Assessing the travel behaviour pattern for work-based trips

Toyosu, Tokyo, Japan

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Team Members

Aditya Saxena (D-3)
Vipul Parmar (D-2)
Simran Choudhary (M-2)
Varun Phadke (M-2)
Soumyadeep Halder (M-2)

Indian Institute Of Technology Bombay

Introduction

- **Toyosu**, neighborhood in Tokyo City
- Characteristics: CBD, **Seafood Wholesale Market**, Transportation Hub, Commercial hub.
- Created on reclaimed land in 1937
- **Largest public market in Japan and the world-** Transactional volume of about **¥370 billion.**[1]

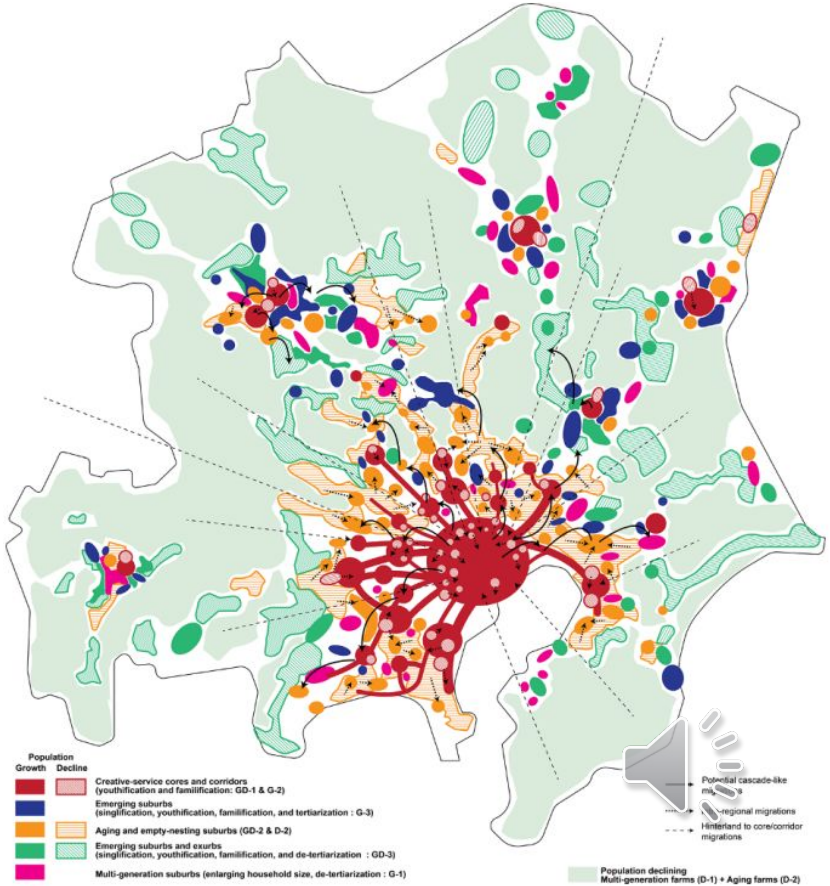


Image Source: Tateishi, 2023 [2]

Source: [1] Toyosu Market's New Initiative Aiming for a Sustainable and Bountiful Ocean (Part 1) - Seafood Legacy Times. (2023). https://times.seafoodlegacy.com/en/2022_new_year_special_1/

[2] Tateishi, E. (2023). The spatiotemporal socio-demography of the Tokyo capital region: a data-driven explorative approach. *Review of Regional Research*, *43*(3), 467–519. https://doi.org/10.1007/s10037-023-00198-1

Literature Review

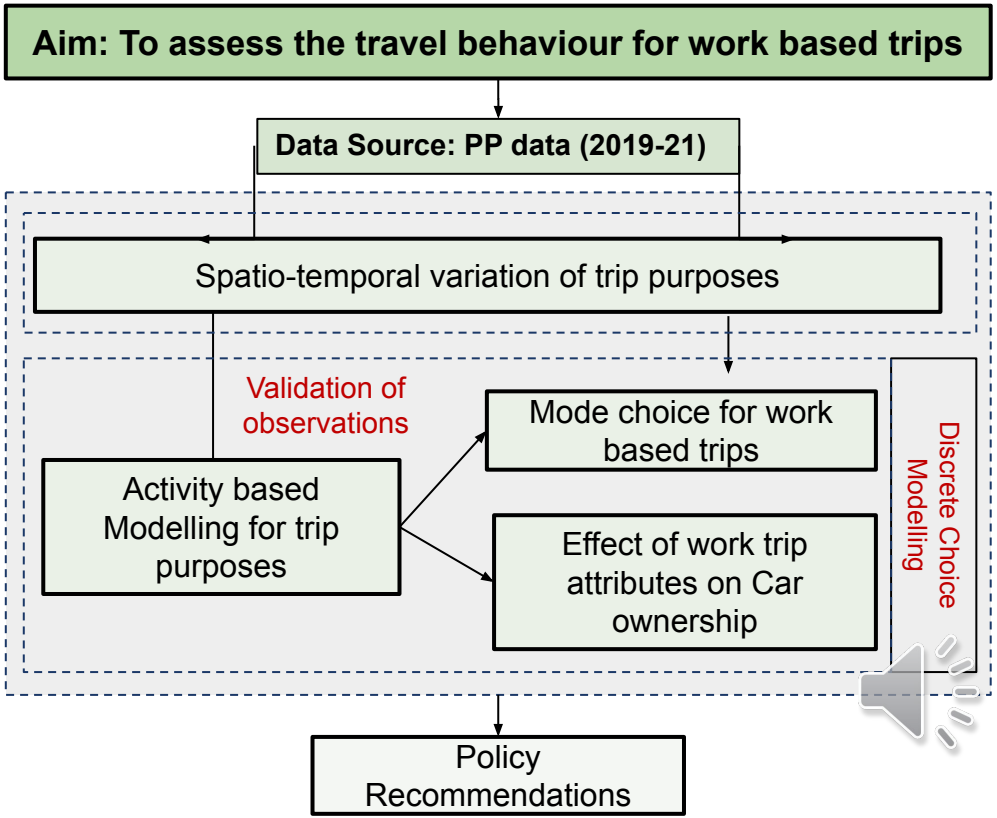
Sr. No.	Title	Author	Identified Parameters
1	Influences on commuter trip departure time decisions in Singapore	Chin, A. T. (1990).	Departure time decisions are more elastic than mode choice decisions with respect to changes in road conditions.
2	Does emphasis change in transportation mode choice affect workers' actual mode choice? Implications from Japan in the COVID-19 era	S. Ishibashi et al.	**Teleworking** also had a significant influence on the use of cars and active transport, but it was not as severe as for public transport
3	How can public transit get people out of their cars? An analysis of transit mode choice for commute trips in Los Angeles	Sandip Chakrabarti	Controlling for factors that may increase the likelihood of transit-dependence (i.e. no driving license, and more workers than cars in household), transit travel among car-owners is more prevalent in contexts where, on average, travel time savings via the alternate auto mode is relatively smaller and where transit service is frequent, reliable, and well-accessible (at both trip ends).

