Travel Behavior of Children to Non-School Destinations

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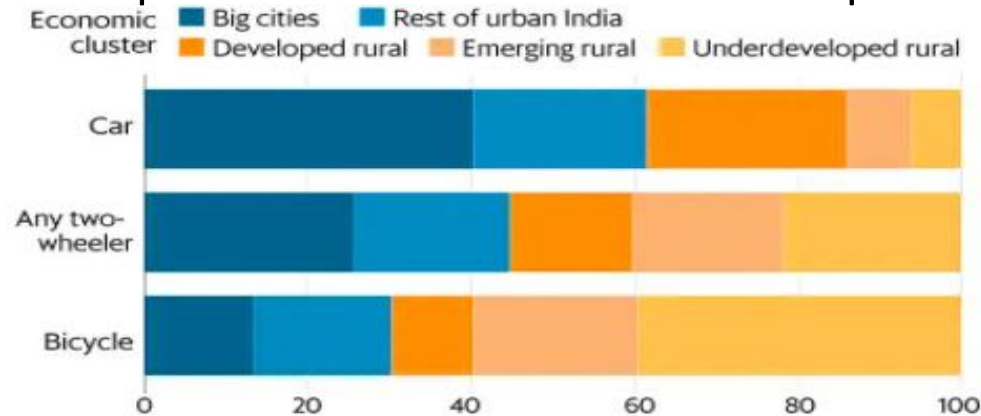Civil Engineering Department,
IIT (ISM) Dhanbad

OUTLINE

1. INTRODUCTION (Context)

❖ **Steady decline in** independent mobility and **active travel** of children:
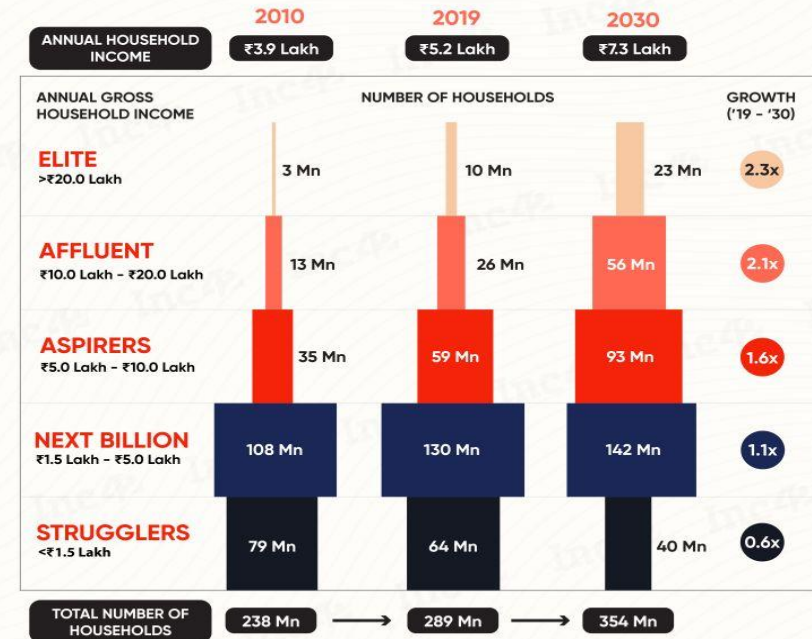
Lack of Pedestrian Infrastructure

THE RISE IN INDIA'S ANNUAL **HOUSEHOLD INCOME**

Nearly 50% of households in India will have an annual income above INR 5 lakh by 2030 as compared to 33% in 2019!

Rapid Growth in Motorized Vehicle Ownership

1. INTRODUCTION (Motivation)

❖ **School travel pattern** can be viewed as **mandatory trips**.
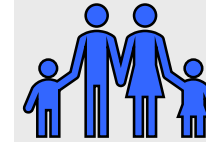
❖ Examining **Non-school trips** is equally important as:

Not time bound

Recreational locations are close to home

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Promote Active Lifestyle
In a university set up, flexible work schedule of parents makes it easier for them to accompany children in non-school trips beyond the office hours.

