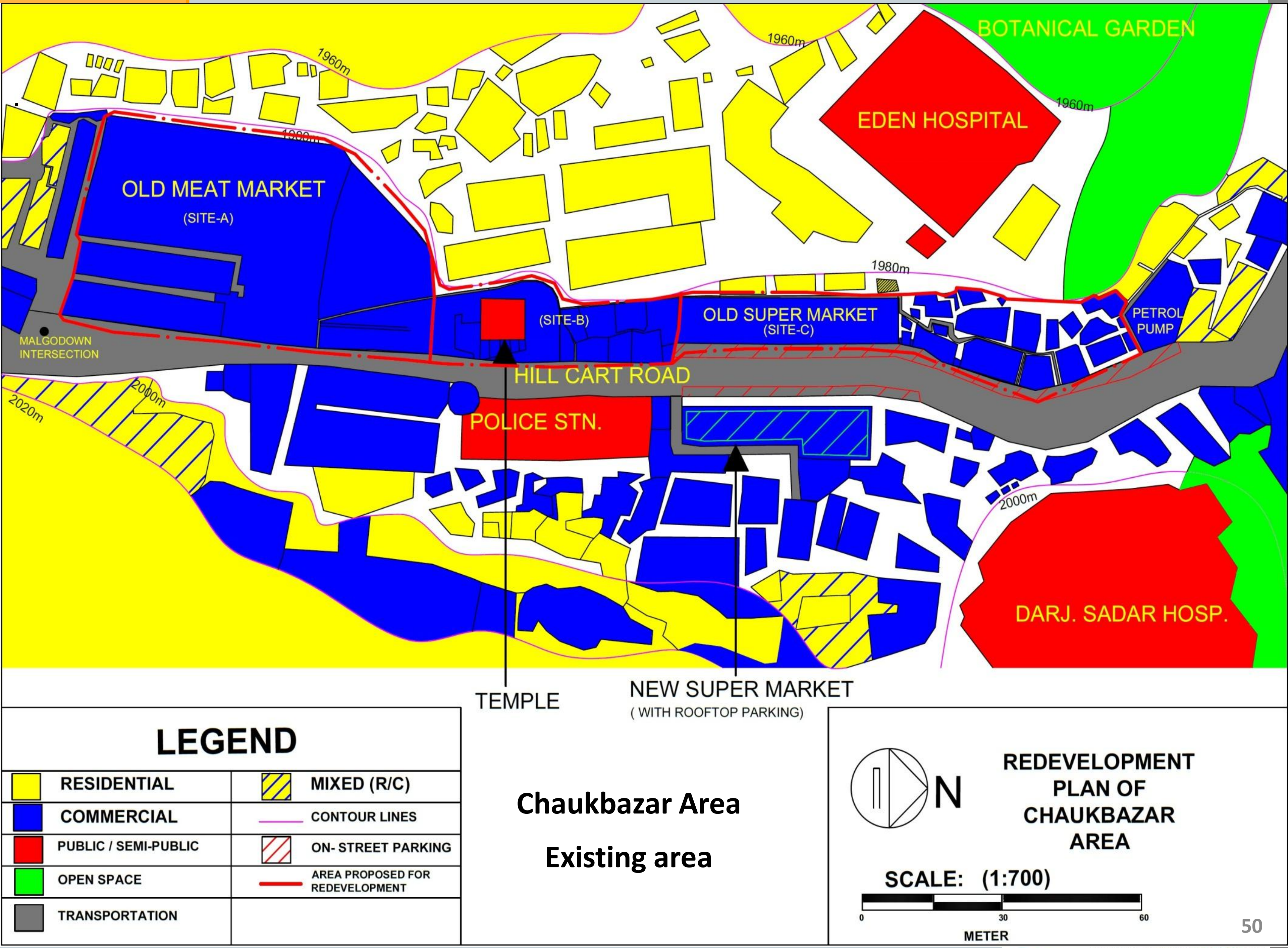
Inferences and Strategies

Broad Strategies:

4. Re-development of Chaukbazar & Bus Stand area

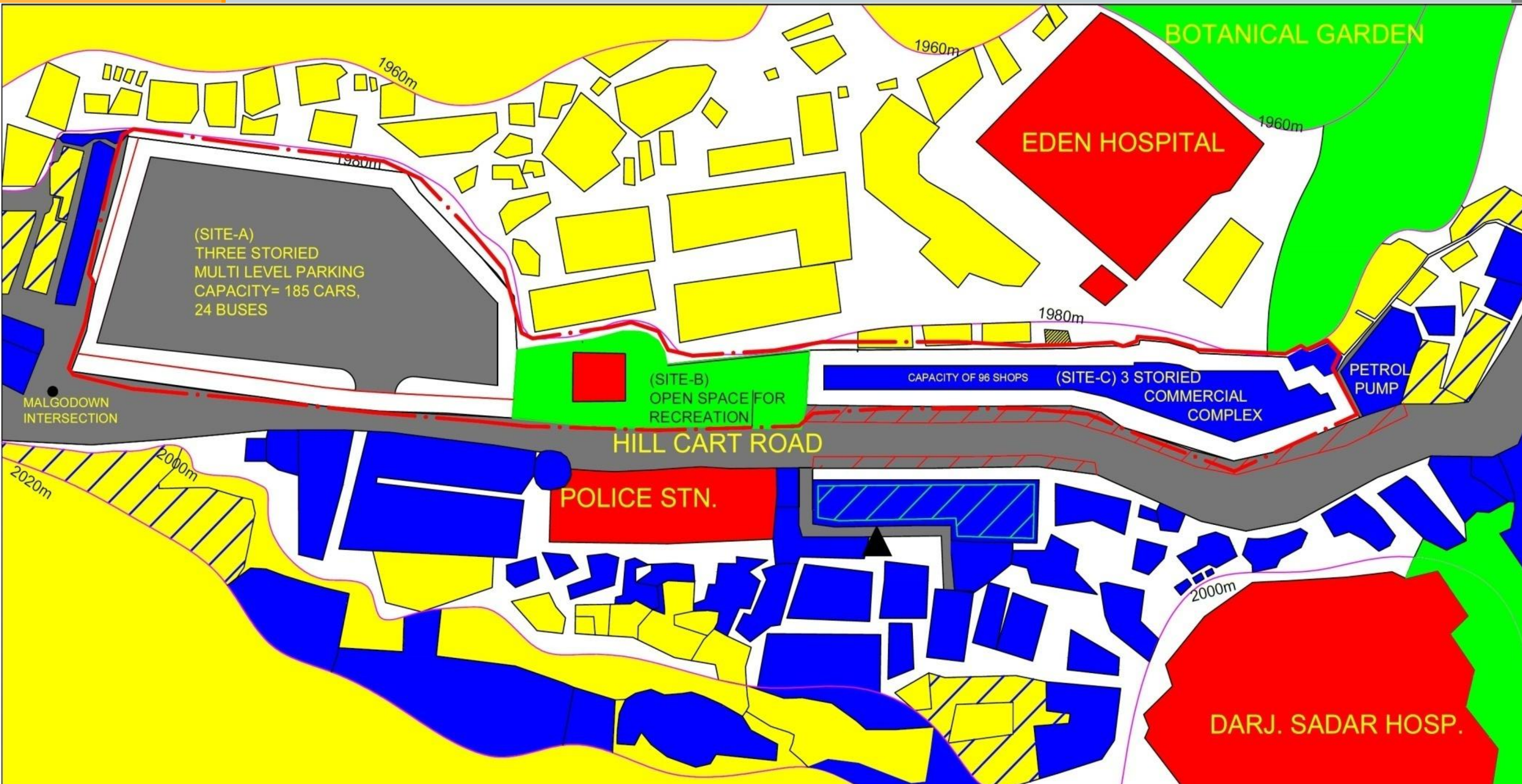


Source: Authors



Chaukbazar Area

Existing area



LEGEND

RESIDENTIAL	MIXED (R/C)
COMMERCIAL	CONTOUR LINES
PUBLIC / SEMI-PUBLIC	ON- STREET PARKING
OPEN SPACE	AREA PROPOSED FOR REDEVELOPMENT
TRANSPORTATION	

Chaukbazar Area

Proposed area

N

REDEVELOPMENT PLAN OF CHAUKBAZAR AREA

SCALE: (1:700)

