

Study of policies to increase the number of community cycle users

Tokyo institute of Technology Seo lab.

Yuki ISHII

Shunnosuke KOSEKI

Hiromichi EGUMA

Yukihiro KOJIMA

Kazuma HAYASHI

Background: Policy of Koto ward

□ Koto Ward Community Cycle Promotion District

Goals

- Improvement of town circulation and creation of liveliness
- Increase in the number of bicycle users to reduce environmental impact

Efforts to achieve goals

- To achieve this, promoting short-distance travel by bicycle is an effective way to do so.
- In this case, **community bicycles** can help expand bicycle use.

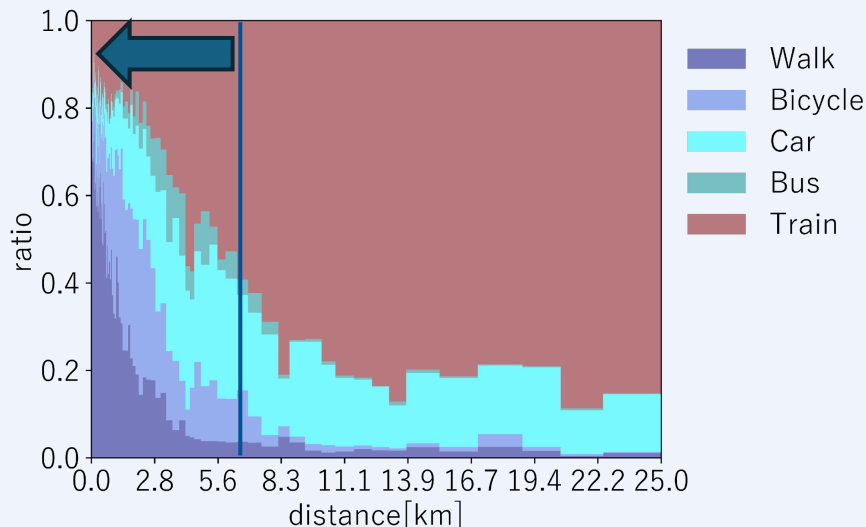


Background: Policy of Koto ward

□ Use data

- PP data of Toyosu (2019–2021)
- Capacity of cycle ports installed in the Toyosu area

□ Basic tabulation



- This figure represents the percentage of transportation sharing by distance.
- We focused on the area below 6 kilometers.
- The proportion of car users increases and the proportion of bicycle users decreases when the distance exceeds 6 km.

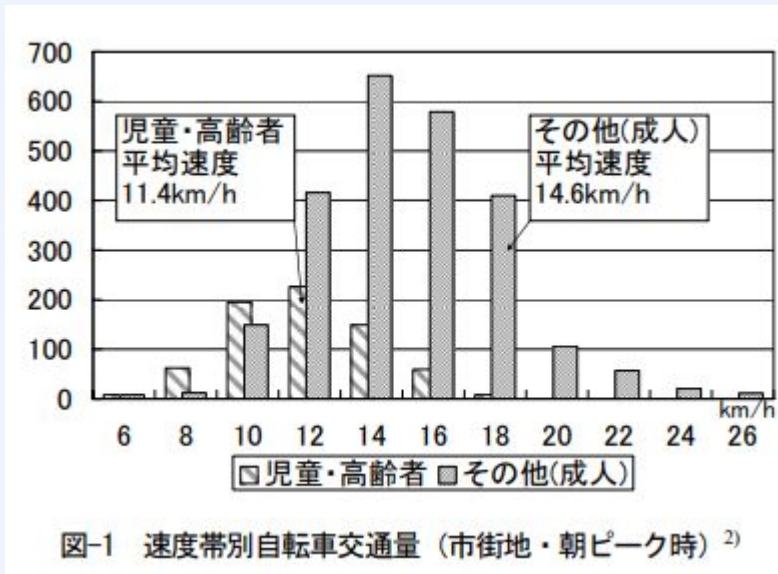
- We examine whether community bicycle ports should be developed as a small number of high-capacity stations or as many small-capacity stations.

Definition of short trip

- Bicycle speed is about 15 km/h. (10km/h)
 (https://www.jice.or.jp/cms/kokudo/pdf/reports/act/20th/nikkan2009_05.pdf)
- The average distance bicyclists travel per week is 20.5 km, which translates to 2.9 km per day.

(<https://www8.cao.go.jp/koutu/chou-ken/h22/houkoku.html>)

→ Many people do not choose to bike on trips that take more than 10 minutes.



