

ROLE OF TAXI SUBSIDY SCHEME AS PUBLIC SERVICE FOR MOBILITY OF ELDERLY PEOPLE IN RURAL AREAS OF JAPAN

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ABSTRACT

Public transportation in rural areas faces increasing challenges with increasingly aging populations. The elderly and disabled people who cannot drive by themselves highly rely on public transport for traveling. Therefore, to ensure the mobility needs for individual door-to-door services in depopulated areas with dispersed populations, several local authorities in Japan are implementing the taxi subsidy scheme (TSS) for the elderly. However, during the implementation, many issues relating to this policy, such as subsidy amount, usage time and number of distributed tickets, settings for target persons, and target area have been encountered. Based on this fact, we examined TSS from three perspectives: the local government that supports the policy with subsidy; small- and medium-sized taxi operators whose business management is influenced by TSS; and the elderly people with their outing status and TSS usage status. Furthermore, based on the trends of national policies, we examined the effective utilization of TSS as a public mobility service for the elderly in rural areas. As a result, for local governments, the TSS was found to be widely known as a support for vulnerable groups and for those who have returned their licenses, and the burden on residents is often not a large expense. From the viewpoint of taxi operators, TSS has considerably contributed to business management. Additionally, many business operators want to increase the usage time and number of people eligible for subsidies. The elderly survey showed that TSS users use taxi for various purposes and are less likely to be influenced by high prices compared with non-TSS users. In other words, it is suggested that the TSS should be the “ideal public transportation” by narrowing down the target users and improving the service.

Keywords: elderly mobility, rural areas, taxi subsidy scheme (TSS).

1 INTRODUCTION

In Japan, ensuring the mobility of elderly people living in depopulated areas with poor transport access has become a serious issue in today’s society. Looking at the socio-economic situation nationwide, the population and birth rate are declining, but the aging rate is increasing. By 2050, the total population will be 100 million or less, and the aging rate (the ratio of 65 years or older to the population) is estimated to be about 38% in Japan. With regard to local public transportation, approximately 74% of regional railway companies and 65% of regional route bus transportation operators face negative balance of payments [1]; it is thus assumed that the condition of local public transportation will become even more severe under rapid population decline in the future. Currently, transportation companies in rural areas are struggling to keep their business sustainable. In Japan, with the revision of the Road Transport Law in 2006, “Private Passenger Transport System” was established. Through this policy, municipalities and non-profit organization corporations provide inexpensive transport service in areas without public transport through private cars. However, this system is only limited to areas with no taxi operators, and its sustainability became an issue owing to shortage of operators. In addition, although the number of demand-type shared taxis, either introduced directly by local governments or outsourced to bus and taxi companies, is increasing, the utilization efficiency tends to be low. Therefore, Sorensen et al. [2] proposed that the role of

demand responsive transport (DRT) on achieving the accessibility and utilization efficiency of public service and reducing car ownership should be investigated.

For the taxi industry, the situation in rural areas is different from urban areas. Even though taxis are now providing the area with mobility service, low demand for service, high operational costs, and rejuvenation needs of drivers presents difficulties in maintaining the business adequately. Even though in some areas demand-responsible type shared taxis are being implemented, the sharing ratio is still low because of individual usage and the system is inefficient [3].

For rural areas, the transportation service demand is low due to deficiency of regular travellers; therefore, it is more sustainable to respond to individual demands achieving flexible door-to-door service rather than focusing on the establishment of public transportation according to the features of rural areas.

Therefore, in Japan, many municipalities have introduced taxi subsidy scheme (TSS), which subsidizes a part of the taxi fee for certain groups of people limited by conditions, such as age, possession of a driving license, and disability. The local government subsidizes part of the taxi fare by issuing a certain number of tickets to the target persons annually. As a welfare policy, the original target of the system, i.e., people with disabilities, has been expanded to include the elderly and poor.

