Study of Clustering Modes based on Choice of Transport across Space :a case study of Tokyo Metropolitan Area

25th – 27th September, 2015|14th Behavior Modeling Workshop in Transportation Networks |The University of Tokyo

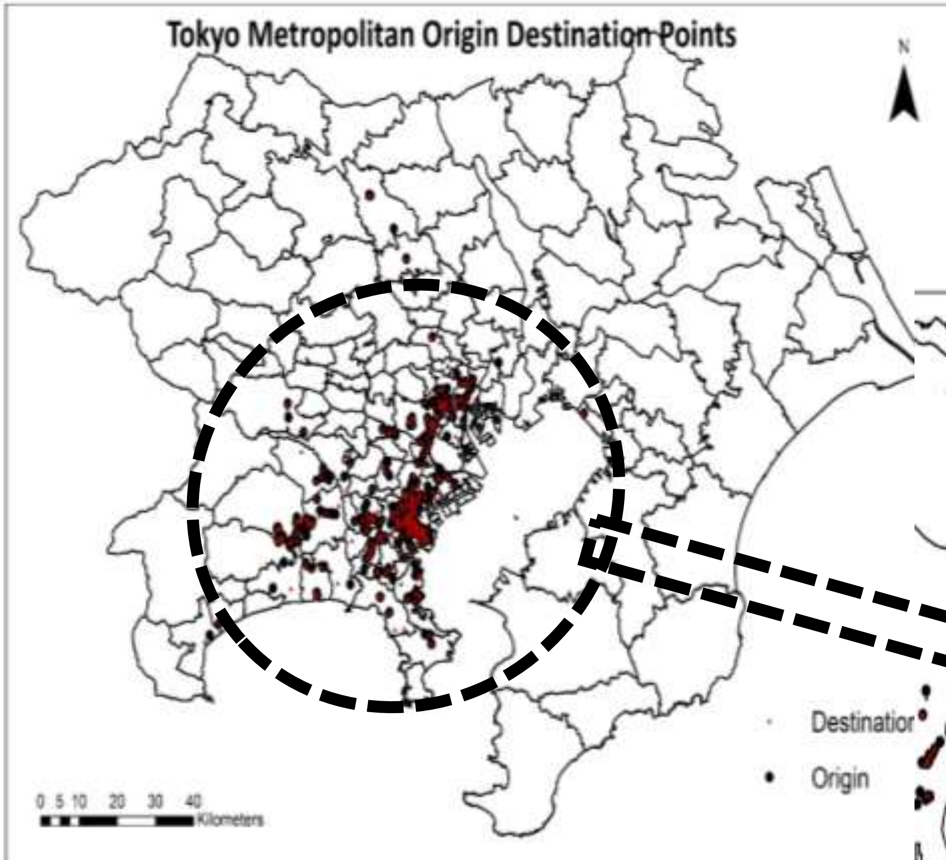
Presented by

IIT Bombay

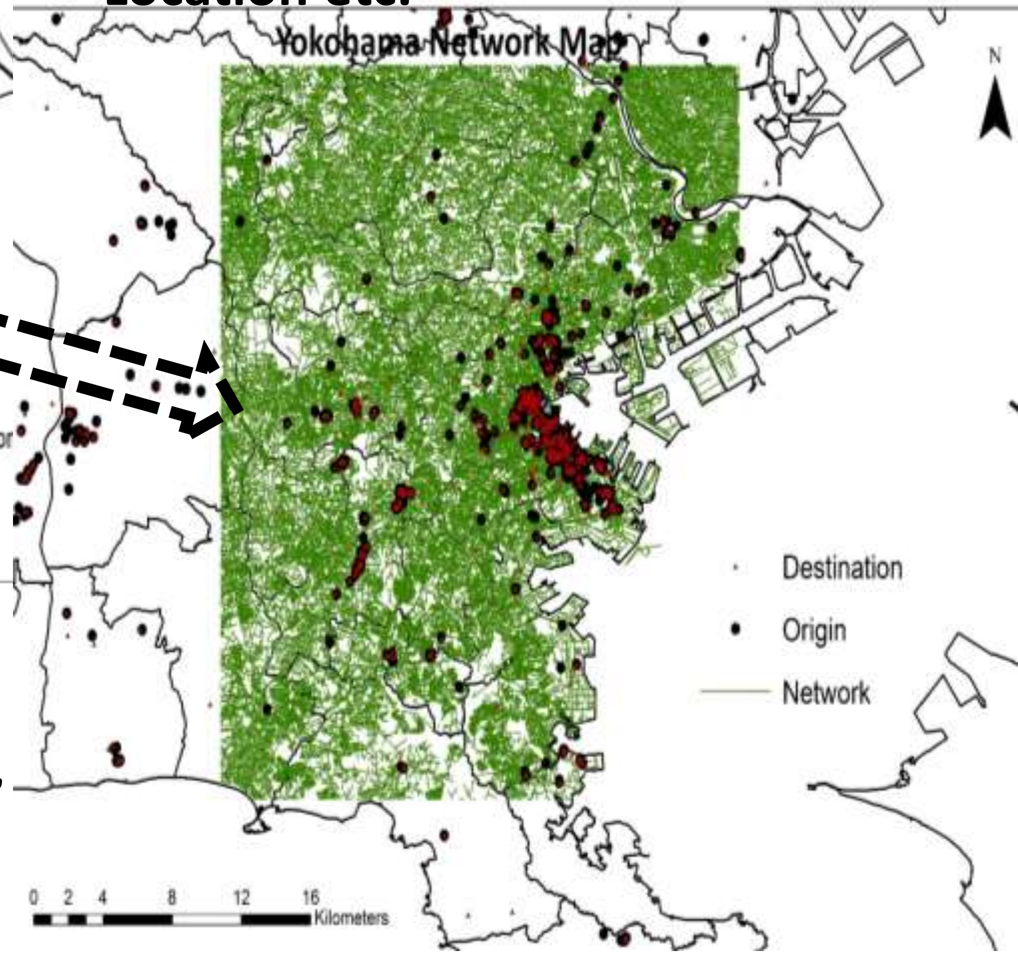
Objectives of the study

1. To evaluate the spatial variation in modal choice within different cohorts for Tokyo Metropolitan area(age, gender, time of the day).
2. To identify areas which are public transport and non-motorized traffic friendly for the selected cohorts.
3. To analyze the change in travel behavior due to changes in policy attributes(fare, travel time etc., no. of transfers).

