

# Evaluating the Economic Consequences of COVID-19: A Comprehensive Study Utilizing probe vehicle data and POI data

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## Background

The COVID-19 pandemic, has had profound and far-reaching impacts on global economies, societies, and daily life. Tokyo provides a unique lens through which to study these changes. Probe vehicle data, which captures the movement and stoppage patterns of vehicles, and point of interest (POI) data, which provides information about various businesses and establishments, are two critical datasets that can offer insights into industry changes before and after the pandemic.

## Objective

This study aims to analyze the economic impacts of the COVID-19 pandemic in Tokyo using probe vehicle data and POI data. Focuses on changes in rate of stay points of vehicles in different areas over the past three years and estimate industries with significant changes in traffic flow due to the pandemic.

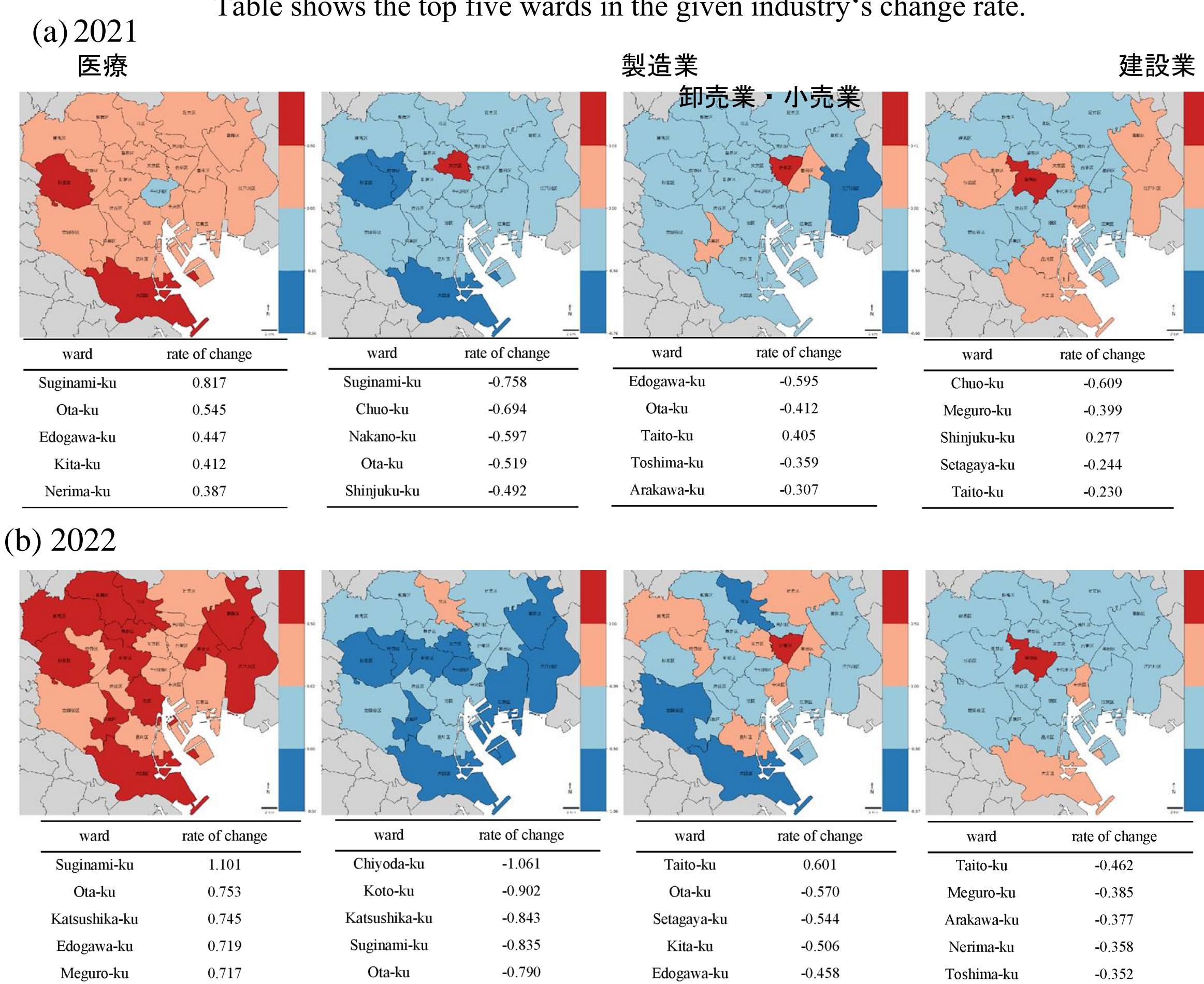
## Methodology

In the mesh grid(b), A is the product sum of the stay points and the number of POI points of different industries, as shown in Equation (1). The number of different POI points in different grids is  $P_i$ . The number of different stop points is  $P_e$ , R represents the change rate of that industry in that mesh over the two years of the analysis as shown in Equation (2).

$$A \equiv \frac{(P_a + P_b + P_c + \dots + P_r) \times P_e}{P_z \times P_e} \quad (1) \quad R = \frac{P_i \times P_e}{P_z \times P_e} \quad (2)$$

## Result

Fig. 2 Industry prosperity change rate map in each wards in (a) 2021 and (b) 2022 (vs. 2019). Table shows the top five wards in the given industry's change rate.