Column1	通勤	通学	業務	習い事 通塾	レジャー 健康づくり	子どもの 送り迎え	買い物	通院	友人・知 人宅訪問	その他	全目的 1週間合 計
0.1~0.9km	0.078	0.107	0.08	0.093	0.031	0.105	0.097	0.144	0	0	0.034
1~1.9km	0.242	0.321	0.312	0.373	0.136	0.382	0.347	0.368	0.547	0.524	0.097
2~2.9km	0.164	0.179	0.208	0.161	0.131	0.171	0.24	0.206	0.236	0.232	0.095
3~3.9km	0.12	0.095	0.088	0.127	0.086	0.079	0.134	0.086	0.093	0.061	0.053
4~4.9km	0.095	0.012	0.024	0.042	0.064	0.039	0.057	0.086	0.018	0.012	0.053
5~5.9km	0.114	0.119	0.112	0.085	0.157	0.158	0.095	0.053	0.089	0.085	0.045
6~6.9km	0.028	0.024	0.008	0.025	0.052	0	0.01	0.005	0.013	0.024	0.049
7~7.9km	0.025	0.012	0.008	0	0.017	0.026	0.003	0.01	0.004	0.061	0.032
8~8.9km	0.036	0.048	0.008	0.025	0.019	0	0.004	0.01	0	0	0.04
9~9.9km	0.006	0	0	0	0.002	0	0	0	0	0	0.027
10km以上	0.092	0.083	0.152	0.068	0.305	0.039	0.014	0.033	0	0	0.476
1回あたり 平均距離	3.7	3.2	3.8	3	8.3	2.6	2.3	2.4	3.1	1.9	20.5

Proposed model

- We considered the following factors and constructed a transportation mode choice model for unlinked trips including walking, bicycle, share cycle, car, bus, and train.

Utility function

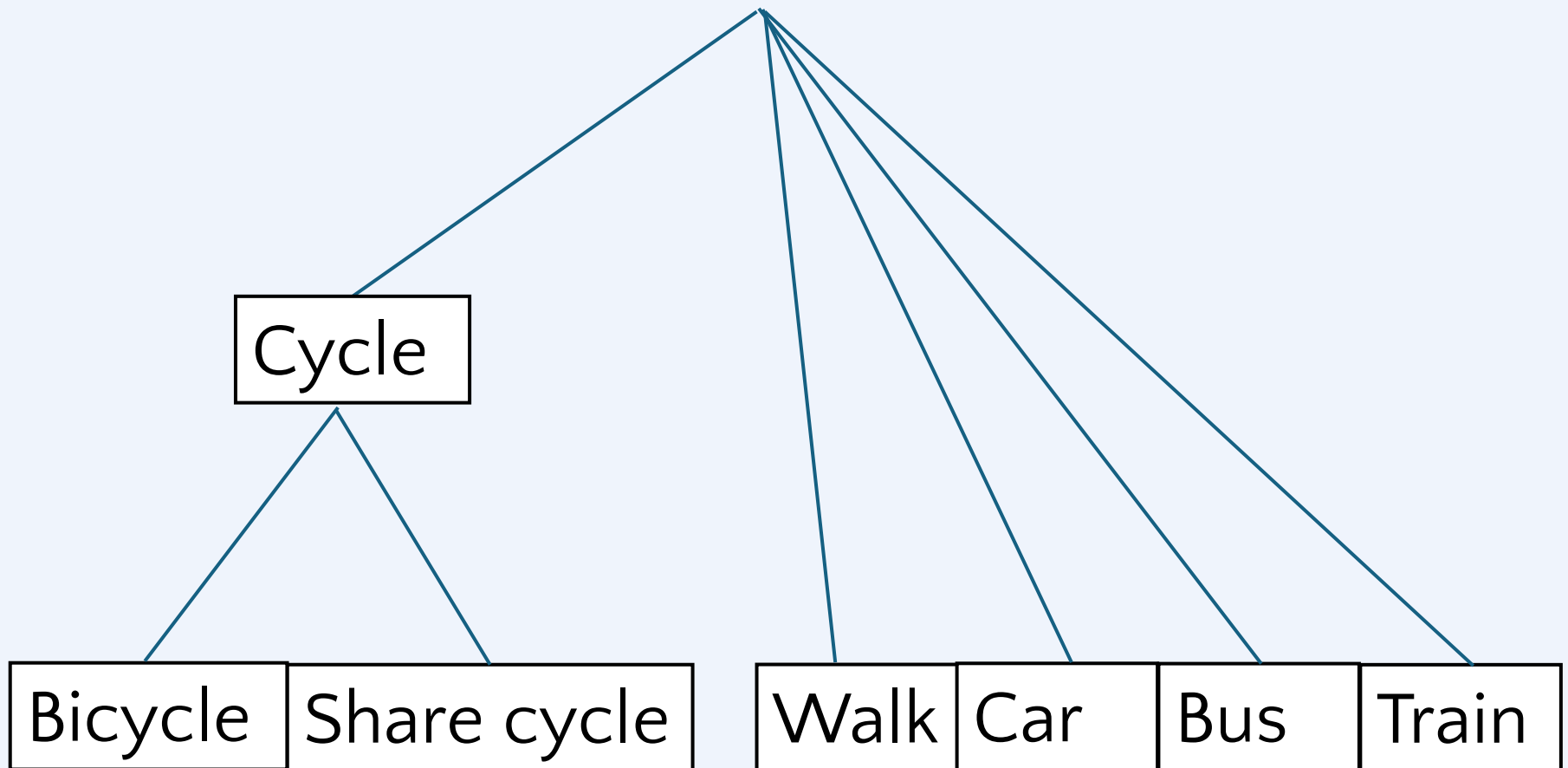
$$\begin{aligned}
 V_{i,j} &= \frac{\beta_{t_i} t_{i,j}}{\text{travel time}} + \frac{\beta_c c_{i,j}}{\text{cost}} + \frac{\beta_{tr_{i,j}} N_{i,j}}{\text{number of transfers}} + \frac{\beta_{age_{i,j}} a_{i,j}}{\text{age}} + \frac{\beta_{inc_i} inc_j}{\text{income}} + \frac{\beta_{s_i} \delta_{s_j, \sigma}}{\text{sex}} \\
 &+ \frac{\beta_{w_i} (1 - \delta_{w_j, sunny})}{\text{weather}} + \frac{\beta_{tmp_i} tmp_j}{\text{temperature}} + \frac{\beta_{joint_i} joint_j}{\text{continuity with public transportation}} + \frac{\beta_{IG} IG_{i,j}}{\text{egress distance}} + \frac{\beta_{AC} AC_{i,j}}{\text{access distance}} \\
 &+ \frac{\beta_P P_j}{\text{probability of bicycle sharing point being unavailable}} + ASC_i
 \end{aligned}$$

