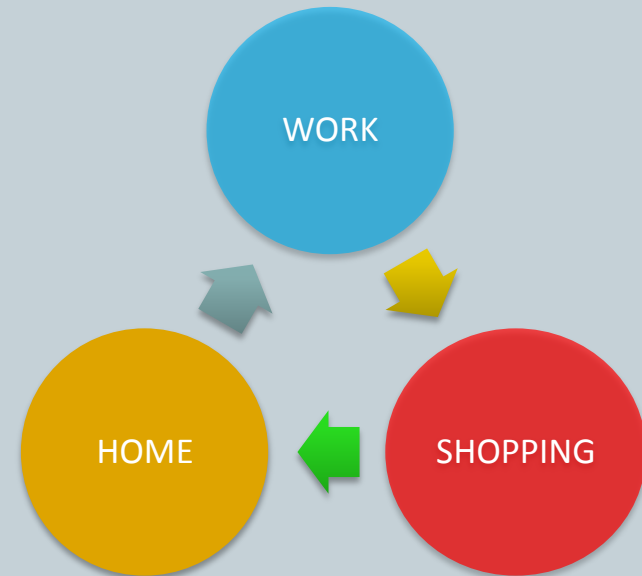# MODELING THE ACTIVITY BASED TRAVEL PATTERN OF WORKERS OF AN INDIAN METROPOLITAN CITY: CASE STUDY OF KOLKATA

ARITRA CHATTERJEE

PROF. DR. P.K. SARKAR

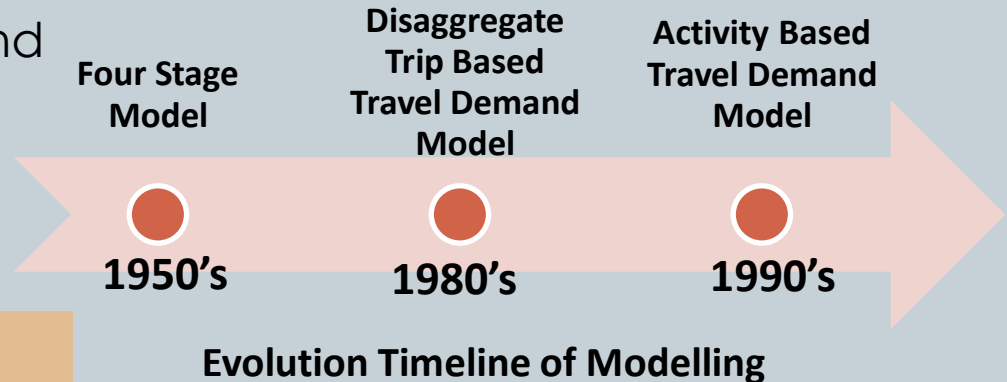**SCHOOL OF PLANNING AND ARCHITECTURE, NEW DELHI**

STRUCTURE OF PRESENTATION

- Research Context
- Methodology
- Literature Review
- Kolkata City Profile
- Data Collection
- Travel Character Analysis
- Development of Trip Generation Model

RESEARCH CONTEXT

ACTIVITY BASED MODELLING

❑ Travel is a derived Demand
❑ Interlink between Trips
❑ Disaggregate Attributes

Four Stage Model — 1950's

Disaggregate Trip Based Travel Demand Model — 1980's

Activity Based Travel Demand Model — 1990's

Evolution Timeline of Modelling

DEFICIENCY OF TRIP BASED MODEL

• Aggregate Bias
• No Interlink of Trips
• No Scheduling of Trips

Activity based travel demand model predicts travel behaviour as a derivatives of activities

RESEARCHED AREAS

• Research has been going on all over the World
• Developed countries are the front runners in application into real situation
• Research has been going on in India also but yet to be applied in Project Execution.

3

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OBJECTIVES & METHODOLOGY

OBJECTIVES

• To study the Activity based travel characteristics of Workers on weekdays and Weekends as part of daily activity pattern

• To develop Activity Based Trip Generation Models

• To appreciate the Mode choice behaviour based on activity participation

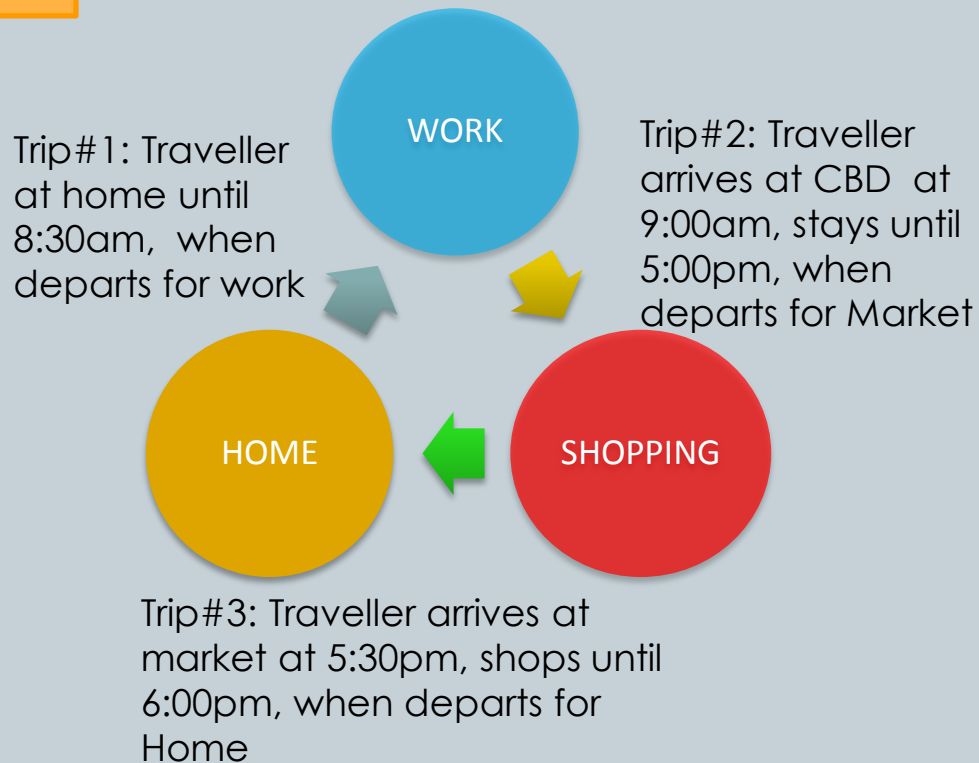| Preliminary	• Study the concept • Literature Search
Data Collection	• Study Area Delineation • Data Collection
Data Analysis	• Relationship between Activity with Age, Income, Gender • Relationship between Mode Choice with Age, Income, Gender
Model Development	• Identification of Parameters • Development of Activity Trip Generation Model

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CONCEPTS OF ACTIVITY BASED MODEL

Trip#1: Traveller at home until 8:30am, when departs for work

WORK

Trip#2: Traveller arrives at CBD at 9:00am, stays until 5:00pm, when departs for Market

