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Measuring Commuters' Willingness-to-Pay for Bicycle-Friendly Infrastructure in Indian Cities: A Case Study of Patna

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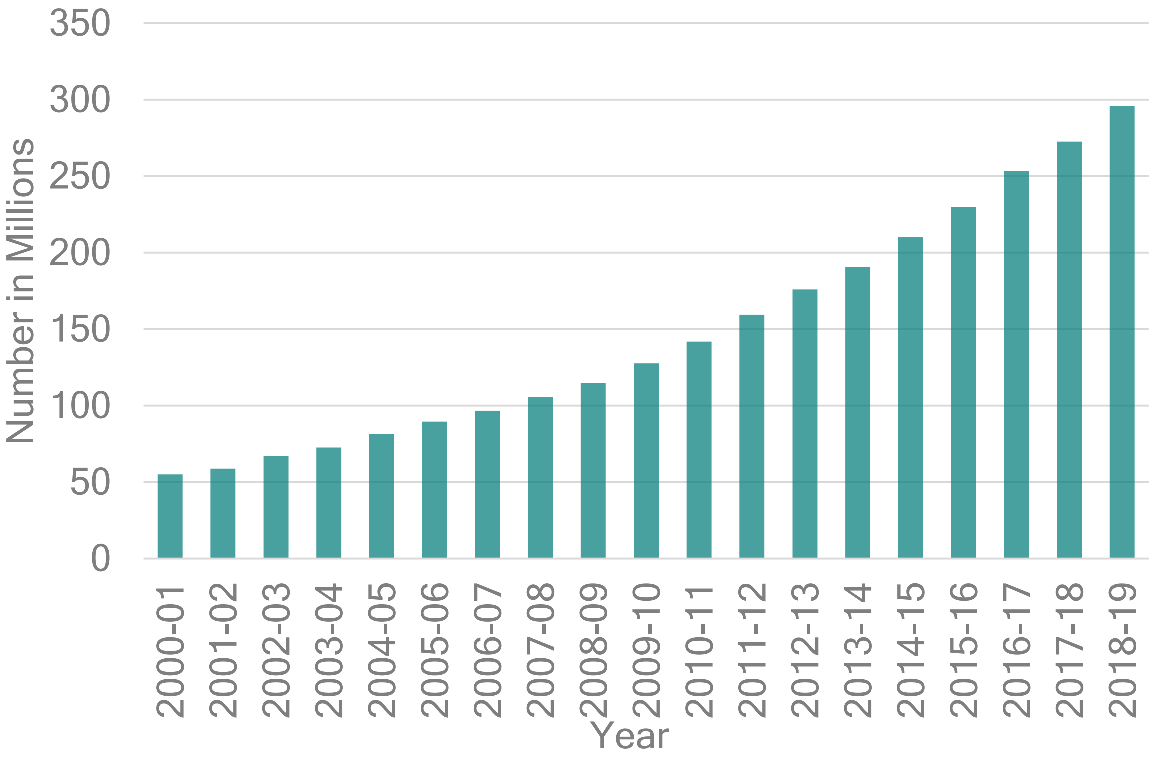
Kochi

Introduction



Growth in Registered Motor Vehicles in India
(Source : MoRTH (2021))

Negative Impacts of growing Motorized Private Vehicle usage

- High Fossil Fuel Consumption
- Air Pollution
- Noise Pollution
- Traffic Congestion
- Increasing Road Accidents

Introduction

Benefits of Bicycle

- Zero dependence on fossil fuels
- Zero Emissions and Pollution
- Health benefits from increased physical activity
- Affordable means of mobility for low income households
- Safe mode of mobility for children

Substituting 50% 2- and 4-wheeler trips in India under 5km length by bicycles can generate annual benefits equivalent to INR 1815 Billion (1.6% of India's GDP)

