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Changes in Commuting Travel Behavior Focusing on the Role of Shared Transportation in the Wake of the COVID-19 Pandemic and the Tokyo Olympics

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Abstract

In order to sustain life in the face of coronavirus infection 2019 (COVID-19), people's lifestyles and tra vel behaviors have to change. Accordingly, such changes are occurring in travel behavior for commuting purposes, especially during periods of heavy congestion. In addition, with the recent development of the sharing economy, the introduction of shared transportation is rapidly expanding in the transportation sector, which may contribute to alleviating traffic congestion and other problems under COVID-19 conditions. In this study, we focused on the changes in travel behavior for commuting purposes during COVID-19, which includes the period of the Tokyo Olympics when traffic congestion is expected. The survey was conducted using a web-based questionnaire. In order to further promote changes in travel behavior during COVID-19, we also analyzed the possibility of changes in the use of passenger transportation resulting from the nudge effect of information provision and incentives.

KEYWORDS: COVID-19, shared transportation, nudge, public benefit

1. Research Background and Objectives

In response to the COVID-19 pandemic, four states of emergency were declared between April 2020 and July 2021, three Cs "closed spaces, crowded places, and close-contact settings" infection control measures were announced, and new work styles (telework, telecommuting, and staggered work hours) were implemented. In addition, the Tokyo Olympics held in August 2021 and the traffic congestion caused by the implementation of transportation demand management measures had a significant impact on people's daily travel behavior especially for commuting purposes. Thus, under the situation where three C's avoidance behavior is required, shared transportation is rapidly introduced as one of the new transportation modes, and its use has been increasing in recent years. Thus, although the use of shared transportation is increasing, its role in transportation planning remains unclear.

Regarding research related to transportation behavior, on top of the mobility management strategies, the use of nudges is advancing not only in the research area of human behavior change, but also in the consideration of concrete proposals in public policy. Nudge is a theory postulated by Richard H. Thaler, who was awarded the Nobel Prize in Economics in 2017, and it is defined as "a policy approach that helps people to voluntarily make better choices for themselves" using behavioral science findings (behavioral insights) [1]. In the field of transportation behavior, there is a need for policies that help people to voluntarily make better choices while avoiding infection and congestion, and it is necessary to focus on the role of shared transportation as a new transportation option and to examine the possibility of promoting its use.

Commuting traffic behavior is generally influenced by time (morning rush hour), space (work location, residence, etc.), and personal attributes, but is said to be more difficult to transform than other trips. In other words, the transformation of commuting transportation behavior is considered to be a long-term change. Therefore, the purpose of this study is to focus on the changes in transportation behavior for commuting purposes during the COVID-19 period and the Tokyo Olympics, when traffic congestion on roads or overcrowding in public transportation systems was expected. We conducted a survey using a web-based questionnaire. In addition, to further promote the change in transportation behavior during the COVID-19 period, this research is novel in that it examines the intention to use and recommend the public, environmental, and financial incentives of shared transportation, and the change in transportation behavior using nudges. The novelty lies in the point of transformation (promotion of use) using nudges. In the field of urban transportation planning, clarifying the role of shared transportation in sanitation and traffic congestion situations is significant toward reducing traffic congestion in future transportation planning.

The shared transportation considered in this study includes car share, bike share, and kickboard share.

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2. Research methodology

2.1. Situation of the target site

The Tokyo Metropolitan Government declared a state of emergencies on April 7, 2020; January 7, 2021; April 23, 2021; July 12, 2021; and August 2, 2021; to prevent the spread of COVID-19 [2].The number of infected people in Tokyo peaked around January 2021, and it spread again in May. By July, the number of infected people increased daily.