The Data

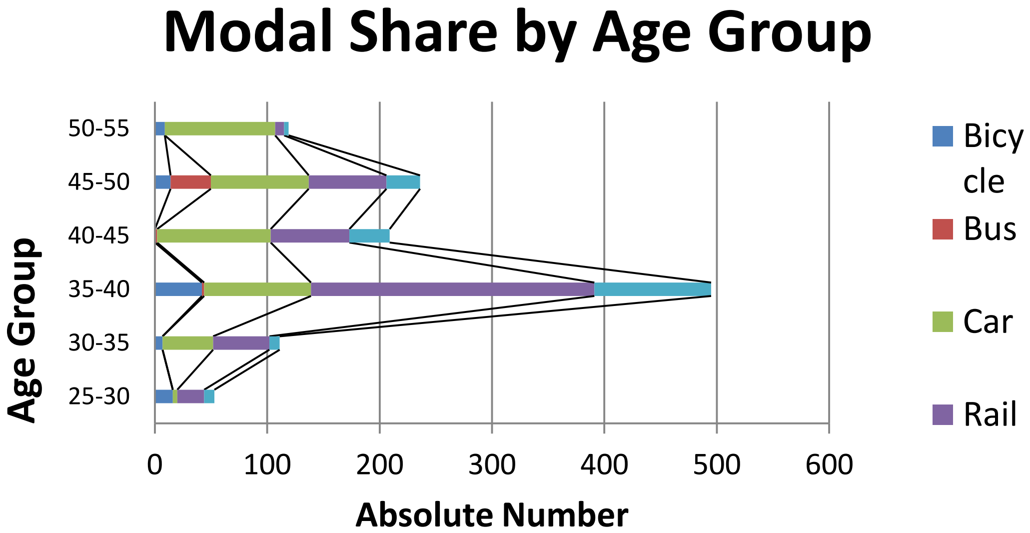


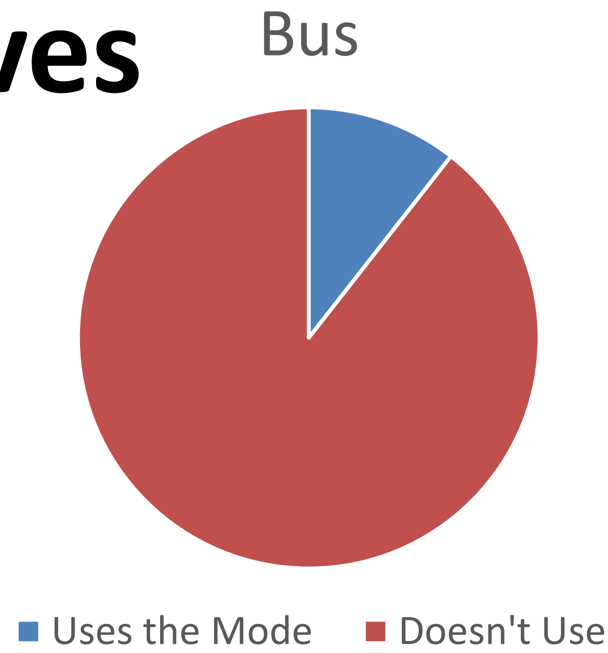
Choice data- Mode choice {Walk, Bike, Train, Bus, & Car}
Trip data- Travel time, Purpose, Location etc.

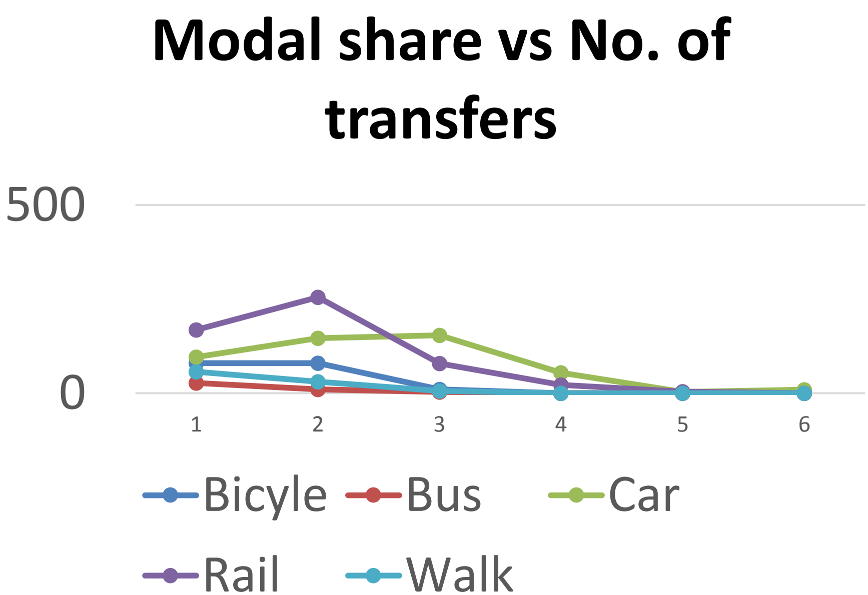


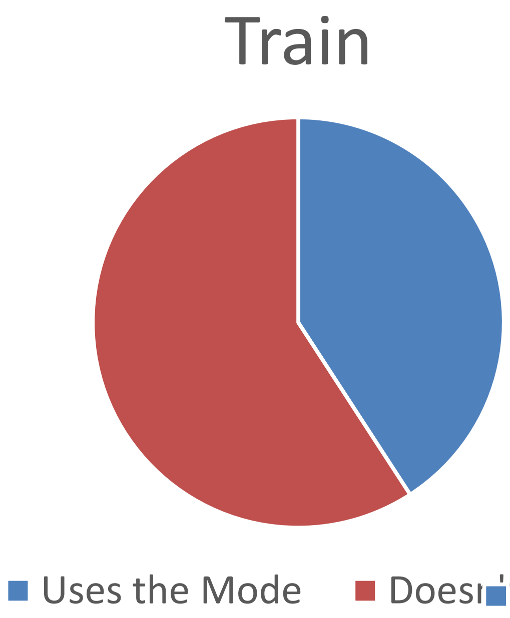
Individual data- Age, Gender etc.
Trip data- Travel time, location etc.
Alternative characteristics- Fare, time, Access, Egress etc.