Be healthier
Incorporating active travel into your daily routine doesn't just get you from point A to point B – it also unlocks a range of health benefits
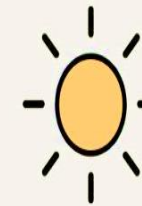
Improve air quality
By reducing our reliance on daily car journeys, we're not just reducing congestion but helping to achieve a healthier, fairer, and greener Scotland.

Health & Economic Benefits

1. INTRODUCTION (Objectives)

1 To assess the impact of **socio-demographic and built environment** factors on **active and motorized trip distances** traveled by children
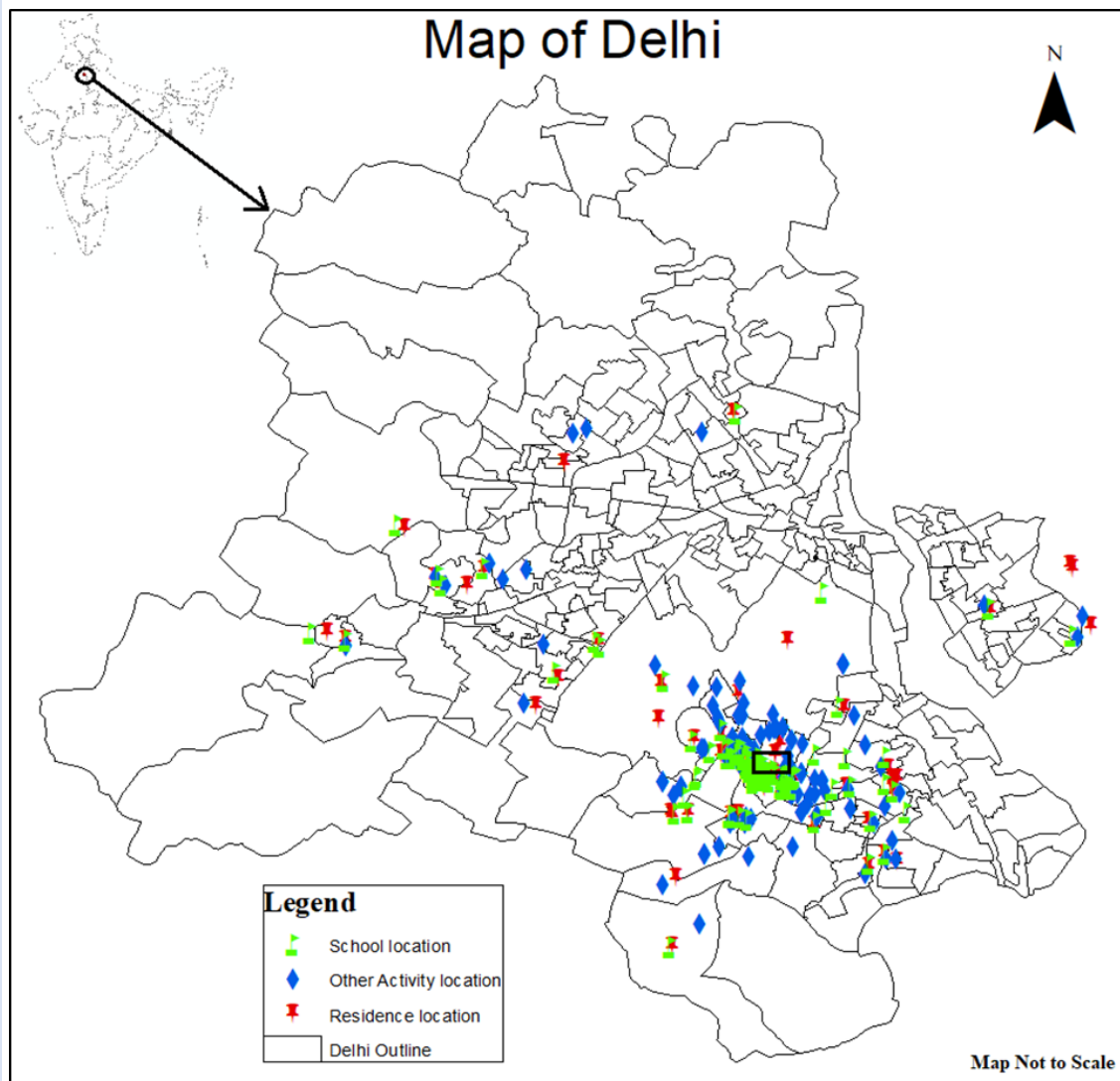
2 To assess the impact of **socio-demographic and built environment** factors on **active and motorized trip distances** traveled by children

