ANALYSIS OF ROLES OF TAXI SERVICE AND TAXI SUBSIDY SCHEME FOR MOBILITY OF ELDERLY PEOPLE LIVING IN DEPOPULATED AREAS

Ayiguli AINI[1], Hideo YAMANAKA[2] and Kaoru ONO[3]

[1]Member of JSCE, Graduate Student, Dept. of Civil and Eng., University of Tokushima
(2-1, Minami-Josanjima, Tokushima 770-8506, Japan)
E-mail: aygul0321@gmail.com
[2]Member of JSCE, Professor, Graduate School of Technology, Industrial and Social Sciences,
University of Tokushima (2-1, Minami-Josanjima, Tokushima 770-8506, Japan)
E-mail: yamanaka@ce.tokushima-u.ac.jp (Corresponding Author)
[3]The Faculty of Regional Innovation, University of Miyazaki
(1-1 Gakuen Kibanadai-nishi, Miyazaki 889-2192, Japan)
E-mail: kaoru_o@cc.miyazaki-u.ac.jp

With an increasingly aging population and the deregulation of policies concerning public transportation, securing the mobility of elderly people, especially those living in rural areas, has become a serious problem. This study aimed to clarify the actual conditions and issues for elderly people when using taxi services, and to examine the role of a taxi subsidy scheme (TSS) as a future policy for securing the mobility of elderly people in rural areas. By using a web questionnaire survey with 300 people over 65 years old and able to go out by themselves, a comparative analysis was conducted between three focus groups: people with private cars, people without a private car and with no TSS, and people supported by a TSS. The results show that the TSS has a certain effect on ensuring mobility for the elderly in depopulated areas. People without the ability to use public or private transportation freely showed a strong desire to increase the subsidy rate and number of usage instances. In view of this, the utilization of a "shared taxi" reservation type is suggested for improving the subsidy rate.

Key Words : taxi service, taxi subsidy scheme (TSS), rural areas, web questionnaire, elderly

1. INTRODUCTION

Mobility in depopulated area, especially for the special groups like elderly and disabled people is facing various challenges, which have direct influence on improving of people's quality of life in their late ages. For securing the mobility of elderly people living in rural areas, lots of measures are being employed.

With the revision of the Road Transport Law in 2002, entry and withdrawal into the bus business was deregulated, and in the revision plan in February 2006, the requirements for regular operation with route settings were eliminated. Owing to depopulation and motorization in rural areas as well as such deregulation policies, the withdrawals of route buses in rural areas have increased. In this context, the characteristics of rural areas, including their dispersed population density, low demand for service, and needs for financial support, cause problems for covering the area with transportation services. Most rural areas have difficulties in maintaining the continuous operation of a public transit service.

In Japan, the number of elderly people is expected to increase in the future, and increasing numbers of people are living well past 80 while maintaining active lives. Thus, it is necessary to understand their mobility needs and travel behaviors. In addition, in recent years, traffic accidents caused by the elderly have become a serious issue requiring close attention. Moreover, owing to the promotion of returning the driver's licenses of elderly people, there is often a need to secure alternative transportation means (e.g., private cars) for these groups. Therefore, in place of route buses, there is an increasing demand for-door to-door service. As such, we need to take a close look at the growing trend of urgently requiring such individual services.

To tackle the mobility problems, the implementation of community bus service has been conventionally been focused on urban areas. This approach, however, could only a limited number of people in rural areas. To meet the increasing needs of special groups such as the elderly and disabled people in rural areas, flexible transport services have been introduced, including on-demand ride sharing taxis and private paid passenger transportation system, called "Jikayou Yushou" in Japanese; these require reservations, but allow for flexible route and schedule settings, so as to support the mobility of elderly in the service area. Owing to such services, mobility support for the elderly is expanding (in certain areas).

In contrast, people living in area where there are no on demand-ride sharing taxis or that are out of the operating service cannot receive these services. Even in the operating area, because of the individual use, the sharing ratio may be excessively low and inefficient. As such, in areas where there is little demand for public transportation, instead of establishing shared types of services, attention is being paid to using individual types of transportation services such as taxis, which can respond to the individual demands and achieve door-to-door service.

In remote rural areas, to provide mobility assistance to residents with disabilities or significant mobility restrictions preventing them from using public and community transport, non-profit organization corporations are using volunteer driving services with the aid of local residents. The users only pay a small amount of reasonable money, i.e., not for business profit. Generally, however, this scheme is only introduced in areas where there is no taxi service. Considering the characteristics of the demands of aged people in rural areas, individual service remains necessary, and the usage of existing taxi services may represent one of the operational solutions.