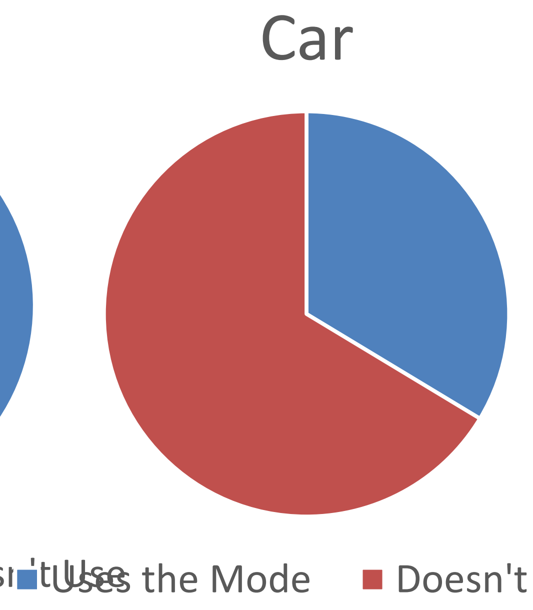
Data Descriptives



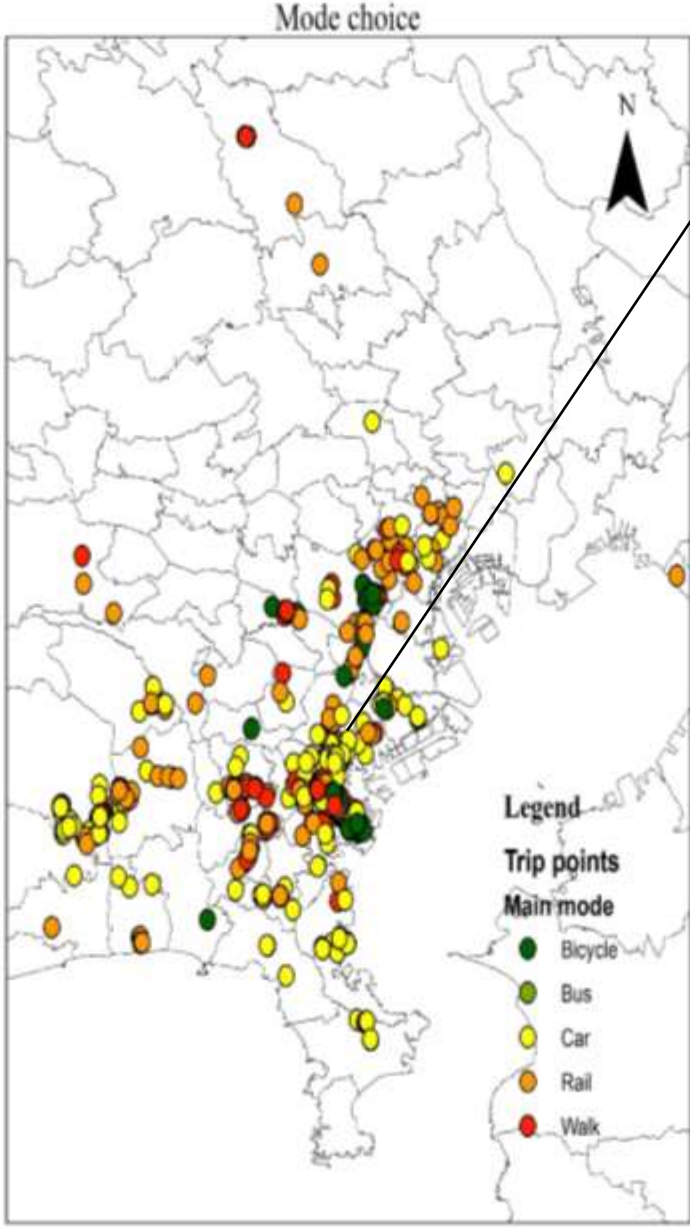






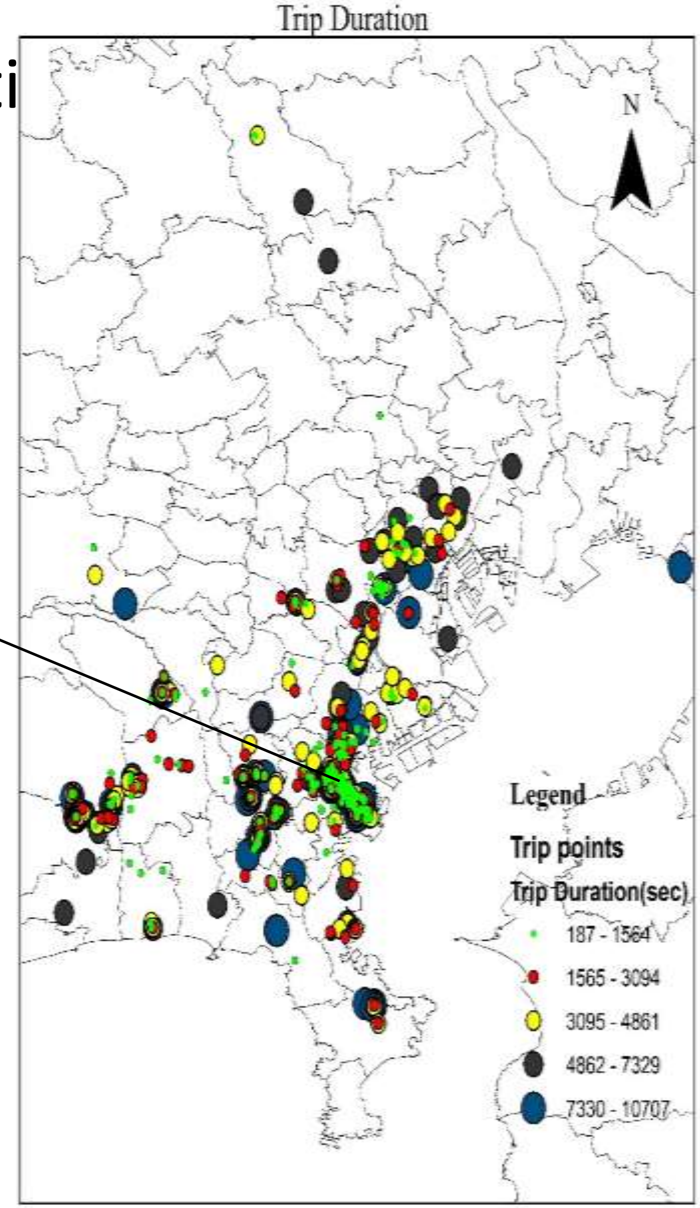


Spatial Variation in Variables

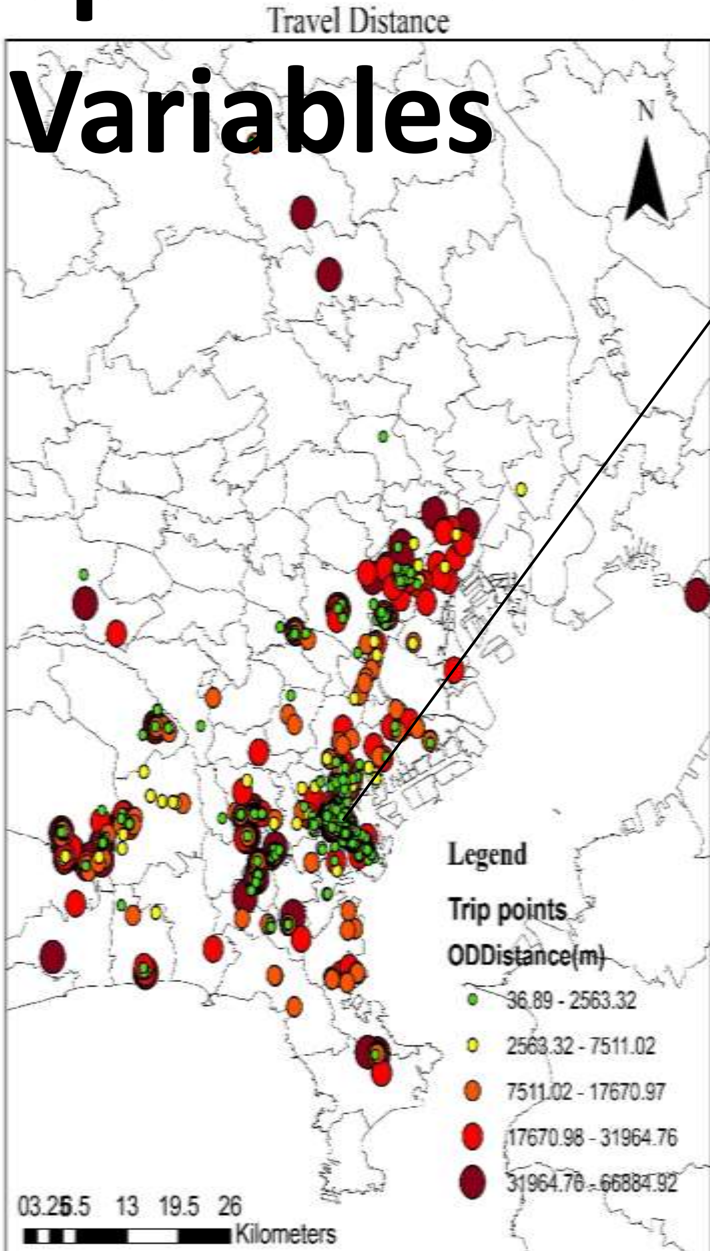


Concentration of car use

Shorter trip times

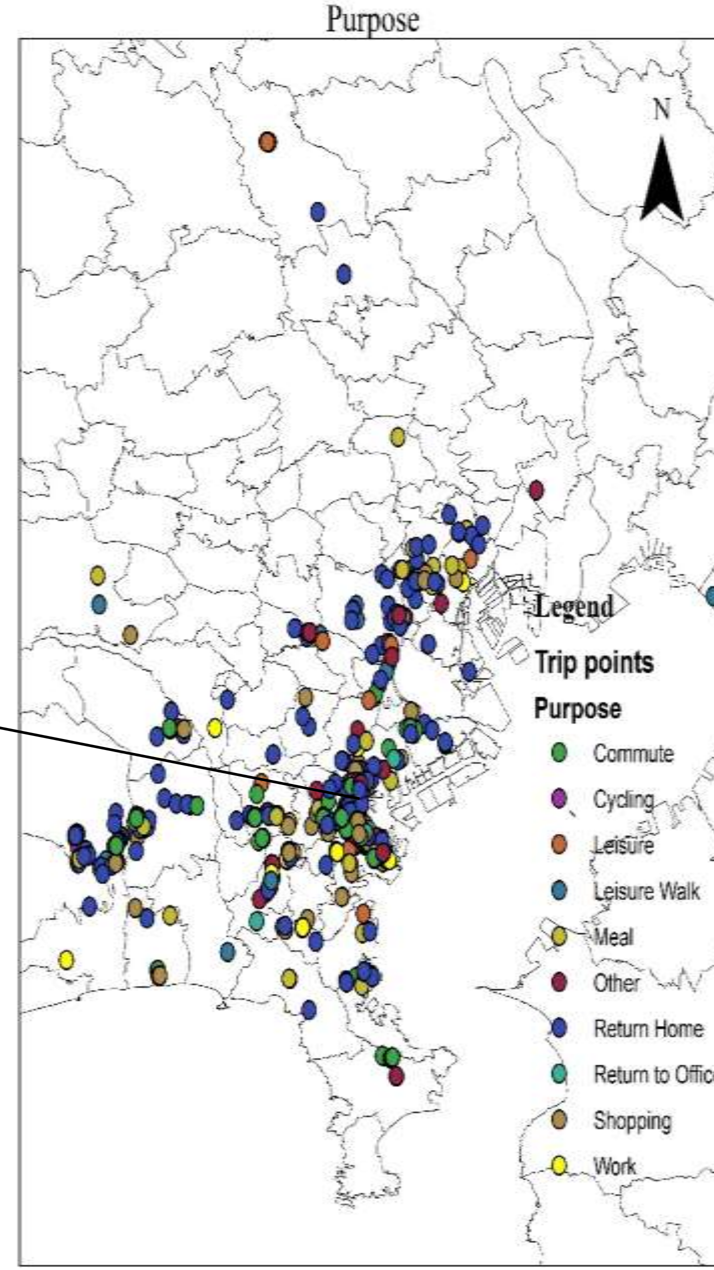


Spatial Variation in Variables



Concentration of smaller trip distances

