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Route Choice Behavior of Bike Share Users in Toyosu

Nagoya University B

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NUTREND

Nagoya University
TRansport and
ENvironment Dynamics

Background

- Users: Popular among tourist
- Advantages:
 - Low cost: ~¥150/30min
 - Low maintenance cost
 - Environmentally friendly
- Disadvantages:
 - Must be returned to designated locations
 - May run out of battery



Background

- Tokyo is promoting the spread of bike share service.
- Users have increased in the recent years.

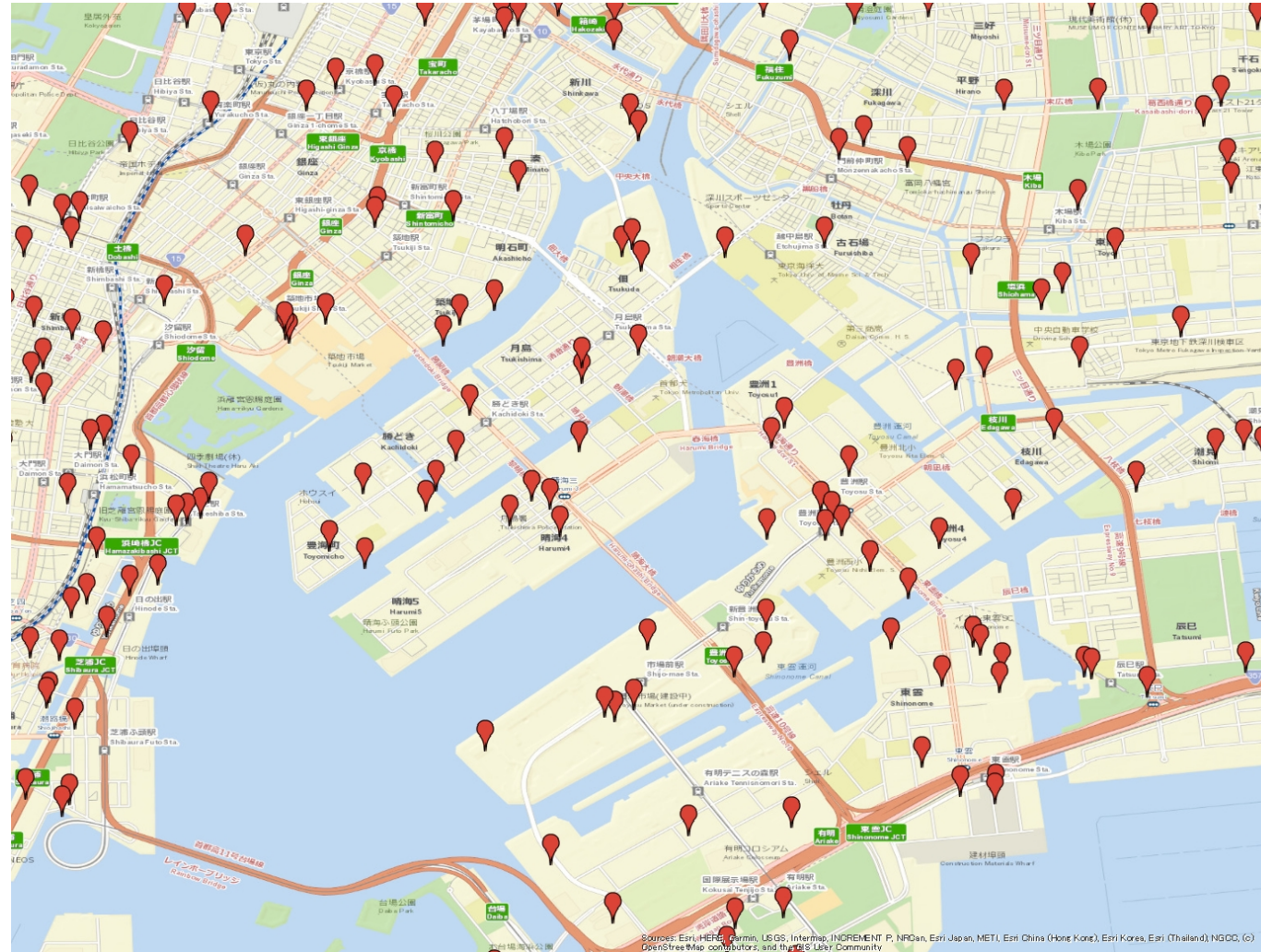


Municipalities with bike sharing service
(Tokyo Metropolitan Bureau of Environment)