Regarding the status of shared transportation in Tokyo, there are several companies providing bike-sharing services, all of which are private companies [3] and receive parking space support from different departments of local government. Of these, only one company operates in the city center, and mutual use is possible in 11 wards. As of the end of March 2021, approximately 870 site ports and 9,200 bicycles have been installed. As for car share [4], as of the end of March 2021, the six major companies (Times Car, Careco, ORIX CarShare, Cariteco, Honda Every Go, and Earth Car) had 17,987 stations and 34,887 vehicles. Among them, the number of stations in Tokyo was 6,741, and the number of vehicles was 12,778. Kickboard Sharing system [43] is a new type of shared transportation, which will be introduced in Tokyo and Osaka in April 2021, in which 200 ports are ready for kickboard use.

During COVID-19, to combat infection and reduce congestion, public transportation adjusted its weekday schedule through telework and staggered work hours, road transportation promoted the use of bicycles, and shared transportation suspended some ports. To reduce congestion during the Olympic Games, public transportation will be operated safely and smoothly as in COVID-19, and road transportation were asked to reduce and disperse travel demand during the Games period through Traffic Demand Management (TDM) including measures providing dedicated lanes or priority lanes for the Games and tolling measures (toll surcharges, half-price discounts at night, etc.). [5] [6]

2.2 Survey overview

The questionnaire survey was conducted through a web-based survey to understand the actual status of changes in commuter transportation behavior and the attitudes and behaviors of commuters. As shown in Table 1, we asked about transportation mode, cost, and time; for the risks and perceptions of COVID-19, we asked about risk avoidance measures and attitudes, and for shared transportation, we asked about awareness, usage, and evaluation.

The plan with nudges consisted of four questions on the intention to use and recommendation (Table 2). Among them, Plan 4 was set only for financial incentives and was a required item. Plans 1, 2, and 3 were combined plans for financial incentives, public benefits, and environmental awareness, and subjects were randomly asked about them.

Table 1. Survey overview

Survey method	Web-based questionnaire survey
Survey Period	July 28, 2021 - August 1, 2021
Survey target	Workers in their 20s to 60s in central Tokyo (1000 samples)
Target area	Chiyoda, Chuo, Minato, Shinjuku, Bunkyo, Shinagawa, Meguro, Koto, Shibuya, and Nakano wards
Main survey items	Personal attributes: gender/age/household composition/ownership of means of transportation and license status/commuting allowance/annual income/place of residence/area of work/occupation/industry Commuting transportation behavior: content of change and reason for change/ mode of transportation and its commuting time before and after change/ transportation cost before and after change/frequency of going out for commuting purposes Covid-19: Awareness of Covid-19 (possibility of infection) / Behavior with Covid-19 (implementation of countermeasures) Shared transportation: Awareness /Time spent using transportation / Frequency of use / Reasons for not using transportation / Evaluation

Table 2. Nudge Plan Contents

Plan	Contents
Plan 1	Environmental awareness: Points awarded based on CO2 reduction (financial incentive)
Plan 2	Public benefit: Points awarded based on the degree of congestion avoidance (financial incentive)
Plan 3	Environmental awareness: Points awarded based on CO2 reduction (financial incentive)
	Public benefit: Points awarded based on the degree of congestion avoidance (financial incentive)
Plan 4	Points awarded based on distance used (financial incentive)

3. Analysis of survey results

3.1 Actual changes in transportation behavior for commuting purposes

The percentage increase and decrease before and after the change in means of transportation by reason are shown in Figure 1. The means of transportation that increased during the "Olympic only" change were buses, cars (with passengers), and bicycles, in that order, and it is thought that the means of transportation changed due to the traffic restrictions on the roads during the Olympic Games. On the other hand, the means of transportation that increased during the "COVID-19 only" change were bicycles, bike share, and cabs. In the case of "COVID-19 only," the increased means of transportation were bicycles, bike share, and taxis, while the decreased means of transportation whose use decreased were public transportation such as "rail/train" and "bus."