Research Approach

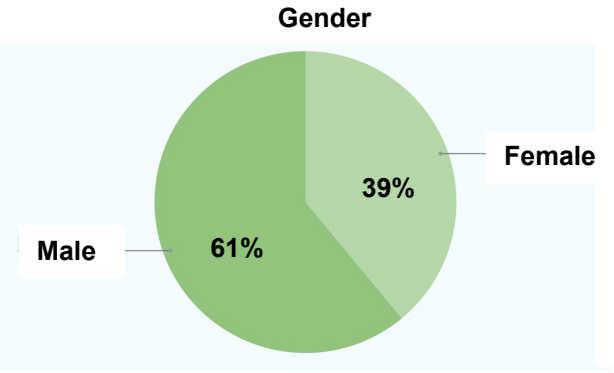
Focus Area- Work Based Trips

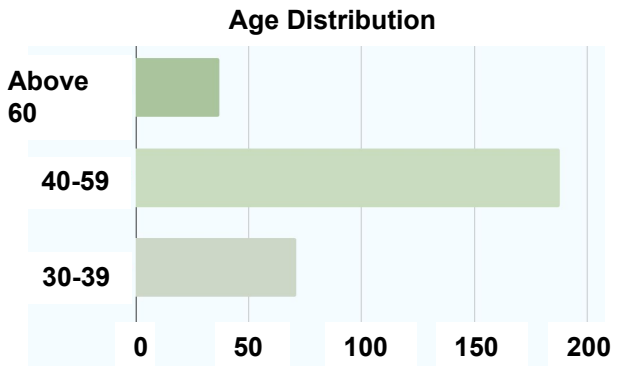
- Work trips are essential and economic in nature.
- The time value associated with work trips is higher compared to other types of travel.
- Nearly 30% of total trips in Toyosu are work based trip.(excluding returning trips)
- Travel behavior for work trips is important for optimizing economic planning, improving transportation systems, and enhancing overall productivity.