The impact of COVID-19 varies by industry and region. The medical and welfare sector is inversely correlated with other sectors in 2021 and 2022. Demand of health and social care are growing, in contrast, demand from the manufacturing and wholesale trade sectors shows an increasing decline in 2021-2022. This is because the number of infected persons increased the most in July 2022. For the construction industry, the trend differed between districts and years.

## Conclusion

In this study, we developed the method to estimating the economic impact of COVID-19 using probe data. It became clear that 15 sectors experienced negative impacts, while medical and welfare and transport, experienced positive impacts. The negative impacts on the hotel and retail sectors were 3 times and 2 times greater compared to other sectors and expanded in 2022. After PCA analysis of 23 wards, we quantitatively clarified the differences in impact around health/ welfare, and manufacturing.

## Dataset

- ETC (Electronic Toll Collection System) data(a) contains several attributes such as the car's ID, driving speed, etc. We use data from 23 wards in Tokyo every July for 3 years which are around 100 million. Meanwhile in July 2021, Tokyo is in a state of emergency which is the focus of the study. PoI data (Telepoint Pack (Zenrin CO., LTD.))(c) contains information about geographic entities and their coordinates for different sectors in Tokyo.

	2019	2021	2022
Record numbers	804,669,920	2,071,864,793	2,424,203,084
Unique ID numbers	1,882,723	3,042,734	3,666,554
Trip numbers	17,533,510	38,159,984	43,621,784