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

With the growing trend of depopulation, decentralized living, and increasing number of single-person households, such individual mobility support service is considered to be a major support measure for last-mile travel that can even be combined with innovations such as autonomous driving and ride sharing in the future.

In this study, the role of TSS and intentions for improvement measures were analysed through a survey of three stakeholders of the scheme: the local government, small- and medium-sized taxi operators, and the users in depopulated areas. Sustainable measures for both TSS and operation of small- and medium-sized taxi businesses were considered for mobility policy for people in depopulated areas. In addition, we provide an overview of recent studies on securing transportation for the elderly in the country and revisions required in the laws on local public transportation; we also propose directions for improving TSS and policies to ensure sustainability of the small and medium-sized taxi businesses in depopulated areas.

2 RESEARCH BACKGROUND & EXISTING RESEARCH

Several studies can be found on transportation services for depopulated areas. Case studies are important to analyse the trip pattern of the elderly because the traveling purpose, time and cost for a single trip, and availability of public transport in their local area have a significant influence on their traveling behaviour [4]. Zhao and Yu [5] found a rapidly increasing trend in aging of population in rural areas caused by migration of the younger generation for employment opportunities, which should be managed by policy developers by encouraging and attracting more migrant residents to ensure regional revitalization. McDonagh [6] found that poor accessibility of transportation not only has a negative influence on social and economic development of rural areas but also contributes to social exclusion and isolation of

the elderly. Mulley et al. [7] found the impact of a properly designed MaaS (Mobility as a Service) on the mobility of the elderly to be positive.

Mobility is key to maintaining independence, especially as people age. Sustainable development goals (SDGs) focus on providing access to safe, affordable, accessible, and sustainable transportation for all by reducing the number of global deaths and injuries from road traffic accidents. Providing transportation facilities for the elderly is an important part of sustainable transportation [8].

Mobility and access rights are important social inclusion issues. Andreas [9] suggested that well-managed human and social mobility can contribute to reduced inequalities within and among countries. It is a precondition for reduced inequalities within the sustainable development agenda, so it must become a core component of policies that tackle inequalities within and among the countries.

The pandemic has considerably affected people's mobility. Silvia [10] conducted a study during the period of lockdown and circulation restriction and in accordance with the objectives of the SDGs and suggested that sustainability of mobility of people contributes to the creation of new models of resilient mobility in times of crisis.

It was found that taxis, as one of the public transport modes used by the elderly in Hong Kong, cannot meet their needs because of high price, long waiting time, and preference for walking to available area. Therefore, a step-wise taxi fare subsidy scheme for improving the mobility of the elderly was suggested [11].

A survey by Harris and Tapsas [12] shows that most of the elderly prefer using taxi. On the contrary, only a tiny fraction uses public transport for their daily life activities. Although high prices result in taxis being affordable only for short trips, most of the respondents still think taxi is convenient public transport tool [7]. In Berkeley City, a taxi scrip program has been established with the cooperation of transportation network companies (TNCs) for two purposes: increase the number of registered taxis and reduce waiting time. According to the survey conducted on the users of this program, most users were found to use it for medical visits and grocery shopping. However, smartphone-based booking has become a challenge because only 40% are smartphone users [13]. Incorporating TNCs with taxi service addresses the difficulty in hailing a taxi, which can be analysed by the "matching degree of supply and demand for taxi resources" model created by the relationship between the subsidy ratio and satisfaction level [14].

Moriyama [15] analysed the transport activities of demand-type shared taxi and the association of residents in mountainous areas and showed that although the operation method is thought to be economical, this service does not meet the expected cost-effectiveness in many cases due to issues such as reservation difficulties for the elderly and long waiting time for drivers.

Yoshida [16] investigated the possibility of increasing the frequency of taxi usage by introducing a flat-rate service for "Mina Taku" in Minamisoma City, Fukushima Prefecture. In this study, it was concluded that among the flat-rate services, the system that allows users to choose between flexible destinations is preferred over that where a fixed amount is set between two points. This also has a positive impact on increasing the usage of taxi. However, even with flat-rate service, the expected usage is approximately 2 times/month. Hence, it is difficult for taxi-business operators to autonomously provide the flat-rate service in rural areas.