Year	Annual Usage (10,000 times)
2011	4
2012	11
2013	35
2014	55
2015	100
2016	220
2017	470

Bike share usage
(NTT Docomo Bike Share)

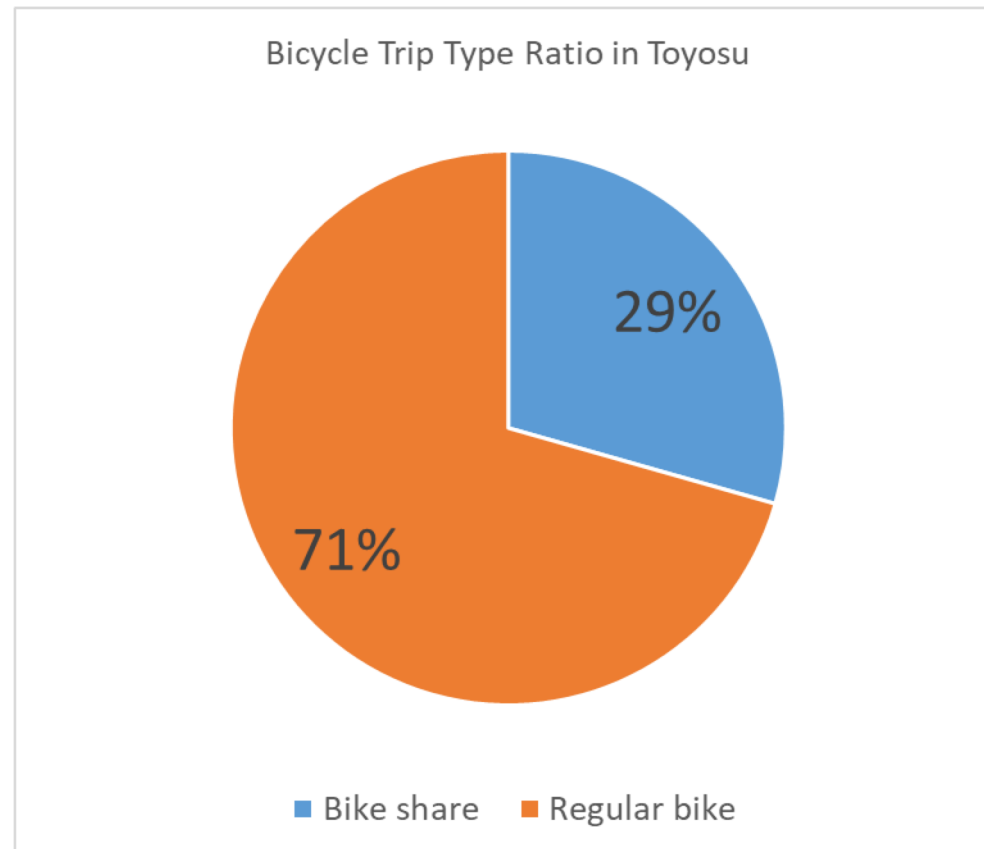
Bike Share Ports in Toyosu



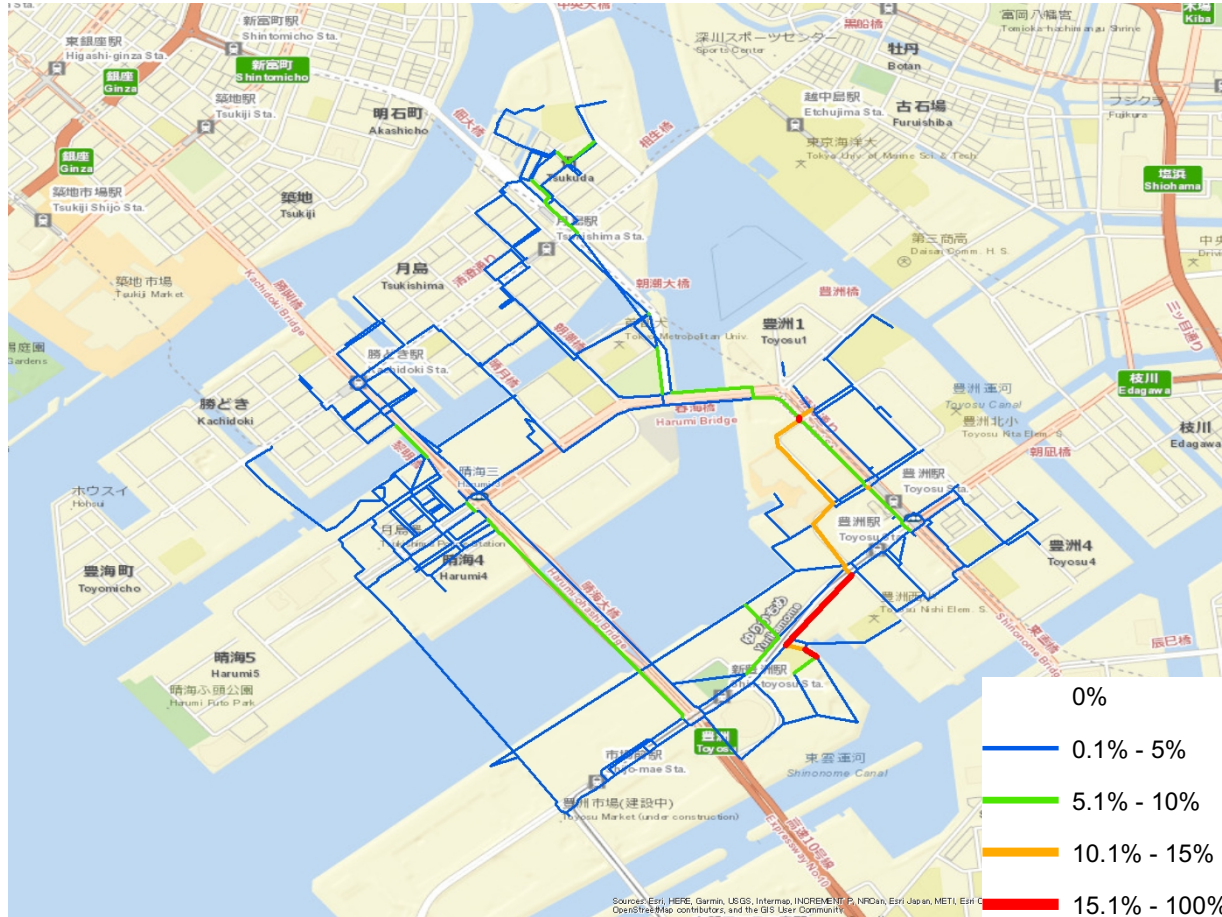
Bike share ports in Toyosu
(NTT Docomo Bike Share)