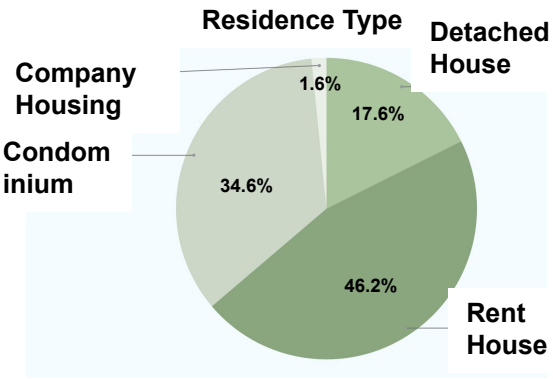
Approach

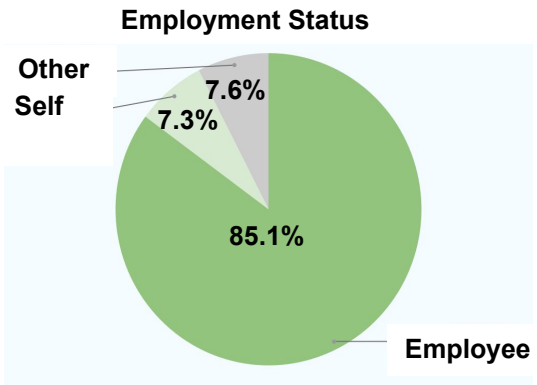


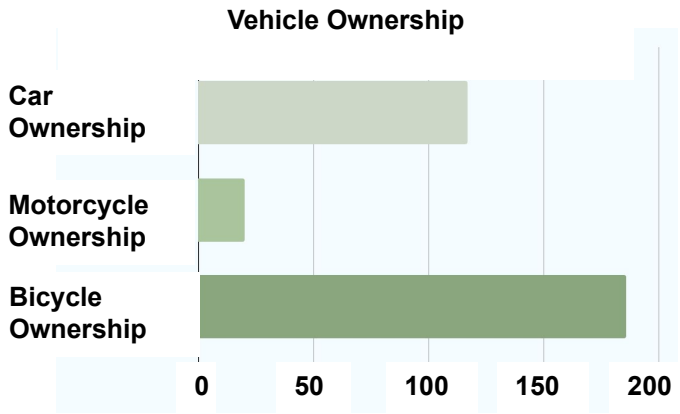
Toyosu- Descriptive Statistics

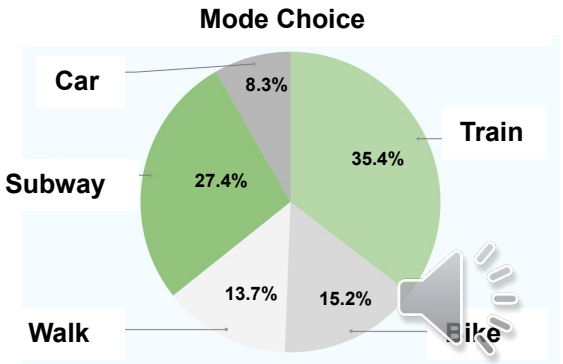












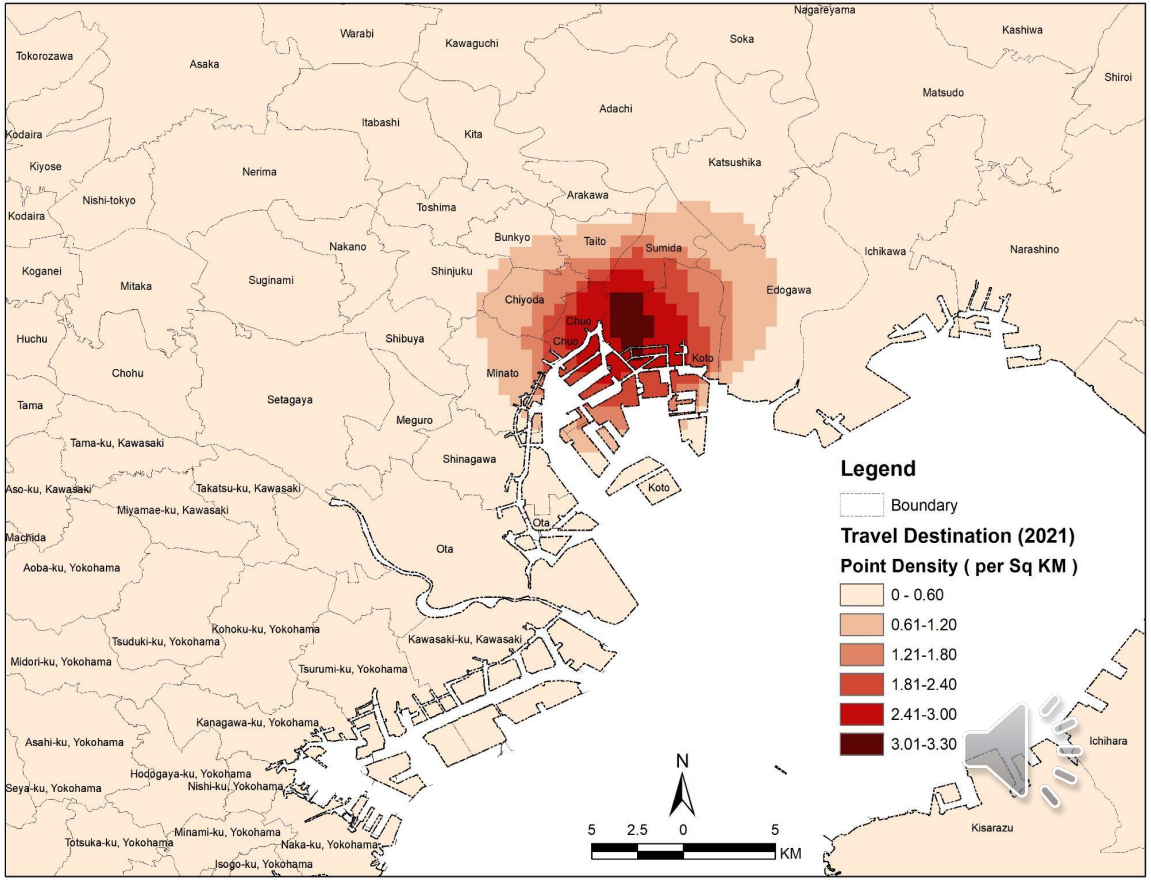
Data Source : PP Data

Spatio-temporal variation in the trip (2019-2021)

All Trips

Spatio-temporal variation in the trip pattern.