$$i \in \{Walk, Bicycle, Share cycle, Bus, Car, Train\}$$

probability of
bicycle sharing
point being
unavailable

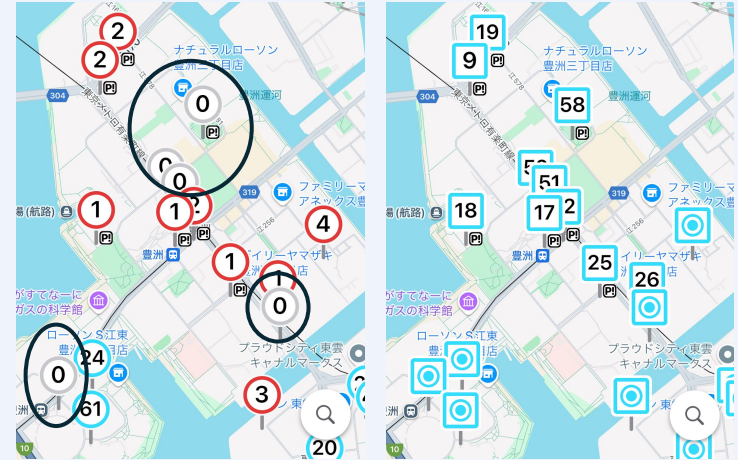
Proposed model

□ We solved a **nested logit model** with cycles as a single nest.

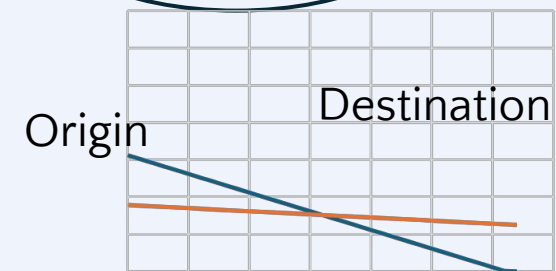


Uncertainty in community cycling

- Users are less willing to use a community cycle if there are many ports that are likely to be unavailable.
- Port capacity is also closely linked to the likelihood of not being able to borrow or return a bike.
- We calculated the probability that the number of bicycles at each port will be between 1 and the capacity (i.e., neither completely empty nor fully occupied) using the Poisson distribution.