- TERI, 2018

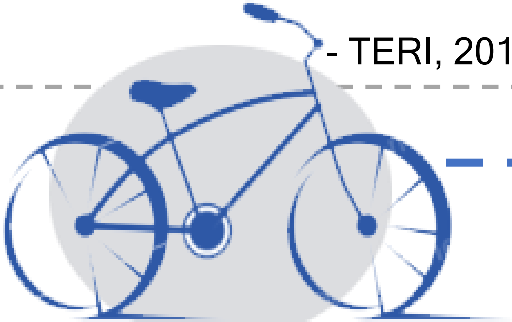


Image Source : Dutch Cycling Embassy, Twitter

SUSTAINABLE DEVELOPMENT GOALS

- 3.6 Road Safety
- 7.3 Energy Efficiency
- 9.1 Affordable and Equitable Access for all (Economic Inclusion)
- 11.2 Safety and Accessibility for vulnerable sections (Social Inclusion)
- 12.c Discouraging Fossil Fuel Consumption

Introduction

Governmental Efforts

2006 — National Urban Transport Policy (2006)

- Presented a vision for Bicycle friendly environment on Indian roads
- Proposed prioritising people on the streets rather than vehicles

2014 — National Urban Transport Policy (2014)

- Advocated working on urban development plans with special attention on bicycle infrastructure

NITI Aayog report on Promoting Bicycles in India

- Presented strategies to strengthen the bicycle infrastructure and Indian bicycle industry

2020 — India Cycles4Change Challenge launched by MoHUA

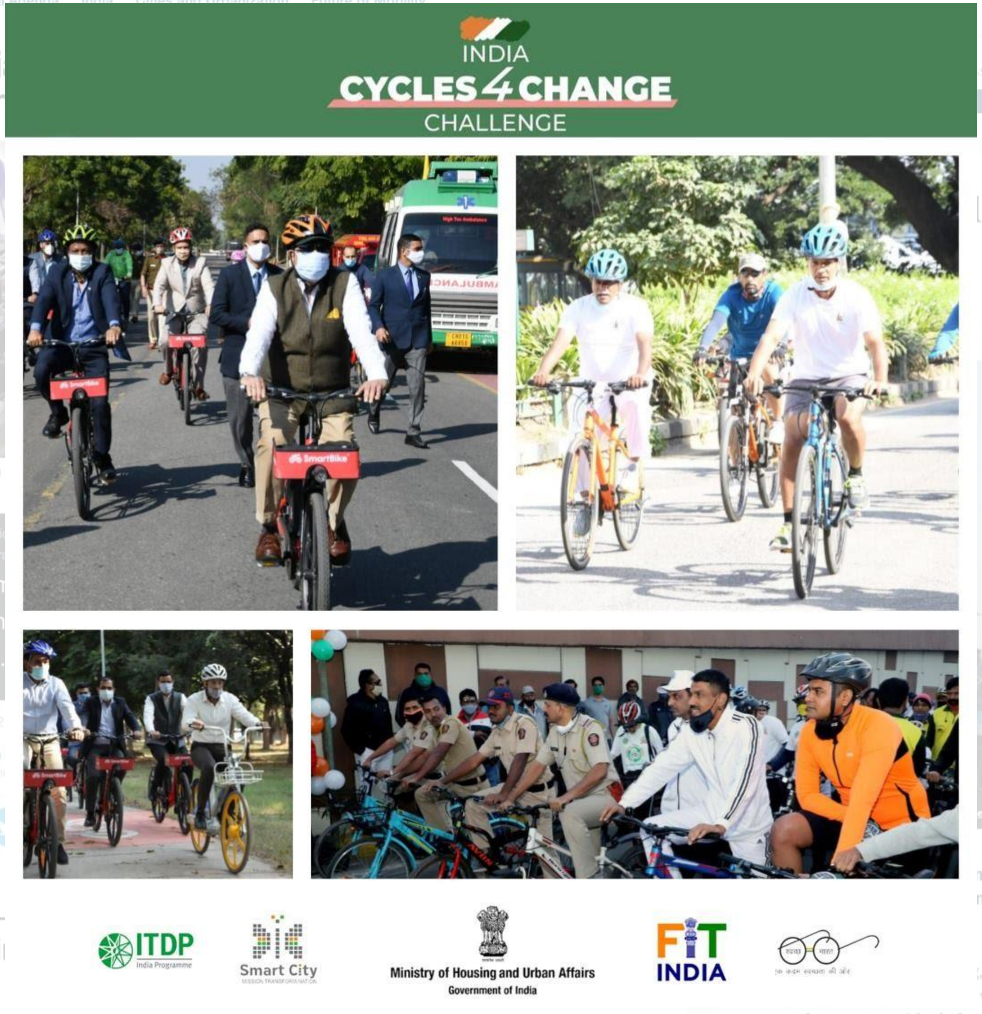
- To encourage citizens to adopt bicycles for mobility within the city.