Ishio et al. [17] conducted interviews with local governments that introduced TSS and public awareness survey and found that local governments see TSS as cheaper than new

transport services like on-demand ride-sharing taxi. Based on a public awareness survey, it was found that there is no opposition to TSS, and many people with poor mobility believe that mobility should be ensured.

Aini et al. [3] described the role of TSS and analysed the improvement measures from the perspective of local governments, taxi operators, and target users. By analysing the operational costs and the subsidy burden on local governments, it was found that when the population density is low, covering areas with TSS is more cost effective than demand-type shared taxis.

In response to the introduction of “Revitalization” of the taxi business as local public transportation by the Revision of Taxi Appropriate Law in 2014, Kato and Sugiura [18] found that by improving the vehicle allocation/reservation system and vehicle diversification by utilizing information and communication technologies with TSS improves usage efficiency of vehicles, which can promote more commercial businesses, such as the elderly support system (Mimamori in Japanese).

Additionally, securing the drivers is a national issue. Nishi [19] found that cooperation with residents is indispensable for drivers for establishing and continuing operation of paid transportation in depopulated areas, the financial cost is the greatest challenge to the sustainability of the operation.

3 ACTUAL CONDITION AND ISSUES OF DEPOPULATED AREAS WITH TSS IN JAPAN

Based on the above-mentioned considerations, this study proceeded with the investigation and analysis using the following approach. To explore issues and future prospects from the perspective of the system supplier, a survey was conducted on the local governments of depopulated areas. With regard to those in charge of service supply, a survey of small- and medium-sized taxi operators in Japan was conducted. Furthermore, to capture the perspective of the beneficiaries of TSS, a web questionnaire survey of elderly people living in depopulated areas was conducted. On the basis of our investigations, we analysed the role of TSS in ensuring the mobility of the elderly and examined its potential for improvement.

3.1 Survey of local governments in depopulated areas

The survey to local governments was undertaken in two ways: website survey and online survey. In the first step, we searched the websites of 817 municipalities designated as depopulated areas¹ in Japan so that we could confirm the status of TSS introduction. As a result, 300 municipalities were found to have introduced TSS. We confirmed that Hokkaido and Tohoku regions have subsidies for non-elderly people, but the rate of introduction of the system for the elderly is lower than that in other regions. In the Chūbu and Chugoku regions, the introduction of the system was confirmed in half of the regions. The reason for these regional differences is unknown. In the second step, based on the website survey, we conducted an online questionnaire survey using Google forms which were administered to those 300 TSS introduced municipalities from November to December in 2019.

¹ The depopulated areas were defined by 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).

Table 1: Survey aggregation for depopulated municipals by classification of population.

	A	B	C	D	E	F
Population	Depopulated municipals	Municipals with TSS	Introduction ratio (B/A)	Municipals that responded	Response rate (D/B)	No. of TSS cases
<15,000	475	136	28.60%	48	35.30%	50
15,001–45,000	199	91	45.70%	47	51.60%	50
>45,000	143	73	51.00%	45	61.60%	50
Total	817	300	36.70%	140	46.70%	150

The online survey consisted of several sections such as the actual situation of the implementation of TSS, the request and examination status for system improvement, and the intention for system improvement measures. According to survey results, the number of collections was 140, and the collection rate was 46.7%.

Because there are multiple systems in some local areas according to the region and target persons, a total of 150 cases were analysed. In addition, considering that the system operation differs depending on the size of the local government, we divided the regions into three categories, with the population of 15,000 and 45,000 as upper and lower limits. Table 1 shows the number of local governments by population category, status of the subsidy introduced, and response number.