Unavailable port
(for borrowing)



Outcome

Name	Value	t-test	Name	Value	t-test	Name	Value	t-test
ASC_BIKE	-5.86	-6.74**	B_AGE_BIKE[10 age]	0.34	3.63**	B_TEMP_BIKE[°C]	0.10	6.90**
ASC_BUS	-1.19	-2.77**	B_AGE_BUS[10 age]	0.26	3.28**	B_TEMP_BUS[°C]	-0.01	-1.34
ASC_SHARE	3.01	12.40**	B_AGE_SHARE[10 age]	-0.35	-17.90**	B_TEMP_SHARE[°C]	0.01	2.97**
ASC_TRAIN	2.31	8.81**	B_AGE_TRAIN[10 age]	-0.37	-10.20**	B_TEMP_TRAIN[°C]	0.00	0.87
ASC_WALK	5.22	42.80**	B_AGE_WALK[10 age]	-0.21	-11.10**	B_TEMP_WALK[°C]	0.00	-1.55
B_TIME_BIKE[s]	-12.30	-22.80**	B_INCOM_BIKE	0.36	3.95**	B_WEATHER_BIKE	0.28	1.73
B_TIME_BUS[s]	-8.27	-15.30**	B_INCOM_BUS	-0.15	-2.35*	B_WEATHER_BUS	0.11	0.88
B_TIME_CAR[s]	-8.72	-15.60**	B_INCOM_SHARE	-0.40	-21.30**	B_WEATHER_SHARE	-0.41	-9.72**
B_TIME_TRAIN[s]	-8.66	-23.80**	B_INCOM_TRAIN	-0.11	-3.09**	B_WEATHER_TRAIN	-0.07	-0.99
B_TIME_WALK[s]	-8.18	-37.90**	B_INCOM_WALK	-0.36	-20.00**	B_WEATHER_WALK	-0.16	-4.04**
B_COST[JPY]	0.01	6.32**	B_SEX_BIKE	-2.80	-11.80**	MU	1.00	24.00**
B_AC[m]	0.00	-0.14	B_SEX_BUS	-1.06	-8.07**	Sample size		37422
B_IG[m]	0.00	-1.74	B_SEX_SHARE	-0.54	-12.10**	Int LL		-49382.45
B_NORIKAE[times]	-1.76	-7.67**	B_SEX_TRAIN	-0.69	-9.06**	final LL		-30631.84
B_SETUZOKU_BIKE	1.29	5.52**	B_SEX_WALK	-0.86	-20.20**			
B_SETUZOKU_BUS	1.99	14.80**						
B_SETUZOKU_SHARE	0.61	7.64**						
B_SETUZOKU_WALK	1.59	19.50**						
B_PORT_SHARE	-2.84	-3.59**						

Policy proposals

- It was statistically shown that uncertainty about port availability is an obstacle to promoting bicycle rental use. $(\beta_{IG}, \beta_{AC}, \beta_p)$
- On the other hand, access to and egress from ports are not statistically significant. (β_{IG}, β_{AC})
- This shows a demand for the development of large-capacity ports. (β_p)
- The results show that a 1% increase in port availability equals a 3.57 JPY reduction in travel costs. (β_p/β_c)

It needs to be simulated the increase in cyclists when port capacity is assumed to be large enough.

Number of bicycle trip

Simulation result

- In the current situation
 - 5660 trip/day
 - In the enough capacity situation
 - 7954 trip/day
- Bicycle trips increased by 1.4 times.

Concrete policy

- Koto Ward leases land to ports free of charge.
 - A policy of gradually increasing the capacity of ports with high levels of unavailability is effective.

