# Impact of Shared Mobility on Travel Pattern in Urban Areas





Urban Mobility India Terence & Expo **2018** 

Dr. Sanjay Gupta **Professor, Transport Planning Department, SPA Delhi** 

# Case Study New Delhi

RBAN

- INTRODUCTION
- LITERATURE
- DATABASE
- SOCIO ECONOMIC CHARACTERISTICS
- TRAVEL CHARACTERISTICS
- SOCIO ECONOMIC WITH TRAVEL CHARACTERISTICS
- COMPARSION BETWEEN SHARED MOBILITY USER AND PRIAVTE VEHICLE USER
- IMPACT OF SHARED MOBILITY ON MOBILITY PATTERNS
- **ISSUES IDENTIFIED**
- **MODELLING CHOICE FOR SHARED MOBILITY**
- SENSITIVITY ANALYSIS
- IMPACT OF CHOICE MODELLING OF SHARED MOBILITY
- CONCLUSION



# **STRUCTURE OF PRESENTATION**



## **Background of the Study**

- In the last 15 years (2000-2015), 20 million cars have been added in comparison to 7 million cars over first five decades since Independence (1951–2000). (Source : Ministry of Road Transport and Highways – Taxi Policy Guidelines, 2016)
- The total number of vehicles continues to grow in the capital, crossing the 10-million mark. Total number of vehicles on Delhi's streets increased from 9.7 million in 2015-16 to 10.4 million in 2016-17

Year	Taxies	
2013-14	74,758	
2014-15	79,606	
2015-16	91,073	
2016-17	1,48,434	

**Source** : Economic Survey of Delhi 2014-2015 Delhi Statistical Hand Book, 2017

- Prior to 2014-15, the rise in number of taxis was usually in the range of 5-10% as only 'black and yellow' cabs or a handful of private cab companies added vehicles to their fleet
- For 2014-2015 ,after Good Vehicles & motorcycles and Scooters, Taxi has the third largest growth rate i.e. 6.48 %
- The number of taxis registered in Delhi rose from 79,606 in 2014-15 to 148,434 in 2016-17, a rise of 86.4%, according to the 'Delhi Statistical Hand Book, 2017
- In 2015-16, the number of taxis on Delhi roads was 91,073, which means the number grew by around 62.98% in 2016-17 in comparison to the previous year
- Ride-sourcing and car-sharing are two disruptive transportation services whose 13. Only Ola, Uber & Shuttle operators have been selected and study have been adoption, use, and impacts in the marketplace remain poorly understood despite their proliferation.



# INTRODUCTION

Gro	wth	Rate

4.72%

6.48%

14.40%

62.98%

## Need of the Study

Indian Shared mobility industry is undergoing a phenomenal change in the recent past, which has revolutionized the way of travel, happens in cities, and very limited empirical work has been done on India

## Aim of the Study

"To study the Impact of Shared Mobility on Travel Pattern in Urban areas "

## **Objectives of the Study**

- 1. To Appreciate the importance of Shared Mobility services in urban areas & identify issues affecting its provision and user
- 2. To review the Best Global Practices of shared mobility services & identify lesson learnt
- 3. To assess the **characteristics** of the shared mobility services for Services provider and users in **Delhi & identify issues** affecting the **performances**
- 4. To evolve the **alternative strategies** for improving the ecosystem of shared mobility services and its evaluation
- 5. To propose the policy for shared mobility

## **Scope and Limitation of the Study**

- 1. The project Includes all mode of Shared mobility which are available in Delhi
- 2. Delhi has been taken as the case study to demonstrate an approach to evolve alternate development strategies & evaluate them.
- carried out these on user







# LITERATURE

cle Sharing - Its is the systems which allow users to access	Indian
cles on an as-needed basis from a <b>network of stations</b> ,	Classifica
h are typically concentrated in <b>urban areas</b>	Operator
<ol> <li>Public Bike sharing – Examples = Available at BRT ,</li> </ol>	City Taxi
Metro Station , BOUNCE	i i
2. Closed campus bike sharing - Examples = Available at	I AITP (Al I India
College, amusement Park & national Parks	Permits fo
Splitting – It facilitates share rides between drivers and	Transport
engers with similar origin-destination pairings. Example –	Operator)
booling, bla-bla car	   Padio Tavi
native Transit Services - Transportation options (which are	
et special populations) have existed in parallel to	Rent c
olished public transit networks. Example - <b>vans, paratransit,</b>	Cab(for
shuttles	Rentals)
1. Shuttles - connect passengers to public transit stations	·
	I Tavi Po
or to employment centers.	Taxi Po
or to employment centers. 2. Micro transit – Alternative transit service which can	Taxi Po• Based
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> </ul>	<ul> <li>Taxi Po</li> <li>Based</li> <li>that c</li> </ul>
or to employment centers. 2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both Demand Ride Services	<ul> <li>Taxi Po</li> <li>Based</li> <li>that c</li> <li>metres</li> </ul>
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to</li> </ul>	<ul> <li>Taxi Po</li> <li>Based</li> <li>that c</li> <li>metres</li> <li>into</li> </ul>
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples</li> </ul>	<ul> <li>Taxi Po</li> <li>Based</li> <li>that c</li> <li>metres</li> <li>into</li> </ul>
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples – Ola micro, Ola mini and Ola prime, Uber Go, Uber</li> </ul>	Taxi Po         • Based         that c         metres         into
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples – Ola micro, Ola mini and Ola prime, Uber Go, Uber Premier</li> </ul>	<ul> <li>Based</li> <li>that c</li> <li>metres</li> <li>into</li> <li>Dynan</li> </ul>
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples <ul> <li>Ola micro, Ola mini and Ola prime, Uber Go, Uber Premier</li> </ul> </li> <li>2. Ride Sharing - Involves sharing a ride sourcing ride with</li> </ul>	Taxi Po         • Based         that c         metres         into         • Dynan         match
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples – Ola micro, Ola mini and Ola prime, Uber Go, Uber Premier</li> <li>2. Ride Sharing - Involves sharing a ride sourcing ride with someone else taking a similar route. Ola and Uber</li> </ul>	<ul> <li>Taxi Po</li> <li>Based</li> <li>that c</li> <li>metres</li> <li>into</li> <li>Dynan</li> <li>match</li> <li>Maxim</li> </ul>
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples – Ola micro, Ola mini and Ola prime, Uber Go, Uber Premier</li> <li>2. Ride Sharing - Involves sharing a ride sourcing ride with someone else taking a similar route. Ola and Uber match riders with similar origins and destinations</li> </ul>	<ul> <li>Taxi Po</li> <li>Based</li> <li>that c</li> <li>metres</li> <li>into</li> <li>Dynan</li> <li>match</li> <li>Maxim</li> <li>times t</li> </ul>
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples – Ola micro, Ola mini and Ola prime, Uber Go, Uber Premier</li> <li>2. Ride Sharing - Involves sharing a ride sourcing ride with someone else taking a similar route. Ola and Uber match riders with similar origins and destinations together, and they split the ride and the cost.</li> </ul>	Taxi Po• Basedthat cmetresinto• Dynan• Maximtimes t
<ul> <li>or to employment centers.</li> <li>2. Micro transit – Alternative transit service which can incorporate flexible routing, flexible scheduling, or both</li> <li>Demand Ride Services</li> <li>1. Ride sourcing- Ride sourcing use smartphone apps to connect community drivers with passengers. Examples – Ola micro, Ola mini and Ola prime, Uber Go, Uber Premier</li> <li>2. Ride Sharing - Involves sharing a ride sourcing ride with someone else taking a similar route. Ola and Uber match riders with similar origins and destinations together, and they split the ride and the cost. Examples – Ola Share, Uber Pool</li> </ul>	Taxi Po         • Based         that c         metres         into         • Dynan         match         • Maxim         times f

# **Demand – Supply = GAP <--> Shared Mobility**

## Scenario



## licy Guidelines,2016

d on the Excise duty criteria and the fact over 87% of the cars are **less than 4** e**s length**, the Taxis may be segregated

Economy (less than 4 m) and Deluxe (more than 4 m) mic pricing to be allowed to effectively and and supply. hum tariff may be permitted up to three the minimum tariff.

**Source**: Ministry of Road Transport and Highways – Taxi Policy Guidelines,2016



	User Survey	Socioeco Attribu
Primary Survey -	→ Non-User Survey	Gender
Thindry Survey		Age
		Education
	Operator Survey	Occupation
	(Driver's Survey)	Income
		Vehicle Owner

## User Attri

Types

Purpose

Number of trips

Trip Length

Travel Time

Travel Cost

Availability

Access

Reliable

Safety

Payment(wallet

Driver behaviou

Drivers Knowled

## Vehicu Attribu

Vehicle Numbe Fuel Type Age of Vehicle Vehicular Occu Operational Ho

Parking hours

Parking Charge

## Information needed to collected

- 1. Socioeconomic parameters
- 2. User Attributes
- 3. Non user Attributes/ Vehicular Attributes
- 4. Operators Attributes

# Choice of Sample Size

- Since the aim of the study is to examine which group predominately uses shared mobility for what purpose
- 6 Purposes categories with Shared mobility users and non-users give **12 stratified classes**
- Assuming 35 samples in each of the strata gives a total sample size of about 420 samples

## Methodology Adopted For Conducting Survey

- Interview Survey & Google online form Survey
- Since different purpose users needed to captured so the interviewing of User and nonuser is performed at different Land uses



# DATA BASE

nomic	<b>Operator Attributes</b>	Land Uses :-
ites	Cab Detail	
	Cab Category	Commercial Area
	Fuel Type	Select City Mall, Saket
	Ownership	≻South X Market
	Age of Vehicle	Institutional Area
	Operational Detail	May Hospital Sakat
ship	Number of passengers	
	Distance Travelled	Delhi University (Vocati
butes	Fuel & Maintenance	College, ARSD)
	Average waiting time	➤IT Sectors
	Trip Targets (per day)	
5	Monthly Expenses	$\sim$
	Cab Financing (EMI etc.)	
	Drivers Personal Detail	
	Age	P-1 / /
	Cab ownership	P-2
	In Cab Business (Years)	$\sim$
	$\langle$	
t/ Card)		н с
Ur		
dge		
Jar		G B A
	$\sim$	X
ITES	K1	Lodbi/Garden D
ers	<u>۲</u>	K-2
		South X
		Select City-Mall
Jpancy		Max Hospital
ours		
		7
25		
		l i