HOME

SHOPPING

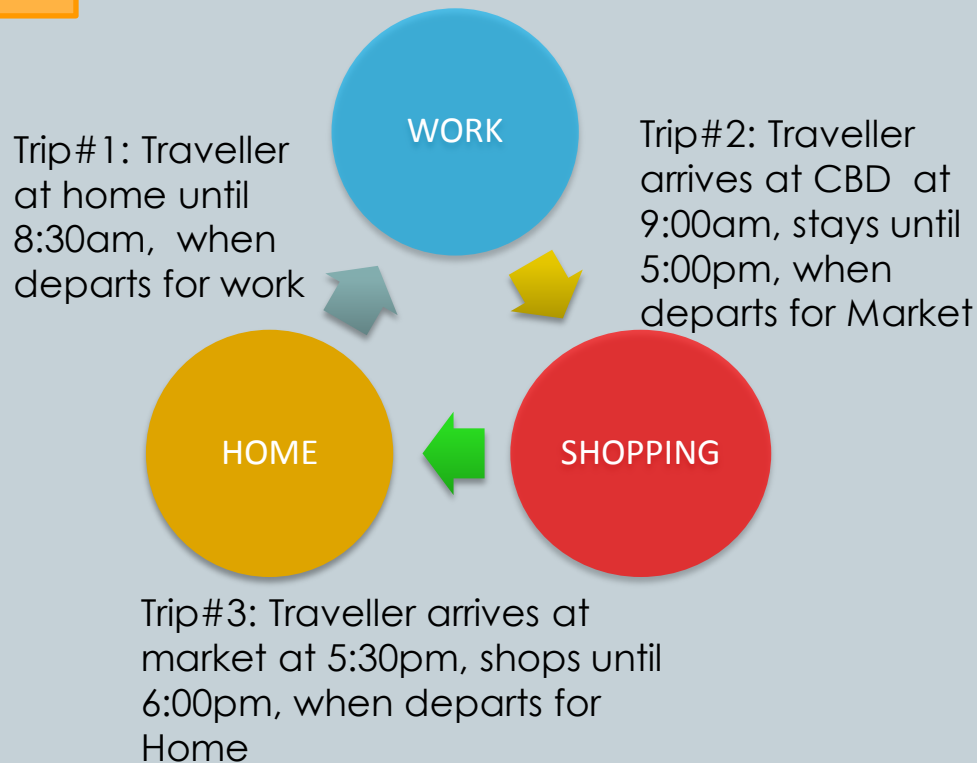Trip#3: Traveller arrives at market at 5:30pm, shops until 6:00pm, when departs for Home

Example of Activity Travel

TRIP

Moving one place to another for a specific purpose except returning Home

E.g.- This example has Three destination but the number of trips would be two

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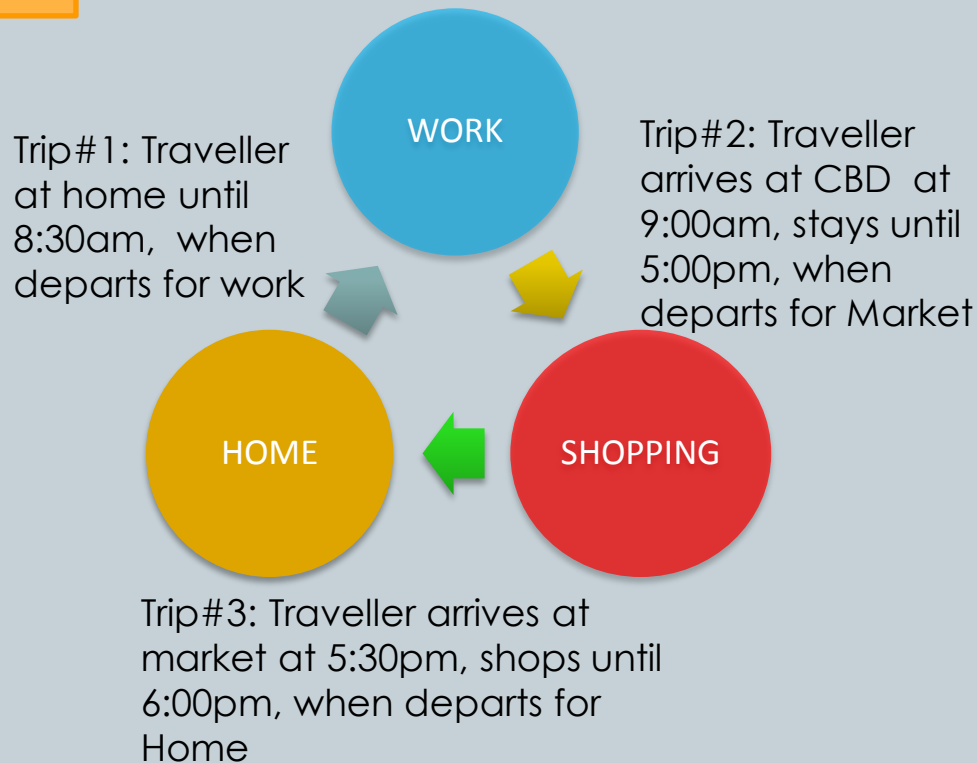Trip#3: Traveller arrives at market at 5:30pm, shops until 6:00pm, when departs for Home

Example of Activity Travel

TOUR

Tour is starting the journey from a place and ending of the journey at same place. May have series of trips in between

E.g.- This example has One tour starting from Home and ending at home with two Trips in between and two activities.

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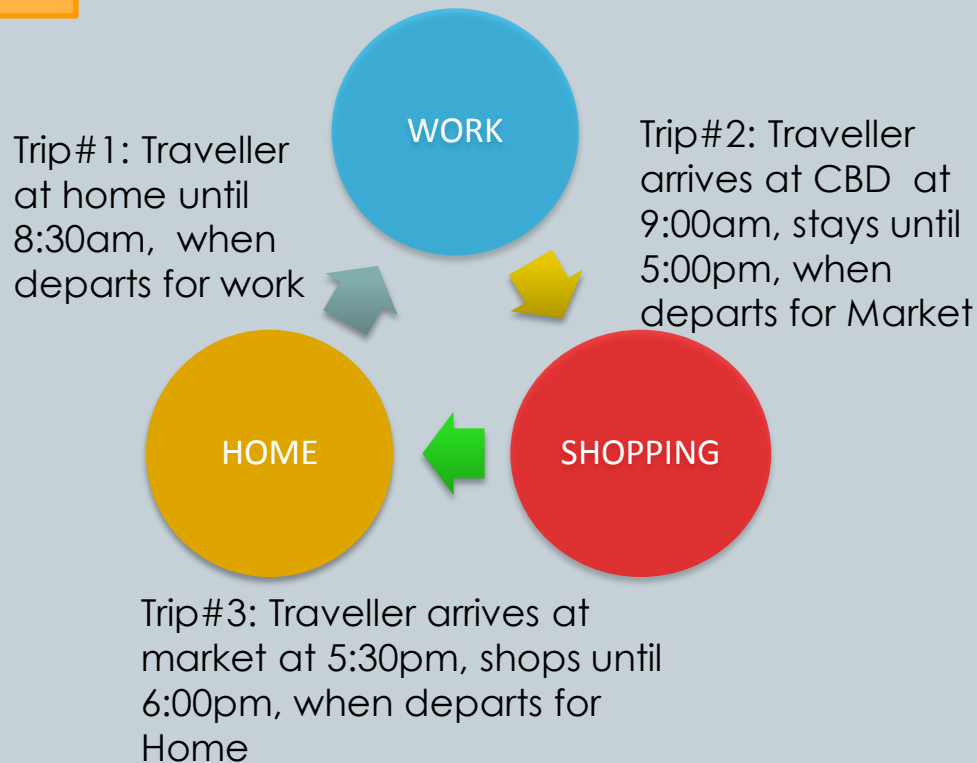Trip#3: Traveller arrives at market at 5:30pm, shops until 6:00pm, when departs for Home

Example of Activity Travel

ACTIVITY

Activity means doing something purposely and which has a duration and spatial location.