3.1.1 Subsidy rate, subsidy amount, and number of subsidy tickets

The number of subsidy tickets distributed annually, and the subsidy rate were divided into several cases, such as fixed amount of subsidy per ticket, variable subsidy amount depending on conditions, subsidizing by usage fee ratio, and subsidy based on the user's burden. In addition, for a fixed subsidy, in some cases, multiple tickets up to half or a full usage fee can be used. The system with subsidy amount of 301–600 Yen is the most common pattern; however, in municipalities with a large population, the percentage of subsidy amounts of 100–300 Yen/s. If the subsidy amount per ticket is high, the number of distributions tends to be small. On the contrary, if the subsidy amount is low, the number of distributions tends to be large. The average public burden per capita is 290 Yen/person, but it is as high as 475 Yen in municipalities with a small population. Compared to general public transportation expenditure,² this is considered to be a small amount in depopulated areas. The number of annually distributed tickets and subsidy amount, subsidy rate, and public burden are shown in Table 2 and Table 3. Furthermore, as we got to know that approximately 60%–70% of municipalities answered “TSS would secure the mobility of the vulnerable groups” in this survey, TSS is assumed to be the appropriate solution for the issue of securing mobility for the elderly.

² According to the Ministry of Land, Infrastructure, Transport and Tourism General Policy Bureau (H24.1) “Regional Public Transport Efforts and Status Analysis Business Report”, the public transport budget in depopulated areas is more than 3,000 Yen/capita with 66.3% municipalities, and the average is 12,356 Yen.

Table 2: Annual subsidy ticket distribution.

Population	<20 tickets	24–30 tickets	32–50 tickets	60–96 tickets	<100 tickets	Changeable by condition
<15,000 population	20.0%	22.0%	24.0%	10.0%	20.0%	4.0%
15,001–45,000 population	18.0%	26.0%	36.0%	12.0%	4.0%	4.0%
>45,001 population	28.0%	14.0%	26.0%	10.0%	18.0%	4.0%

Table 3: Distribution of subsidy amount, subsidy rate, and public burden.

Population	Fixed: 100–300 Yen	Fixed: 301–600 Yen	Fixed: 601–1,000 Yen	Fixed: >1,001 Yen	Fixed: first ride fare	Changeable	Discount: 1%–50%	Discount: 51%–100%	Difference	Public burden/capita
<15,000 population	16.0%	44.0%	0.0%	2.0%	12.0%	8.0%	4.0%	6.0%	8.0%	475 Yen
15,001–45,000 population	19.6%	33.3%	3.9%	9.8%	13.7%	9.8%	3.9%	3.9%	2.0%	227 Yen
>45,001 population	30.6%	34.7%	4.1%	6.1%	10.2%	6.1%	8.2%	0.0%	2.0%	127 Yen

3.1.2 Requests for system improvement, examination status, and issues

We analysed the improvement requests from users, which are obtained from the department in charge of TSS of local governments. Requests for number of usage time and distributed ticket/subsidy amount were high, accounting for approximately 40%–60% of respondents. It seems the larger the population, the higher is the ratio. In areas with a small population, requests for the expansion of available areas are higher than in others. It can be inferred that the demand for taxi use cannot be met in a limited area designated as depopulated by the current availability of taxis. In addition, there is a substantial inclination for increasing the number of eligible people for TSS.

Approximately 20% of the municipalities are considering increasing the number of usage time and distributed ticket/subsidy amount. Approximately 30%–50% of the municipalities that received such requests are preparing to act them by adopting measures such as increasing the subsidy amount and expansion of the target users.

3.2 Effect of TSS on taxi operators

3.2.1 Survey for small and medium-sized taxi operators in depopulated areas

A questionnaire survey was sent to small- and medium-sized taxi operators in August 2020, which was a time of recovery after the emergency status was lifted in Japan. The survey was sent to the companies based on the list from National Hire Taxi Directory [20]. Among the 5886 taxi companies, 2324 companies were chosen as target companies with 1–30 vehicles. Table 4 shows the number of vehicles owned by businesses scaled by the population size of the local government from the National Taxi Directory.