	User	Non User	Total	Operator	Number of Samples Colle	ected	
ommercial Land Use					Prodominately Shared Mobility only		
elect City Mall	27	20	00	21			
outh X	20	23	90	1	Exclusively Private Venicle	e Only	
Share	14%	17%	19%		Mix( Private Vehicles & Sh	nared mobility Both	
stitutional Land Use					Non of the above		
ax hospital, Saket	17	26		7	Total		
hi University (Bhagat Sing	h) 9	39	215			& Non User Typolog	V
	95	32					
	37%	38%	39%			Predom Users or	וו ר
ecreational Land Use						35% Exclusiv	e
dhi Garden	6	27	33	2	Only		
	2%	10%	6%		27%	Mix Use	rs
	Transporte	ation land Use			i	Shared	rr th
amuddin Railway Station	30	14		20	25%		
nnaught Place Parking	32	26		2	Predominately Sh	nared Mobility Users c	or
ehru Place Parking	21	20		4	Mix(Both Private )	Vehicles & Shared ma	С
BT Sarai kale khan	18	17			Non Exclusively Private	e Vehicle User Only	
GI Airport	53	14		16	User Mix(Both Private )	Vehicles & Shared me	Эk
	47%	35%	36%		Type	Samples Nr	2
tal	325	253	543	73			
one G	Zone D	Zone F			User	172+14/ 3.	57
7	35%	50%			Non User	137+147 28	34







#### **Observation :-**

- 35% of the samples are using Shared Mobility on daily basis
- Users (Shared Mobility) analysis is done from 339 samples collected
- Non User (Private Vehicles) analysis is done from 284 samples
- 12% of the above Samples collected have been **excluded** in the analysis



Source : Primary Survey, feb 2018 3 (IND)

# **SOCIO-ECONOMIC CHARACTERISTICS OF SHARED MOBILITY USERS**





ation	Numbers	%Share
ess	20	6%
ervice	17	5%
wife	3	1%
er	7	2%
ervice	176	52%
ent	115	34%
1	339	100%

ne	Numbers	%Share
000	30	4%
25,000	84	9%
50,000	153	22%
,00,000	81	35%
,000	72	7%
	123	23%
l	543	100%

Educatio	'n
High Scho	ol
enior Secor	ndary
School	
Undergradu	Jate
Post Gradu	ate
Doctorat	е
Total	
1%	5%
High School	Senio
	Scho
	Educatio High Schoo enior Secor School Undergradu Doctorat Total 1% High School

#### **Observation:-**

- 67% of Shared Mobility users are male
- 18-35 years
- post Graduate(32%)
- mobility services.
- student (34%)

Numbers	%Share
34	1%
67	5%
203	60%
122	32%
67	2%
339	100%



83% of the Shared mobility users lies in the age range of

92% of the sample users are either Undergraduate(60%) or

43% of samples own a vehicle and are still using Shared

Majority of user are from Private Service (52%) followed by

• Shared mobility users lies in the **income** range of ₹50,000 to **₹1,00,000 (35%)** followed by **₹50,000 to ₹1,00,000 (22%)** 



# TRAVEL CHARACTERISTICS OF SHARED MOBILITY USERS









#### **Observation:-**

Ride Sharing = Uber Pool or Ola Share Ride Sourcing = Single Ride (Micro or GO)

64% of made by trips done by Ride Sharing(32%) and Ride Sourcing(32%) 46% of the trips are being performed by for Work purpose followed by social/Leisure (20%) and Education (15%).

**9%** of the trips are made for **pick up** and drop off from Airport or Railway station

ATL(Average Trip Length) for Pick and drop off purpose is maximum of 21km followed by Work 15.5km

15% trips is made for Education purpose but predominate user of Work and Education makes same number of trips in a week

ATL is maximum for Pick up and drop off is 21km but frequency is 2 which in **minimum** compare to other purpose Travel Cost for pick and drop off is enormously high for pick and drop off because change in rate slab

₹9 per km till 8 km ₹11 per km till 15 km ₹18 per km after 15 km

> Source :OLA, Primary Survey, feb 2018



# SOCIO ECONOMIC WITH TRAVEL CHARACTERISTICS OF SHARED MOBILITY USERS





Source : Primary Survey, feb 2018 URBAN TRA



## **Travel Characteristics**





# **IMPACT OF SHARED MOBILITY ON MOBILITY LEVEL**





Source : Primary Survey Feb. 2018

# **IMPACT OF SHARED MOBILITY ON MOBILITY PATTERNS**

## Societal Impacts

#### Vehicular Reduction

#### Mode Use Before Shifting

Mode	Passenger Trips	Occupancy	In Vehicles	PCU	In PCU
Personal Car	85	1.2	71	1	71
2-Wheeler	71	1.12	64	0.5	32
Cycle	3	1	3	0.3	1
Auto	119	1	119	1	119
Metro	51				-
Bus	10	34	0	3	1
Total	339		257		223

## Mode Use After Shifting

Mode	Passenger Trips	Occupancy	In Vehicles	PCU	In PCU
Car Pooling	37	2	19	1	19
Taxis	10	1	10	1	10
Shuttle	24	16	1	3	4
Car Sharing	14	3	5	1	5
Ride Sharing	108	3	36	1	36
Ride Sourcing	108	1	108	1	108
Scooter Sharing	20	1	20	0.5	10
Bicycle Sharing	17	1	17	0.3	5
Total	339		217		198

#### Inferences From Panel Survey

>Vehicular Reduction after shifting to Shared Mobility = (257-181) = 76

## Vehicles

 $\gg$ % change in vehicular Reduction after Shifting to Shared Mobility =

## (76\*100)/257 = 29%

 $\succ$ Vehicular Reduction in PCU = (223-162) = 61 PCU

>%change in Vehicles = (61\*100)/223 = 27%

Ourban Mobility India Inference & Expo **2018** 



## **Environmental Impacts**

## **Emission Reduction**

## **Emission Standards**

Mode	Fuel	Vehicle Class	CO (g/Km)	HC (g/Km)	NOx (g/Km)	HC +NOx (g/Km)	PM (g/Km)
Scooter	Petrol	2 W (BS IV)	1	0.1	0.06		0.0045
		2 W (B III)	1.2				1.2
Auto	CNG	3 W (BS IV)	0.94	0.44	0.13		0.94
		3 W (BS III)	1.2				1.2
	Petrol	4W (BS IV)	1	0.1	0.08	0.17	0.0045
		4W (BS III)	2.3	0.2	0.15		
Car	Diesel	4W (BS IV)	0.5		0.25	0.3	0.025
Car		4W (BS III)	0.64		0.5	0.56	0.05
	CNG	4W (BS IV)	1	0.03	0.08	0.17	0.0045
		4W (BS III)	2.3	0.06	0.15		
Mini Bus	Diesel	BS III	0.64		0.5	0.56	0.05
Bus	CNG	BS III	4	1.1	3.5		0.03



## Inferences:-

 $\gg$  Major reduction in Emission component is shown CO, HC & PM

>NOx & NMHC are emission component which have increased by 1.5

- times & 10.69 times respectively
- >There is reduction in 426kg of CO(Carbon Monoxide) over an year



50	0.0	1000.0	1500.0 ka	2000.0	2500.
After Shi	ifting to Sh	ared Mobili	ty (kg)		
Before S	hifting To S	Shared Mob	pility (kg)		

	0.5	0.56	0.05
0.03	0.08	0.17	0.0045
0.06	0.15		
	0.5	0.56	0.05
1.1	3.5		0.03

# IMPACT OF SHARED MOBILITY ON MOBILITY PATTERNS



Non User (	Private Car	user)	Sho	ared <i>l</i>	Mobility Use	r (Ola & Uber	.)	Shared M	obility User				
								Category	Base Fare	Distance Fare	Ride time Fare	Total Fare	Total Fare for 3 years
New Car-User		↓ Old Car-Use	r	Ba	Cost of Hiri Ise fare + Distar Ride Time F	ng nce Fare +		Hatch Back	₹ 50	₹ 296	₹100	₹ 446	₹ 4,88,370
								Prime Sedan	₹ 60	₹ 408	₹100	₹ 568	₹ 6,21,960
<ul> <li>Loan Cost (Down Payment + Loan Principle+ Loan Interest)</li> </ul>	) (if	rking / Miscella	neous	1. Ri	<b>ide Sourcing</b> Economy(	hatch		SUV	₹150 for first 4km	₹ 544	₹150	₹ 844	₹ 9,24,180
<ul><li>applicable)</li><li>Insurance Cost</li></ul>	Cn	arges			back) F	200		1 Total C	ost of ownir	na a Car	in 3 voors	(Patrol)	
Registration/taxes		ver s suidry(ii policable)				Go			Cost (N/ith H)	irod Drive	ni o years	- <b>₹10 95</b>	000
<ul> <li>Annual Maintenance Cost</li> <li>Parking / Miscellaneous Chai</li> </ul>	rges S	nning Cost			Premium S F	remier			Cost (without		riv(r) =	- < 10,75, - = 4 42 0	
<ul> <li>Driver's Salary(if applicable)</li> </ul>	C	Resale Value			(Sedan)								
<ul> <li>Kunning Cost</li> <li>(-) Resale Value</li> </ul>				2. Ri	× ide Sharing (PC	NOL)		Z.IOTALC		ig a Car	in 3 years		000
					Source	: Author Source		►Net (	ost (With H	Irea Drive	er) =	= ₹11,40, ~~~~~~	000
New Car-User								➢Nef (	Cost (withou	It Hired D	river) =	= ₹7,08,60	50
			Hatch	back				3.10tal C	ost ot ownir	ng a Car	in 3 years	(CNG)	
Component of C	ost	Petrol	Dies		CNG			Net Cost (With Hired D		ired Drive	er)	= ₹10,25	,000
Cost of Car		5,00,000	6,00,	,000	5,30,000			>Net (	Cost (withou	it Hired D	priver)	= ₹5,93,0	00
Insurance Cost		2.5%	3.0	%	3%								
Road taxes		4 %	5%	70	4%	+							
Annual Maintenance	e Cost	21,000	25,0	000	35,000		St	nared			Now Privo		
Running Cost (ATL =3	86 km)	1,66,955	1,06,5	263	83,220		M	obility	New Privo	ite ,	Vehicle Us	ers Ol	d Car Use
Parking/ Miscellaneous	Charges	37,000	37,0	000	37,000	Category		User /	Vehicle Us	ers Driver (F	Petrol) with	nout (P	etrol) with
Hired Driver (if applic	cable)	4,32,000	4,32,	000	4,32,000				Perroi) wiin i		Driver		Driver
Resale Value		2,34,000	2,00,	000	2,00,000	Hatch Back	₹4	,88,370	₹10,95,00	0	₹ 6,63,00	0 ₹	5,95,000
Net Cost for New Non U	ser = I Cost	of Car + Insur	ance Co	ost + F	Road Taxes +					1			
Annual Maintenance Cost + R	unnina Cost -	+ Parkina/ Misc	ellaneo	us Cha	araes + Hired								
driver( if applicable) - Resale V	aluel												
	~.~~]											TUTE	URBAN TRANSPORT





## **USER ISSUES :-**

#### <u>Ride Sourcing</u>

- > 58% of the users have Cost issue
- >33% of the users have Waiting time issue
- >64% of the users have Accessibility issue
- >35% of the user have rated worst in terms of safety