E.g.- This example has Two Activities, i.e. Work and Shopping and these needs two trips to participate in both these activities.
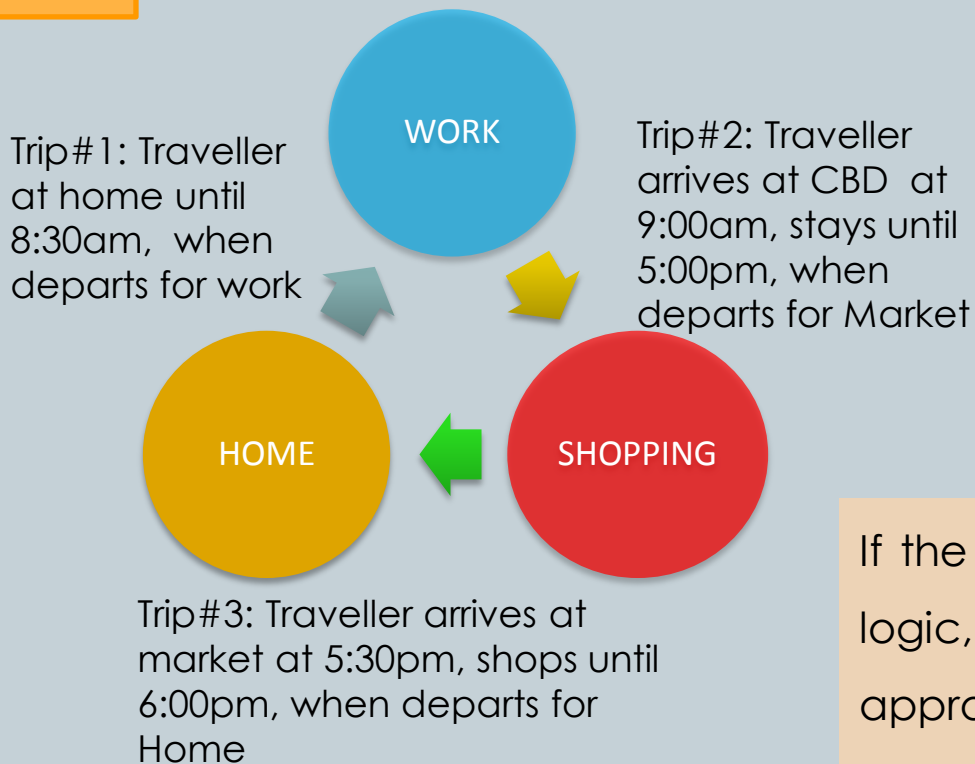
CONCEPTS OF ACTIVITY BASED MODEL

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WORK

HOME

SHOPPING

Trip#3: Traveller arrives at market at 5:30pm, shops until 6:00pm, when departs for Home

Example of Activity Travel

•Each activity needs one trip and total number of activities would be equal to total number of trips for a person.

•A tour would have one or more number of trips and activities. Thus chain of trips could be called Tour.
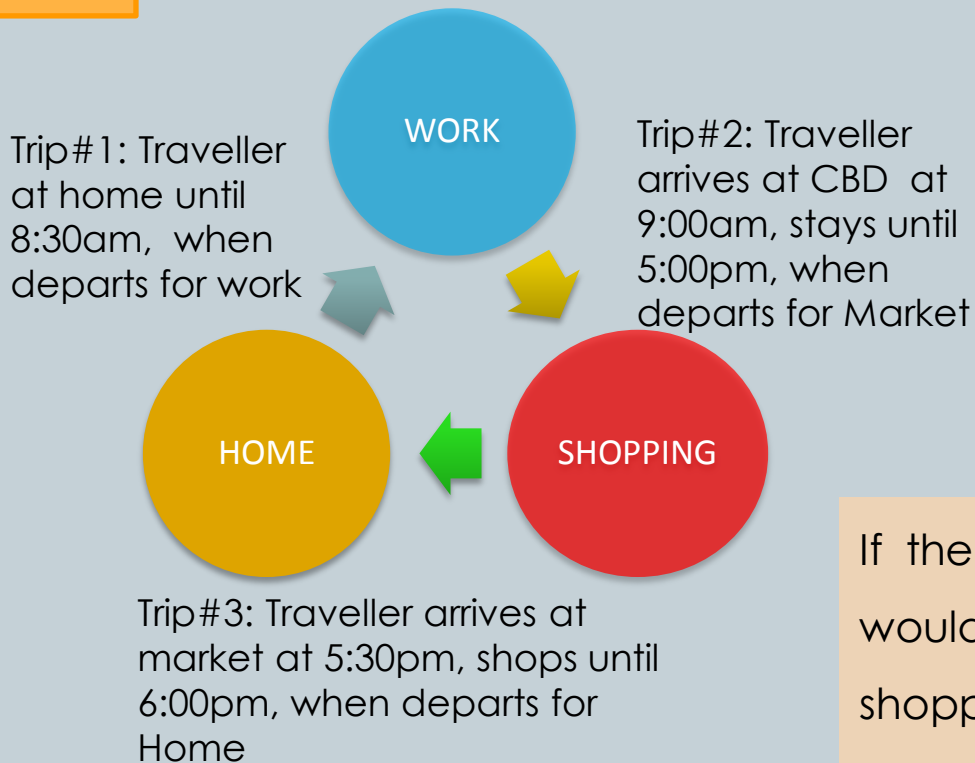
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HOME

SHOPPING

Trip#3: Traveller arrives at market at 5:30pm, shops until 6:00pm, when departs for Home

Example of Activity Travel

TRIP BASED APPROACH

• It consists of Two Trips; One of Work and One of Shopping Purpose.

• One Home Based Trip and One Non-Home Based Trips.

If the first trip has not been performed, then by logic, the second would not. But Trip based approach consider the two trips separately, then in Trip estimation, if the first trip has not been calculated, still the second trip would be calculated. It results in over estimation of trips.

CONCEPTS OF ACTIVITY BASED MODEL

Trip#1: Traveller at home until 8:30am, when departs for work

WORK

Trip#2: Traveller arrives at CBD at 9:00am, stays until 5:00pm, when departs for Market

HOME

SHOPPING

Trip#3: Traveller arrives at market at 5:30pm, shops until 6:00pm, when departs for Home

Example of Activity Travel

ACTIVITY BASED APPROACH

• It consists of One Tour with two interlinked trips.

• It consists of two stops(activities), i.e. Work and Shopping.

If the first trip or the Primary Trip i.e. work trip would not happened, then the second trip i.e. shopping trip would also not happened which would be logically correct.