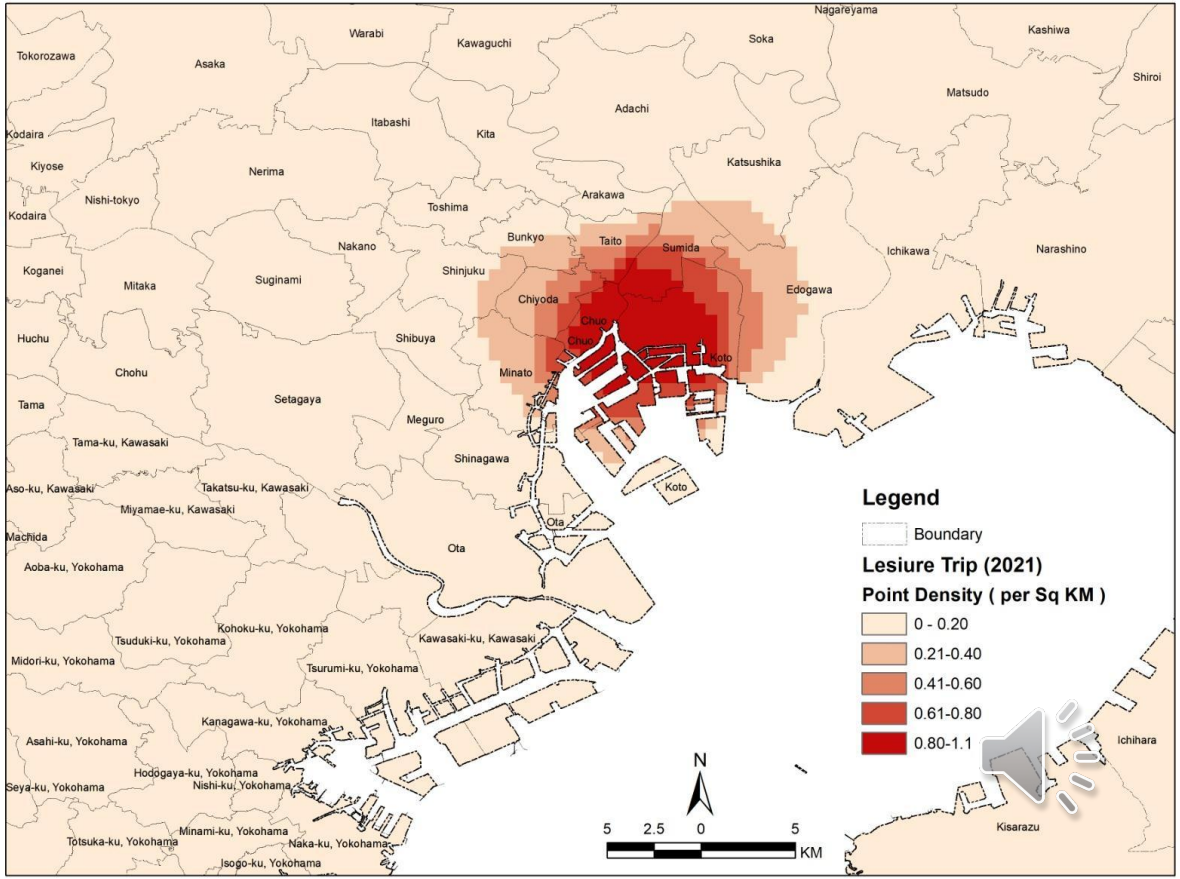
(2019-2021)



Leisure (Shopping and Other) Trips

Spatio-temporal variation in the leisure trips (shopping and others) pattern

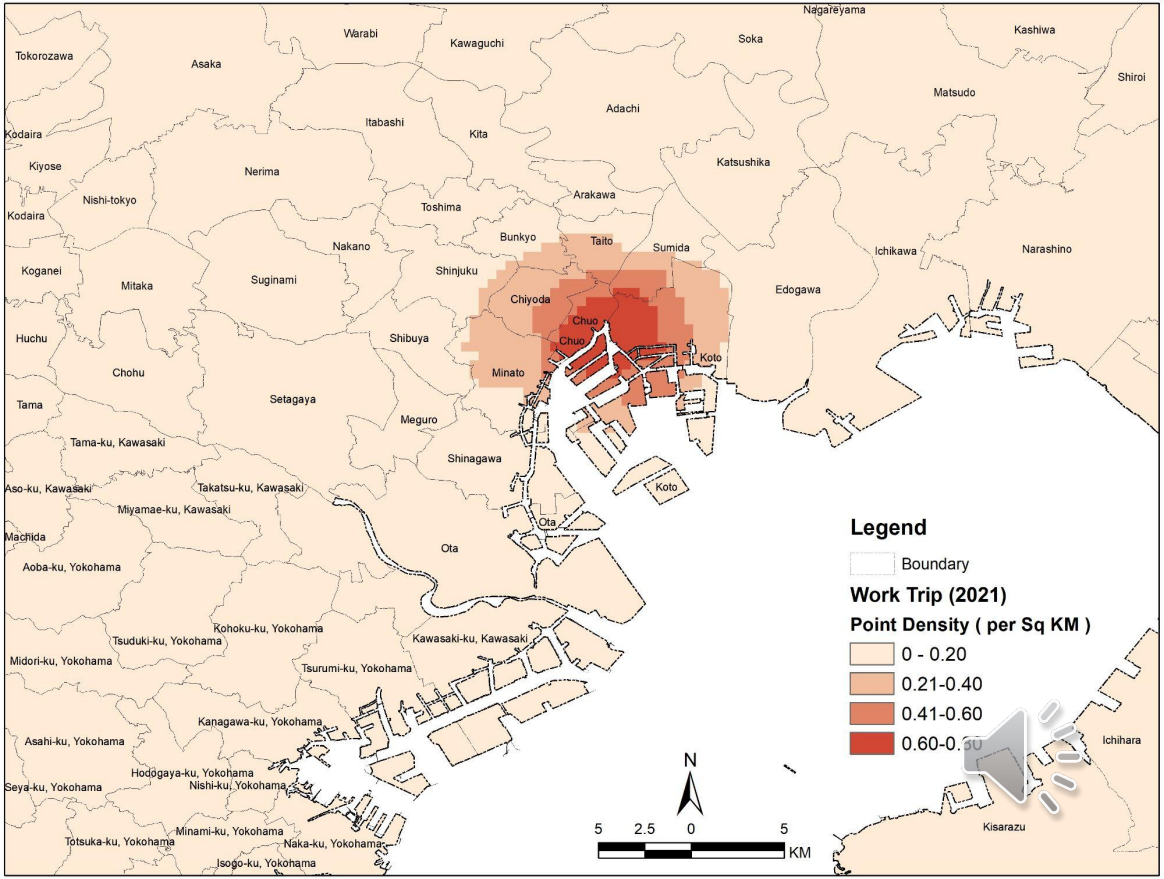
(2019-2021)



Work Based Trips

Spatio-temporal variation in the trip pattern.