#### <u>Ride Sharing</u>

- >68 % of users have said **Cost** is the major issue for choosing ride Sharing
- >63% of the have rated Waiting Time Issue
- >86% of the user said **Travel time** is shared mobility is high



## **NON-USER ISSUES :-**

- 39% of Non-User says shared mobility is costly
- 24 % of Non-User high waiting
- 15% of Non-user says Non availability
- Women Safety

# **ISSUES IDENTIFIED**



100%

# **MODELLING CHOICE FOR SHARED MOBILITY**

1	ln_v	ehi	icl	tim	F
•	III- V	CII			C

<th colu<="" th=""><th>Different sce attributes with choice set</th><th>narios are h different le</th><th>generated in t evel and present</th><th>erms <b>of saving of</b> ted to respondent i</th><th><b>using various</b> In the form of a</th><th>The <b>Binary Lo</b> The Following</th><th><b>git Model</b> is used for Equations are used for</th><th>Predicting mode or the Calculation</th><th>choice Probability of Ride</th><th>e Sharing and Car</th></th>	<th>Different sce attributes with choice set</th> <th>narios are h different le</th> <th>generated in t evel and present</th> <th>erms <b>of saving of</b> ted to respondent i</th> <th><b>using various</b> In the form of a</th> <th>The <b>Binary Lo</b> The Following</th> <th><b>git Model</b> is used for Equations are used for</th> <th>Predicting mode or the Calculation</th> <th>choice Probability of Ride</th> <th>e Sharing and Car</th>	Different sce attributes with choice set	narios are h different le	generated in t evel and present	erms <b>of saving of</b> ted to respondent i	<b>using various</b> In the form of a	The <b>Binary Lo</b> The Following	<b>git Model</b> is used for Equations are used for	Predicting mode or the Calculation	choice Probability of Ride	e Sharing and Car
Altributes ore:1. In-vehicle time 2. Watting timeSincred Mobility User AltributesSincred Mobility User AltributesProbability Of Choosing Ride Sharing ( $P_{BS}$ ) = $\frac{e^{CM}}{e^{100000000000000000000000000000000000$	<ul> <li>In Total 6 sce</li> <li>Optimistic an</li> </ul>	enario are s I <b>d Pessimisti</b>	selected using t i <b>c Savings</b> of attr	he best combinatio	on of <b>Realistic</b> ,	Probability of	Choosing Ride Sharin	$g(P_{RS}) = \frac{e^{\text{Utility}}}{e^{\text{Utility}} \circ fR}}$	of Ride Sharing Fide Sharing + $e^{Car} = \frac{e^{U_{TR}}}{e^{U_{TR}+e^{U_{TC}}}}$		
I. In-vehicle fine 2. Wolfing timeShared Mobility User AltibudesProbability User Altibudes $u_{uutus vertices and verti$	> Attributes are	<b>:</b> -				i i i					
A. Parking Cost       Security Signed Reset Attributes with different Scenario we generate utility equation using SIMPLE BINARY LOGIT MODEL       Scenarios       Waiting Time (min)       In vehicle Time (min)       Parking Search Time (min)       Parking Cost (3)         Actual Values       Waiting Time (min)       In vehicle Time (min)       In vehicle Time (min)       Parking Search Time (min)       Parking S	<ol> <li>In-vehicle time</li> <li>Waiting time</li> <li>Parking Search Time</li> <li>Non User Attributes(Car)</li> </ol>					Probability of	Choosing Ride Sharin	$g(P_{RS}) = \frac{1}{e^{\text{Utility of }R}}$	$\frac{e^{Car}}{e^{ide Sharing} + e^{Car}} = \frac{e^{U_{TC}}}{e^{U_{TR} + e^{U_{TC}}}}$		
P Using these Attributes with different Scenario we generate Uting equation using SIMPLE BINARY LOGIT MODEL       Scenarios       Waiting Time (min)       In vehicle Time (min)       Parking Cost (%)         Actual Values       Waiting Time (min)       In vehicle Time (min)       Parking Search Time (min)       Parking Cost (%)       Scenario 2       Optimistic       Optimistic       Optimistic       Optimistic       Optimistic       Optimistic       Pessimistic       Pessimistic       Pessimistic       Pessimistic       Pessimistic       Pessimistic       Pessimistic       Pessimistic       Pessimistic       Optimistic       Optimistic       Optimistic       Optimistic       Optimistic       Optimistic       Optimistic       Optimistic       Pessimistic       Scenario3       13       16       -3       -38       Scenario3       13 <th></th> <th></th> <th></th> <th></th> <th></th> <th>Scenarios E</th> <th>Building</th> <th></th> <th></th> <th></th>						Scenarios E	Building				
Actual Values         Waiting Time (min)         In vehicle Time (min)         Parking Search Time (min)         Parking Cost (%)         Scenario1         Realistic         Realistic         Realistic         Realistic         Realistic         Optimistic         Optimistic         Optimistic         Optimistic         Optimistic         Optimistic         Optimistic         Optimistic         Optimistic         Pessimstic         Pessimstic <t< th=""><td>Using thes equation using</td><td>e Attribute sing <b>SIMPLE</b></td><td>BINARY LOGIT M</td><td>T Scenario we ge ODEL</td><td>enerate <b>Utility</b></td><td>l Scenarios</td><td>Waiting Time (min) In</td><td>vehicle Time (min)</td><td>Parking Search Time (min)</td><td>Parking Cost (₹)</td></t<>	Using thes equation using	e Attribute sing <b>SIMPLE</b>	BINARY LOGIT M	T Scenario we ge ODEL	enerate <b>Utility</b>	l Scenarios	Waiting Time (min) In	vehicle Time (min)	Parking Search Time (min)	Parking Cost (₹)	
Actual Values         Waiting fine (min)         Parking Search Time (min)         Parking Search Time (min)         Scenario2         Optimistic         Optimistic         Persinstic<						Scenario1	Realistic	Realistic	Realistic	Realistic	
Actual Values Time (min)Time (min)Time (min)Time (min)Time (min)Time (min)Time (min)Time (min)Time (min)Time (min)PessimaticPessimaticOptimistic<		Waiting	In vehicle Time	Parking Search Time	Parking Cost	Scenario2	Optimistic	Optimistic	Optimistic	Optimistic	
Normal Car038550Scenario4RealisticOptimisticOptimisticOptimisticOptimisticPessimisticRealisticOptimisticPessimisticRealisticOptimisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticOptimisticRealisticRealisticOptimisticRealisticRealisticOptimisticRealisticRealisticOptimisticRealisticIn vehicle Time (min)Parking Search Time (min)Parking CostRealisticScenario2S11101020-5-50 <th< th=""><td><b>Actual Values</b></td><td>Time (min)</td><td>(min)</td><td>(min)</td><td>raiking cost (₹)</td><td>Scenario3</td><td>Pessimstic</td><td>Pessimistic</td><td>Pessimstic</td><td>Pessimstic</td></th<>	<b>Actual Values</b>	Time (min)	(min)	(min)	raiking cost (₹)	Scenario3	Pessimstic	Pessimistic	Pessimstic	Pessimstic	
Normal Car         0         38         5         50         Scenario5         Optimistic         Pessimistic         Realistic         Realistic         Optimistic           Ride Sourcing         7         38         0		,	()	()	( )	Scenario4	Realistic	Optimistic	Optimistic	Pessimstic	
Ride Sourcing Ride Sharing738000RealisticRealisticPessimiticRealisticPessimiticRealistic </th <td>Normal Car</td> <td>0</td> <td>38</td> <td>5</td> <td>50</td> <td>Scenario5</td> <td>Optimistic</td> <td>Pessimistic</td> <td>Realistic</td> <td>Optimistic</td>	Normal Car	0	38	5	50	Scenario5	Optimistic	Pessimistic	Realistic	Optimistic	
Ride Sharing105800Ride SharingWaiting Time (min)In vehice Time (min)Parking Search Time (min)Parking Cost ( $\mathfrak{T}$ )SavingsScenario11020-5-50-50Ride SourcingWaiting Time (min)In vehicle Time (min)Parking Search Time (min)Parking Search Time (min)-100-100Realistic70-5-5011-10-100Realistic70-5-5016-5-100Optimistic4-2-100-100Scenario5516-5-100Pessimistic92-3-100Scenario31316-5-50Ride Sharing Time (min)In vehicle Time (min)In vehicle Time (min)In vehicle Time (min)Parking Search Time (min)Parking Cost ( $\mathfrak{T}$ )-50Ride Sharing Time (min)In vehicle Time (min)In vehicle Time (min)In vehicle Time (min)Parking Search Time (min)Parking Cost ( $\mathfrak{T}$ )Ride Sharing Time (min)In vehicle Time (min)Parking Search Time (min)Scenario392-3-38Realistic1020-5-50-50Scenario392-3-38Optimistic511-100-100Scenario392-3-38Optimistic511-10-100Scenario392-3-38Realistic1020-5-5	<b>Ride Sourcing</b>	7	38	0	0	Scenario6	Optimistic	Realistic	Pessimstic	Realistic	
Savings       Scenario1       10       20       -5       -50         Real Sourcing Realistic       In vehicle Time (min)       Parking Search Time (min)       Scenario2       4       -2       -10       -50         Realistic       10       20       -5       -50       Scenario2       4       -2       -10       -38         Optimistic       12       11       -100	Ride Sharing	10	58	0	0	Ride Sharing	Waiting Time (min) In v	vehicle Time (min)	Parking Search Time (min)	Parking Cost (₹)	
Schwarzing-10-100Ride Sourcing Ime (min)Marking Search Time (min)Parking Search Time (min)Parking Cost ( $$ )Scenario31316-3-38Scenario5516-3-38-38-38-38-38-38-38Scenario5516-5-100-38-38-38-38-38-38Optimistic4-2-100-100-100-100-100-5-50-50-50-50-50-50-50Ride Sharing Time (min)Nekicle Time (min)Parking Search Time (min)Parking Cost ( $𝔅$ )Maiting Time ( $𝔅$ )Nu shicle Time (min)Parking Search Time ( $𝔅$ )Parking Cost ( $𝔅$ )Maiting Time ( $𝔅$ )In vehicle Time ( $𝔅$ )Parking Search Time ( $𝔅$ )Parking Cost ( $𝔅$ )Realistic1020-5-50-50-50-50-50-50-50Scenario24-2-10-100-100-100-100-100-100Scenario392-3-38-38-38-38-38-38-38Optimistic511-10-100-100-2-10-100-100Scenario547-2-10-38-38-38-38-38-38-38-38-38-38-38-38-38-38-38-38-38-38	Savinas					Scenario1	10	20	-5	-50	
Ride Sourcing fine (min)         Parking Search Time (min)         Parking Search Time (min)         Parking Search Time (min)         Scenario3         13         16         -3         -38           Realistic         7         0         -5         -36         -38         -38         -38           Optimistic         4         -2         -10         -36         -38         -38           Pessimistic         9         2         -100         -100         -5         -50         -100           Realistic         9         2         -100         -100         -100         -5         -50         -50           Pessimistic         9         2         -3         -100         -100         -100         -100         -100         -100         -50 <td></td> <td></td> <td></td> <td></td> <td></td> <td>Scenario2</td> <td>5</td> <td>11</td> <td>-10</td> <td>-100</td>						Scenario2	5	11	-10	-100	
Ride Sourcing Time (min)Time (min)<		Waiting	In vehicle Time	Parking Search Time	Parking Cost	Scenario3	13	16	-3	-38	
Realistic70-5-100Optimistic4-2-10-50520-3-50Optimistic4-2-10-100 <td><b>Ride Sourcing</b></td> <td>Time (min)</td> <td>(min)</td> <td>(min)</td> <td>(₹)</td> <td>Scenario4</td> <td>10</td> <td>11</td> <td>-10</td> <td>-38</td>	<b>Ride Sourcing</b>	Time (min)	(min)	(min)	(₹)	Scenario4	10	11	-10	-38	
Realistic70-5-50Scenario6520-3-50Optimistic4-2-10-100 $$ <t< th=""><td></td><td></td><td></td><td>_</td><td></td><td>Scenario5</td><td>5</td><td>16</td><td>-5</td><td>-100</td></t<>				_		Scenario5	5	16	-5	-100	
Optimistic4-2-10-100Pessimistic92-3-10Ride SourcingWaiting Time (min)In vehicle Time (min)Parking Search Time (min)Parking CostRide SharingIn vehicle Time (min)In vehicle Time (min)Parking Search Time (min)Parking Search Time (min)Parking CostParking CostRide SharingIn vehicle Time (min)Parking Search Time (min)Parking CostScenario170-5-50Realistic1020-5-50Scenario24-2-100-100Optimistic511-10-100-100Scenario542-10-100Pessimistic1316-3-38Scenario640-5-50	Realistic	7	0	-5	-50	Scenario6	5	20	-3	-50	
Pessimistic92-3-10Ride SourcingWaiting Time (min)In refinite (min)Taking Sector (min)Taking Sector (min)Taking Sector (min)Ride SharingWaiting (min)In vehicle Time (min)Parking Search Time (min)Parking Cost ( $\mathfrak{T}$ )Scenario170-5-50Realistic1020-5-50Scenario24-2-10-100Optimistic511-10-100Scenario542-10-38Pessimistic1316-3-38Scenario640-5-50	Optimistic	4	-2	-10	-100			In vehicle Ti	me Parking Search Time	Parking Cost	
Ride Sharing Time (min)In vehicle Time (min)Parking Search Time (min)Parking Cost (T)Scenario170-5-50Realistic1020-5-50-505cenario24-2-10-100Optimistic511-10-505cenario392-3-38Optimistic1316-3-385cenario542-10-30Scenario540-5-50-50-50-50-50-50Scenario540-5-50-50-50-50	Pessimistic	9	2	-3	-10	Ride Sourcing	Waiting Time (min)	(min)	(min)	(₹)	
Realistic         10         20         -5         -50         Scenario3         9         2         -3         -38           Optimistic         5         11         -10         -100         Scenario5         4         7         -2         -10         -38           Pessimistic         13         16         -3         -38         Scenario6         4         0         -5         -50	<b>Ride Sharing</b>	Waiting Time (min)	In vehicle Time (min)	Parking Search Time (min)	Parking Cost (₹)	Scenario1 Scenario2	7 4	0 -2	-5 -10	-50 -100	
Optimistic         13         16         -3         -38           Optimistic         13         16         -3         -38	Realistic	10	20	-5	-50	Scenario3	9	2	-3	-38	
Optimistic         Optimis	Ontimistic	5	11	_10	-100	Scenario4		-2	-10	-38	
	Possimistic	12	16	-3	_38	Scenario6	<u>4</u> Д	0	-10	-100	