3 To assess the impact of **socio-demographic and built environment** factors on **active and motorized trip distances** traveled by children

2. DATA (Study Area & Data Collection)

Map of Delhi

Legend
- ⚑ School location
- ◆ Other Activity location
- ⚑ Residence location
- ☐ Delhi Outline

Map Not to Scale

Characteristic	Description
Study Area	**IIT Delhi** Campus, India
Geography	**In and around** the campus
Time Frame	**Mar** 2018 – **April** 2018
Sampling Frame	**Activity – Travel Diary** of Children in the **age group of 4-17** years
Sampling Type	**Simple Random Sampling**
Survey Mode and Time	**Paper-based questionnaire, 10-15 minutes per household**
Sample Size	**174 Households** (66% Response Rate), 263 approached.

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2. DATA (Socio-demographics)

Demographic Characteristics	Share in % (n)	Demographic Variables	Share in % (n)
Parental characteristics		*Household(HH) characteristics*	
Completed age (in years)		*Children in household**	2.37 ± 1.12
Father*	37.61 ± 4.99	*Earning members in family*	
Mother*	34.13 ± 5.22	Single earner#	53.44 (93)
Completed degree (Father)		More than one earners	46.56 (81)
Below graduation	47.69 (83)	*Family Income per Month (in ₹)*	
Graduation and above#	52.31 (91)	Low (< ₹30000)	50.57 (88)
Completed degree (Mother)		Middle (₹30000 – ₹50000) #	24.14 (42)
Below graduation	48.85 (85)	High (> ₹50000)	25.29 (44)
Graduation and above#	51.15 (89)	*Vehicle ownership*	
Occupation status (Father)		No vehicle HH#	24.71(43)
Married scholar#	13.22 (23)	Atleast one vehicle HH	75.29 (131)
Faculty	21.84 (38)	*Bicycle ownership*	
Staff	64.94 (113)	No bicycle HH#	33.91 (59)
Occupation status (Mother)		Atleast one bicycle HH	66.09 (115)
Employed#	36.21 (63)	*Place of Residence*	
Homemaker	63.79 (111)	Inside Campus#	47.13 (82)
Children Characteristics		**Outside Campus**	**52.87 (92)**
*Completed age (in years)**	8.94 ± 4.03		
Gender			
Male#	58.62 (102)		
Female	41.38 (72)		

Note: * represents continuous variables summarized in mean ± SD. Rest all are categorical variables expressed in %. # denotes the reference categories that were kept as fixed during the binary logit model estimation.