(2019-2021)



Activity based Modelling for trip purposes

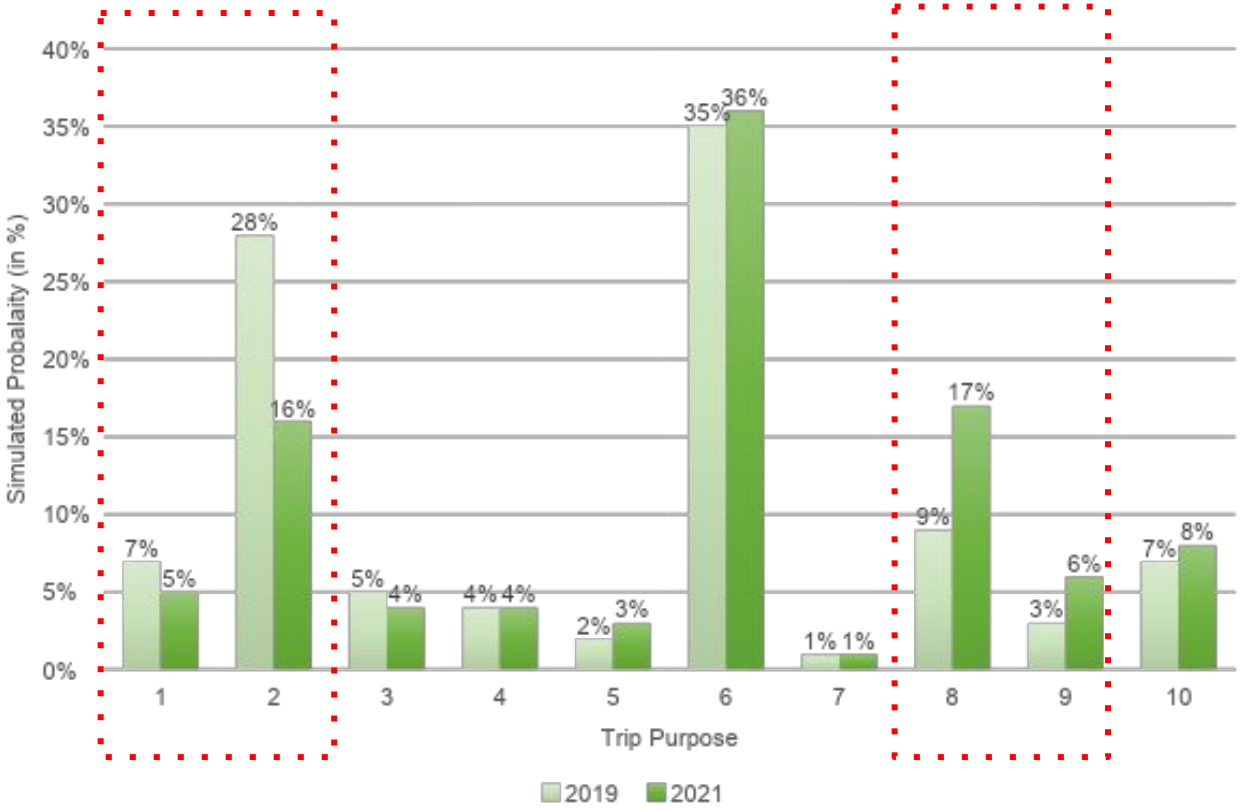
Activity based Modelling for trip purposes

Fractional Multinomial Logit Model (FMNL)

Model fit indices	2019	2021
LL(start)	-27800.35	-29595.3
LL(final)	-21001.91	-23396.9
AIC	42021.81	46811.75
BIC	42088.06	46878.6

	2021			2019		
	Estimate	Rob.s.e.	Rob.t.rat.(0)	Estimate	Rob.s.e.	Rob.t.rat.(0)
asc_business	0.5897	0.15347	3.8424	0.96733	0.12222	7.9149
asc_work	1.68735	0.08096	20.8426	2.39108	0.07864	30.4066
asc_eat	0.28386	0.08794	3.2281	0.65152	0.08229	7.9171
asc_leisure	0.25431	0.11966	2.1253	0.30406	0.08688	3.4996
asc_pick_up	-0.08965	0.14635	-0.6126	-0.27505	0.18972	-1.4498
asc_return_home	2.49266	0.05654	44.0883	2.58653	0.06428	40.2383
asc_return_work	-1.31833	0.14117	-9.3383	-0.60213	0.13396	-4.4948
asc_shopping	1.76516	0.06427	27.4656	1.19639	0.07814	15.31
asc_strolling	0.68976	0.14095	4.8935	-0.02694	0.17277	-0.1559
asc_other	1	NA	NA	1	NA	NA

Activity based Modelling for trip purposes



- **25% decrease** in **Business trip** (7% to 5%)
- **75% decrease** in **Work based trip** (28% to 16%)
- **Shopping and strolling** activities doubled to **17% and 6%** respectively
- Variation due to **increase** in the **telecommuting activities** after COVID-19

Assessment of Factors affecting Mode Choice for Work Trip

Factors affecting Mode Choice for Work trip – Utility Equations

$$U_{train} = B_1 * Time\ Train + B_2 * Fare\ Train + B_3 * Access\ time\ train + B_4 * Female + B_5 * Departure\ Five\ Seven + B_6 * Departure\ Seven\ Nine + C$$

$$U_{car} = B_1 * Time\ Car + B_2 * Age\ 40\ to\ 59 + B_3 * Car\ Ownership + B_4 * Female + B_5 * Departure\ Five\ Seven + B_6 * Departure\ Seven\ Nine + C$$

$$U_{subway} = B_1 * Trip\ Time + B_2 * Female + B_3 * Age\ 30\ to\ 39 + B_4 * Departure\ Five\ Seven + B_5 * Departure\ Seven\ Nine + ASC$$

$$U_{walk} = B_1 * Time\ Walk + B_2 * Female + B_3 * Departure\ Five\ Seven + B_4 * Departure\ Seven\ Nine + ASC$$

$$U_{bike} = B_1 * Trip\ Time + B_2 * Female + B_3 * Departure\ Five\ Seven + B_4 * Departure\ Seven\ Nine + ASC$$