➢ Different sce	> Different scenarios are generated in terms of saving of using variou					git Model is used	for Predicting mode	e choice Probability of Ri	de Sharing and Car.
attributes witl	n different le	evel and presen	ted to respondent in	n the form of a	The Following	Equations are use	ed for the Calculation	า:-	
choice set					i				
≻In Total 6 sce	enario are s	selected using t	he best combination	on of <b>Realistic</b> ,	1		IItility	of Ride Sharing U	
Optimistic an	d Pessimisti	<b>c Savings</b> of attr	ributes		Probability of	Choosing Ride Sho	aring (P <sub>RS</sub> ) = $\frac{e^{\text{Outility}}}{e^{\text{Utility}} of}$	$\frac{e^{\Theta_{TR}}}{Ride Sharing + e^{Car}} = \frac{e^{\Theta_{TR}}}{e^{\Theta_{TR}} + e^{\Theta_{TC}}}$	
►Attributes are	):-				i				
1. ln-v	ehicle time	She	arad Mability Usar						
2. Wait	tina time	Att	ributes		Probability of	Choosing Ride She	aring ( $P_{RS}$ ) = <u>Utility of</u>	$\frac{e^{Car}}{Pide Sharing Car} = \frac{e^{\mathbf{U}_{TC}}}{\mathbf{U}_{TC}}$	
2 Park	3. Parking Search Time Non User					C		$e^{\mathbf{U}_{\mathbf{T}}} \mathbf{R} + e^{\mathbf{U}_{\mathbf{T}}} e^{\mathbf{U}_{\mathbf{T}}} \mathbf{R} + e^{\mathbf{U}_{\mathbf{T}}} \mathbf{C}$	
J. PUIK	Attributes(Car)								
<b>4. Park</b>	ing Cost				Scenarios I	Buildina			
$\succ$ Using these Attributes with different Scenario we generate Utility			<b>_</b>						
equation Us	sing <b>SIMPLE</b>	BINARY LOGIT M	ODEL		Scenarios	Waiting Time (min)	In vehicle Time (min)	Parking Search Time (min)	Parking Cost (₹)
					Scenario1	Realistic	Realistic	Realistic	Realistic
	Waiting	In vehicle Time	Parking Search Time	Parking Cost	Scenario2	Optimistic	Optimistic	Optimistic	Optimistic
Actual Values	Time (min)	(min)	(min)	(₹)	Scenario3	Pessimstic	Pessimistic	Pessimstic	Pessimstic
		()	()		Scenario4	Realistic	Optimistic	Optimistic	Pessimstic
Normal Car	0	38	5	50	Scenario5	Optimistic	Pessimistic	Realistic	Optimistic
Ride Sourcing	7	38	0	0	Scenario6	Optimistic	Realistic	Pessimstic	Realistic
Ride Sharing	10	58	0	0	Ride Sharing	Waiting Time (min)	In vehicle Time (min)	Parking Search Time (min)	Parking Cost
			· · ·			waiting time (iiiii)		raiking search nine (nin)	(₹)
Savings					Scenario1	10	20	-5	-50
					Scenario2	5	11	-10	-100
	Waiting	In vehicle Time	Parking Search Time	Parking Cost	Scenario3	13	16	-3	-38
Ride Sourcing	Time (min)	(min)	(min)	(₹)	Scenario4	10	11	-10	-38
Realistic	7	0	-5	-50	Scenario5	5	20	-5	-100
Ontimistic	1	2	_10	_100			20	U	
Pessimistic	9	-2	-3	-10	Ride Sourcing	Waiting Time (r	min) In vehicle T	ime Parking Search Time	Parking Cost
T CSSITTISTIC		۷		Ĩ		7	(min)	(min)	(₹)
<b>Ride Sharing</b>	Waiting	In vehicle Time	Parking Search Time	Parking Cost	Scenario1			-5	-50
	Time (min)	(min)	(min)	(₹)	Scenario3		2	3	_38
Realistic	10	20	-5	-50	Scenario4	7	-2	-10	-38
Optimistic	5	11	-10	-100	Scenario5	4	2	-10	-100
Pessimistic	13	16	-3	-38	Scenario6	4	0	-5	-50



$$\frac{haring}{ing + e^{Car}} = \frac{e^{\mathbf{U}_{\mathsf{T}\,\mathsf{R}}}}{e^{\mathbf{U}_{\mathsf{T}\,\mathsf{R}} + e^{\mathbf{U}_{\mathsf{T}\,\mathsf{C}}}}}$$

$$\frac{e^{\mathbf{U}_{\mathsf{TC}}}}{e^{\mathbf{U}_{\mathsf{TR}}} = \frac{e^{\mathbf{U}_{\mathsf{TC}}}}{e^{\mathbf{U}_{\mathsf{TR}}} \mathbf{U}_{\mathsf{TC}}}$$



# MODELLIN

<b>Binary L</b>	ogit Regre	ession A	nalysis Ric	de Sharing		I Binary Lo	ogit Regre	ssion And	alysis Ride	Sourcing	
Utility Equation $U_T = -1.612-0.17$ (WT)- 0.006(INVT) + 0.03 (Parking Search Time) + 0.054 (Parking Cost)					Utility 0.078(I	Equation Parking Se	UT = earch Ti	-2.010-0 me) + 0.1	).113(WT)- 98(Parking	0.002(INVT) + Cost)	
				Mode	Ridership(%)					Mode	Ridership(%)
U <sub>T R</sub>	-3.005	e <sup>u</sup> t RS	0.0495	Ride Sharing	27.3	UT R	-4.903	eUT R	0.0074	Ride Sourcing	4.6
U <sub>T C</sub>	-2.026	e <sup>U</sup> TC	0.1318	Car	72.7	UTC	-1.863	eUT C	0.15519	Car	95.4
Probab Probab	oility of c	hoosing hoosing	g Ride sha g Car = <b>0.</b> '	aring = <b>0.2</b> 7 727	73	Probal	oility of ch oility of ch	noosing noosing	Ride sha Car =0.9	ring =0.46 54	

# **OVERALL UTILITY OF SHARED MOBILITY** Utility Equation UT = - 0.389-0.23(WT) - 0.029(INVT) + 0.096(Parking Search Time) - 0.018(Parking Cost)

Probability of choosing Sha	Ridership(%)	Mode				
	29.4	Shared Mobility	0.049687	eUT R	-3.0022	UT R
Probability of choosing Prive	70.6	Car	0.119529	eUTC	-2.1242	UTC



# red Mobility = 0.294

## ate Car **=0.706**



Scenarios	Waiting Time (min)	In vehicle Time (min)	Parking Search Time (min)	Parking Cost (₹)	Pro Shif
Scenario 1	Realistic	Realistic	Realistic	Realistic	
Scenario 2	Optimistic	Optimistic	Optimistic	Optimistic	
Scenario 3	Pessimistic	Pessimistic	Pessimistic	Pessimistic	
Scenario 4	Realistic	Optimistic	Optimistic	Pessimistic	
Scenario 5	Optimistic	Pessimistic	Realistic	Optimistic	
Scenario 6	Optimistic	Realistic	Pessimistic	Realistic	