Figure 2 shows the changes before and after the combination of transportation modes. The combination of public transportation only and walking + public transportation decreased. The combination of public transportation and individual transportation has increased. The use of shared transportation has increased. Note that (2) public transportation is represented by rail/train and bus (3) individual transportation is represented by car (private car), car (passenger), cab, Motorcycle e and bicycle (private car) (4) shared transportation is represented by Bike Share, Car Share and Kickboard Share.

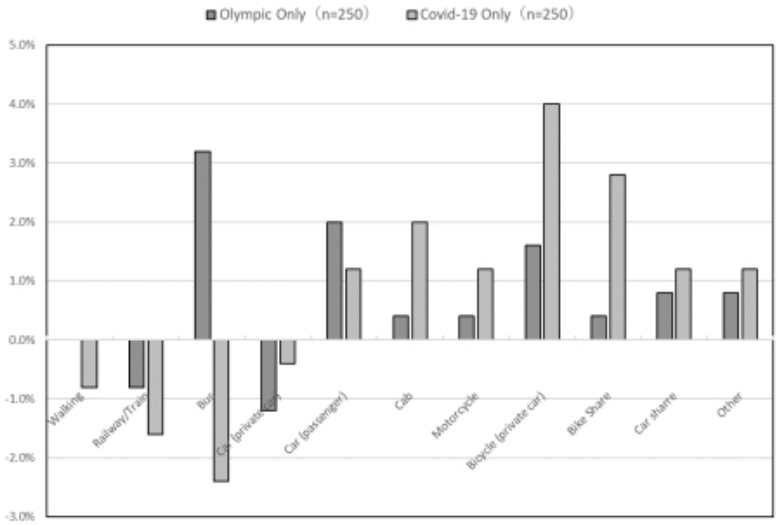


Fig.1.Percentage increase or decrease before and after change in means of transportation by reason

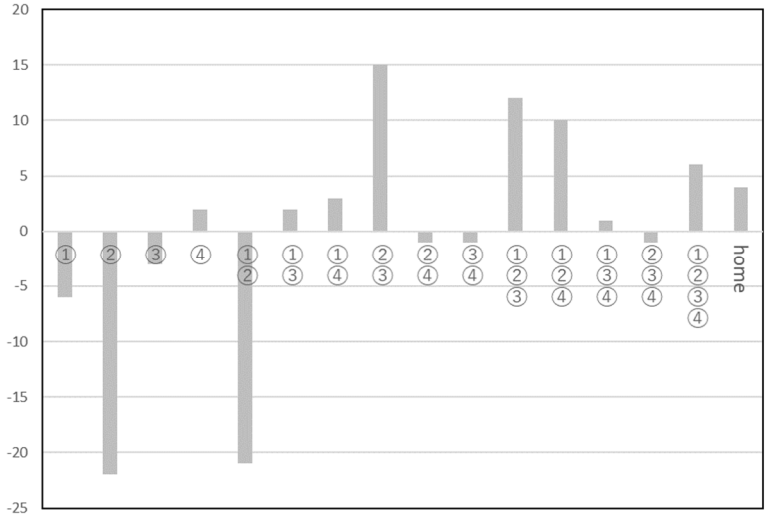


Fig.2.Change before and after combining transportation methods (n=750)

Table 4 shows the results of the regression analysis on the main factors affecting commuting time. Case 1 shows the results of the analysis on the impact of the reason for the change and the details of the change on

the commuting time. As for Changed reason the commuting time for "Olympic only" became shorter, and " Olympic+COVID-19" became longer. As for the place of residence, it can be seen that commuting time becomes longer for those who live farther away. In terms of changes, changes in the means of transportation have the greatest impact on commuting time. As for the contents of changed behavior, all have an impact on commuting time, with transportation means having the greatest impact. Case 2 shows the impact on commuting time for those whose means of transportation has changed. As for the means of transportation, commuting time is longer for "Car (Driver) " and " Motorcycle ", and for Shared transportation, " Bike Share" has no effect on commute times, while" Car Share" affects commuting times, and using" Car Share" increases commute times. And "Kickboard Share" will make the commute less time consuming.