Bike Share Usage in Toyosu

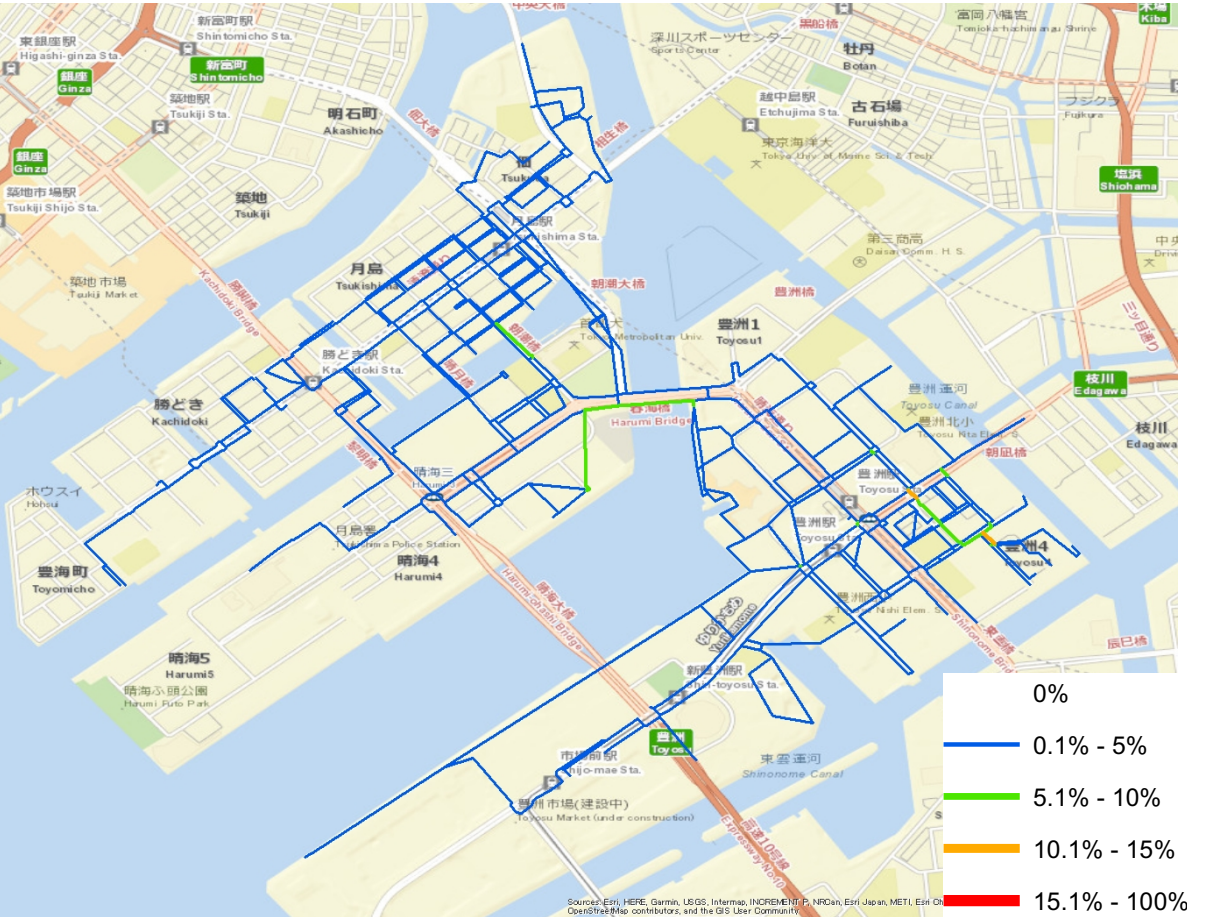
- 2019 Toyosu PP data
- High usage rate of bike share