	%Change in Probability of Ride Sharing										
% Change in Attribute	Waiting Time	In vehicle Time	Parking Search Time	Parking Cost							
-20%	2.2%	0.4%	-2.80%	-3.30%							
-10%	1.1%	0.2%	-1.40%	-1.60%							
0%	0.0%	0.0%	0.00%	0.00%							
10%	-1.2%	-0.2%	1.40%	1.60%							
20%	-2.3%	-0.4%	2.70%	3.20%							

	%Change in Probability of Ride Sourcing										
% Change in Attribute	Waiting Time	In vehicle Time	Parking Search Time	Parking Cost							
-20%	3.5%	0.20%	-0.9%	-3.70%							
-10%	1.7%	0.10%	-0.4%	-1.80%							
0%	0.0%	0.00%	0.0%	0.00%							
10%	-1.7%	-0.15%	0.4%	1.80%							
20%	-3.5%	-0.18%	0.9%	3.50%							



# **SENSTIVITY ANALYSIS**



# **IMPACT OF CHOICE MODELLING OF SHARED MOBILITY**

Vehicular Reduction												
				Occupancy	1.2	3						
		21%	4.68	29.40%	13%	87%						
Zones	Population (2001)	Car Ownership/ Modal Share	VEHICULAR TRIPS Over All Daily Person Car Trip Rates	% of Shift to Shared Mobility	PASSENGER TRIPS Ride Sourcing	PASSENGER TRIPS Ride Sharing (Pool)	Vehicular trips					
Zone D	5,87,000	1,23,270	5,76,904	1,69,610	22,049	4,42,681	67,561					
Zone F	17,17,000	3,60,570	16,87,468	4,96,115	64,495	12,94,861	1,97,619					
Zone G	16,29,000	3,42,090	16,00,981	4,70,688	61,190	12,28,497	1,87,491					
Zone H	16,01,300	3,36,273	15,73,758	4,62,685	60,149	12,07,607	1,84,303					
Total	55,34,300	11,62,203	54,39,110	15,99,098	2,07,883	41,73,647	6,36,974					
Reduction in number of Vehicles on Road			9,62,124									
Vehicular Trips Before Shifting			54,39,110									
Vehicular Trips After Shifting			44,76,986									
Actual Vehicular Reduction on Road			9,62,124									
% Actual Vehicular Reduction on Road			17.69%									

## **Emission Reduction**

Before Shifting		Vehicle Class	CO (ton/Km)	HC (ton/Km)	NOx (ton/Km)	NMHC (ton/km)	HC +NOx (ton/Km)	PM (tonKm)
	Petrol	4W (BS IV)	5.7	0.6	0.5	0.0	1.0	0.0
		4W (BS III)	96.6	8.4	6.3	0.0	0.0	0.0
	Diesel	4W (BS IV)	1.1	0.0	0.6	0.0	0.7	0.1
Car		4W (BS III)	10.5	0.0	8.2	0.0	9.2	0.8
	CNG	4W (BS IV)	1.7	0.0	0.1	0.1	0.3	0.0
		4W (BS III)	29.5	0.0	1.9	0.8	0.0	0.0
	Total		145.2	9.0	17.6	0.8	11.1	0.9

After Shifting		Vehicle Class	CO (ton/Km)	HC (ton/Km)	NOx (ton/Km)	NMHC (ton/km)	HC +NOx (ton/Km)	PM (tonKm)
	Petrol	4W (BS IV)	4.6	0.5	0.4	0.0	0.8	0.0
		4W (BS III)	77.9	6.8	5.1	0.0	0.0	0.0
Car	Diesel	4W (BS IV)	0.9	0.0	0.5	0.0	0.5	0.0
		4W (BS III)	8.5	0.0	6.6	0.0	7.4	0.7
	CNG	4W (BS IV)	1.4	0.0	0.1	0.0	0.2	0.0
		4W (BS III)	23.8	0.0	1.6	0.6	0.0	0.0
	Total		117.1	7.2	14.2	0.7	9.0	0.7



Source : Transport Demand Forecast Study, RITES(2010), Author Source

Overall Utility

Probability of choosing Shared Mobility = 0.294

Probability of choosing Car =0.706



Analysis	Findings	Conclusions
STUDY OF SOCIO-ECONOMIC CHARACTERISTICS OF SHARED MOBILITY USERS	<ul> <li>Majority of the shared mobility users are male, above 18years old, at least under graduated with an income range lies between ₹25,000 to ₹1,00,000 (57%)</li> </ul>	<ul> <li>Safety is the one of shared mobility users</li> </ul>
STUDY OF TRAVEL CHARACTERISTICS OF SHARED MOBILITY USERS	<ul> <li>67% of the shared mobility users are using ride sharing and ride sourcing as the primary source of travel majorly for work purpose (46%) followed by social purpose (20%) with an average ATL of 14.88km</li> <li>Economic (36%) and time savings (19%) are the primary reason to shared mobility as mode of travel</li> </ul>	<ul> <li>Many people are regular basis (work period be made each are</li> <li>As compared to a period to a period option advantage in time so</li> </ul>
IMPACT OF SHARED MOBILITY USERS ON MOBILITY LEVELS	<ul> <li>Mode use shared mobility user before shifting to shared mobility are Auto (38%) followed by personal Car (25%) and 21% (2-W)</li> <li>Shared mobility has enhance the mobility pattern of the users as number of trips made per week for work and social has shown a significant change.</li> </ul>	<ul> <li>29 % of Vehicular rec mobility</li> <li>Emission reduction of 63kg/km of NO<sub>X</sub> and observed over a yea</li> </ul>
MODE CHOICE MODELLING	<ul> <li>Mode choice modelling for shared mobility is performed using attributes In-Vehicle time, Waiting Time, Parking search time and Parking Cost.</li> <li>Probability of car users willing to shift is 29.4%</li> <li>Sensitivity analysis is performed and we find out Non users are more sensitive to waiting time and Parking Cost</li> </ul>	<ul> <li>17.8% of vehicular re</li> <li>Emission reduction of</li> <li>3.4 ton/km of NO<sub>X</sub> a</li> <li>observed over a yec</li> </ul>

## Recommendations

dead mileage travelled by the driver can be achieved. • Minimising of Waiting time can be done by using Upper Level model • In vehicle time can be reduced by providing HOV(High Vehicle Occupancy lane) by increasing the income of driver and increasing Fleet Size



# CONCLUSION

• Zoning Operation area can also reduce waiting time. Because of shorter trips, further reduction in

of the issue because of which female rs are less.

eady to use the Shared mobility on a ourpose) although a separate booking is nd every day.

private mode, shared mobility is a more to the user as well as having an avings.

duction has taken after shifting to Shared

of 426 kg/km of CO & 1262 kg/km of PM , d 252kg/km of (HC+  $NO_X$  ) have been ar for the sample collected

eduction

of 28 ton/km of CO & 0.2 ton/km of PM , and 2.1 ton/km of (HC+  $NO_x$  ) have been ar for the sample collected





THANK YOU





# **IMPACT OF SHARED MOBILITY ON MOBILITY PATTERNS**

Shared Mobility Impacts	I Me
The Potential Impacts of Shared Mobility can be :-	Em
1. Environmental Impacts	Sar
Lower greenhouse gas emissions	
Improved air quality	
Increased transit ridership	n
2. Social Impacts	i
Reduce Congestion	
≻ Improved Health	
House Cost Saving	
3. Economic Impacts	
Reduced Infrastructure and maintenance	
The shared mobility Impacts can also be categories as :-	_ E
<b>1</b> Societal Impacts – Those are Impacting at society level	r
<b>1. Societal impacts</b> – mose are impacting a society level	I
2. Individual impacts - Those are impacting at individual	I
level (Users or Operators)	

## Societal Impacts

Mode Use Be	efore Shiftir	ng				Mode	Passenger Trips	Occupancy	In Vehicles	PCU	In PCU
	Passenaer					Car Pooling	37	2	19	1	19
Mode	Trips	Occupancy	In Vehicles	PCU	In PCU	Taxis	10	1	10	1	10
				_		Shuttle	24	16	1	3	4
Personal Car	85	1.2	71	1	71	Car Sharing	14	3	5	1	5
2-Wheeler	71	1.12	64	0.5	32	<b>Ride Sharing</b>	108	3	36	1	36
Cycle	3	1	3	0.3	1	Ride	108	1	108	1	108
Auto	119	1	119	1	119	Scooter					10
Metro	51	0			0	Sharing	20		20	0.5	10
Bus	10	34	0	3	1	Bicycle	17	1	17	0.3	5
Total	339		257		223	Total	339		217		198



ethodology for Calculation	Emission	Stand	ards					
nission Imple of different modes with different	Mode	Fuel	Vehicle Class	CO (a/Km)	HC (a/Km)		HC +NOx	PM (a/Km)
purposes	Scooter	Petrol	2 W (BS IV)	1	0.1	0.06		0.0045
ATL(Average Trip Length) of different mode with different purpose is taken			2 W (B III)	1.2				1.2
Number of trips made per Week	Auto	CNG	3 W (BS IV)	0.94	0.44	0.13		0.94
(predominate user & Mixed User)			3 ₩ (BS III)	1.2				1.2
		Petrol	4W (BS IV)	1	0.1	0.08	0.17	0.0045
T/person/ week is Calculated for Each			4W (BS III)	2.3	0.2	0.15		
Mode	Cor	Diesel	4W (BS IV)	0.5		0.25	0.3	0.025
	Cui		4W (BS III)	0.64		0.5	0.56	0.05
Emission Standards Values are taken		CNG	4W (BS IV)	1	0.03	0.08	0.17	0.0045
mode for different Class of vehicles			4W (BS III)	2.3	0.06	0.15		
	Mini Bus	Diesel	BS III	0.64		0.5	0.56	0.05
Emitted Emission for each class of	Bus	CNG	BS III	4	1.1	3.5		0.03
Vehicle is then Calculated					C e i			

Mode	Use	After	Shifting
------	-----	-------	----------

Source : ARAI emission norms

#### Inferences:-

> Vehicular Reduction after shifting to Shared Mobility = (257-181) = 76

#### Vehicles

- >% change in vehicular Reduction after
- Shifting to Shared Mobility =

## (76\*100)/257 = 29%

> Vehicular Reduction in PCU = (223-

## 162) = 61 PCU

>%change in Vehicles = (61\*100)/223 =

27%

Source : Author Source



# IMPACT OF SHARED MOBILITY ON MOBILITY PATTERNS

## Societal Impacts

#### **Emission for Different Mode Before Shifting**

Mode	Fuel	Vehicle Class	CO (kg/Km)	HC (kg/Km)	NOx (kg/Km)	NMHC (kg/km)	HC +NOx (kg/Km)	(k
Scooter	Petrol	2 W (BS IV)	56.0	5.6	3.4	0.0	0.0	
		2 W (B III)	492.7	0.0	0.0	0.0	0.0	
Auto -	CNG	3 W (BS IV)	74.9	35.0	10.4	0.0	0.0	
		3 W (BS III)	700.8	0.0	0.0	0.0	0.0	
	Petrol	4W (BS IV)	29.9	3.0	2.4	0.0	5.1	
		4W (BS III)	503.5	43.8	32.8	0.0	0.0	
Car	Diesel	4W (BS IV)	5.8	0.0	2.9	0.0	3.5	
		4W (BS III)	54.6	0.0	42.7	0.0	47.8	
	CNG	4W (BS IV)	9.1	0.0	0.7	0.3	1.5	
		4W (BS III)	153.6	0.0	10.0	4.0	0.0	
	Total		2080.9	87.4	105.3	4.3	57.9	1