A taxi subsidy scheme (TSS) subsidizes the taxi fare by distributing tickets to a limited target group according to certain conditions such as age, driving license, disability, and socio-demographic background. The TSS is a solution that has been widely introduced by rural local authorities. The local government subsidizes part of the taxi fare by issuing a certain number of tickets to target persons annually, and users can pay part of their taxi fees with this ticket. As a welfare policy, the original target of the system, i.e., people with disabilities, has been expanded to include the elderly and poor.

According to the subsidy amount and number of distributed tickets, the programs in the available areas can differ, according to the local authorities and their own conditions. The range of subsidy tickets distributed annually varies from 20 to 100 sheets. The subsidy rate can be divided into several cases, e.g., a fixed amount of subsidy per ticket, or a changeable subsidy amount depending on conditions.

Therefore, several issues are considered herein, such as the actual situation for the mobility of the elderly in rural areas, the role(s) taxis play in elderly mobility, and the roles of TSS policy and people's attitudes toward it.

2. EXISTING RESEARCH AND PURPOSE OF THIS STUDY

There are existing research studies on the role of taxi services in a depopulated area. Kato[1] provides an overview of recent changes in the legal system related to taxis, and discusses the direction for taxi projects aiming to contribute to regional public transport services and to play an indispensable role. In addition to the contributions of on-demand ride sharing taxis, there may be various contributions in the form of original taxi businesses for transporting passengers individually by deactivating the taxi meter. In the future, with the diversification of travel needs and the aging and population decline in regional and suburban areas, taxis are expected to expand into securing public transport services by complementing or replacing public bus transportation modes.

According to the research on on-demand shared taxi schemes, Hayakawa[2] showed that, in an area where the conventional public transport has been abolished, focusing on demand-type shared taxis (representing cooperation by taxi companies and private paid passenger transportation) is vital. Moreover, it is important to introduce the proper type of scheme according to the local situation, i.e., it is not always necessary or appropriate to copy a solution thoroughly (similar to cases of introducing IT technologies to small business in the same manner as in advanced cases). A study by Kato[3] estimated the cost-saving effect of local public transportation in Toyota City, Aichi Prefecture. The results showed that taxis could be used as a local public transportation option where the density of the transportation demand is low, and would be expected to reduce 20–70% of the operation costs for public transportation. It also suggested that according to regional characteristics, areas with inefficient bus routes with large detour ratios are suitable for the replacement of community buses by taxi services with a mileage fare system. Meguro[4] focused on the introduction of group taxis, and revealed that there were limitations in the current public transport sys-

tem insofar as covering the mobility needs of the elderly and disabled people. They also noted that the introduction of group taxis could contribute to improvements in socializing by participants.

However, according to another research study by Moriyama[5], demand-based ride-sharing taxi services may not be economical, owing to the costs for the reservation procedures. In fact, sometimes it is necessary for the driver to wait for customers, which is costly. In addition to this, the procedures for making reservation procedure can also form barriers for older people. As such, a proper introduction, especially regarding the policies including taxi utilization, can be vital when considering the local conditions in depopulated areas. According to Hayakawa's[6] research, Tatebayashi city of Gunma prefecture (population approximately 78,000) and Omachi city of Nagano prefecture (population 29,000) introduced a TSS to the elderly along with the elimination of bus service. In these two cities, elderly people were supported by distributing taxi tickets, but the pressure on the municipality increased. In this case, it revealed that bus service is more efficient than a TSS, and ultimately led to a restart of bus services in these regions. However, Hayakawa said that the TSS makes a certain amount of sense, because some elderly people have difficulty accessing bus stops. Another study by Ishio et al.[7] evaluated the characteristics of TSSs as policy for supporting the movement of the vulnerable groups in remote areas. The feasibility of a TSS depended on the environment in which it was implemented. In addition, it was found to be implemented at a low cost relative to other demand-based transport services. In this article, the TSS was examined from the perspective of public awareness. Based on the results of a questionnaire, it was found that citizens did not oppose taxi assistance in principle; in particular, they indicated that those requiring support should be provided with appropriate assistance.