Return to home, commute trips



Multi-nominal Logit Model

Walk has been taken as the base case

- X1 or ASC1=Train
- X2 or ASC2=Bus
- X3 or ASC3=Car
- X4 or ASC4=Bike

Variables considered for the analysis

X5= Travel Time

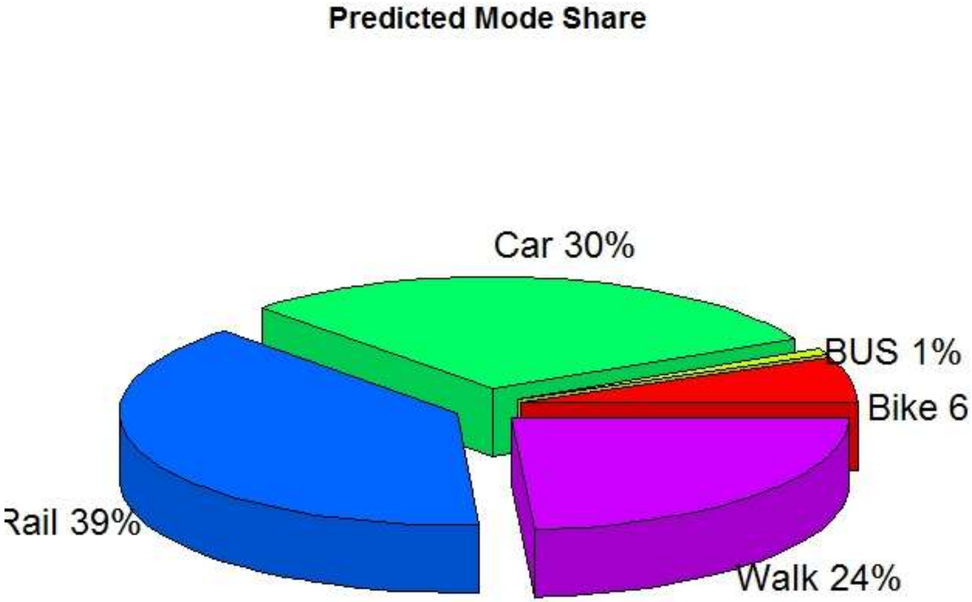
X6= Age

- Log likelihood value=-1273.97
- t-statistics=6.491065, -4.896915, -5.309969 -4.221034, -21.073350,   4.304434