## **Emission for Different Mode After Shifting**

Mode	Fuel	Vehicle Class	CO (kg/Km)	HC (kg/Km )	NOx (kg/Km )	NMHC (kg/km )	HC +NOx (kg/Km)	(k
Piko	Petrol	2 W (BS IV)	52	5	3	0	0	
ыке		2 W (B III)	0	0	0	0	0	
Petrol	Petrol	4W (BS IV)	0	0	0	0	0	
		4W (BS III)	0	0	0	0	0	
Car	Diesel	4W (BS IV)	56	0	28	0	34	
		4W (BS III)	0	0	0	0	0	
	CNG	4W (BS IV)	1527	0	122	46	260	
		4W (BS III)	0	0	0	0	0	
Mini Bus	Diesel	BS III	19	0	14	0	16	
Bus	CNG	BS III	0	0	0	0	0	
	Total		1654	5	168	46	309	





# Consideration :Emission are Calculated for 1 year of the mode use before and after shifting to shared Mobility Idling Emission through vehicles are not considered in Calculation Major reduction in Emission component is shown CO, HC & PM NOx & NMHC are emission component which have increased by 1.5 times & 10.69 times respectively There is reduction in 426kg of CO(Carbon Monoxide) over an year

## Shared Mobility User (Ola & Uber)



JS 1. Ride Sourcing Economy(hatch back) Pool Go Premium Sedan Premier (Sedan) XL (XUV) 2. Ride Sharing (POOL)

# MODELLING CHOICE FOR SHARED MOBILITY)



Zone	% Sample
D	20%
F	25%
G	20%
Н	35%
Total	100%



#### Socio- Economic Characteristics

		By Ge	ender		By	Age	Group			В	y Monthl	y Income	•	
Description	Total	Male	Fema le	Upto 18 yrs	18- 25 yrs	25- 35 yrs	35-50 yrs	Above 50 yrs	Up to ₹10,000	₹10,000 -25,000	₹25,000- 50,000	₹50,000- 1,00,000	Above ₹1,00,00 0	NA
Sample Size	100	74	26	0	36	43	16	5	0	9	23	35	10	23
						Distri	bution	by age	2					
Up to 18 yrs	0%	0%	0%							0%	0%	0%	0%	0%
18-25 yrs	36%	20%	33%							54%	15%	0%	0%	75%
25-35 yrs	43%	40%	64%							35%	45%	30%	10%	25%
35-50 yrs	16%	35%	3%							11%	40%	70%	40%	0%
Above 50 yrs	5%	5%	0%							0%	0%	0%	50%	0%
					D	istrib	ution b	y Gend	ler					
Male	74%				45%	90%	85%	100%		90%	72%	85%	100%	40%
Female	26%				55%	10%	15%	0%		10%	28%	15%	0%	60%
				[	Distrik	pution	by Mo	onthly Ir	ncome					
Upto ₹10,000	0%			0%	0%	0%	0%	0%						
₹10,000-25,000	9%			0%	25%	5%	0%	0%						
₹25,000-50,000	23%			0%	12%	32%	25%	0%						
₹50,000-1,00,000	35%			0%	0%	47%	70%	0%						
Above ₹1,00,000	10%			0%	0%	3%	5%	100%						
NA	23%			0%	63%	13%	0%	0%						



ravel	Characte
-------	----------

**Average Fare** 

Average In-Vehic (Min)

Average Waiting T

Average Income

Purpose

Work

Education

Social / Leisure

Medical

Shopping

Pick up and Drop

Mean ATL

Average Speed

Sample Siz	ze % Sample
10	10%
5	5%
35	35%
6	6%
Δ	1%
	4/0
10	10%
10	10%
20	20%
100	100%

#### eristics

e(₹)	284
cle Time	49
ime (Min)	0
₹/month)	52000

	ATL	% Share
	21 km	42%
	14 km	2%
Ş	11 km	27%
	7 km	13%
	10 km	14%
Off	25 km	2%
	14.88	km
d	24 km	/hr

Source : Primary Survey, feb 2018 & CSE Study,2017



# **MODELLING CHOICE FOR SHARED MOBILITY**

Binar	y Logit Reg	gressio	n Analysis	s Ride S	haring	g				Bind	ary L	ogit R	egres	sion A	nalysi	is Ride	Sourci	ing				
Omni	bus Tests of I	Model Co	oefficients			Model	Summa	ry		Om	nnibus	s Tests c	f Mod	el Coef	ficients			M	odel	Summa	ry	
	C squ	hi- Jare d	f Sig.	Step	-2 Lo likelih	og Co ood R	ox & Snel Square	I Nage Sc	elkerke R quare			S	Chi- quare	df	Sig.	Ste	ep  -2 like	Log lihoo	d R	x & Snel Square	l Nagel Squ	kerke R Jare
	Step 34.	.789 2	.000	1	297.0	69a	0.019	(	0.04		S	Step	Step	33.374	2		210	).4330	a	.05	0.	123
Step 1	Block 34.	.789 2	.000	-		Classific	ation Ta	ble		Step	5 1 B	lock l	Block	33.374	2			Cla	ssific	ation Ta	ble diatad	
	Model 34.	789 2	.000	Ohse	erved	Re	Pre	dicted Per	centade	I	N	odel N	Nodel	33.374	2		bserved		Re	rre sponse	aictea Perc	entage
							1		Correct		Hos	ner and	leme	show 1	est				0	1		orrect
F	losmer and L	.emeshov	w Test	Respor	nse 0	14	7 12	2	92.5						<u> </u>		oonse –	0	178	3 6	7	96.7
Step	Chi-square	df	Sig.			23	3 70		93.0			ni-squai	re	dt	Sig.		Dverall		51	I .		25.0
1	11.946	8	.154	Perce	entage				86%			12.649		8	.125	_ Per	centag	e				77.4
					Variables in the Equation s																	
		В	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.	.for EXP(B)					B	S.E.	Wald	df	Siç	<b>g</b> .	Exp(B)	95% C.I.1	or EXP(B)
	WT	+0.03	0.002	20.906	1	0.03	1.030	.986	1.994												Lower	Upper
	INVT	-0.006	0.001	42.009	1	0.05	.994	0.994	0.998				-0.	.113	0.01	6.906	1	0.0	24	0.893	0.893	1.994
Step 1	Parking_ST	-0.017	0.10	23.012	1	0.02	1.030	0.983	1.012	   Stor		INVI arkina (	<b>+</b> 0 T <b>-</b> 0	.078	.035	21 135		0.0	38	0.984	1.081	0.998
	Parking_C	054	.020	16.033	1	0.001	.94/	0.94/	1.260			arking_(	<b>C +0</b>	.198	.070	21.100	, 1 1	0.0	)5	1.218	.960	1.583
	CONSIGN	-1.012		10.004		0.001	1.100				C	Constan	† <b>-2</b> .	.010	2.454	3.416	1	.06	55 ·	-12.327		
Utility + 0.05	Equation <b>4(Parking C</b>	U <sub>T</sub> = -1.6 Cost)	512-0.17(W	T)- 0.006	6(INVT)	) + 0.03	3(Parkin	g Sear	ch Time)	Util 0.1	ity Eq <b>98(Pc</b>	uation Irking (	U <sub>T</sub> = · Cost)	-2.010-	0.113 <b>(</b> V	VT)- 0.0	02(INVT	) + 0	.078(	Parking	Search	Time) +
						Mode		Riders	ship(%)									M	ode		Riders	nip(%)
U <sub>t R</sub>	= -3.0	)05 e	$e^{U}_{TRS} = ($	0.0495	Ric	de Shari	ing	27	7.3		TR =	=	1.903	eUT	२ =	0.0074	R	ide S	ourci	ng	4.	6
U <sub>TC</sub>	= -2.0	)26 e	$e^{U}_{TC} = ($	0.1318		Car		72	2.7		ITC =	= -1	.8631	eUT	C =	0.15519		C	Car		95	.4
Proba	bility of choc	osina Ride	e sharina = <b>C</b>	).273			•			Pro	babili	ty of ch	noosina	a Ride s	haring =	=0.46						
Proha	hility of choc	osina Car	=0 727							Pro	babili	, ty of ch	noosina	a Car =	0.954							
OVE		Y OF SH	ARED MC	OBILITY											M	ode	Ridership %	ɔ(	Prob	ability o	f choosir	ng
Utility Equation UT = -0.389-0.23(WT)- Model Summary														0.049	68 Sh	ared	70]		Share	ed Mob	ility = <b>0.2</b>	294
0.029	(INVT)+0.09	6(Parkin	g Search T	ime)	Stop	-2 Log		& Snell R	Nagelkerk		$\begin{bmatrix} \mathbf{U}_{TR} = -3.0022 \\ e^{U_{TR}} = \begin{bmatrix} 0.04768 \\ 7 \end{bmatrix} \begin{bmatrix} Shared \\ Mobility \end{bmatrix} \begin{bmatrix} 29.4 \\ Probability \end{bmatrix}$			ability o	f choosir	ng Car						
-0.01	8(Parking C	ost)			siep	likelihoo	od So	uare	R Square		; = -2	2.1242	e <sup>∪</sup> tc =	0.119	52	Car	70.6		=0.70	)6		
					1	87.24	0	.027	0.035					/						S	ource : Au	hor Source
1 <sup>th</sup>	Urban Ma	obility Indi Expo <b>201</b>	0																		2 2 2 2 2 1 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1 1 5 1	SPORT (IND)