A report submitted by the Department of Transport and Main Roads[8] in the Queensland government of Australia provided a series of information regarding the background of their TSS, the sustainability of the service, reviews for eligibility, entitlements, and duplication of Government benefits and assistance through other systems, and funding for the TSS program. A TSS was introduced in Queensland in 1987 to provide an affordable and accessible transport option for people with disabilities who experienced profound difficulties when using other modes of public passenger transport. The state government subsidy funded 50% of the taxi fare for each trip, up to a maximum subsidy of $25. Membership was not means-tested, and the number of taxi trips able to be undertaken and number of subsidies paid per member were unlimited. Members were issued with an electronic membership smartcard, and were also entitled to a maximum of 20 interstate travel vouchers each 12-month period, for use with any taxi service in other jurisdictions. After consideration of all of the information made available and the views put forward by the Panel members, the Panel made recommendations such as undertaking research to identify more detailed demographics and usage patterns. i.e., to better understand the availability of access to members and transportation network.

Considering the above research, this study aims to clarify the actual conditions and issues concerning elderly mobility in depopulated areas. A comprehensive analysis is conducted to identify the roles of the taxi service and TSS in securing the mobility of elderly, along with the level at which they influence the movement behaviors of the elderly for their daily life activities.

3. RESEARCH METHOD

(1) Outline of questionnaire survey

We conducted a web questionnaire survey on Rakuten Insight in July 2019, aiming to obtain an understanding of the current actual situation regarding the use of taxis with a TSS by the elderly.

In this research, the questionnaire survey was conducted with elderly people living in depopulated areas. The depopulated areas were defined as local governments and included 817 municipalities designated according to the Act on Special Measures for Promotion of Independence in Depopulated Areas (revised in April 2017).

In a screening question of the Web survey, we requested the postal code of the corresponding living area of the respondent; then, the target person was extracted after checking his/her postal code to the list of 817 municipalities. The web survey required the respondent to answer 20 short questions, and was intended to last for 15 minutes. The contents of the questions asked in the questionnaire are shown in **Table 1**.

(2) Sampling and focus group

A total of 300 people over 65 years old living in depopulated areas were chosen as the sampling group, as this ground was considered as being able to provide a better understanding regarding the actual situations of their daily life experiences. The sampling group was divided into three groups using screening questions. Group S1 could freely go out with a car, motorcycle, or moped by themselves.

Table 1 Questionnaire survey content, including on taxi subsidy scheme (TSS)

Q	Question	
1	Occupation	
2	Transportation that can be used freely	
3	Frequency of outing by purpose	
4	The most common one-way traveling time	
5	Usage of transportation	
6	Dissatisfaction with the use of buses and railways	
7	Purpose of using taxi	
8	Reasons for using taxi	
9	Difficulties for using taxi	
10	Status of introduction of taxi subsidy scheme	
	1	TSS has been introduced and receiving the distributed ticket
	2	Targeted person but has not registered and did not receive distributed ticket
	3	TSS has been introduced but not aimed as target person
	4	TSS has not been introduced but being aware of subsidy system
	5	Knows nothing about the subsidy scheme
11	1	Annual number of taxi tickets distributed (upper limit)
	2	Annual number of taxi tickets used (number of uses)
12	Discount rate by taxi subsidy scheme	
13	Self-pay per vist	
14	Request for improvement of taxi subsidy scheme	
15	The frequency of outing with the increasing number of distributed tickets and discount rate	
16	Possible increase on the usage of taxi by 50% fare discount and no limitation on using number	
17	Suggestion for supporting the mobility in depopulated arae	
	1	Expansion on amount of subsidy to limited targeted person
	2	Expansion on the scope of targeted person with inconvenient transportation
	3	Expansion on the scope of targeted person, subsidy rate and number of times
	4	Substantial public transportation except the taxi
	5	Support for the mobility of family members
18	Opinions about ride sharing taxi	
19	Role of taxi in the region	
	1	Mobility for daily life
	2	Transport tool for emergency
	3	Support for the mobility vulnerable residents
	4	Transportation availability for visitors
	5	Door-to-door high quality transportation service
20	Pros and cons of taxi business maintenance measures in depopulated areas	
	1	Maintain local taxis with public support
	2	Public support through policy mitigation for improving taxi management
	3	Policy mitigation on using private car for supporting mobility
	4	Introduction and development of self-driving taxis
	5	Policy mitigation for running taxi business as second career for migrants

Group S2 did not have driving licenses and could not use a motorcycle or moped. Finally, group S3 comprised persons without a driving license, motorcycle, or moped, and who answered the question by listening to the explanation of families. The sample collection for the focus group was designed with 100 samples for each group; however, from the results of the confirmation question, two people were found to belong to another group.

For further analysis, sampling groups S2 and S3 with the same feature (unable to use car or moped freely) were subdivided according to the status of receiving a TSS so as to provide three focus groups, i.e., focus groups A, B, and C.

Table 2 Structure of sampling and focus groups.