2. DATA (Mode share & Trip characteristics)

| Trip Characteristics	Mode Share in % (n)		Overall Sample Share in %
	Active mode	Motorized mode	
Non-School Trip Share	73.56 (128)	26.44 (46)	100 (174)
Distance Travelled (in km)*	0.68 ± 0.55	3.81 ± 2.29	1.51 ± 1.87
Accompanied By:			
Alone#	18.75 (24)	19.56 (9)	18.97 (33)
Direct family members	39.06 (50)	43.48 (20)	40.23 (70)
Non-family members	**42.19 (54)**	**36.96 (17)**	**40.80 (71)**
Trip Purpose			
Educational#	45.31 (58)	30.43 (14)	41.38 (72)
Recreational	54.69 (70)	69.57 (32)	58.62 (102)
Activity Time Spent			
≤ 1hr#	50.78 (65)	39.13 (18)	47.70 (83)
> 1hr	49.22 (63)	60.87 (28)	52.30 (91)

Note: * represents the mean ± sd for the distance variable.
   # represents the reference variables used during model estimation.

3. METHODOLOGY (Curve Fitting)

❑ **Distance** is calculated between **OD pairs** using **OSRM package in R**.
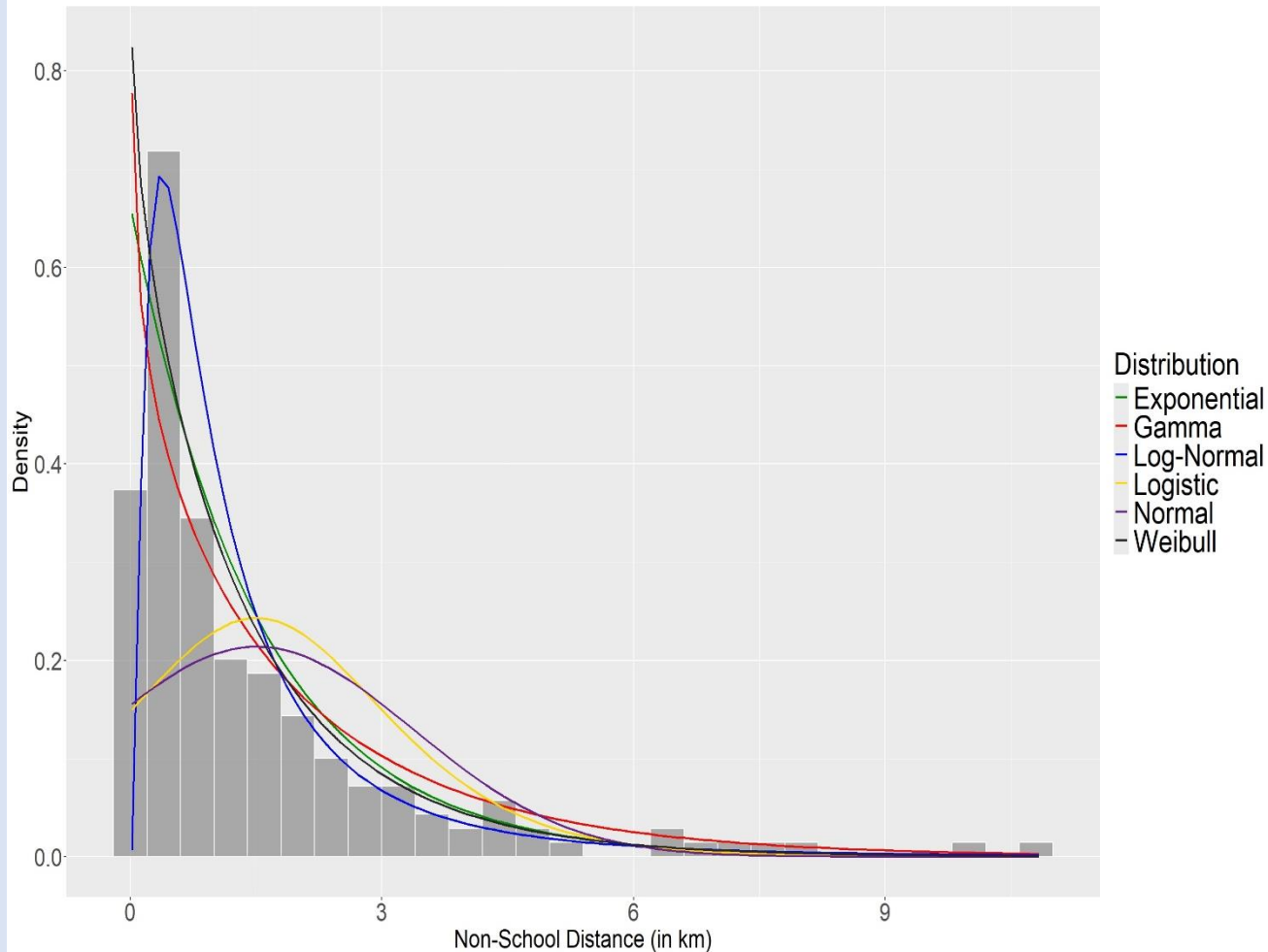
Distribution	AIC	KS	AD
— Exponential	512.857	0.137	3.085
— Gamma	514.001	0.139	4.969
— Lognormal	502.884	0.126	2.557
— Logistic	680.555	0.213	5.387
— Normal	714.712	0.218	6.215
— Weibull	510.857	0.132	2.569