Routes



Bike share route

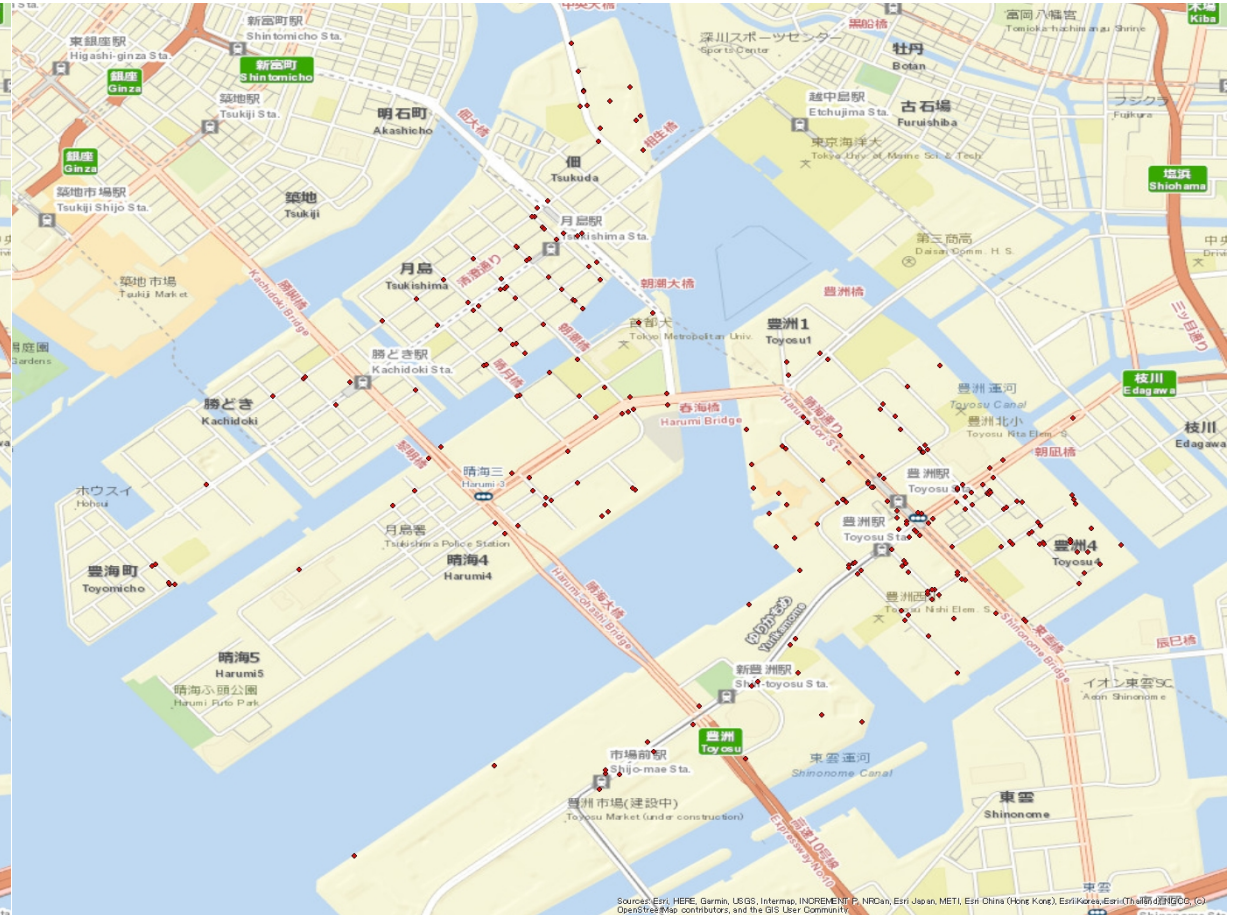


Regular bike routes

Origin/Destination



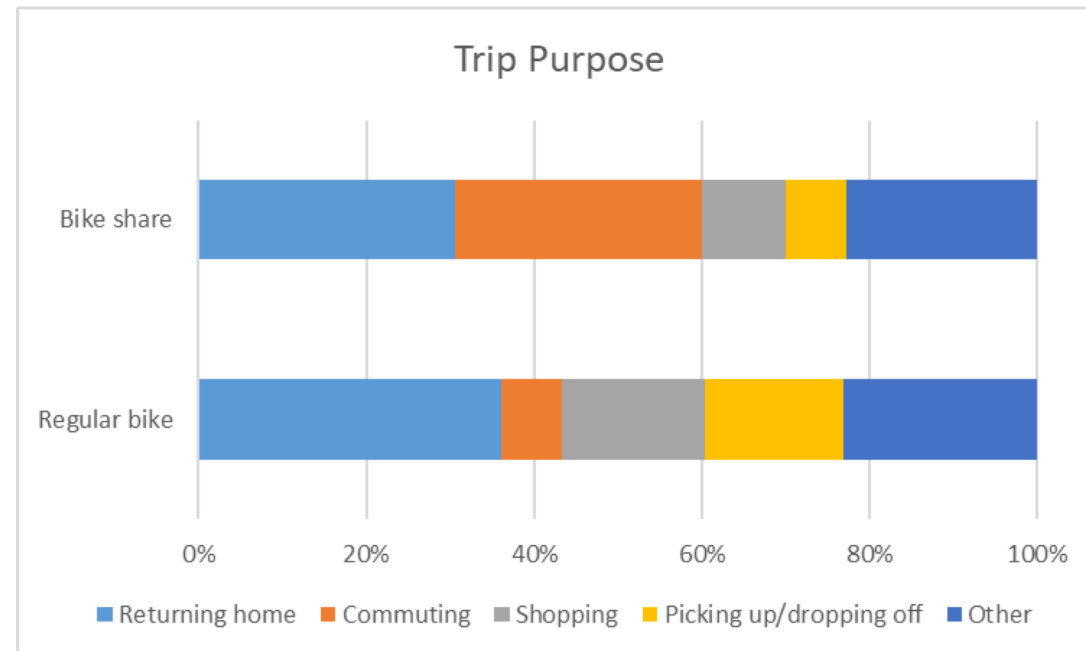
Bike share OD



Regular bike OD

Trip purpose

- Participants are limited to those who live/work in Toyosu.
 - Data of tourists is not available.
- Bike share is popular for commuters.
- Regular bike is used by local residents for daily activities.