Utility equations

- train <- Data$ModeAvailableTrain*exp(d1*Data$TotalTimeTrain/100 +b1*matrix(1,nrow =hh,ncol=1))
- bus <- Data$ModeAvailableBus *exp(d1*Data$TotalTimeBus/100 +b2*matrix(1,nrow =hh,ncol=1))
- car <- Data$ModeAvailableCar *exp(d1*Data$TimeCar/100 +b3*matrix(1,nrow =hh,ncol=1))
- bike <- Data$ModeAvailableBike *exp(d1*Data$TimeBike/100 +b4*matrix(1,nrow =hh,ncol=1))
- walk <- Data$ModeAvailableWalk *exp(d1*Data$TimeWalk/100 +d2*Data$Age/10

Predicted Mode Share



Prediction Success Table

	Predicted				
	bike	bus	car	Rail	walk
Bicycle	67	0	21	55	68
Bus	1	0	34	1	5
Car	48	0	326	72	66
Rail	3	15	62	442	6
Walk	16	0	4	18	192

Elasticities

- Direct elasticities with respect to time

- BUS - 1.43
- Train - 1.73
- car- -1.29
- bike -.94
- walk- -1.01

- cross elasticities with respect to time
- bus- .33
- train = .077
- car - .15
- bike= .47
- walk = .51

Mixed Logit Model 1.(Age group 25-40)

Walk has been taken as the base case

- X1or ASC1=Bus
- X2 or ASC2=Car
- X3 or ASC3=Bike

Variables considered for the analysis

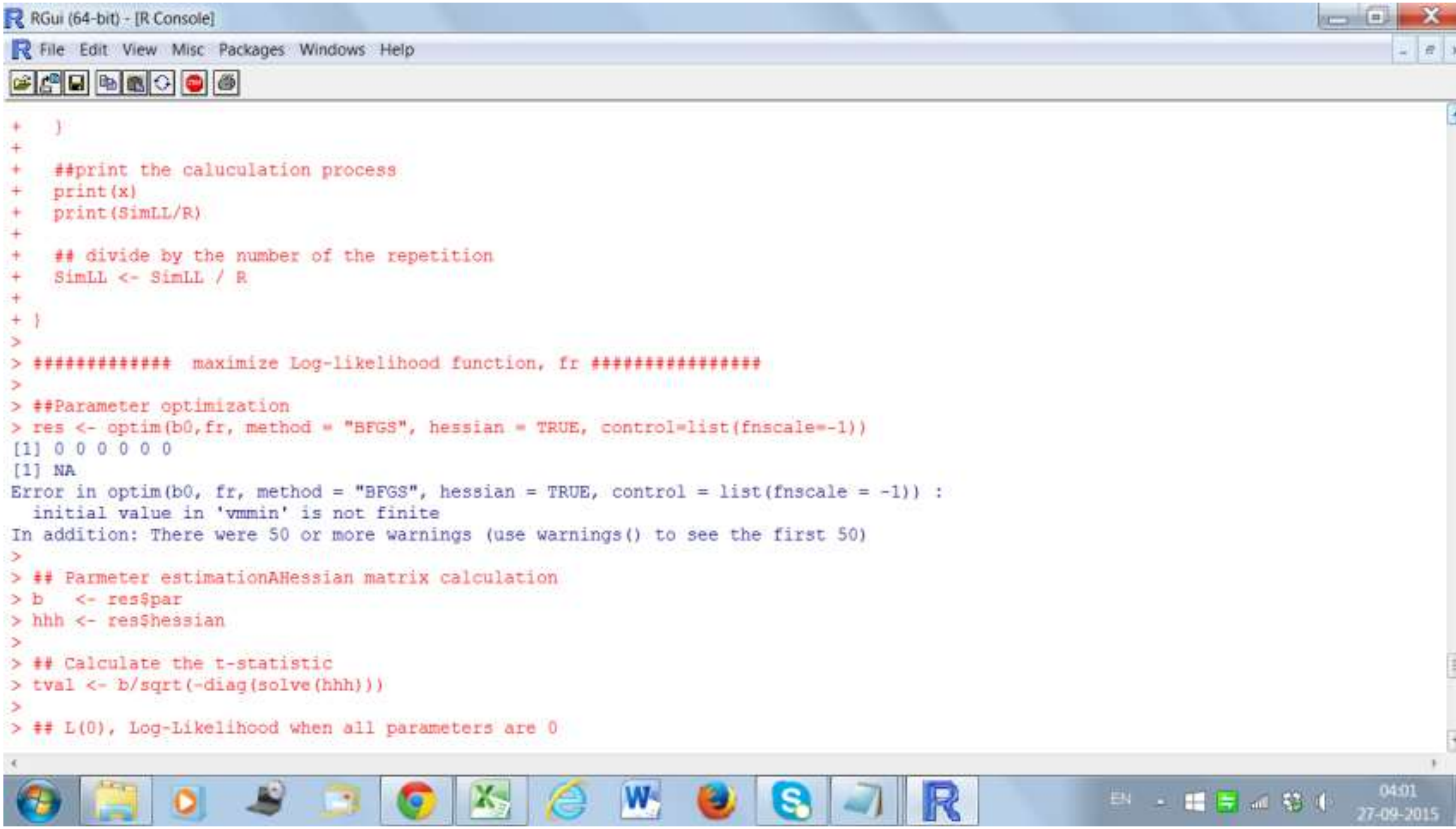
X4= mean Travel Time

X5= variance in TT

- Log likelihood value=-1300.548
- Parameters- -1.93,-1.85,-1.53,-10.62,0.085
- t-statistics= -10.8363935, -18.7976434, -15.7871061, -21.1553319, 0.2435727

(If the values are between -1.96 to 1.96, it is considered to be significant)