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LITERATURE SEARCH

Sl No.	TITLE	AUTHOR/ RESEARCHER	OBJECTIVE	OUTCOME
1	**A Comprehensive Activity-Travel Pattern Modeling System for Non-Workers with Empirical Focus on the Organization of Activity Episodes**	Chandra Bhat, Rajul Misra; Department of Civil Engineering, University of Texas at Austin	•Empirical analysis using activity-travel data from travel diary survey •Activity-Travel choices of non-workers	•Econometric for temporal and spatial attributes of the daily activity-travel pattern •Stop Occurrence/Number of Stops (SOC-NOS) Sub-Model •Stop Type (STYPE) Model •Activity-Sequencing (ASEQ) Model
2	**Analysis of Household Activity and Travel Behaviour: A Case of Mumbai Metropolitan Region**	Subbarao SSV, Krishna Rao KV; Department of Civil Engineering, *IIT Bombay*	•Designing of activity-travel diary •Analysis of activity-travel behaviour in the context of developing countries	•Relationship between socioeconomic attributes with activity and trip making behaviour •Multinomial logit model for mode choice behaviour
3	**Activity based trip generation and travel pattern modeling in space and time domains: a case study of west zone Surat**	Krishna Saw, B. K. Katti; Department of Civil Engineering, Sardar Vallabhbhai National Institute Of Technology	•Study household and travel characteristics •Development of Activity Based Trip Generation Models to address spatial and temporal activities •Development probabilistic model for time choice of activities.	•Socio-economic analysis of household •Analysis of trips based on activity, duration of activity •Trip generation model based on disaggregate parameters •Trip Generation and Mode choice model based on time slot of the day

LITERATURE SEARCH

SI No.	TITLE	AUTHOR/ RESEARCHER	OBJECTIVE	OUTCOME
4	**A Comprehensive Daily Activity-Travel Generation Model System for Workers**	Chandra R. Bhat , University of Texas at Austin; Sujit K. Singh, University of Massachusetts at Amherst	•Activity-travel pattern of workers •Analysis framework to model the activity-travel attributes	Descriptive Activity-Travel pattern a) Before morning commute pattern b) Work commute pattern c) Midday pattern d) Post home-arrival pattern Analytical Aspect covered- •Number of tours •Number of stops •Interaction in stop-making across different times of the day, •Interaction of mode choice with number of stops
5	**On Modeling Adults' Weekend Day Time Use by Activity Purpose and Accompaniment Arrangement**	Chandra R. Bhat , University of Texas at Austin; Aarti Kapur, Cambridge Systematics, Inc.	•Analyze the weekend time use patterns of individuals aged 15 years or older •Considering the "with whom" dimension of the activity participations	•Uses the Bhat's multiple discrete continuous extreme value (MDCEV) model formulation to examine adults' weekend day time investments in maintenance, in-home leisure, and out-of-home discretionary (OHD) activities. •Participation on type of Out of Home Activity depends on income and gender
6	**Implementing Activity-Based Modeling Approach for Analyzing Rail Passengers' Travel Behavior**	Jin Ki Eom, Dae-Seop Moon; Korea Railroad Research Institute	Analysis of intercity rail passengers' activity characteristics and travel patterns based on the 2001 Seoul-Busan rail passengers' Travel Survey	•The income does not have critical effect on destination choice •Travel time, transfer status, and date for travel affects on destination choice for both work-related and recreation activity

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FINDINGS FROM LITERATURE

GENERAL ACTIVITY BASED TRAVEL PATTERN

1. Activity based travel pattern have direct bearing of Socio Economic characteristic.

2. Mode choice behaviour could be developed using Multinomial Logit Model

3. It consider number of stops in a tour which has a significant effect in mode choice behaviour

STATUS OF RESEARCH

1. There has been limited number of studies on Activity Based modelling in India and foreign countries. This modelling still is in developing stage in need of more research

2. In advanced economies, specially US and UK, they have make research possible based on comprehensive data base, Taken care of activity travel pattern also in policy decision.

LITERATURE SEARCH

1. Different models such as Trip Generation Model, Mode Choice Model, Preference for Time of the Day for an activity could be done using Activity Based Model

4. Activity Travel Pattern of Workers could be modelled using commuting parameters like Time of the day, Number of Tours, Number of Stops and Stop making in different time of the day.

5. This model has many features like it considers individual travellers, inter-related decision making, detail socio economic information etc in a integrated travel model

6. Activity Based Modelling provides a comprehensive guideline for policy formulation in the transport sector

STUDY AREA PROFILE
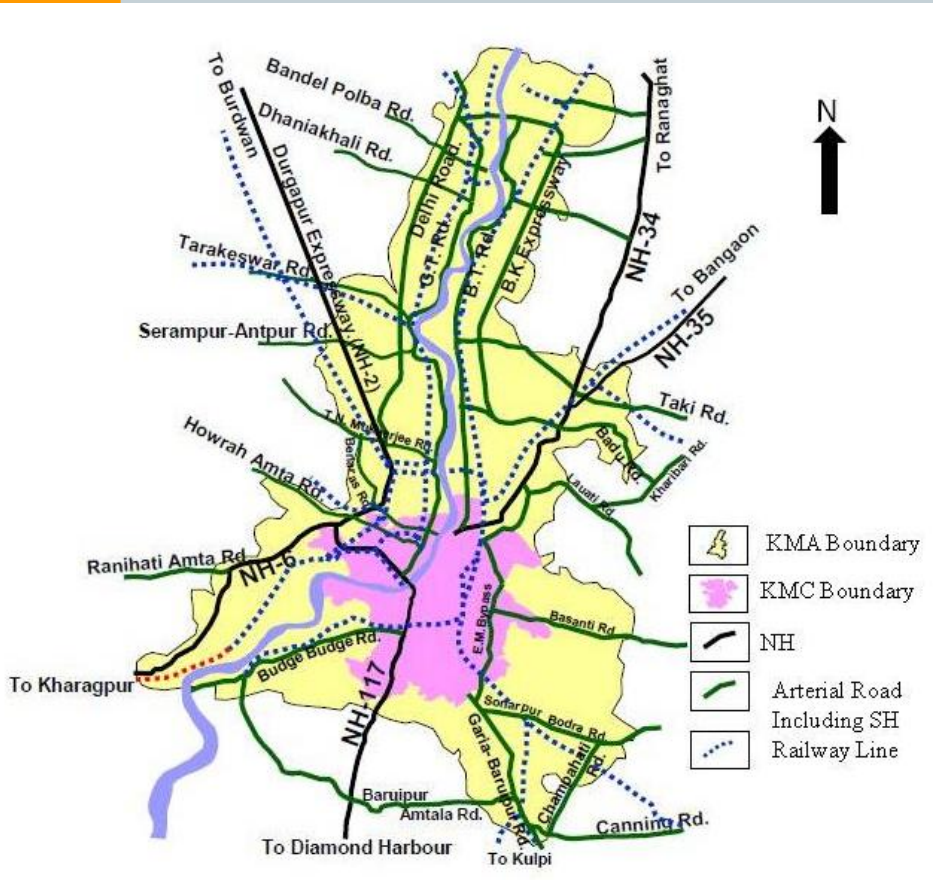
SOURCE: KOLKATA CMP

- 3rd Largest Urban Agglomeration in India
- Area- 1886 Sq.Km
- Population- 14.1 Million(2011)
- Population Density- 7,480person/Sq.Km
- WFPR-40.8%
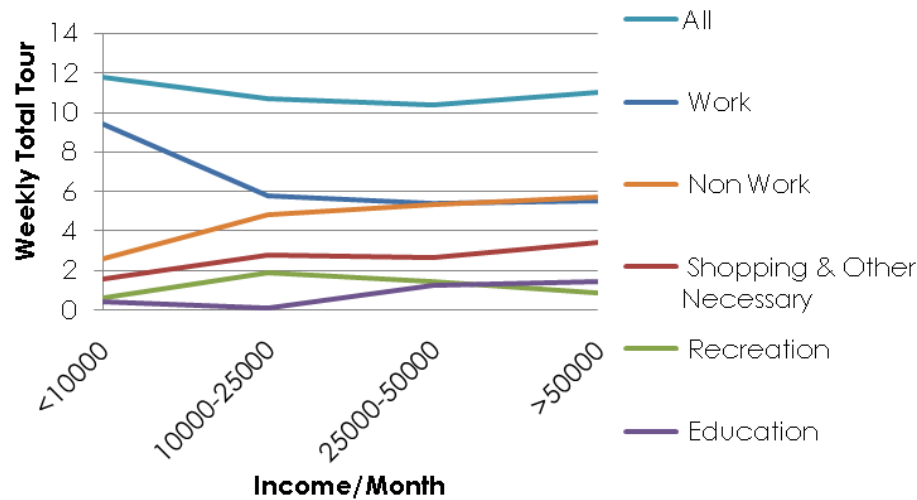- PCTR: 1.4 on Average Weekday