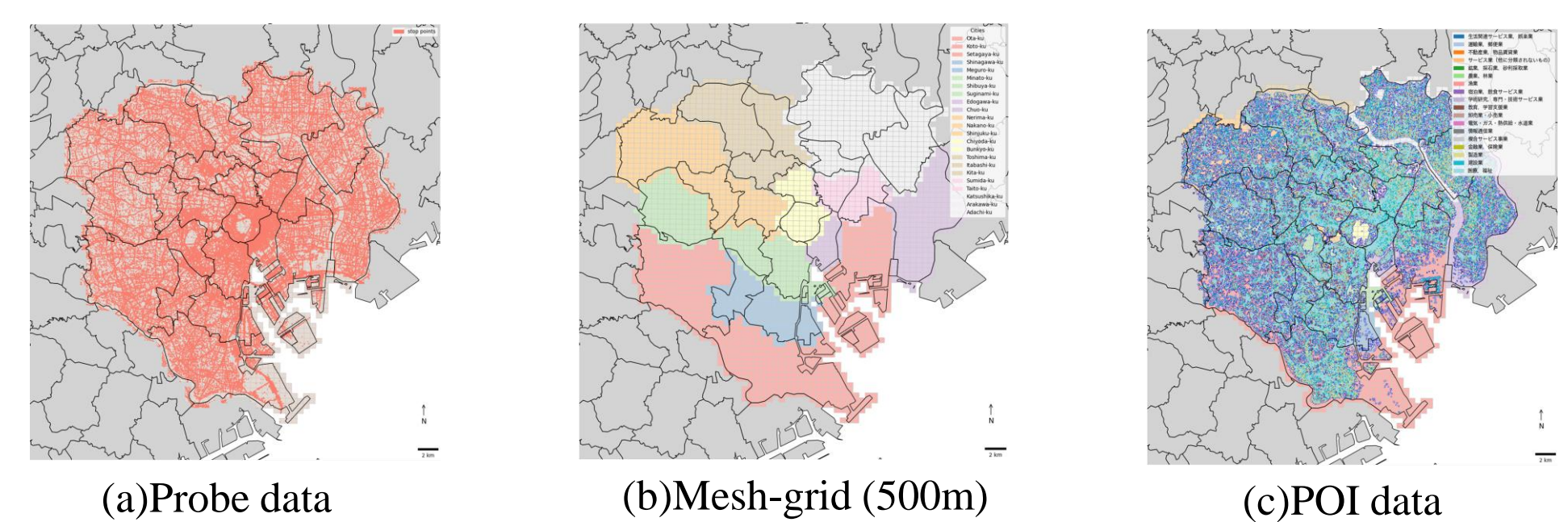
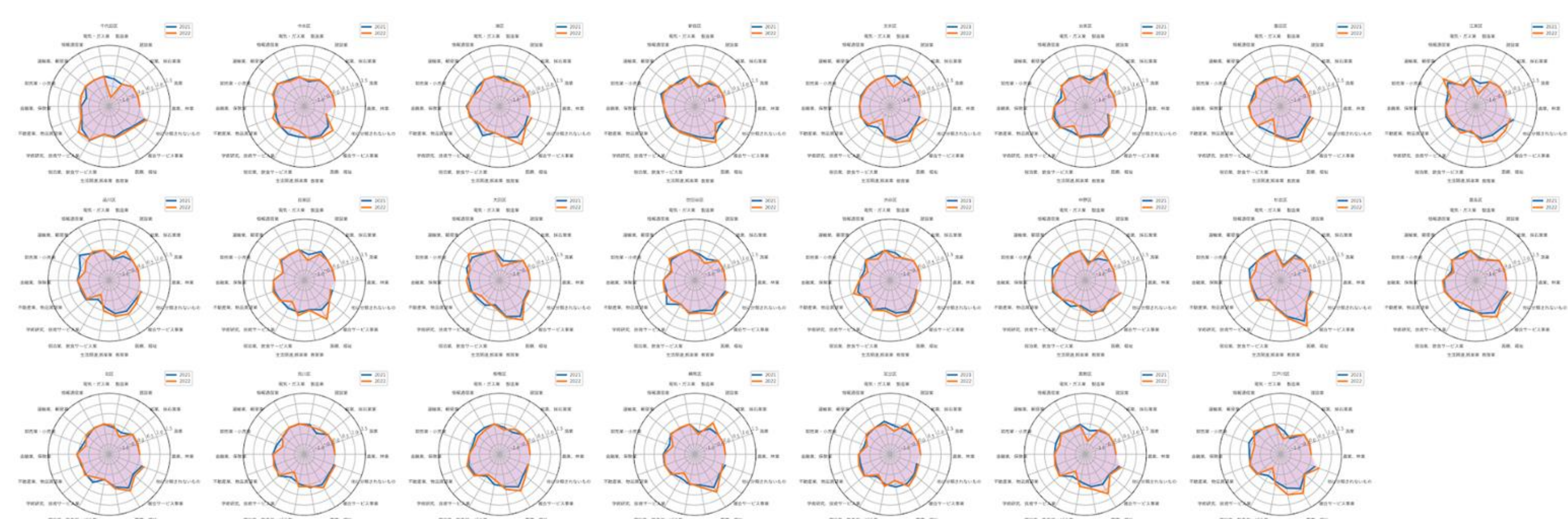