Focus groups / Sampling groups by screening question	A: With PC/ No TSS	B: No PC/ No TSS	C: No PC/ With TSS	Total	Age : Mean (STD) Female ratio
S1: People over 65 years who can freely go out with car, motorcycle, or moped by themselves	98	0	0	98	68.9 (3.45) 49.0%
S2: People over 65 years who can go out by themselves, but has no driving license, or cannot use motorcycle or moped	0	94	8	102	69.8 (3.63) 51.0%
S3: Over 65 years who don't have driving license, motorcycle or moped, answering the question by listening to the explanation of families	0	93	7	100	43.2 (10.3) 50.0%
Total	98	187	15	300	
S1 + S2: Age : Mean (STD) Female ratio	68.9 (3.45) 49.0%	69.6 (3.49) 50.0%	71.6 (4.96) 62.5%	69.4 (3.56) 50.0%	
PC : Private Car Owner, TSS: Taxi Subsidy Scheme User					

Table 2 shows the definitions and sizes of the sampling groups (S1, S2, S3) and focus groups (A, B, C), as well as the age (mean and standard deviation) and gender ratio of each group.

Regarding occupation, unemployed, housewife, and company employees accounted for the largest three proportions, from highest to lowest at 32.7%, 25%, and 24.7%, respectively.

4. SUMMARY OF SURVEY RESULT

(1) Situation of mobility for focus groups

Fig.1 shows the available mobility modes for the three focus groups. A one-way analysis of variance is used to determine whether there are any statistically significant differences between the means of the three groups. In this figure, significantly different ($p < 0.05$) pairs of groups are shown as arrows, based on the results of a multiple comparison according to Tukey's method. Bicycle is the most commonly used mode of transportation, with approximately 40% of the usage rate relative to the other transportation modes. A significantly large portion of TSS users appear to have no available mobility mode. For scooters, TSS users also show high significance relative to the other two groups.

Going out for daily life activities is an indispensable part of daily life. **Fig.2** shows a comparison of the annual frequencies of going out between the focus groups. In total, the frequencies of TSS users'outings for all purposes seem lower than those in other groups. However, TSS users without a private car have a significant higher frequency of traveling for hospital visits.
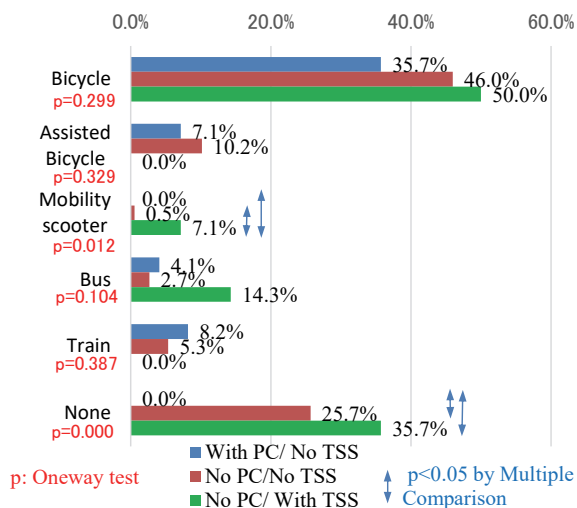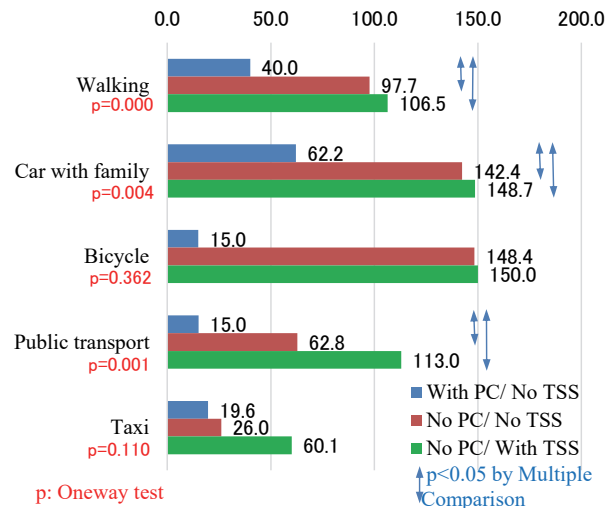
Fig.1 Available mobility modes.