Mixed Logit Mode Error



Mixed logit Model(without Age segmentation)

- X1 or ASC 1=Train
- X2or ASC2=Bus
- X3 or ASC3=Car
- X4or ASC4=Bike

Variables considered for the analysis

X5= mean Travel Time

X6= variance in TT

X6=mean age

X8=variance in age

- Log likelihood value= -1276
- Parameters=1.16, -1.11, -0.97,-0.75,11.09,0.13,0.19,-0.01
- t-statistics= 6.48,-4.83,-5.33,-4.24,-21.06,0.37,4.25,-0.29

Mixed Logit Model

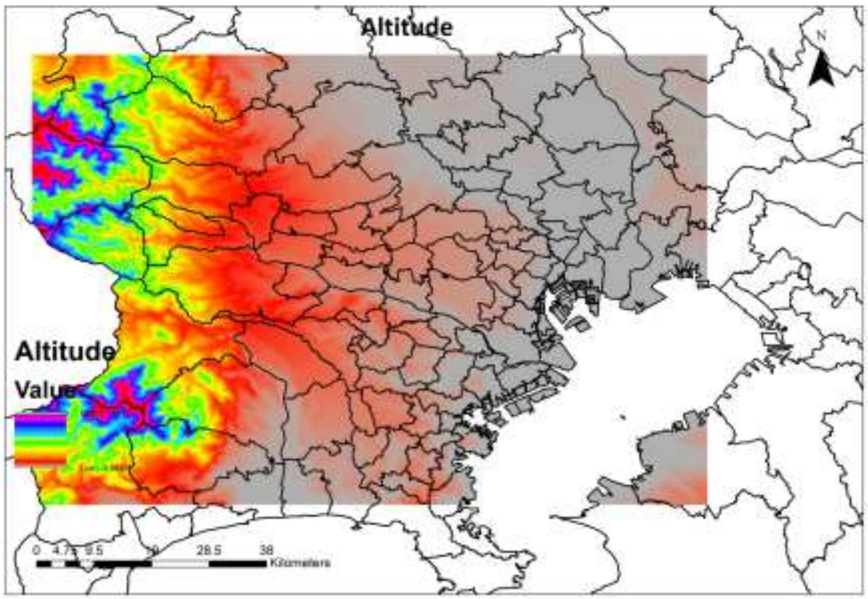
RGui (64-bit) - [R Console]

File Edit View Misc Packages Windows Help

```
[3,]  26.17438253  -0.79037477   132.6945923  2.280538e-01
[4,]   6.87250656   0.78896500   181.9389536  3.068333e+00
[5,]  -8.29316383   0.06467786   -28.7210833  1.099414e-02
[6,]   0.06467786  -8.29325433    -0.2633192 -2.507361e+01
[7,] -28.72108325  -0.26331918 -1712.8604233 -3.034560e+01
[8,]   0.01099414 -25.07361302   -30.3455996 -1.709821e+03

> ## L(0)
> print(L0)
[1] -2135.675
> ## LL
> print(LL)
[1] -1276.333
> ##rho-square
> print((L0-LL)/L0)
[1] 0.402375
> ## adjusted rho-square
> print((L0-(LL-length(b)))/L0)
[1] 0.3986291
> ##estimated parameter values
> print(b)
[1]   1.167047571  -1.114725834  -0.968422027  -0.748100331
[5] -11.088914999   0.132997882   0.191448906  -0.007237038
> ## t-statistic
> print(tval)
[1]   6.4774542  -4.8293026  -5.3296519  -4.2412200 -21.0611020
[6]   0.3742781   4.2599632  -0.2924898
>
> 
```

Elevation Map



The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{\frac{\left[n \sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j} \right)^2 \right]}{n-1}}} \tag{1}$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

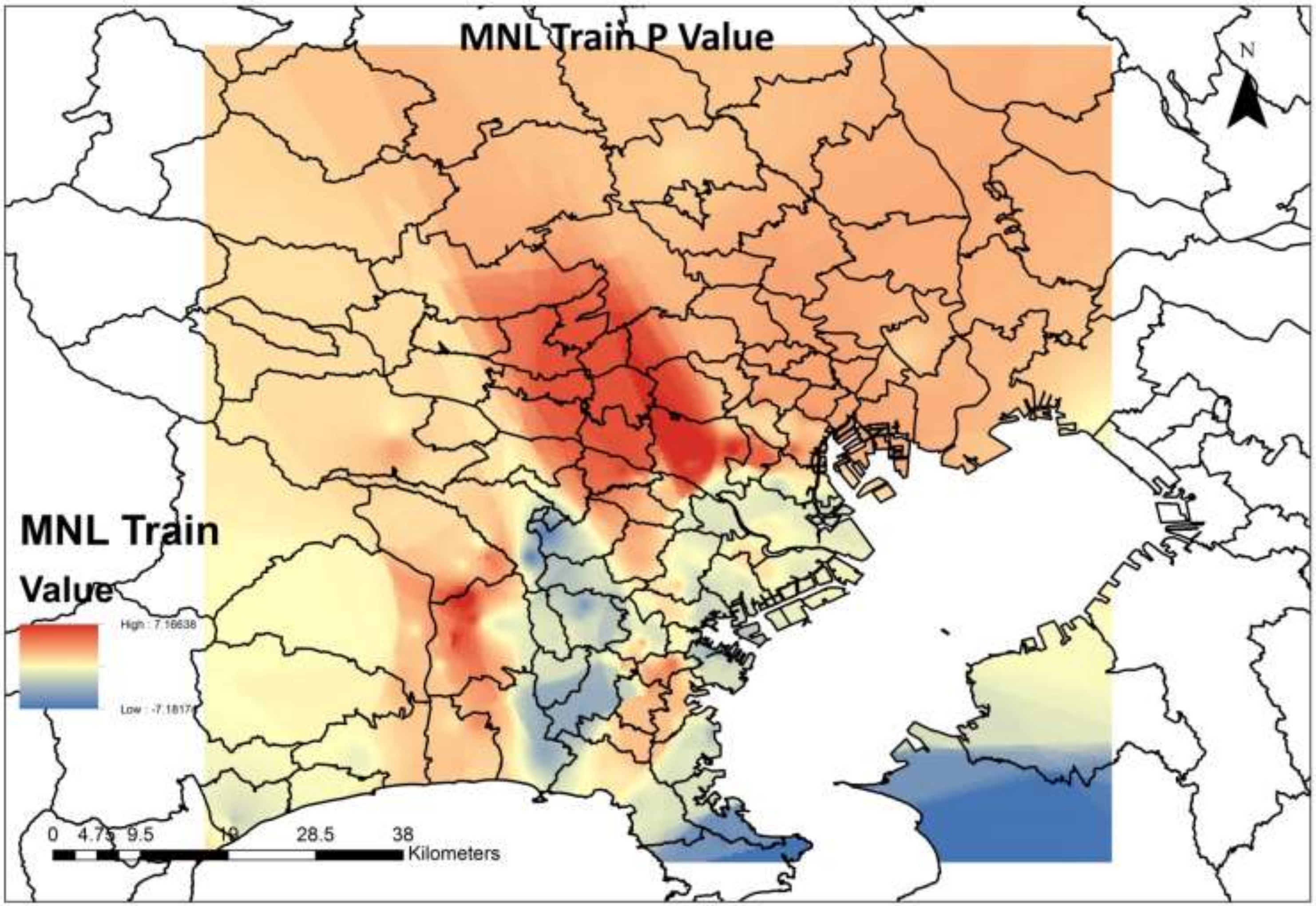
$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \tag{2}$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - \left(\bar{X}\right)^2} \tag{3}$$