Binar	y Logit Reg	gressior	n Analysi	is Ride S	Shari	ng				Binar	y Logit Reg	gression	Analy	vsis Ride	e Sourc	ing			
Omni	ibus Tests of <i>I</i>	Model Co	oefficients			Mode	el Summo	ary		Omni	bus Tests of		efficient	ts		Мос	lel Summo	ıry	
	CI squ	hi- Iare di	f Sig.	Step	-2 likel	Log C ihood	Cox & Sne R Square	ell Nag	elkerke R quare		C squ	Chi- Jare df	Sig	. St	ep  -2 like	2 Log lihood	Cox & Sne R Square	ill Nagel	kerke R Jare
	Step 34.	789 2	.000	1	297	.069a	0.019		0.04	!	Step St	ep 33.37	74 2		1 210	D.433a	.05	0.	123
Stop 1		780 2 780 2	.000	_		Classifi	cation To	able		Step 1	Block Blo	ock 33.37	74 2			Classi	fication To	able	
316h 1	DIOCK 34.	707 2	.000	-			Pre	edicted			Model Mc	odel 33.37	74 2				Pre	edicted	
	Model 34.	/89 2	.000	_ Obs	erved		<u>esponse</u>		rcentage				·   -		Observed		Response		entage
н	losmer and L	emeshow	w Test			0 1	47 1	2	92.5	I F	losmer and l	Lemeshow	v Test			0	178	6	96.7
Step	Chi-square	df	Sig.	- Respo	nse –	1 2	23 7	70	93.0	Step	Chi-square	df	Sig.		sponse -	1	51 1	7	25.0
1	11.946	8	.154		verall entag	e			86%	1	12.649	8	.125	Ρε	Overall ercentag	e			77.4
			Variabl	es in the	Equat	ion s							Vario	ables in tl	he Eauat	ion s			
		В	S.E.	Wald	df	Sig.	Exp(B)	95% C.	I.for EXP(B)			В	S.E.	Walc	d df	Sig.	Exp(B)	95% C.I.1	ior EXP(B)
	WT	+0.03	0.002	20.906	1	0.03	1.030	.986	1.994				0.01		· .			Lower	Upper
	INVT	-0.006	0.001	42.009	1	0.05	.994	0.994	0.998			-0.113	0.01	6.900	$\frac{3}{4}$ 1	0.024	0.893	0.893	1.994
Step 1	Parking_ST	-0.017	0.10	23.012	D12     1     0.02     1.03       D33     1     0.001     .94			$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		Step 1	Parking ST	-0.078	.033	21.13	$\frac{4}{5}$ 1	0.030	0.984	0.984	0.998
	Parking_C	054 -1.412	.020	16.033	16.0331 <b>0.001</b> 16.6641 <b>0.001</b>			0.94/	1.260		Parking C	+0.198	.005	2.55	5 1	0.05	1.218	.960	1.583
	CONSIGN	-1.012		10.004		0.001	1.100	1.106			Constant	-2.010	2.454	3.41	6 1	.065	-12.327		
Utility + 0.05	Equation 54(Parking C	U <sub>T</sub> =  -1.6 Cost)	512-0.17 <b>(</b> V	VT)- 0.00	6 <b>(</b> INV	ΥT) + 0.0	03(Parkir	ng Sear	rch Time)	Utility 0.198	Equation <b>(</b> Carking Co	U <sub>T</sub> = -2.010 ost)	0-0.113	(WT)- 0.0	)02(INV1	) + 0.0	78(Parking	g Search	Time) +
						Mode	9	Rider	ship(%)							Mod	e	Riders	nip(%)
U <sub>T R</sub>	= -3.0	05 e	U <sub>TRS</sub> =	0.0495	R	lide Sha	Iring	2	27.3	UTI	R = -4.9	903 eU	TR =	0.0074	1 <b>R</b>	ide Sou	vrcing	4.	6
U <sub>TC</sub>	= -2.0	26 e	U <sub>TC</sub> =	0.1318		Car		7	/2.7	UT	C = -1.8	631 eU	TC =	0.1551	9	Ca	r	95	.4
Proba	bility of choc	sing Ride	e sharing =	0.273						Probo	ability of cho	osing Ride	e sharing	g = <b>0.46</b>					
Proba	bility of choc	osing Car	=0.727							Probo	ability of cho	osing Car	=0.954						
OVERALL UTILITY OF SHARED MOBILITY										1				Mode	Ridershi %)	p( Pr	obability a	of choosir	ng
Utility	equation	UT = -(	0.389-0.23	(WT)-		N	lodel Sum	mary		U <sub>T P</sub> =	-3.0022 e <sup>L</sup>	$J_{TP} = 0.04$	4968 S	Shared	29.4	Sh	nared Mok	oility = <b>0.2</b>	294
-0.01	8(Parking C	o(rarking ost)	g searcn	iime)	Step	-2 Lc likelihc	og Cox bod So	& Snell R quare	R Square			0.11	/ N 1952		70 /	Pr	0000011119 (	ot choosir	ig Car
					1	87.2	4 (	0.027	0.035			TC -	9	Cui	/0.6			Source · Au	thor Source
	~																	H UP	BANTRANSA

Bina	ry Logit Reg	gressio	n Analys	is Ride S	Shari	ng				Binar	y Logit Reg	gression	Analy	ysis Ride	e Sourc	ing				
Omn	ibus Tests of <i>I</i>		oefficients			Mode	el Summo	ary		Omni	bus Tests of <i>I</i>		efficien	its	I	Мос	el Summo	iry		
	C squ	hi- Iare d	f Sig.	Step	like	Log C lihood	Cox & Sne R Square	ell Nag	elkerke R quare		C squ	hi- Iare df	Sig	g. St	ep  -2 like	2 Log lihood	Cox & Sne R Square	II Nagel Squ	kerke R Jare	
	Step 34.	789 2	2.000	1	297	7.069a	0.019		0.04		Step Ste	ep 33.37	74 2		1 210	D.433a	.05	0.	123	
Sten 1	Block 31	789 2	> 000			Classifi	cation T	able		Step 1	Block Blo	ock 33.37	74 2			Classi	fication To	ıble		
5100		700 2					Pr	<u>edicted</u>			Model Mo	del 33.37	74 2				Pre	edicted	Porcontago	
		/89 2	2 .000		ervec		<u>esponse</u>		centage						Jbservec		Response		entage	
ŀ	losmer and L	emeshov	w Test			0 1	47	12	92.5	F F	losmer and L	.emeshow	/ Test			0	178	5	96.7	
Sten	Chi-square	df	Sia	Respo	nse	$\frac{1}{2}$	23 7	70	93.0	Step	Chi-square	df	Sig	.   Res	sponse	1	51 1	7	25.0	
1	11.946	8	.154	- Ov Perce	erall entag	e			86%		12.649	8	.12	<b>5</b> Pe	Overall ercentag	le			77.4	
			Variab	les in the	Eaua	ion s		·					Vari	ables in tl	he Fauat	ion s				
		В	S.E.	Wald	df	Sig.	Exp(B)	95% C.	I.for EXP(B)			В	S.E.	Wald	d df	Sig.	Exp(B)	95% C.I.1	or EXP(B)	
	WT	+0.03	0.002	20.906	1	0.03	1.030	.986	1.994		1							Lower	Upper	
	INVT	-0.006	0.001	42.009	1	0.05	.994	0.994	0.998			-0.113	0.01	6.90	$\frac{6}{1}$	0.024	0.893	0.893	1.994	
Step 1	Parking_ST	-0.017	0.10	23.012	1	0.02	1.030	0.983	1.012	Stop 1	INVI Parking ST	+0.078	.035		4 I	0.038	1.081	1.081	1.115	
	Parking_C	054	.020	16.033	1	0.001	.947	0.947	1.260		Parking C	+0.198	005	2.55	5 1	0.05	1,218	960	1.583	
	Constant	-1.012	1./92	10.004		0.001	1.106				Constant	-2.010	2.454	3.41	5 <u>1</u>	.065	-12.327			
Utility + 0.05	Equation 5 <b>4(Parking C</b>	U <sub>T</sub> = -1.6 Cost)	612-0.17(V	VT)- 0.00	6(IN\	/T) + 0.(	03(Parki	ng Sear	ch Time)	Utility 0.198	Equation L (Parking Co	J <sub>T</sub> = -2.010 ost)	0-0.113	8(WT)- 0.0	)02(INV1	() <b>+ 0.0</b>	78(Parking	g Search	Time) +	
						Mode	9	Rider	ship(%)					1		Mod	е	Riders	nip(%)	
U <sub>T R</sub>	= -3.0	05 e	$e^{U}_{TRS} =$	0.0495	F	Ride Sha	iring	2	27.3	UTI	R = -4.9	03 eU	TR =	0.0074	1 <b>R</b>	lide Sou	rcing	4.	6	
U <sub>TC</sub>	= -2.0	26 e	e <sup>U</sup> TC =	0.1318		Car		7	2.7		C = -1.86	631 eU1	TC =	0.1551	9	Ca	•	95	.4	
Probc	bility of choc	osing Ride	e sharing =	=0.273						Probo	ability of choo	osing Ride	e sharin	g = <b>0.46</b>						
Probc	ibility of choc	osing Car	c = <b>0.727</b>							Probo	ability of choo	osing Car	=0.954							
OVERALL UTILITY OF SHARED MOBILITY														Mode	Ridershi %)	p( Pr	obability (	of choosir	ng	
Utility	Equation	UT = -(	0.389-0.23	B(WT)-		N	lodel Sun	nmary		U <sub>T D</sub> =	-3.0022 e <sup>U</sup>	= 0.04	4968	Shared	29.4	Sh	ared Mok	oility = <b>0.2</b>	294	
-0.01	8(Parking C	o(Parkin ost)	g search	lime)	Step	-2 Lc likelihc	og Cox bod S	& Snell R quare	Nagelkerk R Square	$\frac{11}{100} = 0.1040 \text{ ell} = 0.11952 \text{ Control 70.4} = 0.706$				of choosir	ng Car					
1 <b>87.24 0.027 0.035</b>							0.035		e <sup>1</sup> -2.1242 e <sup>0</sup>		9	Car	/0.6	-(		Source · Au	than Source			
																		JUDICE . AU	BANSPORCE	