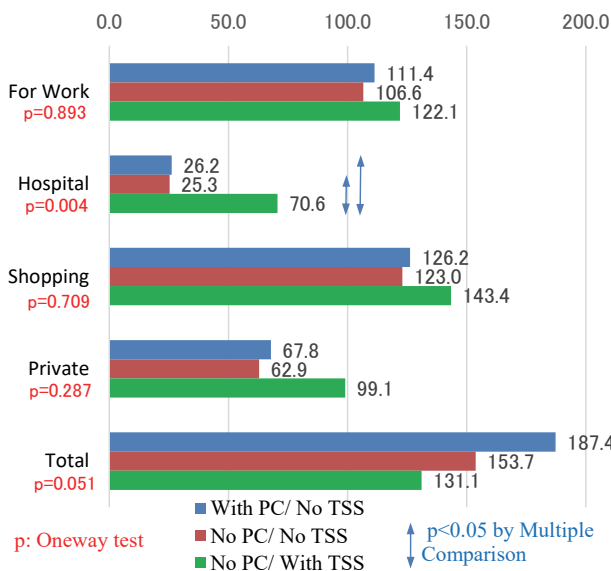**Fig.2** Annual frequency of going out by purpose.
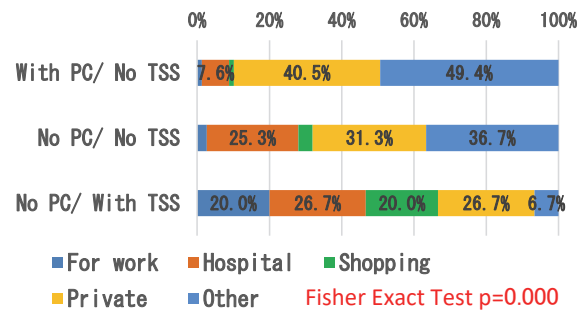

Fig.3 Annual frequency of going out by modes.

Fig.4 Purpose for using taxi.

Table 3 Result for regression model of taxi usage.

	Estimated parameter	Std.Error	t-value	Pr(>|t|)
Intercept	0.0433	0.0089	4.8740	0.0000
TSS(dummy)	0.1477	0.0397	3.7170	0.0002

Fig.3 shows the frequency of outing by transportation mode, except for private car or motorcycle. When focusing on outings for TSS users and non-TSS users without private cars, they show a higher frequency of outing compared to the group with private car as transportation mode. Insofar as the taxi mode, despite the significance level being weak, the TSS users show a higher frequency than the others.

(2) Role of taxi service relating to taxi subsidy scheme (TSS)

When examining and measuring the roles of taxis in securing mobility for elderly, the purposes and reasons for using taxis, difficulty in using taxis, and influences of TSSs on taxi usage are analyzed according to the different groups. As shown in **Fig.4**, the purpose for using the taxi differs according to the state of owning a private car and receiving a TSS. TSS users are using taxis for various purposes

in their daily life activities more than the other two groups; the Fisher's exact test shows significant independence, with p = 0.000.

To analyze the relationship between a TSS and taxi usage, a simple linear regression is conducted. The linear regression equation evaluates the percentage of usage of taxi services (dependent variable) from the existence of a TSS (dummy variable). The model indicates a positive coefficient for the relationship between the existence of the TSS and taxi usage, and the coefficient is significant according to the t-test, as shown in **Table 3**.