Factors affecting Mode Choice for Work trip

Independent variable	Dependent variable	Estimate	Rob.std.err.	Rob.t-ratio(0)
Alternate specific constant	Bike	1.180**	0.563	2.097
Alternate specific constant	Train	0.000	NA	NA
Alternate specific constant	Walk	1.132***	0.310	3.654
Alternate specific constant	Subway	0.315	0.322	0.978
Alternate specific constant	Car	-1.080*	0.676	-1.597
Travel time	Bike	-0.001***	0.000	-2.948
Train	Access time	-0.441	0.881	-0.501
Travel time	Subway	0.000	0.000	-0.611
Travel time	Car	-0.228	0.437	-0.521
Travel time	Walk	-2.135***	0.416	-5.126
Travel time	Train	-2.374***	1.110	-2.139
Travel cost	Train	0.005***	0.001	3.997
Female	Subway	1.000	NA	NA
Female	Train	1.197***	0.373	3.209
Female	Car	1.381*	0.798	1.730
Female	Walk	1.091***	0.321	3.402
Female	Bike	1.667***	0.570	2.927
Age (30 to 39)	Subway	0.014	0.345	0.040
Age (40 to 49)	Car	0.000	NA	NA
Car ownership (yes)	Car	1.561**	0.786	1.986
Departure time (5 to 7 am)	Car	-1.562	1.211	-1.289
Departure time (5 to 7 am)	Bike	0.000	NA	NA
Departure time (5 to 7 am)	Subway	-0.031	1.081	-0.029
Departure time (5 to 7 am)	Walk	0.186	1.581	0.117
Departure time (5 to 7 am)	Train	0.336	1.059	0.317
Departure time (7 to 9 am)	Car	-1.057*	0.634	-1.667
Departure time (7 to 9 am)	Bike	0.000	NA	NA
Departure time (7 to 9 am)	Subway	0.736*	0.490	1.502
Departure time (7 to 9 am)	Walk	0.153	0.527	0.289
Departure time (7 to 9 am)	Train	0.298	0.495	0.601

- **Travel time for bike, walk, train** had **negative** and significant effect on the mode choice for the respective alternative.
- **Gender** was found to have significant effect on mode choice for work trip with highest preference for **bike**.
- **Age** of respondents was not found to have any significant effect on mode choice
- For departures between 7 to 9 am, the negative coefficient for car usage suggests that **traveling during this period has a negative effect on car usage,** which aligns with peak traffic congestion periods.

LL (Start) = -8376.55
LL(Final) = -6338.33
AIC = 12726.67
BIC = 12890.44
Adj.Rho-Squared = 0.2385

Effect of work trip attributes on Car Ownership

Effect of work trip attributes on Car Ownership – Utility Equations

$$U_{car} = B_1 * Female + B_2 * Age\ 30\ to\ 39 + B_3 * Female\ * Age\ 30\ to\ 39 + B_4 * Female + B_5 * Age\ 40\ to\ 59 + B_6 * Female\ * Age\ 40\ to\ 59 + B_7 * Housing\ Cost\ 50k\ to\ 100k + B_8 * Housing\ Cost\ 100k\ to\ 150k + B_9 * Motorcycle\ Ownership + B_{10} * Bicycle\ Ownership + B_{11} * Time\ Train + B_{12} * Transfers\ Train + B_{12} * Fare\ Train + B_{13} * Access\ Time\ Train + B_{14} * Egress\ Time\ Train + B_{15} * Time\ Walk + ASC$$

$$U_{car\ not\ owned} = ASC$$

Effect of work trip attributes on Car Ownership

Independent variable	Dependent variable	Estimate	Rob.std.err.	Rob.t-ratio(0)
Alternate specific constant	Car owned	1.000	NA	NA
Alternate specific constant	No Car	2.192***	0.801	2.739
Female	Car owned	-2.287**	1.204	-1.899
Age (30 to 39)	Car owned	-1.953**	1.083	-1.803
Female with age 30 to 39	Car owned	1.615	1.685	0.959
Age (40 to 49)	Car owned	1.480***	0.661	2.238
Female with age 40 to 49	Car owned	0.885	1.336	0.662
Housing cost (50k_to 100k)	Car owned	0.608	0.541	1.124
Housing cost (100k to150k)	Car owned	0.613	0.527	1.163
Motorcycle ownership	Car owned	1.916***	0.825	2.323
Bicycle ownership	Car owned	-0.465	0.421	-1.105
Work trip Travel time (Train)	Car owned	0.508	1.728	0.294
Work trip no. of transfers (Train)	Car owned	0.642*	0.400	1.605
Travel cost (Train)	Car owned	-0.004**	0.002	-1.993
Work trip access time (Train)	Car owned	2.558**	1.460	1.752
Work trip egress time (Train)	Car owned	1.883*	1.063	1.771
Work trip travel time (Walk)	Car owned	0.249**	0.113	2.192

- The coefficient for **"Female"** with **"Car owned"** is **-2.287** suggesting that being female is associated with a lower likelihood of car ownership.
- For the age group 30 to 39, the coefficient is -1.953, reinforcing the notion that **individuals in this age range are less likely to own cars compared to older individuals.**
- For females aged 40 to 49, the coefficient for car ownership is 0.885, indicating **no significant effect** (t-ratio of 0.662). This suggests that the trend changes with age, as older females may not exhibit the same levels of reluctance towards car ownership as their younger counterparts.