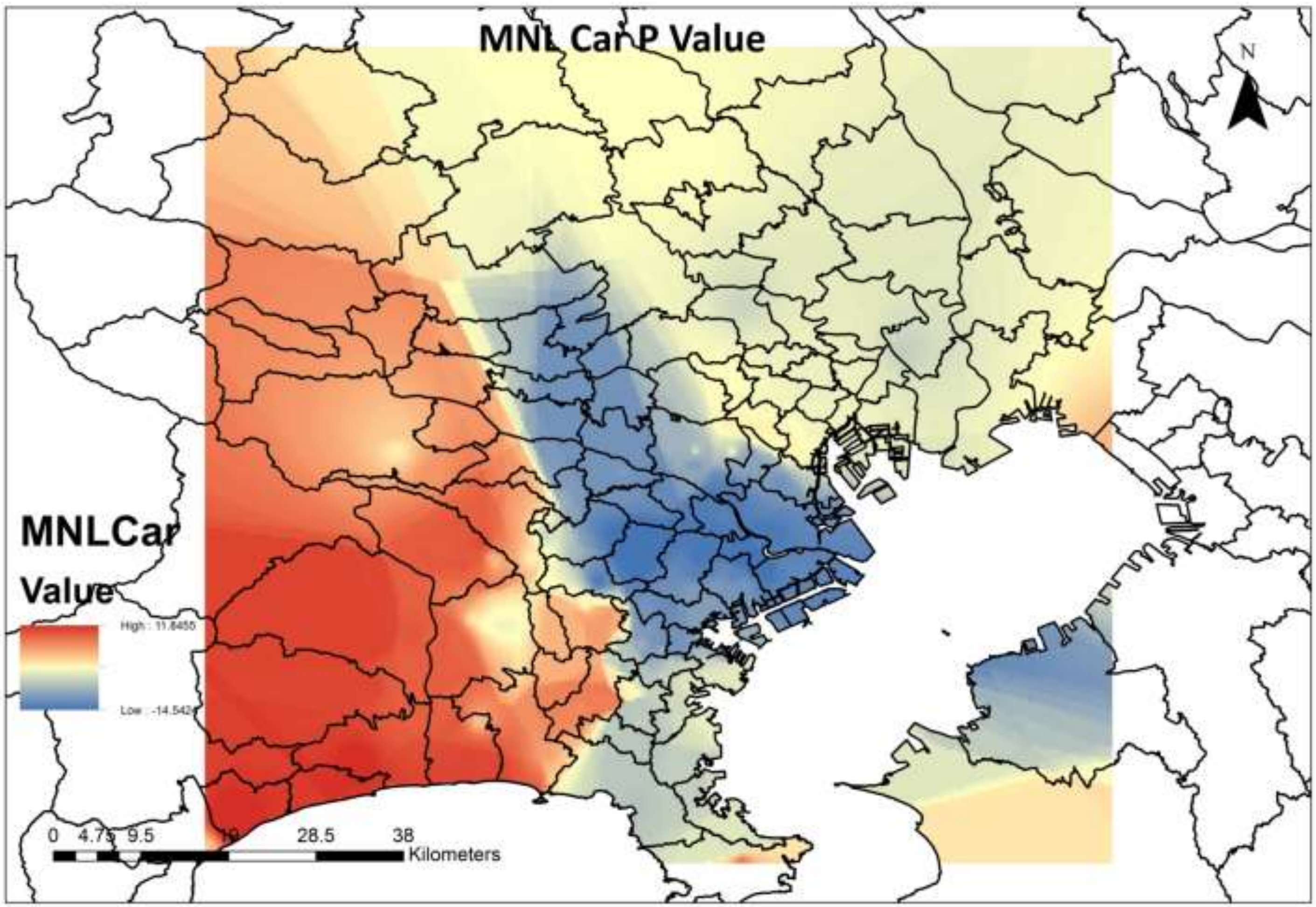
The G_i^* statistic is a z-score so no further calculations are required.