Fig.5 shows the reasons for using taxis, including safety, comfortableness, time flexibility, speediness, drinking parties, and the subsidy. TSS users have significantly higher proportions than the other two groups, especially for items like comfortableness, time flexibility, and the subsidy. In contrast, TSS users do not show any interest for using taxis to go to drinking parties.
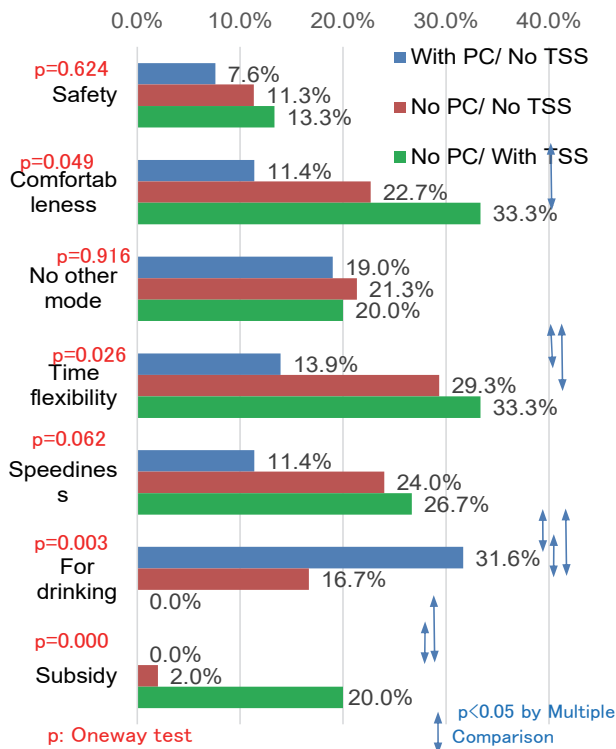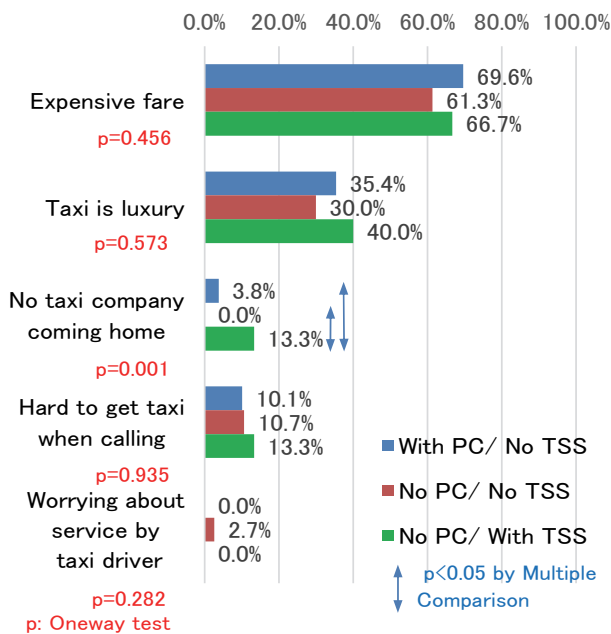
Fig.5 Reasons for using taxi.

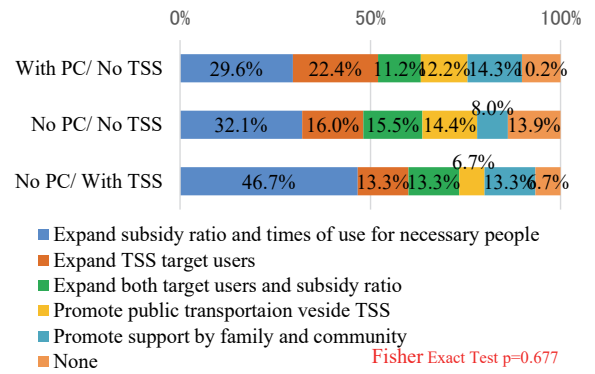**Fig.6** Reasons for difficulties in using taxi.
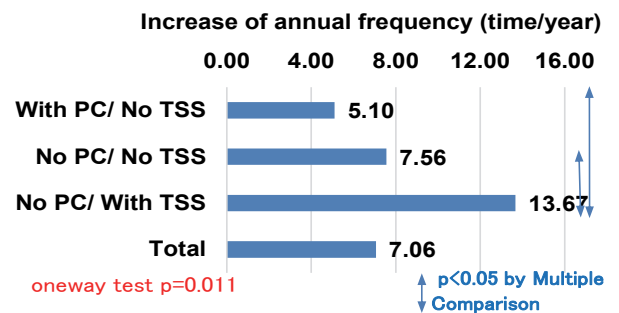

Fig.7 Best improvement policy for taxi subsidy scheme (TSS).

Fig.8 Intention for increasing the annual frequency of taxi usage in case of 50% fare subsidy without limit.

After asking about the advantages of using taxis, the counterpoints concerning their difficulties were identified based on several items in the questionnaire, including those concerning the expensive fare, its state of being a luxury, a lack of availability ("no taxi company coming home"), difficulty in obtaining taxi services when calling ("hard to get taxi when calling"), and worrying about the service by taxi drivers. Among them, the expensive fare and "luxuryness" are the main reasons for the present state, and there are no large differences between

groups regardless of receiving the TSS subsidy or not, as shown in **Fig.6**.

(3) Improvement for taxi service with TSS

Fig.7 shows the opinions of the focus groups concerning the best improvement policy for TSSs. No significant independency appears among the focus groups. Over 60% of people, and particularly over 70% of TSS users, believe in either expanding the subsidy ratio for the people for whom it is necessary, or targeting additional users for TSSs. Expanding the subsidy seems to have larger approval than expanding the number of users.

As a means of securing mobility for the group(s) that most need it, proposals including increasing the annual usage of taxis by assuming that taxi fares are halved by the subsidy system and making the number of usages or time unlimited are being discussed.

Fig.8 shows the intentions for growing the annual frequency of taxi usage times in the case of this scheme. TSS users show significantly a higher intention compared to other two groups, with average increases of 14 times, eight times, and five times, respectively.