Table 4. Results of multiple regression analysis on factors affecting commuting time

		Case 1 (Pooled)				Case 2(where only the means of transportation was changed)			
		coefficient	Std. error	t -value		coefficient	Std. error	t -value	
Constants		4.609	0.123	37.534	**	1.997	0.340	5.873	**
Changed reason (dummy)	Not changed (Reference)	-							
	Olympic	-0.535	0.221	-2.424	*				
	COVID-19	0.320	0.218	1.468					
	Olympic+COVID-19	0.624	0.221	2.819	**				
Residence (dummy)	Tokyo (Reference)	-				-			
	Saitama Prefecture	1.828	0.321	5.691	**	1.110	0.592	1.874	
	Chiba Prefecture	0.829	0.310	2.676	**	-0.234	0.646	-0.363	
	Kanagawa Prefecture	1.811	0.261	6.940	**	1.252	0.450	2.782	**
Contents of changed behavior (dummy)	Not Changed	-							
	Origin or Destination	0.527	0.160	3.285	**				
	Means of Transportation	1.268	0.177	7.161	**				
	Routes	0.469	0.200	2.341	*				
Means of transportation (dummy)	Walking					1.913	0.279	6.852	**
	Train/train					2.034	0.331	6.150	**
	Bus					1.876	0.317	5.922	**
	Car (Driver)					2.420	0.361	6.712	**
	Car (Passenger)					0.875	0.564	1.551	
	Cab					1.037	0.481	2.158	*
	Motorcycle					2.271	0.622	3.649	**
	Bicycle					1.517	0.388	3.908	**
	Bike Share					0.763	0.485	1.574	
	Car Share					1.528	0.666	2.294	*
	Kickboard Share					-3.177	0.867	-3.665	**
R				0.308				0.719	
Adjusted R2				0.090				0.501	
F-value				20.307	**			32.364	**
Sample number				1750				438	

*p<.05 **p<.01

Table 5 shows the results of multiple regression analysis on factors affecting transportation costs. Case 1 shows the results of the analysis on the impact of the reason for the change and the details of the change on the change on the transportation cost. As for the reason for the change, the transportation cost was relatively higher for those who chose " Olympic only". As for the place of residence, the transportation cost was higher for those who lived farther away. Regarding the Contents of changed behavior, the transportation cost was relatively higher for all the behavior. Case 2 shows the results of the impact on transportation costs due to changes in the means of transportation of those who changed. As can be seen, transportation cost increases for those who chose “Bus ", " Car (Driver)", " Motorcycle ", and " Bicycle”. In Shared transportation, those who chose "Car Share" spent the most on transportation, and " Bike Share" has no effect on transportation costs.

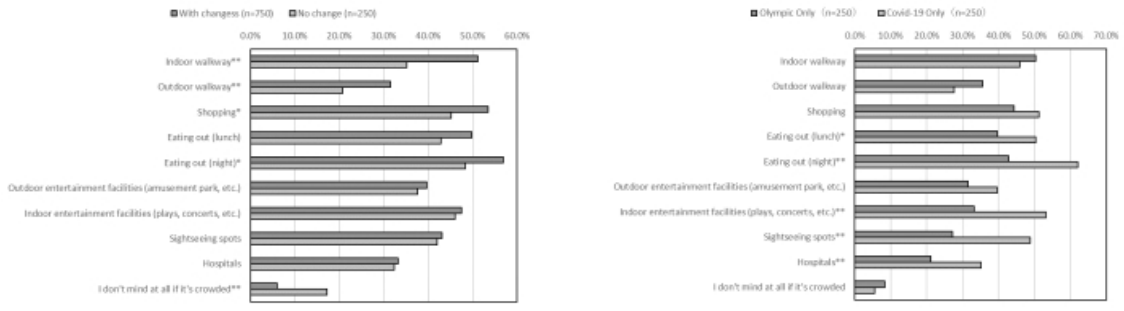
Table 5. Results of Multiple Regression Analysis on Factors Affecting Transportation Costs