LL (Start) = -4707.19
LL(Final) = -2519.58
AIC = 5071.15
BIC = 5175.97
Adj.Rho-Squared = 0.2972

Effect of work trip attributes on Car Ownership

Independent variable	Dependent variable	Estimate	Rob.std.err.	Rob.t-ratio(0)
Alternate specific constant	Car owned	1.000	NA	NA
Alternate specific constant	No Car	2.192***	0.801	2.739
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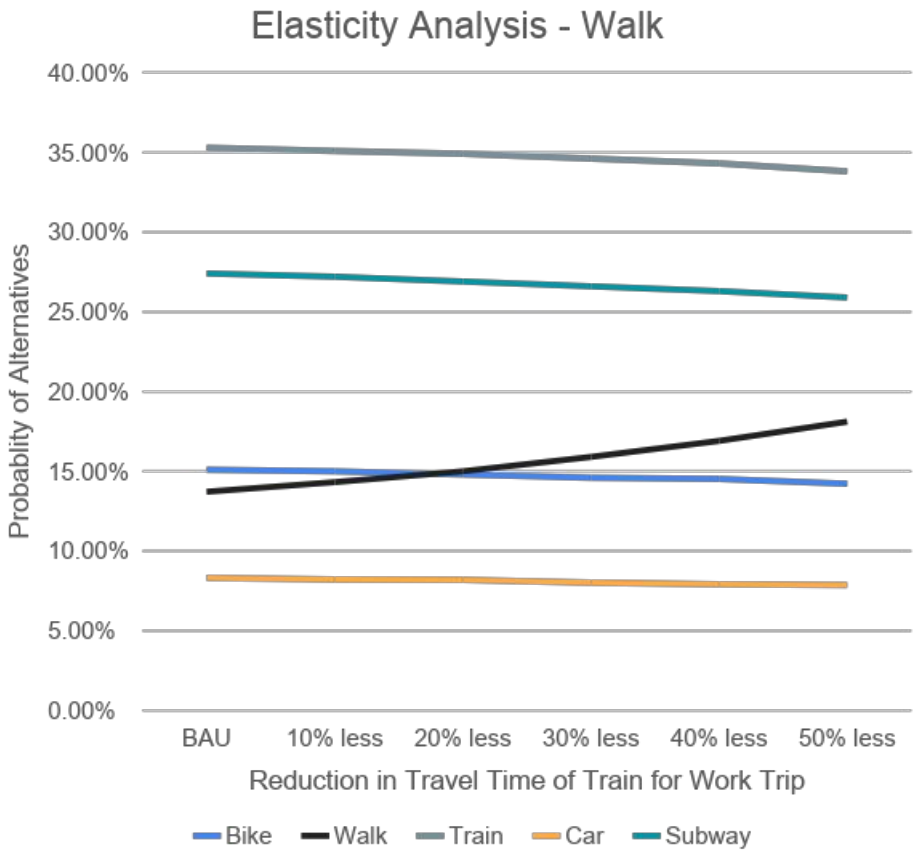
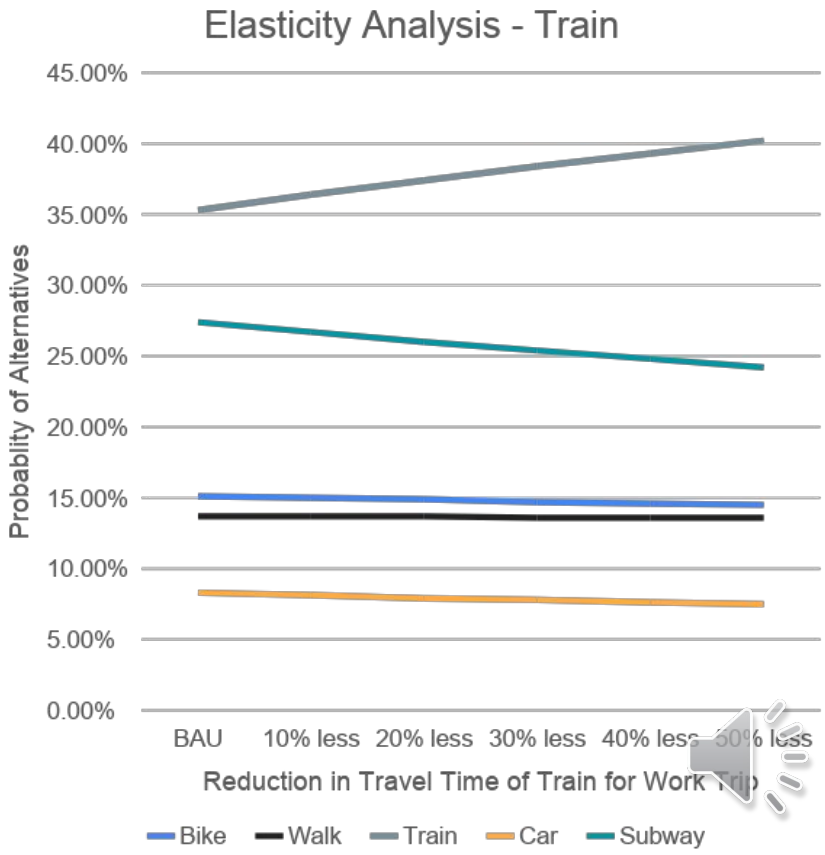
- However, the coefficient for individuals aged 40 to 49 without specifying gender shows a significant positive value of **1.480** (t-ratio of 2.238), indicating a higher likelihood of car ownership in this age group.
- Motorcycle ownership was positively linked top car ownership.
- Variables related to travel times, including work trip travel time and access/egress times by train, show a significant positive association with car ownership, as indicated by coefficients of 2.558 (work trip access time) and 1.883 (work trip egress time), both significant with robust t-ratios. **This indicates that longer travel times related to train use increase the likelihood of choosing to own a car.**