Streets for People Challenge

Freedom 2 Walk and Cycle Challenge

Introduction

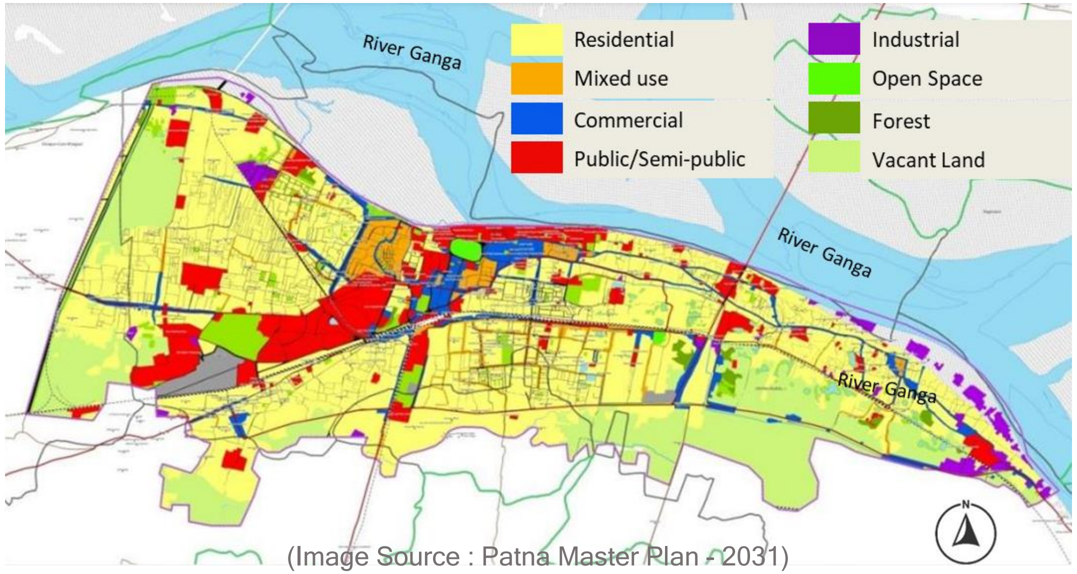
The Changing Scenario



Introduction

Need of the study

As Urban Professionals, we need to work on a systematic planning of the urban street environment, **considering people's expectations from a bicycle-friendly road infrastructure**, so that the increase in enthusiasm for this mode of urban mobility can be sustained.



(Image Source : Patna Master Plan - 2031)

Aim of the study

To determine the commuters' desire (in the form of willingness to pay) for specific infrastructural improvements to generate a bicycle-friendly environment in the cities

Study Area - Patna

- Linear Form of the city
- Mixed Land use Character
- More than 70% trips less than 6 km in length
- 22% existing mode share of bicycles

(Source : Patna Comprehensive Mobility Plan, 2018)

Methodology

Identification of Factors

Factor Frequency analysis from Literature

Factors' Importance Rating Survey in Patna

Identification of contextually relevant factors through appropriate MADM techniques

Source : Monga, M. (2022)

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Methodology

Factors Selected for the Study

- Route Visibility **[VIS]**
- Road Surface Quality **[RSQ]**
- Segregation from Motorized Vehicles **[SMV]**
- Integration with Public Transport **[IPT]**
- Trip Length **[TPL]**
- Cost **[CST]**

Steps involved in calculating willingness-to-pay (WTP)

1. Defining Levels
2. Designing SP Survey
3. Data Collection and processing
4. Random Parameter Logit Modeling
5. WTP calculation