		Case 1 (Pooled)				Case 2(where only the means of transportation was changed)			
		coefficient	Std. error	t -value		coefficient	Std. error	t -value	
Constants		1.957	0.071	27.743	**	2.052	0.226	9.074	**
Changed reason (dummy)	Not changed (Reference)	-							
	Olympic	0.406	0.127	3.204	**				
	COVID-19	-0.210	0.125	-1.675					
	Olympic+COVID-19	0.099	0.127	0.776					
Residence (dummy)	Tokyo (Reference)	-				-			
	Saitama Prefecture	0.748	0.184	4.057	**	0.967	0.394	2.455	*
	Chiba Prefecture	0.883	0.178	4.962	**	-0.101	0.429	-0.235	
	Kanagawa Prefecture	1.083	0.150	7.231	**	1.128	0.299	3.768	**
Contents of changed behavior (dummy)	Not Changed	-							
	Origin or Destination	0.546	0.092	5.923	**				
	Means of Transportation	0.406	0.102	3.998	**				
	Routes	0.253	0.115	2.200	*				
Means of transportation (dummy)	Walking					0.006	0.186	0.030	
	Train/train					0.225	0.220	1.023	
	Bus					0.515	0.211	2.445	*
	Car (Driver)					1.083	0.240	4.514	**
	Car (Passenger)					0.375	0.375	1.001	
	Cab					0.058	0.320	0.182	
	Motorcycle					1.294	0.414	3.126	**
	Bicycle					-0.701	0.258	-2.715	**
	Bike Share					-0.329	0.322	-1.021	
	Car Share					2.027	0.443	4.579	**
	Kickboard Share					-0.096	0.577	-0.167	
R				0.288				0.507	
Adjusted R2				0.078				0.232	
F-value				17.469	**			10.440	**
Sample number				1750				438	

*p<.05 **p<.01

3.2 Awareness of risk and the impact of travel behavior on commuting purposes

This section discusses the impact of risk avoidance measures and attitudes on travel behavior for commuting purposes on the risk perception of COVID-19. Figure 3 shows Situations where people avoid crowded places. The left section shows the percentage of places avoided in the "with change" category was slightly higher than in the "no change" category. One of the more significant differences is that the "with change" places more emphasis on the environment in which they are moving: indoor pathways and outdoor sidewalks. This may be one of the reasons for the changes in behavior. The right section shows "COVID-19 only" placed more importance on the crowdedness of indoor places such as restaurants and shopping malls, which may be the reason for the change in behavior.



*p<.05 **p<.01

Fig.3. Situations where people avoid crowded places: Left; Change or not, Right; By reason for change

As can be seen from the table 6, there is a difference in the perception of risk depending on the mode of transportation. There was a large difference in risk perception between rail/train users and shared transportation users.

Table 6. Risk perception aggregation results: shared transportation and other modes (*p<.05 **p<.01)

Transportation	Bike Share(n=48)		Car share(n=23)		Kickboard share(n=16)	
	t-value		t-value		t-value	
Rail / Train(n=794)	3.088	**	2.983	**	0.036	
Bus(n=132)	1.207		1.978		-0.324	
Car (private) (n=86)	0.043		1.214		-0.608	
Car (passenger) (n=44)	-0.293		0.792		-0.71	
Cab(n=42)	-1.633		-0.04		-1.145	
Motorcycle(n=31)	-0.034		0.937		-0.605	
Bicycle (private) (n=98)	2.139	*	2.577	*	-0.022	

3.3 Shared transportation perceptions and roles for commuting purposes

In terms of frequency of use, car share users were most likely to use it 3-4 days a week (52%), while bike share users were most likely to use it for "10-30 minutes or less" (52%). A comparison of awareness of shared transportation and experience of changing transportation behavior showed that awareness of shared transportation was high, with a difference of about 40%.