The role of taxi service according to the types of trips for different groups is also analyzed, as shown in **Fig. 9.** There are no significant differences between focus groups, as they all put strong value on emphasizing the roles of taxis for daily mobility, as an emergency safety net, and for supporting disa-

bled people. TSS users are more likely to emphasize their daily mobility role.

When asked about their opinions regarding improvement measures for local taxi businesses as shown in **Fig.10,** again, no significant differences are found between the focus groups. Higher approval and expectations are reached regarding measures such as maintaining the local taxi businesses with public support, lifting the ban on mobility services as a second business for migrants and retirees, and deregulation for business management or improvement. The only significant difference among the focus groups appears in the introduction of self-driving taxi businesses. The approval ratio for this item by non-TSS users without private cars is significantly lower than by other groups, and this item gets the lowest votes relative to the other suggestions overall.

As another method of reducing the operation costs of taxi services, reservation type ride-sharing taxis are being widely discussed. **Fig.11** shows the acceptance level of reservation-type shared taxis. Specifically, 50% of people said they will use-reservation type shared taxis if the price is cheaper, and the willingness to make reservations is relatively higher compared to the unwillingness to make reservations and/or to share with other people. In particular, for TSS users, there are no significant differences, owing to both sides opinions' for preference and rejection.

5. CONCLUSION

The following points were clarified from the comparison of the three focus groups. Overall, the frequency of going out annually for all purposes by TSS users is less than in the other two groups, but their use of taxis for going to the hospital is significantly higher. This means that TSS users are mainly using taxis for securing the basic movements fundamental to the daily life experience.

The movement by taxi usage revealed another fact, i.e., that TSS users are using taxis for more diverse purposes compared to the other two groups, and with the aid of TSSs, the elderly tends to use taxis more frequently.

Even though TSS users place significant value on comfort and time flexibility when using taxis, and despite the fact that some amount of the taxi fee is subsidized, the reasons for avoiding the use of taxis (expensive fares and a feeling of unnecessary luxury) rate as high as in the other two groups. These are assumed to be the reasons for the low subsidy rates and limited number of usages.
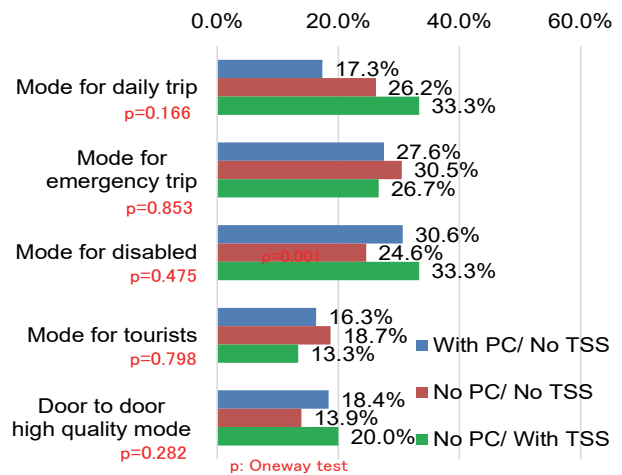
In each group, more than 60% of respondents said

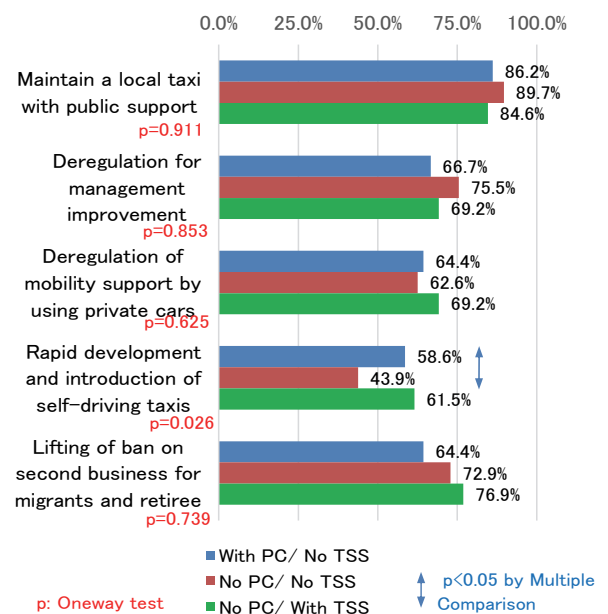

Fig.9 Expected role of local taxi.