Methodology

Defining Levels

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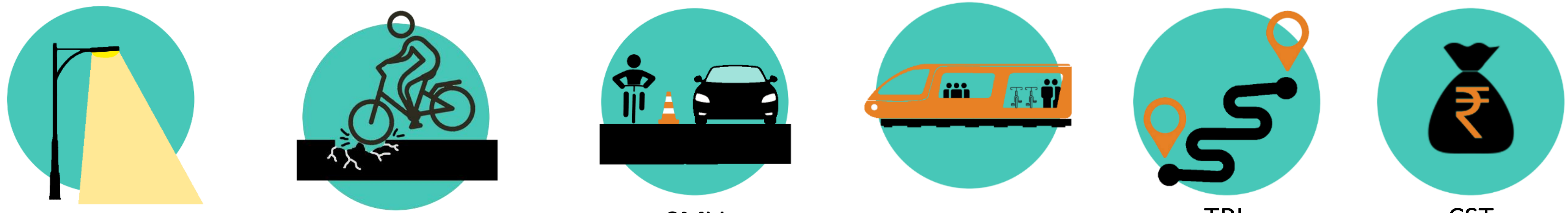

VIS RSQ SMV IPT TPL CST

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Methodology

Stated Preference Survey

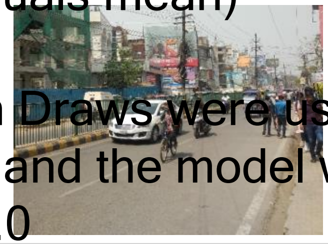
- To identify **hypothetical scenarios** in which commuters would prefer to use a bicycle, SP survey was selected
- 12 choice sets with 2 alternatives in each were prepared
- The choice sets were divided into 3 blocks of 4 choice sets each to avoid respondents' fatigue

Data Collection

- Respondents' choice data was collected using online form circulation and tablet based personal interviews
- 298 responses were received, out of which 278 were used for the RPL modelling. With 4 choice sets in each response, total 1112 observations were fed to the model

Random Parameter Logit Model

- For VIS, RSQ, SMV, IPT and TPL, dummy variable coding was done
- CST was used as a continuous variable
- All factors other than CST were considered to have random parameters with a constrained triangular distribution (spread equals mean)
- 500 Halton Draws were used for simulation and the model was run using NLOGIT 4.0

Defining Factors	Alternatives 2	3
Route Visibility	 No Street Lighting Present	 Continuous Street Lighting present
Road Surface Quality	 Smooth road surface without any potholes	 Undulating/broken road surface with potholes
Segregation from Motorized Vehicles	 No separate lane or track for bicycles	 A separate painted bicycle lane present
Integration with Public Transport	Dedicated bicycle parking present on all Public Transport stops and stations	No integration with Public Transport
Trip Length	Trip length more than 10 km	Trip length between 5 to 10 km
Cost of buying and maintaining a bicycle	50 paisa/km	40 paisa/km

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Results and Discussions

Factors and their Levels	Coefficients (t-statistics)	WTP (In paisa/km)	WTP (In INR/km)
Random Parameters in Utility Function			
Route Visibility Level 1 (VIS_L1)	-1.9048 (-1.681)	91.14	0.91
Road Surface Quality Level 1 (RSQ_L1)	-1.3010 (-4.575)	62.25	0.62
Road Surface Quality Level 2 (RSQ_L2)	-1.7851 (-2.956)	85.41	0.85
Segregation from motor vehicles Level 1 (SMV_L1)	-1.0715 (-4.415)	51.27	0.51
Segregation from motor vehicles Level 2 (SMV_L2)	0.8087* (2.840)	-38.69*	-0.39*
Integration with Public Transport Level 1 (IPT_L1)	-0.9841 (-2.409)	53.77	0.54
Integration with Public Transport Level 2 (IPT_L2)	-0.8929 (-1.704)	42.72	0.43
Trip Length Level 1 (TPL_L1)	-2.9716 (-2.306)	142.18	1.42
Trip Length Level 2 (TPL_L2)	-1.3399 (-1.674)	64.11	0.64
Non-random Parameter in Utility Function			
Cost (CST)	-0.0209 (-1.932)		
Total Observations	1112		
Log Likelihood Function	-453.3982		
Adjusted ρ^2	0.40643		
*Positive coefficient and Negative WTP denote a higher utility of this level in comparison to the base level			