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3. METHODOLOGY (Log-normal Regression)

- A multivariate log-normal regression is carried out to assess the impact of socio-demographics and travel-related variables on non-school distances traveled by children:

$$g(E[Y]) = log(E[Y]) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \qquad \textbf{(1)}$$

- Here, $g(\cdot)$ is the log-link function, i.e., $g(E[Y]) = log(E[Y])$. $E[Y]$ is the expected value (mean) of the distance variable Y.

- Mean and standard deviation (SD) of Y on the original scale can be derived from the properties of the log-normal distribution and is given below:

$$Mean\ of\ Y: E[Y] = exp\left(\mu + \frac{\sigma^2}{2}\right) \qquad \textbf{(2)}$$

$$SD\ of\ Y: SD[Y] = \sqrt{Var(Y)} = \sqrt{[exp(\sigma^2) - 1]exp(2\mu + \sigma^2)} \qquad \textbf{(3)}$$

- Here, μ and σ^2 are location and scale parameter of Y that follows a log-normal distribution such that $log(Y) \sim N(\mu, \sigma^2)$.

3. METHODOLOGY (Binary Logit Model)

- A binary logit model was used to analyze mode preference across socio-demographic variables and trip characteristics factors for non-school trips.

$$U = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \cdots + \alpha_k X_k + \varepsilon \tag{4}$$

$$P(U) = \frac{e^{\alpha'}}{1 + e^{\alpha'}} \; where \; \alpha' = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \cdots + \alpha_k X_k \tag{5}$$

- ε is the error term and is assumed to be IID Gumbel distributed.

- Model is estimated using the 'Apollo' package in R software.

4. RESULTS (Overall)

Variable	LN model	BL model	Variable	LN model	BL model
Model characteristics			Household characteristics		
Log-likelihood (Null model)	–355.558	–200.498	Children in household#	–0.081**	–0.281***
Log-likelihood (Final model)	–202.514	–143.776	Earning members in family		
Estimated parameters	16	17	More than 1 earners	—	—
Pseudo R-Square			Family income per month (in ₹)		
ASC	–4.592***	5.627***	Low (< ₹30000)	–0.645***	–0.634***
Parental characteristics			High (> ₹100000)	0.875***	–2.302**
Completed age (in years)#			Vehicle ownership		
Father	—	—	Atleast 1 vehicle	0.704***	–0.536**
Mother	—	–0.050*	Bicycle ownership		
Completed degree (Father)			Atleast 1 bicycle HH	–0.455**	0.616***
Below graduation	–0.936***	1.966*	Place of Residence		
Completed degree (Mother)			Outside Campus	0.188*	—
Below graduation	–2.290***	1.401**	Trip characteristics		
Occupation status (Father)			Accompanied by		
Faculty	0.076*	–1.569*	Direct family members	—	0.548***
Staff	–0.178***	0.710**	Non-family members	–0.417**	—
Occupation status (Mother)			Trip Purpose		
Homemaker	—	—	Recreational	–2.043***	1.618**
Children characteristics			Activity Time Spent		
Completed Age (in years)#	0.185***	–0.224**	> 1hr	2.251***	–2.271***
Gender			Distance traveled#	NA	–1.781***
Female	–0.194**	—			