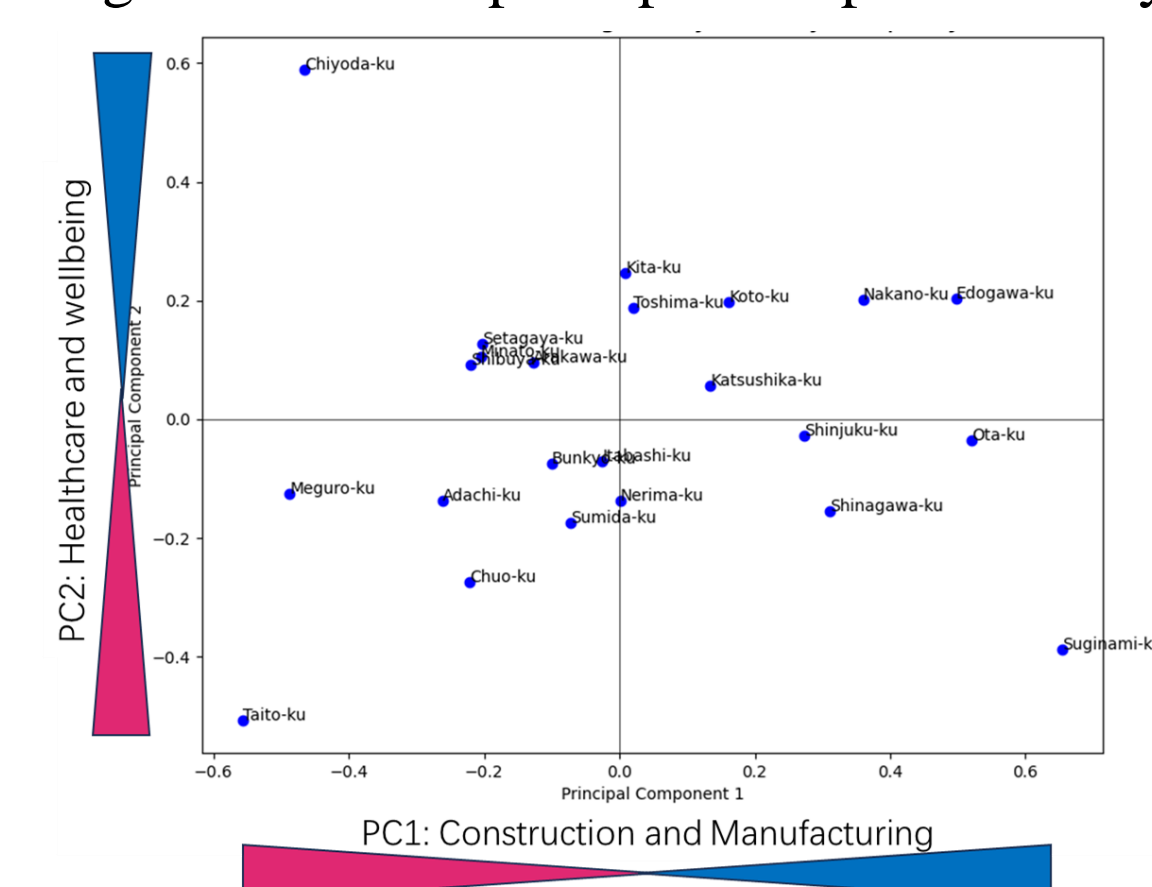
Fig. 1 Study area and data used in this study

Fig. 3 Radar map of change rate of each industry in Tokyo 23 wards



Time variation was reduced in 16 sectors, except in the medical and welfare and transport sector. In particular, the accommodation and manufacturing sectors were reduced in all 23 wards, with 2022 being the largest number of infections on record, and the impact was greater than when the state of emergency was declared in 2021.

Fig. 4 Results of principal component analysis



The positional relationship by region can be divided into the construction industry (x-axis), which has a large contribution from PC 1, and the medical and welfare industry (y-axis), which has a large contribution from PC 2. This allows a visualisation of similarities in the economic impact of different regions. For example, Setagaya and Shibuya wards, which are close to each other, show similar trends, while Chiyoda and Suginami wards, which are further away, show opposite trends.

## Future work

- clarify the changes in intercity freight transportation during the pandemic.
- analysis and the differences in the impact of the coronavirus on freight transportation from the perspective of trip changes in different industries.