Purpose of Trip

- Work 60%
- Education 16%
- Social 12%
- Others 12%
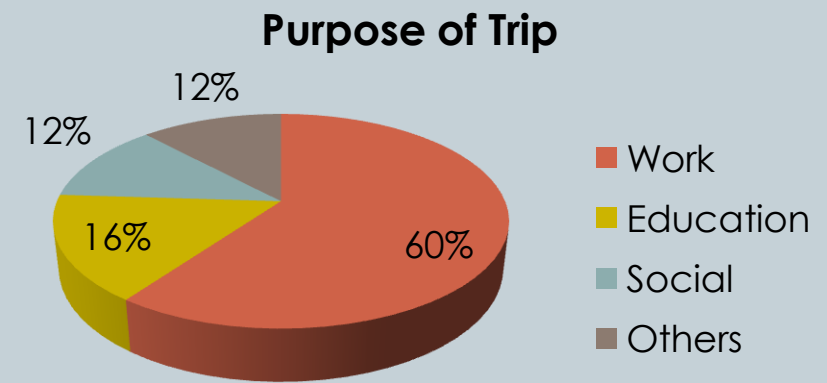
Workers contributes maximum percentage of travel demand, Studying their behaviour would help to understand the individual travel pattern better within given time constrain
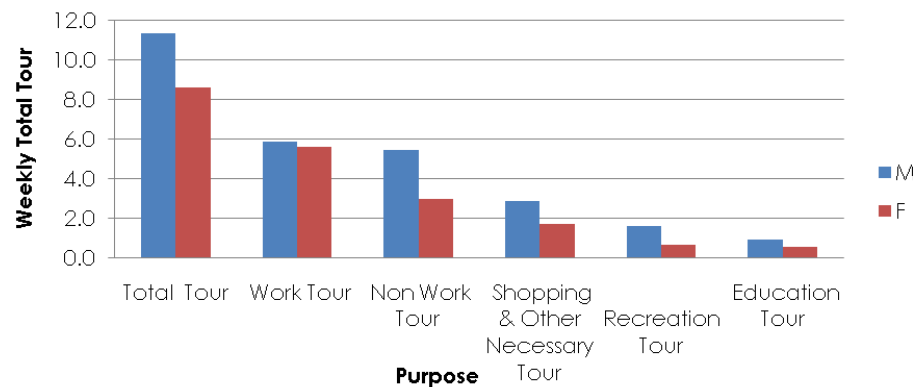
14

8th Urban Mobility India cOnference & Expo 2015
Transforming Mobility for Liveability

IMPACT OF PERSONAL ATTRIBUTES

Tour-Income Relation

Legend: All, Work, Non Work, Shopping & Other Necessary, Recreation, Education

X-axis: Income/Month (<10000, 10000-25000, 25000-50000, >50000)
Y-axis: Weekly Total Tour

Tour-Gender Relation

Legend: M, F

X-axis: Purpose (Total Tour, Work Tour, Non Work Tour, Shopping & Other Necessary Tour, Recreation Tour, Education Tour)
Y-axis: Weekly Total Tour

- Income does not have a significant effect on overall number of tours
- Workers with less income(<10000) has more Work Tours than other due to close proximity to their work places and took lunch at home
- Non Work Tour increases with increase in income

- Gender has significance impact on number of Tour
- Except Work Tour, Working males take more Non Work Tours than Working Females
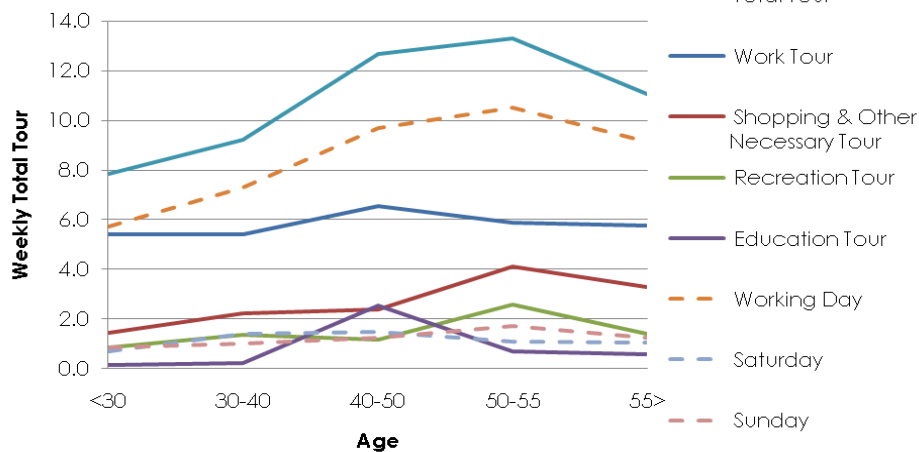
NOTE: 'Shopping & Other Necessary' includes all the Maintenance Activities i.e. Daily Shopping of FMCG products, Going to Banks or Utility Offices etc. 'Education' means education of Children

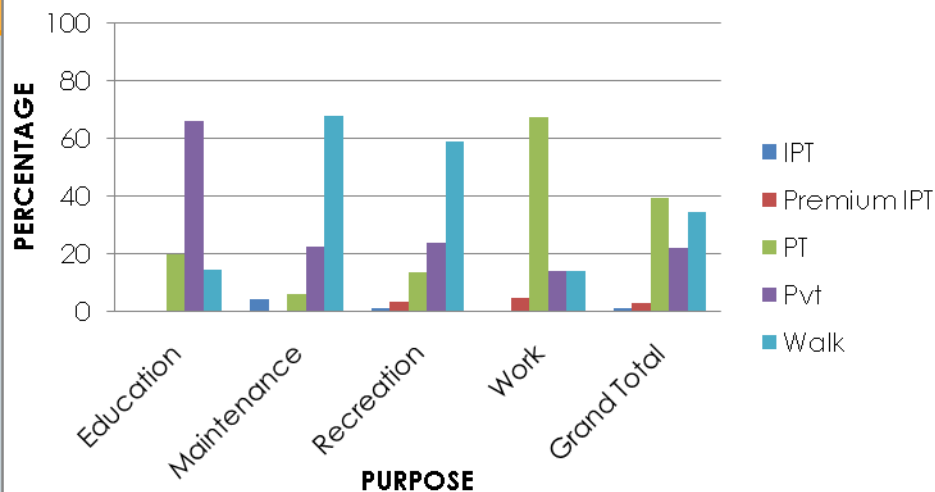# IMPACT OF PERSONAL ATTRIBUTES
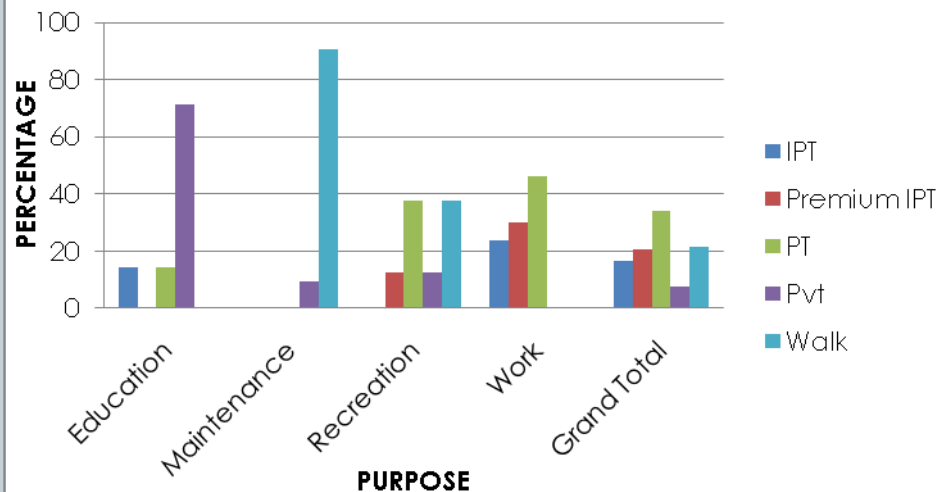