Summary

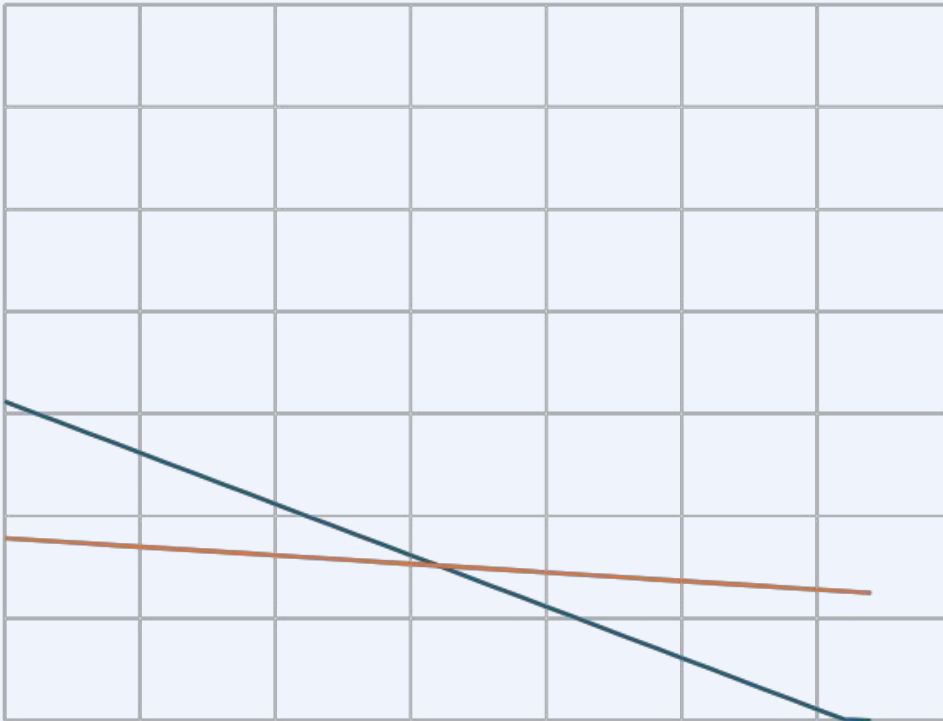
- We focused on community bicycles.
- The access and egress times to the port and the possibility of not being able to rent or borrow bicycles at the port were considered to influence the choice of community bicycles.
- It was estimated that the possibility of not being able to rent or borrow had a larger impact on utility than access and egress times.
- These results indicate that it is more effective to install at a small number of port with a large capacity than to install many ports with a small capacity.

References

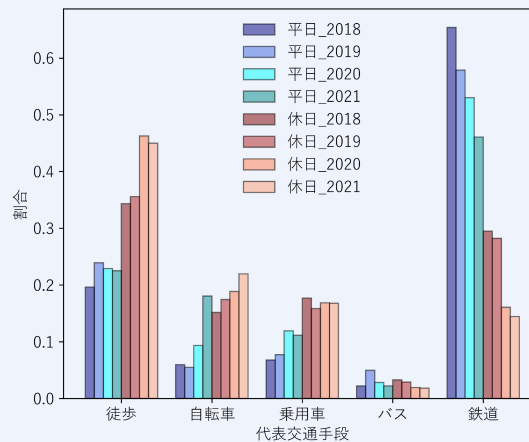
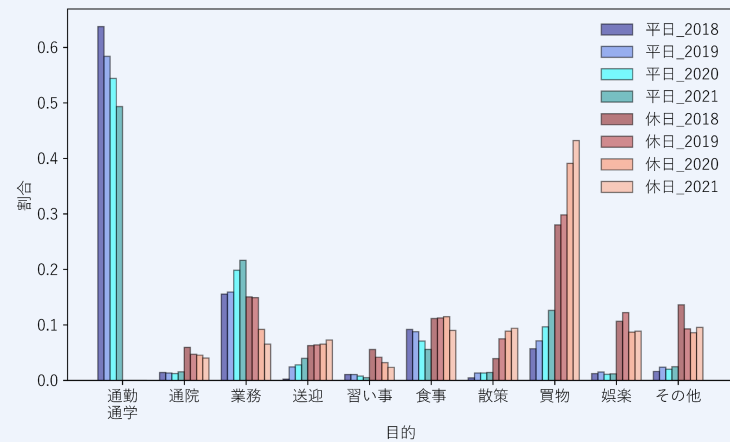
1. 江東区コミュニティサイクル推進地区整備方針
<https://www.city.koto.lg.jp/392201/machizukuri/toshi/jigyo/documents/tosisaiseiseibi202302.pdf>
2. 日本の自転車交通の現状と改善への取り組み
https://www.jice.or.jp/cms/kokudo/pdf/reports/act/20th/nikkan2009_05.pdf
3. 平成22年度自転車交通の総合的な安全性向上策に関する調査報告書
<https://www8.cao.go.jp/koutu/chou-ken/h22/houkokou.html>

Appendix

Poisson distribution



基礎集計



- 豊洲のデータを用いる.
- 休日には通勤・通学を行わず、行動基準が変化すると考えられる.
- 新型コロナウイルスの影響で公共交通の利用が年次的に減っている.

目的

江東区は、まちの回遊性向上と賑わいの創出、環境負荷の低減を図るべく**自転車利用者の増加**を目指している。
実現のためにどんな政策が有効か豊洲のデータを用いて検討する。

モデルの方針

政策検討のために、ロジットモデルを用いて豊洲のPPデータを分析する。

効用関数では、所要時間や費用、個人属性、目的などを考慮する。
選択肢として、徒歩、自転車、乗用車、バス、鉄道類を検討している。