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4. RESULTS (Log-normal Regression Model)

1 **Parental Characteristics:**
Lower parental education levels are linked to shorter travel distances for children.
Mother's employment status does not significantly affect the distance traveled.

2 **Child Characteristics:**
As a child's age increases, the distance traveled to non-school destinations increases by 20.32%.
Female children tend to travel shorter distances compared to male children.

3 **Household Characteristics:**
Higher-income families travel farther, while lower-income families choose closer destinations.
Vehicle ownership increases travel distances, while bicycle ownership has the opposite effect.

4 **Residential Location:**
Children living outside the IIT Delhi campus travel longer distances compared to those living on campus.

5 **Trip Accompaniment & Activity Type:**
Being accompanied by non-family members results in shorter travel distances.
Recreational trips are associated with shorter travel distances.

4. RESULTS (Binary Logit Model)

1 **Parental Characteristics:**
Lower parental education levels are associated with a greater preference for active mode.
Male parents working as faculty members are less likely to choose active modes.

2 **Child Characteristics:**
Older children are less likely to use active modes.
Non-school trips are more likely to be jointly pursued with family members than traveling alone.

3 **Household Characteristics:**
Use of active modes decreases with each additional child in the household.
Household income, whether low or high, serves as a barrier to active transportation.

4 **Residential Location:**
Staying inside or outside the campus does not have a significant effect on mode choice decisions for non-school trips.

5 **Trip Accompaniment & Activity Type:**
Children are more likely to use motorized modes for non-recreational trips.
As time spent at non-school activities increases, preference for active modes decreases.

5. CONCLUSION

Clean & Active Travel

Promoting active travel to local amenities:
Average distance to non-school destinations is 1.41 km, use of active modes for non-school trips should be promoted, in urban settings

Priority Weightage
Walk 50%
Ride/NMT 30%
Vehicular Integration 20%
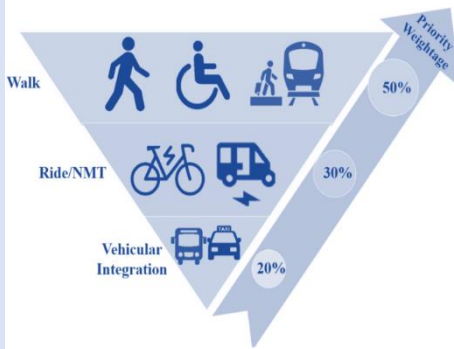
Supporting flexible transportation options:
Develop transportation policies that meet the diverse travel needs of families, particularly for those families with multiple children
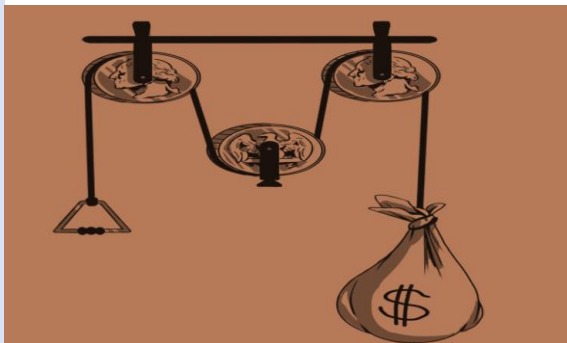
Leverage University Resources:
Urban universities like IIT Delhi should promote community-based transportation solutions, such as shared bicycle schemes.

Thank You for your attention