Figure 4 compares the differences in evaluations between bike share and car share. The evaluation of bike share was better than that of car share in terms of convenience of use (ports, time of use, etc.), public nature (easing traffic congestion), and environmental friendliness. There are fewer traffic restrictions and congestion related to bike share, and they can be used more freely. On the other hand, car share was rated better than bike share in terms of economic efficiency (purchase cost, maintenance cost, and pricing plans). This could be because the cost of a car is higher than that of a bike.

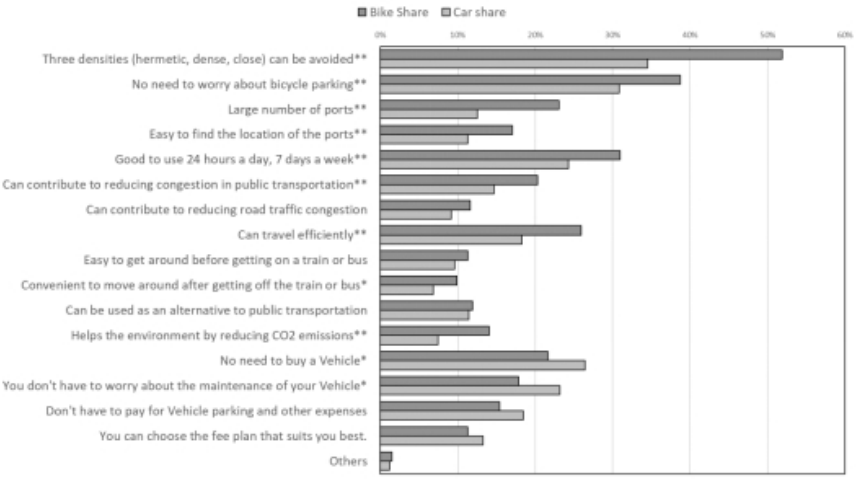


Fig.4. Evaluation of bike share and car share (multiple responses) (*p<.05 **p<.01)

3.4 Plan Considerations with Nudges

Figure 5 shows the intention to use and recommendation of the shared transportation type according to whether they have experienced it. There is a significant difference between the intention to use and the intention to recommend between experienced and inexperienced users. The presentation of financial incentives in the form of versatile points will also be effective in promoting the use of shared transportation. For inexperienced users, use should be encouraged after increasing the penetration rate. For example, information such as the fact that using shared transportation in COVID-19 can be avoided to "Three Cs" and that it can be avoided in traffic congestion situations during commuting can be given to inexperienced users.

Figure 6 shows the results of intention to use and recommendation between those with high-risk perception and those with low-risk perception. It shows that there is a significant difference between the intention to use and recommend shared transportation between those with high and low awareness of Plan 1

and Plan3. There is no significant difference between the four plans for high-risk perception people, suggesting that they are more responsive to the incentives offered. Those with low-risk perception have a clear intention to use Plan 1, and Plan 3 having the lowest intention to use.

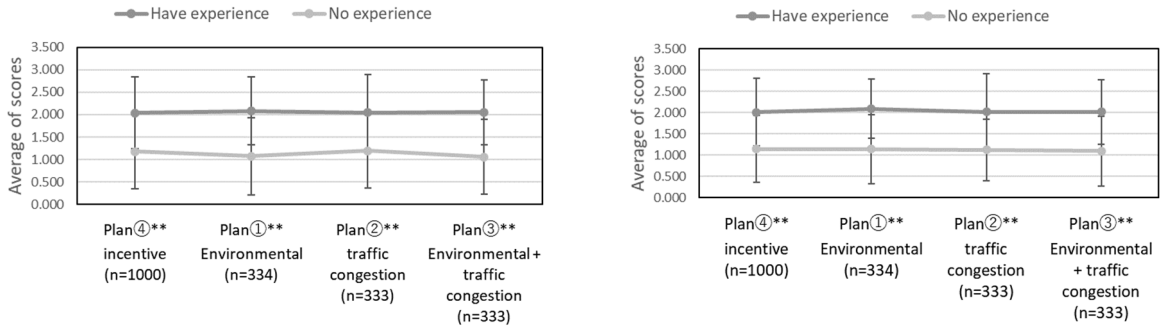


Fig.5. Experienced or not: Left; Intention to use, Right; Intention to recommend (*p<.05 **p<.01)