Model

- Goal: Clarify differences in route choice behavior between bike share users and regular cyclists.
- Cross nested logit (CNL) model
 - Alleviate route overlap problem caused by IIA property in MNL.

$$P(n) = \sum_m P(n|m) \cdot P(m) = \sum_m \frac{(\alpha_{mn} e^{V_n})^{\psi\mu}}{\sum_l (\alpha_{ml} e^{V_l})^{\psi\mu}} \cdot \frac{\left(\sum_n (\alpha_{mn} e^{V_n})^{\psi\mu}\right)^\mu}{\sum_b \left(\sum_n (\alpha_{bn} e^{V_n})^{\psi\mu}\right)^\mu} \quad (1)$$

$$\alpha_{nm} = \left(\frac{L_m}{L_n}\right) \delta_{nm} : 0 \leq \alpha_{nm} \leq 1, \quad \sum_m \alpha_{nm} = 1, \quad \forall n \quad (2)$$

Model

$$V_n = \beta_1 \cdot D_n + \beta_2 \cdot CW_n + \beta_3 \cdot SW_n$$

where

D = distance in km

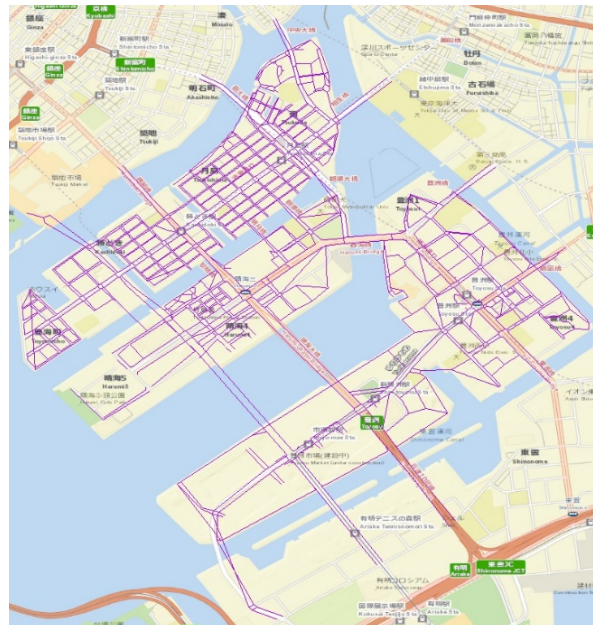
CW = number of crosswalks

SW = average sidewalk width level

Actual width	Width level
No sidewalk	0
Less than 2m	1
2m ~ 3.5m	2
3.5m ~ 4.5m	3
4.5m ~	4

Generation of Choice Set

- Choice sets are generated using k shortest path routing.
 - 25 shortest paths are used.
- Link lengths greater than 400m are divided by 100 (Kikuchi et al 2018).
 - This allows for the choice set to be more diverse.



Bike Network in Toyosu

Estimation Result

Bike share:

Variable	Coefficient estimate	t statistic
distance in km	0.429	3.93**
number of crosswalks	-0.0256	-2.68**
average sidewalk width level	0.0344	1.51
scale parameter	0.0194	3.36**
N	156	
ρ^2	0.316	
$\bar{\rho}^2$	0.308	

Regular bike:

Variable	Coefficient estimate	t statistic
distance in km	-1.46	-3.33**
number of crosswalks	-0.0151	-1.34
average sidewalk width level	0.165	2.41**
scale parameter	0.0676	5.66**
N	363	
ρ^2	0.284	
$\bar{\rho}^2$	0.280	

Estimation Result

- Regular cyclists prefer short routes with wide sidewalks.
- Possible reason:
 - People who use regular bikes for daily activities, such as picking up/dropping off children, prioritize efficient time use and safety.

Regular bike:

Variable	Coefficient estimate	t statistic
distance in km	-1.46	-3.33**
number of crosswalks	-0.0151	-1.34
average sidewalk width level	0.165	2.41**
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- Bike share users prefer longer routes with less crossings.
- Possible reasons:
 - They want to take advantage of the full 30 min rental time.
 - e.g. For getting some exercise after work
 - Distance is not a concern because the bikes are electric.

Policy

- Toyosu is going through urban renewal.
 - Transportation demand is expected to change greatly before/during/after Tokyo Olympics.
- This model could be used to predict routes of bike share users when new bike ports and POI are implemented.
 - Such information could be used to enhance cycling infrastructure, such a bike lanes and street signs.
- More research is needed to analyze behavior of tourists using bike share services.



Conclusion

- CNL model was used to model route choice behavior of bike share users and regular cyclists.
- Differences in route choice behavior were revealed.
 - Regular cyclists select routes suited for efficient use of time and safety.
 - Bike share users select routes suitable for cycling as an activity.
- Understanding the route choice behavior of bike share users could help improve cycling infrastructure as Toyosu goes through urban renewal.

Reference

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