Binar	y Logit R	egressi	ion A	Analysis	s Ride S	harin	g				Bina	ry Log	git Reg	gression	n Analy	ysis Ride	Sour	cing	J				
Omni	ibus Tests d	of Model	Coeff	ficients			Mode	l Summa	ry		Omr	nibus Te	ests of <i>l</i>	Model Co	oefficien	Its			Mode	el Summo	iry		
	S	Chi- quare	df	Sig.	Step	-2 I likelil	Log Canood R	ox & Snel 8 Square	II Nag S	elkerke R quare			C squ	hi- Jare df	f Sig	g. Ste	ep  lik	-2 Lo celiho	ng C bod f	ox & Sne R Square	II Nagel Squ	kerke R Jare	
	Step 3	34.789	2	.000	1	297.	069a	0.019		0.04		Ste	ep St	ер 33.3	74 2		2	10.43	33a	.05	<b>0.</b>	123	
Step 1	Block 3	34,789	2	.000			Classific	cation Ta	ble		Step	1 Bloo	ck Blo	ock 33.3	74 2			С	lassifi	cation To	ible		
		24 789	2	000				Pre	dicted		i -	Мос	del Mc	odel 33.3	74 2		bconve		D	Pre	alcted	antaga	
		94.707	Ζ	.000		ervea		esponse		Correct				•			DSEIVE	EC		$\frac{\text{esponse}}{1}$		orrect	
н	losmer and	d Lemesh	now Te	est			D 14	47 12	2	92.5		Hosme	er and l	.emeshow	w Test	Bost		0	1	78	5 1	96.7	
Step	Chi-squa	re df		Sig.	Respor		1 2	3 70	C	93.0	Step	Chi-	square	df	Sig.	.   Kes		1	5	51 1	7	25.0	
1	11.946	8		.154	Ov Perce	erall entage	•			86%	1	12	2.649	8	.125	5 Pe	Overa rcentc	ll age			77.4		
				Variable	es in the E	Equatio	on s								Vario	ables in th	e Equ	ation	S				
		В		S.E.	Wald	df	Sig.	Exp(B)	95% C.	I.for EXP(B)				В	S.E.	Wald	df	F	Sig.	Exp(B)	95% C.I.1	or EXP(B)	
	WT	+0.03	<b>3</b> C	002	20,906	1	0.03	1 030	286	1 994											Lower	Upper	
	INVT	-0.00	6 C	0.001	42.009	1	0.05	.994	0.994	0.998			WT	-0.113	0.01	6.906		0	.024	0.893	0.893	1.994	
Step 1	Parking_S	ST -0.01	7 (	0.10	23.012	1	0.02	1.030	0.983	1.012	Stop		VVI vina st	+0.078	.035				.038	1.081	1.081		
	Parking_	<u> </u>	<b>4</b> .	.020	16.033	1	0.001	.947	0.947	1.260		Park	(ing_st	+0.198	.078	2 5 5 5	)       1		).35 0.05	1 218	960	1.583	
	Constan	T   <b>-1.61</b>	2	./92	16.664		0.001	1.106				Cor	nstant	-2.010	2.454	3.416	1		.065	-12.327	./00	1.000	
Utility + 0.05	Equation <b>4(Parking</b>	U <sub>T</sub> = - Cost)	1.612	-0.17(W	T)- 0.000	6(INV	() + 0.0	3(Parkin	g Seai	rch Time)	Utilit 0.19	y Equa 8(Park	ation <b>l</b> ation <b>l</b>	J <sub>T</sub> = -2.01 ost)	0-0.113	8(WT)- 0.0	02(IN)	√T) +	0.078	B(Parking	g Search	Time) +	
				Γ			Mode		Rider	ship(%)						I			Mode		Riders	nip(%)	
U <sub>T R</sub>	= -3	3.005	$e^{U}_{TR}$	$_{2S} = 0$	0.0495	Ri	de Shar	ing	2	27.3	UT	R =	-4.9	203 el	JTR =	0.0074		Ride	Sour	cing	4.	6	
U <sub>TC</sub>	= -2	2.026	e <sup>U</sup> TC	_ = (	0.1318		Car		7	72.7		C =	-1.80	631 el	JTC =	0.15519	,		Car		95	.4	
Proba	bility of ch	oosing Ri	ide sh	naring = <b>0</b>	).273						Prob	ability	of cho	osing Ride	e sharin	g = <b>0.46</b>							
Proba	bility of ch	oosing C	Car = <b>0</b>	.727							Prob	ability	of cho	osing Cai	r = <b>0.954</b>								
OVE	RALL UTIL		SHAI		OBILITY						1					Mode	Riders	hip(	Pro	bability o	of choosir	ng	
Utility	Equation	n <b>UT =</b>	-0.3	89-0.23(	(WT)-		M	odel Sum	mary			= -3.00	022 e <sup>U</sup>	0.0	4968	Shared	70) <b>29</b> (	4	Sho	ared Mot	oility = <b>0.2</b>	<u>294</u>	
0.029	(INVT)+0.0 8(Parkina	096(Park Cost)	king S	earch T	ime)	Step	-2 Log likeliho	g Cox & od Sc	& Snell R Juare	R Square				0.1	7 / 1952	Mobility		• 	Prol	bability a	of choosir	ng Car	
	. 0					1	87.24		.027	0.035		=  -2.12	242   e <sup>u</sup>		9	Car	70.	6	-0.7	/ 00	Source · Arr	that Sauras	
	×					-															Source . Au	BANSPORCE BANSPRANSP	

÷ S	harin	g				4	Binary	<sup>v</sup> Logit	Regre	ssion	Ana	Ilysis	Ride	Sourc	ing				
		Mode	el Summ	nary			Omnik	ous Tests	s of Mod	del Co	efficie	ents			Мо	del S	umma	ry	
р	-2 L likelih	.og C nood	Cox & Sr R Squar	rell Nag	elkerke R quare	i			Chi- square	, df	S	Sig.	Ste	p  -2 like	2 Log elihooc	Cox R S	& Sne quare	ll Nage Sq	kerke R Jare
	297.0	069a	0.019		0.04			Step	Step	33.37	74	2	1	210	D.433a		.05	0.	123
		Classif	ication 1	Table			Step 1	Block	Block	33.37	74	2			Clas	sifica	tion Ta	ble	
			Р	redicted				Model	Model	33.37	74	2					Pre	dicted	
SSE	erved		Respons	e Per	centage	I					•		Ok	oservec	لا	Resp	oonse		:entage
		<u>ן</u>	0	10		1	H	osmer a	nd Lem	eshow	v Test				0	178			<u>96 7</u>
or			23	70	93.0	I	Step	Chi-sau	lare	df	Si	a.	Resp	onse  -	1	51		7	<u>25.0</u>
Dve	erall											9.	C	Dverall				<u>.</u>	77 4
се	ntage				86%		1	12.64	9	8	.1	25	Per	centag	je				//.4
e E	quatic	on s									Va	riable	es in the	e Eauat	ion s				
				9.5% C	for EXP(B)	i													
	df	Sig.	Exp(B							В	S.E	•	Wald	df	Sig	.   E	xp(B)	95% C.I.	or EXP(B
	1	0.03	1 030															Lower	Upper
,	1	0.05	.994	0.994	0.998			WT	-0	D.113	0.0	1	6.906	1	0.02	4 (	0.893	0.893	1.994
	1	0.02	1.030	0.983	1.012			INVI	「 <b>+(</b>	0.078	.03	5	17.514	1	0.03	8	1.081	1.081	1.115
,	1	0.001	.947	0.947	1.260		Step 1	Parking	<u>g_ST</u> -C	0.002	.07	6	21.135	1	0.3	5 (	0.984	0.984	0.998
•	1	0.001	1.106	<b>)</b>			-	Parking	<u>g_C</u> +(	0.198	.00	5	2.555		0.0	<b>)</b>	1.218	.960	1.583
	<b>.</b>		/			Ì		CONSIC	ani   •∡	2.010	Z.40	)4	3.410		.00:		12.327		
)06	o(INVT	) + 0.0	03(Park	ing Sear	ch Time)	ł	Utility 0.198(	Equatic Parking	on U <sub>t</sub> = g Cost)	-2.010	0-0.11	13(WT	r)- 0.00	)2(INV1	ſ) + 0.(	)78(P	arking	g Search	Time) +
		Mode	9	Rider	ship(%)										Мо	de		Riders	hip(%)
	Rio	de Shc	aring	2	7.3	i	UT R	=	-4.903	eU	TR =	C	0.0074	R	lide Sc	ourcin	g	4	,6
		Car		7	2.7		UT C	) =	-1.8631	eU	TC =	0	.15519		C	ar		95	.4
							Proba	bility of	choosin	na Ride	e shari	ina = <b>(</b>	0.46						
						i	Proba	bility of	choosin		-0 95								
											-0.75								
Y						1						Mo	de	Ridershi %)	p( F	Proba	ıbility o	of choosi	ng
		N	Nodel Su	mmary				0.0000		0.04	4968	Shar	red		5	share	d Mob	ility = <b>0</b> .2	294
	<b>^</b>	-2 Lc	og Co	x & Snell R	Nagelkerk	e	$U_{TR} =$	-3.0022	$  e_{TR} =$	=	7	Mob	oility	29.4	F	roba	ibility o	f choosi	ng Car
	ыер	likeliho	bod	Square	R Square		$U_{TC} =$	-2.1242	$e^{U_{TC}}$	= 0.1	1952	Сс	ar	70.6	=	=0.706	5		
	1	87.2	24	0.027	0.035						7						9	Source : Au	thor Source
																		AF OF	



## 1(a) Waiting Time Reduction by using Upper Leve

- It aims at improving the reliability of Ride Sourcing and Ride Shared reducing the waiting time which is the function of Demand, Incomand fleet size
- Waiting time can be reduced by increase the fleet size with pro income to driver per day
- When Cab fleet size is small, waiting time of passenger is long.
- Excessive fleet size can attract more passengers. But the taxi driv decreases due to high vacancy rate that further reduces the su



**Upper Level Model** -The upper-level model is minimizing the waitin passenger in peak hour and maximizing the income of the driver f

$$T_{w}^{p} = \frac{\gamma}{\frac{Nh}{24} - \mu^{p}Q^{p}}, (\gamma > 0)$$
$$W = \frac{(aQ^{p} + bQ^{o}) \bullet (P + (D - 3) \bullet P_{z})}{N}$$

- $T_{w=}^{p}$  The average waiting time of passenger at rush hour
- N = the taxi fleet size of a city
- h =(0 < h < 24) is the average operating time of a taxi per day
- $\mu^{p}$  = Average time of passenger taking taxi at rush hour
- $\gamma$  = Positive parameter to weight the passenger waiting
- $Q^o$  and  $Q^p$  = Demand at off-peak hour and rush hour
- D = Average distance of passenger taking taxis
- a = Hours of rush hour
- b = Hours of off-peak hour
- P = Flag down fare
- $P_z$  = Fare per kilometre
- $\tilde{W}$  = Income of driver per day

**Source :-**Fleet size and fare optimization for tax dynamic demand China, Baozhen Yao (2016)

Outcome there is a considerable reduction in waiting from 10 min to 3min



# PROPOSALS

el Model	1(b) Waiting Time Reduction by Zoning
aring by ome of Driver oportion to iver income upply	<ul> <li>Area of Delhi NCT = 1483 km<sup>2</sup></li> <li>Area of Each Zone = 370 km<sup>2</sup> (Radius of Each Zone = 11 km</li> <li>Zoning the Operation Area of Delhi into 4 zones and Capping them with minimum of cabs so that Waiting time can be reduced</li> </ul>
TAXIDRIVER	<ul> <li>4 Zone are made with approx. 11km radius</li> <li>Each zone will become accessible with reduction</li> <li>There will be significant reduction in Dead mileage</li> <li>Dedicated Parking Lots for Shared Mobility share</li> </ul>
ng time of for one day.	reduce WAITING TIME Proposal 2- Reduction In Vehicle time
	<ul> <li>High Occupancy Vehicles (HOV) lane</li> <li>Provide HOVs with faster, more reliable travel the vehicles)</li> <li>Priority at Signals, preferential parking for HOV's</li> <li>Inner most lane should be made priority lane for</li> </ul>
zation for taxi under	

## g Operation Area



- in Waiting time as Short trips are
- **e** also
- ould be provide in Multi-level Parking, vhich are **Demand Zone** which furthe**r**

## an non-HOVs (primarily single occupant

#### Shared Mobility