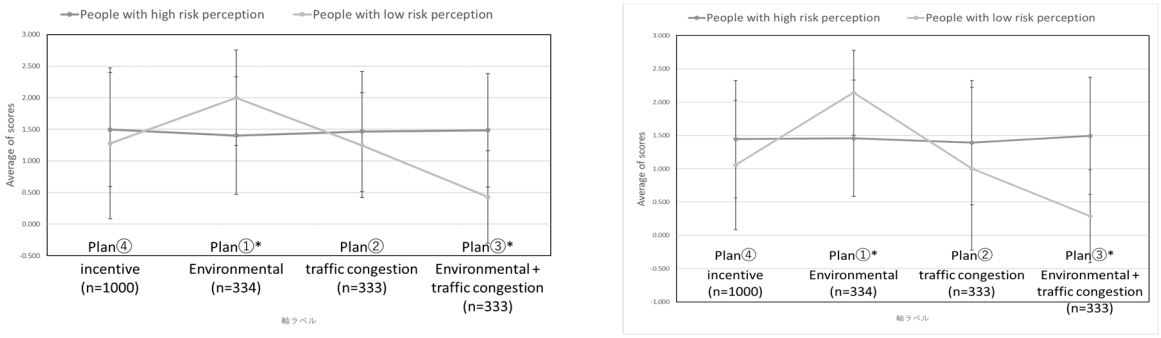


Fig.6. Risk perception: Left; Intention to use, Right; Intention to recommend (*p<.05 **p<.01)

4. Conclusions

Change or not lead to a change between different means of transportation; the use of public transportation tends to decrease, and the commuting time tends to change to longer. Differences in risk perception lead to changes in commuter transportation behavior. There is a difference in the perception of shared transportation depending on whether the user has used it before or not, and it was found that there are still issues of dissemination and convenience. The role of shared transportation for commuting purposes can be considered in terms of safety, economy, environment, and public nature. People respond to the provision of financial incentives, and it is possible to encourage the use of shared transportation by providing them appropriately.

Further study needs to consider changes in attitudes depending on the vaccination status and changes in Covid-19 after the Olympics. As for the plan using nudges, a plan for those who have not experienced shared transportation is necessary due to the decreasing popularity. Plans for shared transportation publicity (traffic congestion reduction) need to be more specific.

References

1) Japanese version of Nudge Unit (BEST): http://www.env.go.jp/earth/ondanka/nudge.html, (Viewed on May 24, 2021). HP.
2) N.H.K. COVID, 19 Special site HP: https://www3.nhk.or.jp/news/special/coronavirus/, (Viewed on May 24, 2021).
3) Bureau of Environment. Tokyo Metropolitan Government., Bicycle sharing HP: https://www.kankyo.metro.tokyo.lg.jp/vehicle/management/bycicle_sharing/index.html, (Viewed on May 24, 2021).
4) Car sharing comparison 360°: https://www.carsharing360.com/, (Viewed on May 24, 2021). HP.
5) Ministry of Land, Infrastructure, Transport and Tourism, Immediate Road Measures to Cope with the New Normal HP: https://www.mlit.go.jp/report/press/road01_hh_001332.html(Viewed on July 20, 2021).
6) Tokyo 2020, Organizing Committee: Traffic Measures During the Games HP: https://olympics.com/tokyo-2020/ja/games/transportation-management/ (Viewed on July 20, 2021).