- The coefficients of factors denote the additional perceived utility (negative sign denoting disutility) of the concerned level with respect to the assumed base level
- WTP denotes the quantification of the users' desire to shift from the corresponding level to the base level
- Negative WTP (or positive coefficient) denotes a higher perceived utility of the said level as compared to the assumed base level

Results and Discussions

- The users associate highest utility with a reduction in trip length (TPL), followed by improvements in route visibility (VIS), segregation from motorized vehicles (SMV), an improved road surface quality (RSQ) and integration with Public Transport (IPT).

- The users perceive SMV Level 2 to have a higher utility than SMV Level 3 (assumed base level)

- The users value maneuverability much more than the additional safety offered by the physical segregation

- The bicycle users **want their claim on a section of the road**, but **do not want to be strictly constrained** or confined within that space

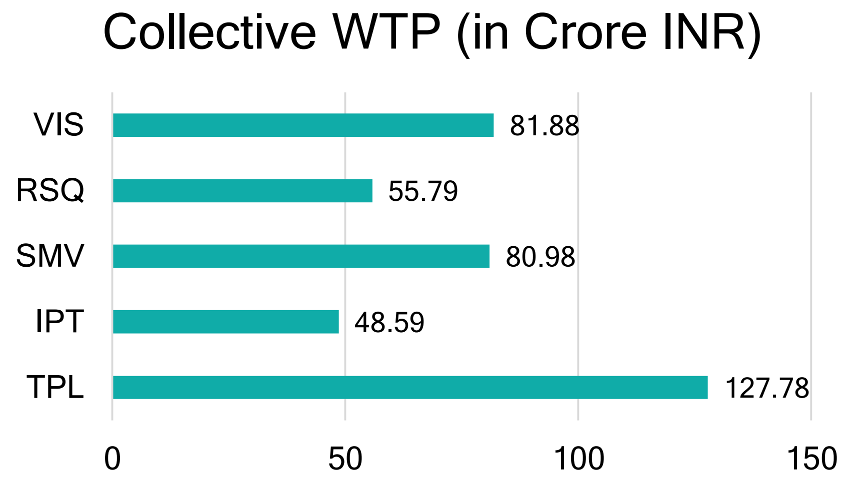
SMV Level 2

SMV Level 3

Results and Discussions

Factor	From Level	To Level	WTP per person per km traveled in INR (a)	Bicycle users in Patna# (b)	km traveled per person per year# (c)	WTP (in Crore INR) of all bicycle users in Patna per year (a*b*c) / 10^7
VIS	Level 1	Level 2	0.91	3,70,545	2,428.4	81.88
RSQ	Level 1	Level 3	0.62	3,70,545	2,428.4	55.79
SMV	Level 1	Level 2	0.90	3,70,545	2,428.4	80.98
IPT	Level 1	Level 3	0.54	3,70,545	2,428.4	48.59
TPL	Level 1	Level 3	1.42	3,70,545	2,428.4	127.78
Total	**Existing scenario**	**Ideal Scenario**	**4.62**	**3,70,545**	**2,428.4**	**395.02**

Source : Patna Comprehensive Mobility Plan, 2018



- The calculated value of collective WTP indicates that the **perceived social benefit of bicycle infrastructure development in Patna** can be considered **equivalent to INR 395.02 crore**

- This considers the perceived benefit of **cyclists alone**. However, improvement in VIS and RSQ will **directly benefit other commuters as well**. Hence, the net social benefit will be **higher**.

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Conclusion

- The results provide a **strong justification for the local authorities** to work towards the development of bicycle-friendly infrastructure in the city
- The large fraction of the **population currently using bicycles in Patna will benefit** from the said development
- Additionally, **other commuters will also get convinced** of the potential of bicycle as a sustainable and efficient alternative to private motorized vehicles
- This can **trigger a modal shift towards bicycles**, reducing the use of private motorized vehicles and associated adversities such as air pollution, noise pollution and traffic congestion
- An increased bicycle usage can **potentially improve social health and fitness**, which can further lead to a more productive society

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Thank You

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