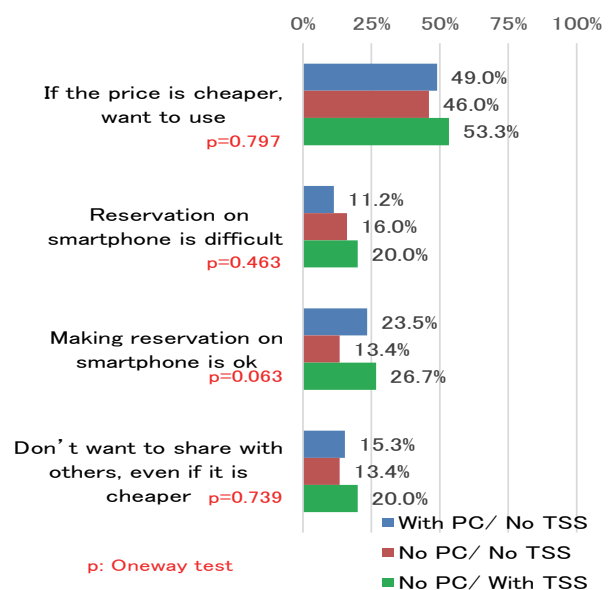**Fig.10** Opinions on improvement measures for local taxi.

Fig.11 Intention for using reservation-type shared taxi.

that it is necessary to increase the TSS subsidy rate or expand the number target users. Nevertheless, from this research, it is found that under the appropriate level of public burden, an effective selection method for target persons, with the same amount of subsidy to the people needing the most, is more favorable. As we know that the frequency of the elderly going out for various purposes is relatively low compared to other members of society, simply securing fundamental outing purposes by providing additional ticket application procedures for the persons needing them the most is recommended.

Assuming that measures can be expand the subsidy through reducing the taxi fee by half and eliminate the upper limit on the number of usages, TSS users answered they will increase their annual taxi usage by approximately 14 times on average.

For taxi service in rural areas, regardless of the group type, all groups emphasize the roles of taxis in daily transportation, emergency transport, and mobility for disabled people. For maintaining the taxi service in rural areas, support from local government is strongly desired. As a measure for expansion of mobility support, it is conceivable to use the reservation-type shared taxi. Regardless of the group, nearly 50% of people say they will use this method (depending on the subsidy rate).

As described above, it was clarified that TSSs have a certain effect on ensuring mobility for the elderly in depopulated areas. However, there is a strong desire to increase the subsidy rate and number of usages for those who are either unable to use private transport, or who are out of the circle of public transportation service. To improve the effectiveness of the subsidy ratio, it is possible to use a sharing method.

This study analyzed taxi services and TSSs from the user side, but it is necessary to analyze the opinions from taxi operators, and to understand the intentions of the local governments providing the subsidies.

REFERENCES
1) Kato, H.: Social roles of taxis positioned as public transport, *Proc. of Infrastructure Planning, Japan Society of Civil Engineers*, Vol. 49, 2014 (in Japanese).
2) Hayakawa, S.: Current status and challenges of unconventional transportation services in rural areas—Focusing on demand-type shared taxis and volunteer transportation by private cars, *J. Japan Soc. Transp. Econ.*, Vol. 48, pp. 71-80, 2005 (in Japanese).
3) Kato, H.: A possibility of community bus replacement service provided by taxi, *JSTE J. Traffic Eng.*, Vol. 5, No. 2, pp. 27-32, 2019 (in Japanese).
4) Meguro, T.: Current status and measures regarding support of outdoor mobility for elderly and handicapped persons—Towards introduction of the group taxi, *J. Archit. Plan.*, Vol. 80, No. 714, pp. 1843-1852, 2015 (in Japanese).
5) Moriyama, M.: Life and public transportation for the depopulated and aging mountainous area, *J. Hous.*, Japan Housing Association, Sep. 2010 (in Japanese).
6) Hayakawa, S.: Taxi subsidy scheme for elderly can secure the mobility of residents: Case study of Tatebayashi city Gunma Prefecture and Omachi city Nagano Prefecture, *J. Public Econ., Society of Public Utility Economics* ,Vol. 57, No. 2, pp. 105-118, 2005 (in Japanese).
7) Ishio, M., Yamanaka, H. and Sanada, J.: A Study on Characteristics of Tax Fare Subsidy Scheme in Rural Areas and Its Future, *J. Japan Soc. Civ. Eng.. D3 Infrastruct. Plan., Japan Society of Civil Engineers*, Vol. 69, No. 5, pp. I_771-I_780, 2013.(in Japanese).
8) Department of Transport and Main Roads (TMR) of Queensland Australia: Taxi Subsidy Scheme – Eligibility and Entitlements Review, *Report to Government*, 2013.