Activity-Age Relation
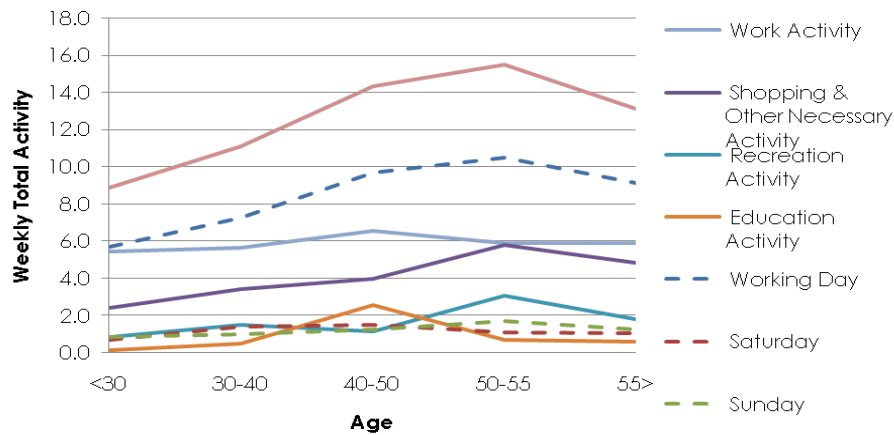
Tour-Age Relation

- Age has the most significant effect on Activity participation rate probably because of increase in age means more family responsibilities
- Work Activity has been remain almost constant for all the age groups
- Non Work Activity, specially Shopping and Maintenance activity increases with the age and at peak in 50-55 age group
- Significance difference in Weekday and Weekend activities has been observed across the different age groups, probably due to Non Work Activates on Weekends.
- Number of Tours are less compared to the same type of activity due to more than one activity has been performed during one Tour
- Shopping Tours are less than shopping activities as considerable percentage of shopping activity done on the time of work tours

IMPACT OF PERSONAL ATTRIBUTES
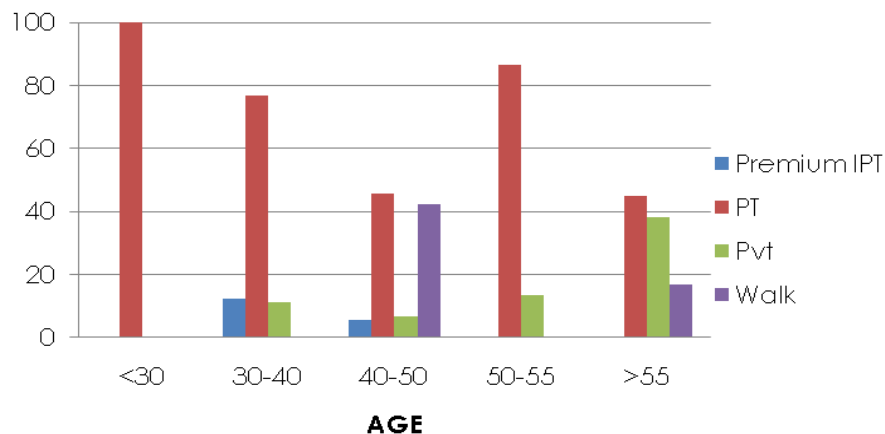

ALL TRIPS BY MALE

(IPT, Premium IPT, PT, Pvt, Walk by Purpose: Education, Maintenance, Recreation, Work, Grand Total)

ALL TRIPS BY FEMALE

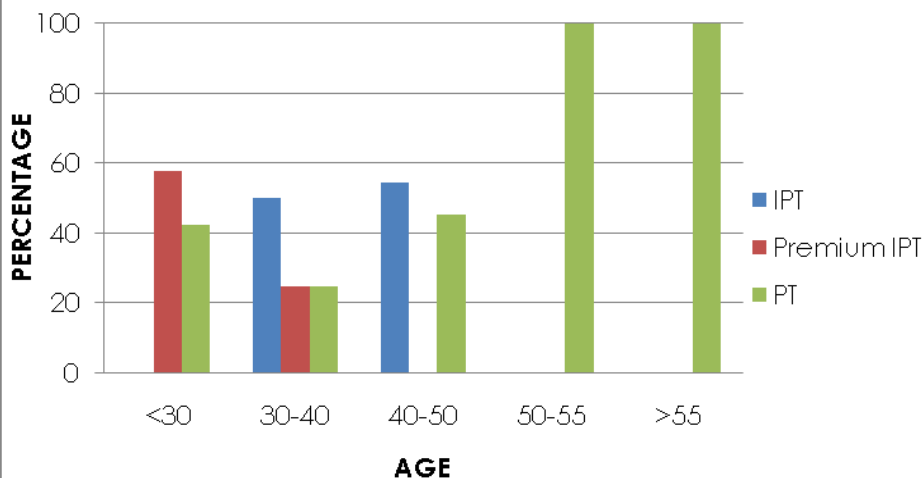(IPT, Premium IPT, PT, Pvt, Walk by Purpose: Education, Maintenance, Recreation, Work, Grand Total)

- Public Transport is the predominant mode for Work Trips due to well connectivity by PT network and Lack of Road space discourage people to take personal vehicles

- Walk is the predominant mode for Maintenance and Recreation as these activates has been performed in the close proximity of home or work place.

- Females have more tendency to use Premium IPTs than Male for Overall trips may be due to safety and comfort issue

- Female uses IPT and Premium IPT more than PT for Work purpose compared to Male.