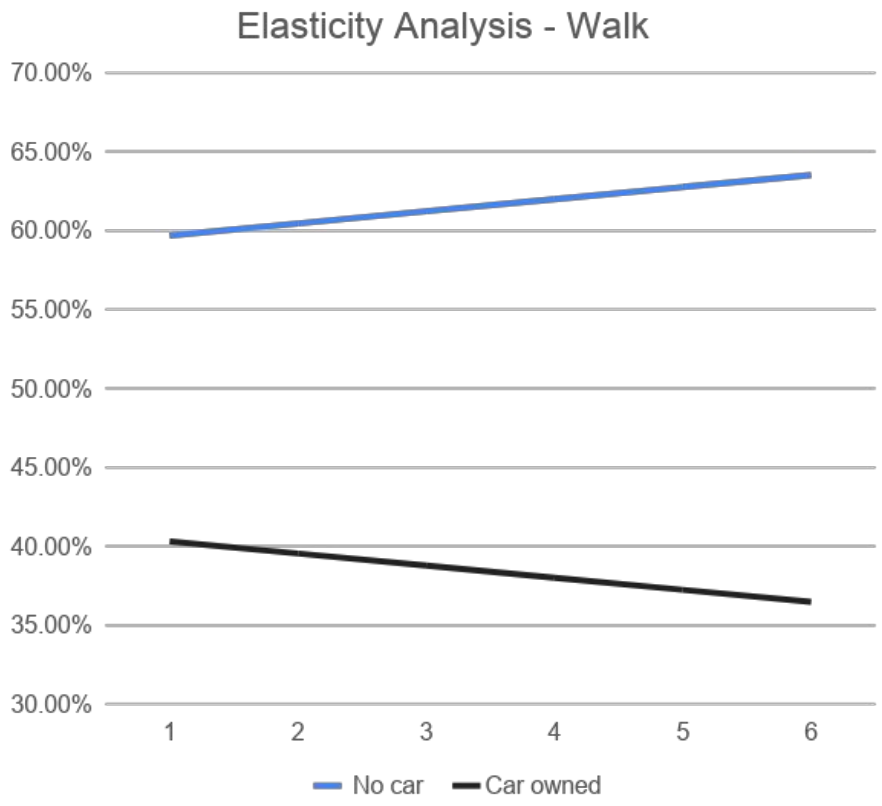
Policy Analysis

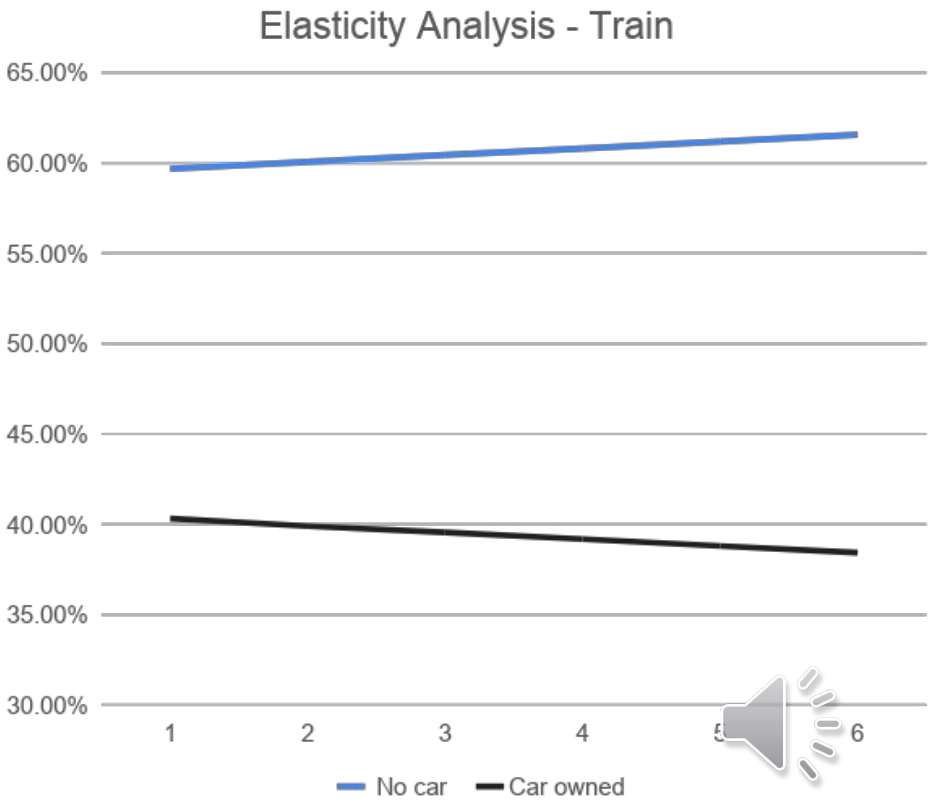
Mode choice for work trip





Car Ownership elasticity for work trip





Conclusion

- Telecommuting is evident through spatial analysis and activity-based modelling and prominently increased post COVID-19.
- Reducing walk time for work trip had significantly positive influence on promoting active mobility.
- For improving public transit ridership, reducing travel time of train is imperative.

Thank you