0 30 60

METER

Inferences and Strategies

Broad Strategies:

4. Re-development of Chaukbazar & Bus Stand area

Site	Area	Developed area	FAR Consumed	Allowable FAR as per by laws	Ground Coverage	Purpose
A	6109 sq m	7855.62 sq m	1.89	2.5	57.76%	3 storied parking lot with recreational spaces on the roof top
B	2472 sq m	4517sq m	2.05	2.5	59.4%	3 storied Commercial complex
C	2040 m^2	-	-	-	-	Open space for recreation

Thus Site A is used as a 3 storied parking complex with a food court at the top. This could serve as a view point along with Site C, which is an open space in the vicinity of a temple.

Site B will be used to house all the resettled Shop Owners.

References

1. Commission for Sustainable Development. (2005). *Moving On Sustainable Transport*, World Bank.
2. Black, J. A., Paez, A., & Suthanaya, P. A. (2002). Sustainable Urban Transportation: Performance Indicators and Some Analytical Approaches, *Journal of Urban Planning and Development.*
3. *Census*. (2011). Census. Govt. of India.
4. CPCB. (2009). National Ambient Air Quality & Monitoring. New Delhi: Ministry of Environment & Forests, Govt. of India.
5. CPCB. (2000). Noise Pollution (Regulation & Control) Rules. New Delhi: Ministry of Environment & Forest, Govt. of India.
6. Darjeeling Municipality. (2008). *Draft Development Plan*, Darjeeling Municipality.
7. Dobranskyte-Niskota, A., Perujo, A., & Pregl, M. (2007). Indicators to Assess Sustainability of Transport Activities. Luxembourg: European Commission, Joint Research Centre, Institute for Environment and Sustainability.
8. ECMT. (2004). Assessment and Decision Making for Sustainable Transport. OECD.
9. FHWA. (2010). Sustainable Highways Self-Evaluation Tool. Washington: U.S. Federal Highway Administration.
10. Gilani, V. (2012). Emission Factors Ready Reckoner, India. New Delhi: The no2co2 Project.
11. Gilbert, R., & Tanguay, H. (2000). Brief Review of some Relevant Worldwide activity & Development of an initial long list of indicator. Toronto: The Centre for Sustainable Transportation.
12. Henderson, H. (1996). Building a Win-Win World. San Francisco: Berrett-Koehler.
13. Kaur, P. (2009). Environmentally Sustainable Mobility for Raipur. Unpublished Masters' Thesis. Kharagpur, India: IIT Kharagpur.
14. Litman, T. (2007). Well Measured: Developing Indicators for Comprehensive and Sustainable Transport. Transportation Research Record 2017, TRB, 10-15.
15. Littman, T. (2007). Developing Indicators for Comprehensive and Sustainable Transport Planning. *Transportation Research Record 2007*, Transportation Research Board, 10-15.
16. Littman, T., & Burwell, D. (2006). Issues in sustainable transportation. *Int. J. Global Environmental Issues*, Vol. 6, No. 4, 331–347.
17. Nesamani, K. (2002). Sustainable Transportation for Darjeeling. New Delhi, India.
18. OECD. (1999). Indicators for the Integration of Environmental Concerns into Transport Policies. Paris: Organisation for Economic Co-operation and Development (OECD).
19. Papacostas, C., & Prevedouros, P. (3rd Edition, 2009). *Transportation Engineering and Planning*. PHI.
20. Saaty. T.L.(2008). Decision making with the analytic hierarchy process. Int. J. Services Sciences, Vol. 1, No. 1, 2008, 83-98.
21. Schilleman, B., & Gough, J. (2012). Sustainability in Your Words. *ITE Journal*, 20-24.
22. US Environmental Protection Agency. (2011). Guide To Sustainable Transportation Performance Measures.
23. WBPCB. (2009). Darjeeling Ambient Air Quality. Retrieved Feb 2015, from West Bengal Pollution Control Board: http://www.wbpcb.gov.in/
24. Zheng, J. (2011). *Development & Application of the Transportation Index for Sustainable Places (TISP)*. Retrieved Sept 11, 2014, from Master's Theses. Paper 64: http://digitalcommons.uconn.edu/gs_theses/64

Thank You !