Source: Esri

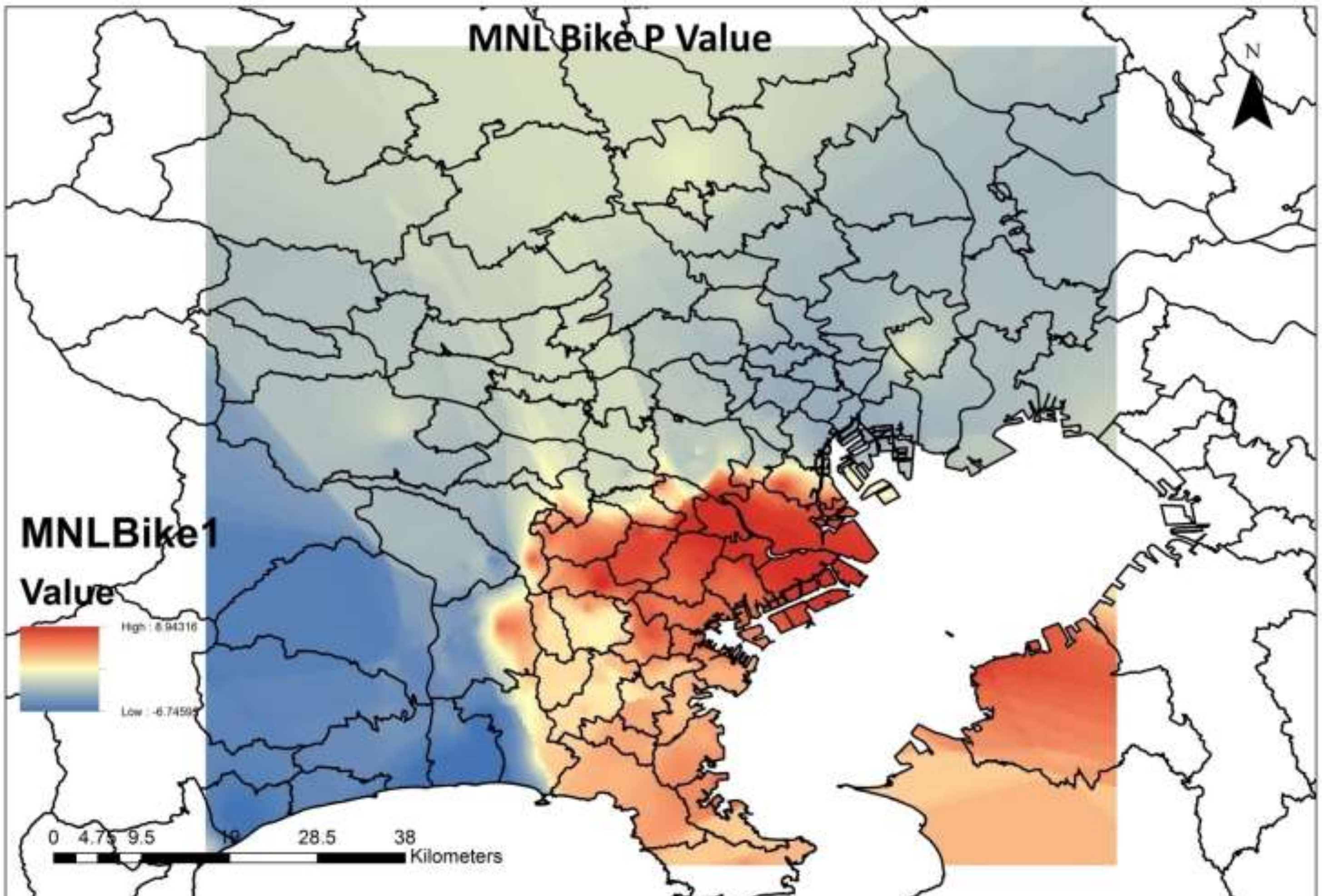
Spatial Distribution of probability of modal choice: Train



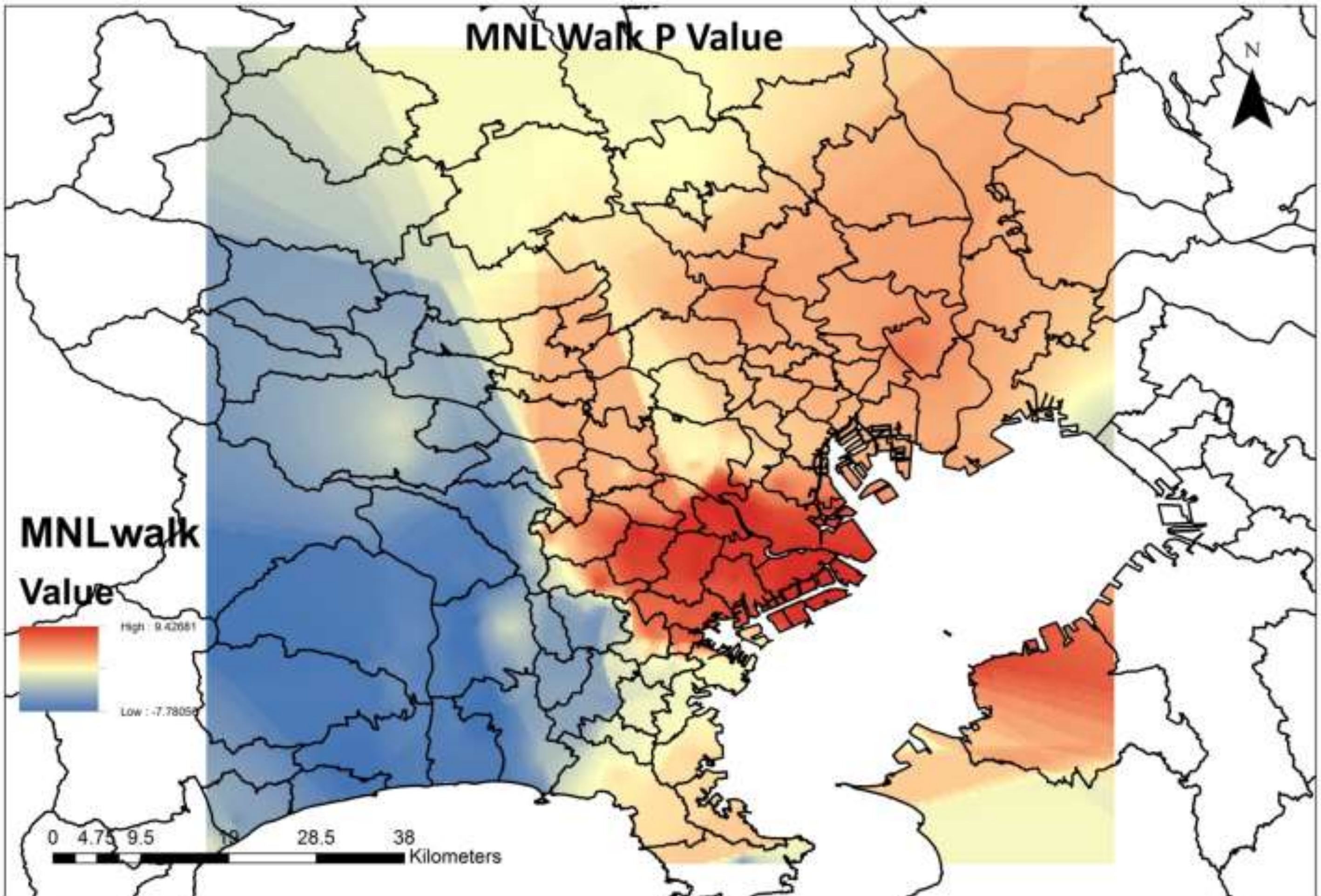
Spatial Distribution of probability of modal choice: Car



Spatial Distribution of probability of modal choice: Bike



Spatial Distribution of probability of modal choice: Walk



Policy Simulation

```
  K
            bike bus car TRAIN walk
  Bicycle     67   0  21    55   68
  Bus          1   0  34     1    5
  Car         49   0 326    72   65
  Rail         3  15  62   442    6
  Walk        16   0   4    18  192
 mode  direct elasticities  cross elasticities

bus -1.42                     .33
train -1.73                 .029

car    1.29                 3
bike    .32                  .94
walk       1.01              .53
```

Conclusion

- Mode choice is significantly affected by the age factor
- Spatial variation in P values across the Tokyo metropolitan region gives an insight into travel behavior across space

Thank You

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