17   *Premium IPT- Taxi/Cabs; Maintenance- Shopping & Other Necessary Activities*

IMPACT OF PERSONAL ATTRIBUTES

WORK TRIP BY MALE — bar chart showing PERCENTAGE vs AGE (<30, 30-40, 40-50, 50-55, >55) with series: Premium IPT, PT, Pvt, Walk

WORK TRIP BY FEMALE — bar chart showing PERCENTAGE vs AGE (<30, 30-40, 40-50, 50-55, >55) with series: IPT, Premium IPT, PT
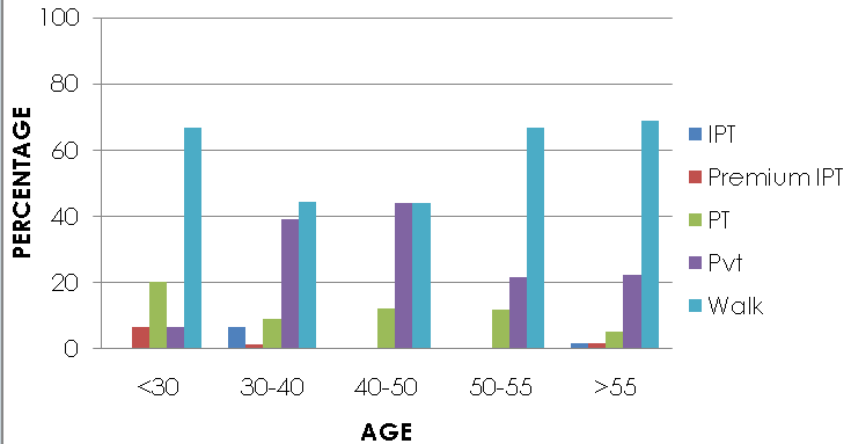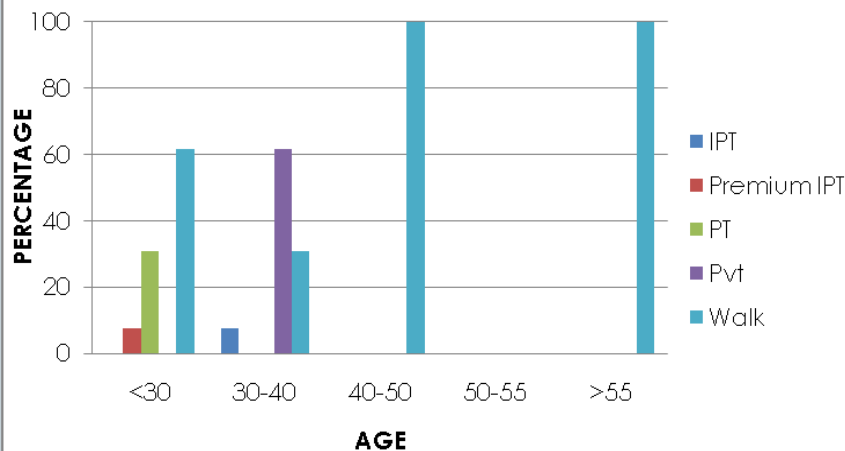
- Public Transport is the predominant mode across all age group of male

- Use of PT started decreasing after age of 55 probably due to comfort factor private mode becomes more attractive to them

- Male do not use IPT as main mode of transport to Work probably either they cover the distance by private mode or by Public Transport.

- Young Female mostly preferred IPT for work purpose than aged female probably due to safety issues.

Premium IPT- Taxi/Cabs

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IMPACT OF PERSONAL ATTRIBUTES


NON WORK TRIP BY MALE

NON WORK TRIP BY FEMALE

- Walk is the predominant mode for Non Work Activities for all male probably because of the activity locations are near the vicinity of the home or work place.
- Private mode comes as the second most preferred mode of travel for males for non work purpose and it decreases with age as driving become more difficult with increase in age.
- Female in young age group of less than 40 years generally performed Non Work Activities are Recreational and Social in nature that requires long travel thus they use of PT and Private Mode
- Older Females generally performed Shopping and Maintenance kind of activities which are in near vicinity thus walking become convenient for them.

Premium IPT- Taxi/Cabs

IMPACT OF PERSONAL ATTRIBUTES


WORK TRIP BY MALE
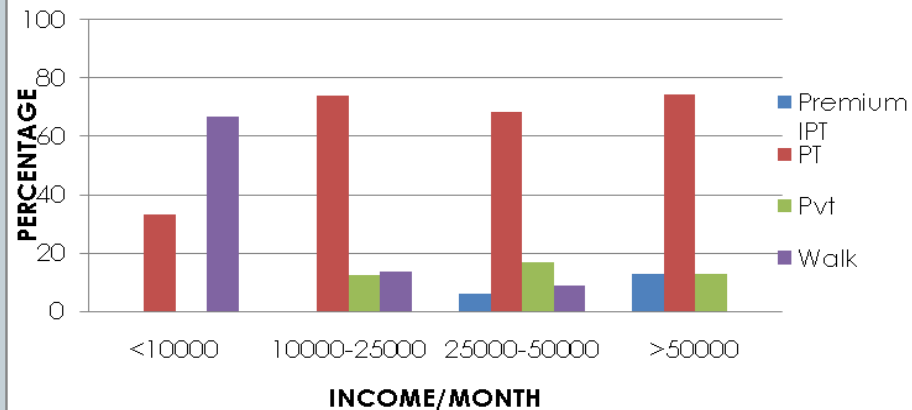
WORK TRIP FEMALE

- Income has significant effect in mode choice for female rather than male
- Worker in the lower income level(<10000) has walk as the predominant mode for Work trip due to their stay near their work place to minimize the travel cost.
- Workers with income range of more than 10,000 per month has Public Transport as significant mode of transport for work as they travel more distance for suitable job opportunities.
- Female in lower income group uses IPT as their mode of transport to work because females do not prefer to walk long distance and they are in a hurry for their household works.
- Public Transport comes as predominant mode for females but use of Premium IPT increases with Income

Premium IPT- Taxi/Cabs

IMPACT OF PERSONAL ATTRIBUTES

NON WORK TRIP MALE
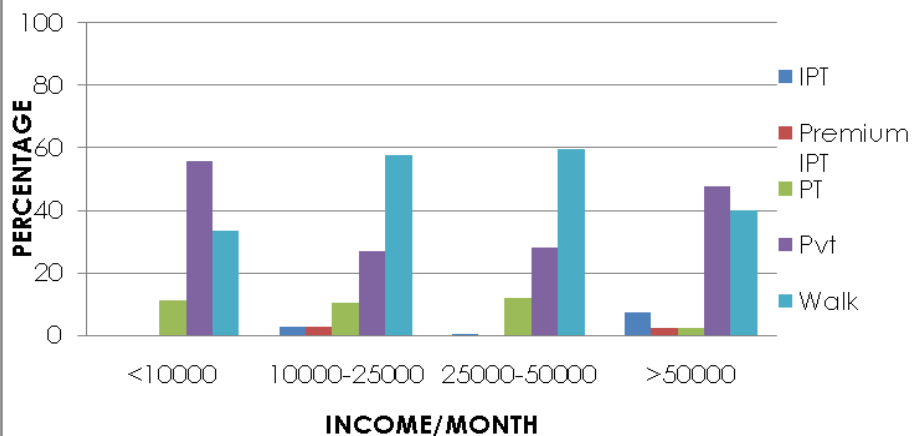
NON WORK TRIP FEMALE
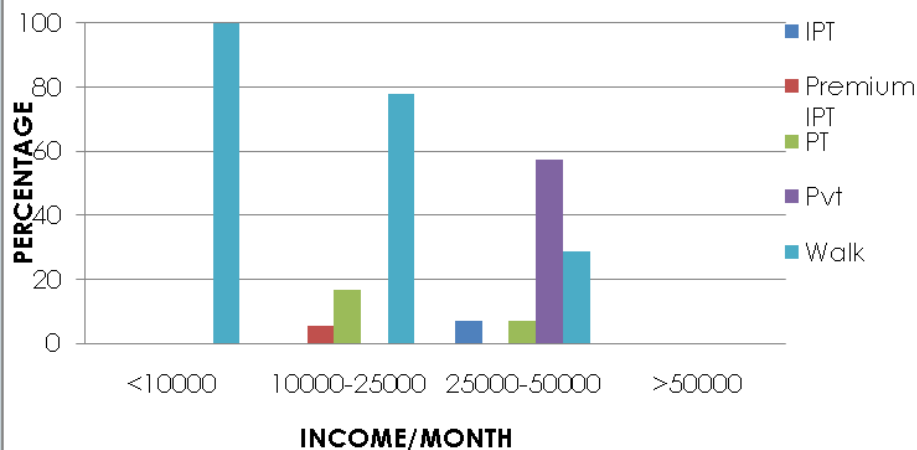
- Walk is the predominant mode for Non Work Activities

- Male Worker in the lower income group uses bi-cycle as their preferred mode for Non-Work Activities

- For Male, With increase in income, use of Private vehicle increases for Non-Work Activities.

- Females prefer walk as the mode of transport for Non Work activities but with increase in Income, use of Private Mode increases as they are more tends to participate in Recreational and Social activities away from home.

Premium IPT- Taxi/Cabs

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OBSERVATIONS FROM PRIMARY SURVEY

- Age has the maximum influence on Trip rate

- Gender has a influence of trip rate with females have lesser trip rate than males

- Income has not shown any significance influence in Trip rate and Mode choice

- Four type of Workers: Government Employee, Private Sector Employee, Self Employed and Daily Wage Earners has some distinct travel behaviour characteristics.
  I.e. Workers in Government service generally does shopping in the morning before leaving for the office but worker employed in private sector does the shopping while returning home.

TRIP GENERATION MODEL

Activity	Duration	Equation	R^2	T Value			Accuracy of Prediction in Percentage
				Age	Gender	Income	
All	Weekday	$Y=0.172X_1+1.845X_2$	0.829	8.614	2.56	-	84
	Weekend	$Y=0.062X_1+0.010X_3$	0.725	5.683	-	0.666	79
	Weekly	$Y=0.242X_1+1.810X_2$	0.841	9.638	1.988	-	87
Work	Weekday	$Y=0.077X_1+1.907X_2$	0.865	7.648	7.259	-	86
	Weekend	$Y=0.021X_1-0.015X_3$	0.216	3.817	-	-2.002	71
	Weekly	$Y=0.090X_1+1.800X_2$	0.827	7.197	3.989	-	84
NON WORK	Weekday	$Y=0.088X_1+0.008X_3$	0.536	3.920	-	0.274	79
	Weekend	$Y=0.042X_1+0.0025X_3$	0.646	3.715	-	1.608	82
	Weekly	$Y=0.130X_1+0.030X_3$	0.636	4.370	-	0.816	81
Shopping and Other Necessary	Weekday	$Y=0.053X_1+0.374X_2$	0.484	4.121	0.798	-	74
	Weekend	$Y=0.043X_1-0.273X_2$	0.573	6.861	-1.205	-	76
	Weekly	$Y=0.096X_1+0.101X_2$	0.603	6.021	0.175	-	73
Recreation	Weekday	$Y=0.028X_1-0.417X_2$	0.187	3.589	-1.476	-	57
	Weekend	$Y=0.009X_1+0.296X_2$	0.392	2.148	1.863	-	76
	Weekly	$Y=0.037X_1-0.121X_2$	0.296	3.527	-0.314	-	68
Education	Weekday	$Y=0.022X_1+0.019X_3$	0.132	-0.432	-	1.496	54
	Weekend	$Y=0.005X_1+0.049X_2$	0.096	1.223	0.341	-	70
	Weekly	$Y=0.019X_1+0.029X_2$	0.156	1.953	0.837	-	78

Y –Total Individual Trip on Weekday/Weekend/Weekly; X_1 – Age
X_2– Gender; Male=1; Female=2 X_3 –Income in Thousand(x1000)

TOUR GENERATION MODEL

Activity	Duration	Equation	R^2	T Value			Accuracy of Prediction in Percentage
				Age	Gender	Income	
All	Weekday	$Y=0.118X_1+0.081X_3$	0.805	5.482	-	2.743	81
	Weekend	$Y=0.057X_1+0.007X_3$	0.73	5.146	-	0.512	76
	Weekly	$Y=0.177X_1+0.089X_3$	0.834	6.619	-	2.443	84
Work	Weekday	$Y=0.074X_1+1.757X_2$	0.887	8.712	5.694	-	88
	Weekend	$Y=0.020X_1-0.017X_3$	0.248	4.721	-	-2.877	43
	Weekly	$Y=0.083X_1+1.754X_2$	0.845	7.541	4.401	-	87
NON WORK	Weekday	$Y=0.037X_1+0.035X_3$	0.422	2.047	-	1.656	72
	Weekend	$Y=0.042X_1+0.022X_3$	0.673	4.213	-	1.405	78
	Weekly	$Y=0.079X_1+0.056X_3$	0.637	3.519	-	1.837	79
Shopping and Other Necessary	Weekday	$Y=0.025X_1+0.007X_3$	0.299	2.211	-	0.471	69
	Weekend	$Y=0.031X_1+0.004X_3$	0.580	4.339	-	0.459	74
	Weekly	$Y=0.055X_1+0.012X_3$	0.562	4.061	-	0.616	73
Recreation	Weekday	$Y=0.030X_1-0.542X_2$	0.195	4.010	-1.958	-	59
	Weekend	$Y=0.001X_1+0.297X_2$	0.406	2.295	1.855	-	70
	Weekly	$Y=0.040X_1-0.245X_2$	0.307	3.832	-0.635	-	64
Education	Weekday	$Y=-0.001X_1+0.035X_3$	0.145	-0.908	-	2.441	54
	Weekend	$Y=0.004X_1+0.056X_2$	0.135	1.217	0.438	-	76
	Weekly	$Y=-.008X_1+0.041X_3$	0.175	-0.629	-	2.403	82

Y –Total Individual Tour on Weekday/Weekend/Weekly; X_1 – Age
X_2– Gender; Male=1; Female=2 X_3 –Income in Thousand(x1000)

OBSERVATIONS FROM TRIP/TOUR GENERATION MODEL

ALL TRIP: Age and Income has the significance influence on trip rates except Gender on Weekends

NON WORK TRIP: As on weekdays, Non Work trips are less, the R^2 value has been coming poor compare to weekends

WORK TRIP: Very few people have offices on weekends, results in poor statistical parameters on weekends

SHOPPING TRIP: As there are significant number of shopping activities rather than shopping tours, the R^2 value is comparatively good from the Tours

ALL TOUR: Age and Income has the significance influence on trip rates except Gender on Weekends

NON WORK TOUR: As on weekdays, Non Work trips are less, the R^2 value has been coming poor compare to weekends

WORK TOUR: Very few people have offices on weekends, results in poor statistical parameters on weekends

EDUCATION TOUR: As number of samples observed with educational trips are very less, the R^2 value has coming out to poor

SUMMING UP

KEY FINDINGS

- Activity based travel pattern have direct bearing of Socio Economic characteristic.

- It has been established that Travel is a derived demand which generates from eagerness to participate in an activity

- Personal attributes like Age, Income and Gender influence the travel characteristic of an individual to a great extent.

- Mode choice behaviour varies significantly depending on Purpose of Travel as well as a person's personal attributes.

WAY FORWARD

- This study has been a small step forward to appreciate the travel pattern for various activities at Micro Level which are essentially the major catalyst for Policy Formulation

- More extensive research needed for Indian context as it has a diversified class of people with complex problems across the cities.

- Disaggregate analysis could be a good tool to solve the problem of congestion in more scientific way.

? ANY QUERIES

THANK YOU