Table 4: Vehicle ownership status of taxi operators.

Population	Categories by no. of vehicles				Total no. of companies
	<5 vehicles	6–10 vehicles	11–20 vehicles	Over 21 vehicles	
<15,000	310	105	36	5	456
	68.00%	23.00%	7.90%	1.10%	5.25
15,000–45,000	258	161	127	47	593
	43.50%	27.20%	21.40%	7.90%	9.32
>45,000	240	239	310	486	1275
	18.80%	18.70%	24.30%	38.10%	27.64
Total by no. of vehicles	808	505	473	538	2324
	34.80%	21.70%	20.40%	23.10%	18.57

We design the questionnaire survey with seven main sections. The first section was organized with the basic information for the structure of company (number of vehicles, staff and changes during the pandemic). The second section was regarding drivers and included age construction, changes in drivers' numbers, and problems regarding securing drivers' numbers and rejuvenation. The third section was on the influence of the pandemic on business management. The fourth section included prevention measures for COVID-19. The fifth section was regarding the TSS. The sixth and seventh sections were the expectations about future business management and expectations from local governments towards the taxi business.

We received 644 responses by mail and 159 responses via Google Forms, for a total of 803 responses (collection rate 26.8%). Furthermore, out of the 794 valid responses, 490 companies whose locations were confirmed as depopulated areas were extracted [20].³

To compare the business management and contribution of TSS by business scale, we divided them into three categories: companies with under 5 vehicles, $n = 207$, 42.2%; those with 6–10 vehicles, $n = 152$, 31%; and those with over 11 vehicles, $n = 131$, 26.9%. Small business operators exist regardless of the size of the municipality, but medium- and large-sized business operators with over 11 vehicles are decreasing in small municipalities.

3.2.2 The role of TSS for taxi operators

As taxis constitute one of the individual types of transport service, analysing the usage frequency of taxi service by the elderly help us examine the mobility demand and service response. A wide implementation of TSS in many areas in Japan supports elderly mobility by encouraging them to go out actively. As per the survey on the introduction status of TSS, more than 80% of the respondents said they have introduced the scheme; most of the target users are disabled people and half of them are elderly. For the remaining un-introduced areas, 73% of companies want to introduce the scheme with the expectation of increasing business profit due to the increased number of taxi users.

³ Because some business operators answered the location that is different from the address listed in the National Hire Taxi Directory (it is considered to be the relationship between the branch office and the head office), we used this extraction method.

Furthermore, regarding the usage status of the TSS, 52% of companies responded that there are TSS users every day. Regarding the degree of contribution of TSS to management, 43.5% responded that it is an important business component, and 44.8% responded that it has a certain degree of contribution.

3.2.3 Expectation from local government by taxi industry

Among the requests for policy improvement, requests for the expansion of targeted persons and distributed tickets accounted for a large portion with 35% and 44%, respectively. As for support measures requested from the local government, urgent need for financial support for dealing with the impact of COVID-19 accounted for the highest share at 52%, and surprisingly, 45% show a higher desire for the introduction and expansion of TSS. Subsidy for purchasing safety support and fuel-efficient vehicles and introduction of reservation-type shared taxi account for the second- and third-highest share. However, there was no request for the introduction of private-paid passenger transportation with the cooperation of taxi operators in transportation vacant areas; on the contrary, more than 20% were opposed to this. More than 20% of small businesses (those with under 5 vehicles), also opposed the introduction of unlimited-ride and flat-rate taxis.

3.3 Role of TSS in mobility of elderly

3.3.1 Web survey of the elderly in depopulated areas

Targeting the elderly people in depopulated areas, we investigated their intention and evaluation toward mobility status, carpooling, flat-rate fare taxi, and vehicle dispatch service. We conducted a web questionnaire on Rakuten Insight for the elderly (over 60 years old) living in depopulated areas, in November 2020. We extracted samples of 300 people: 60, 100, and 140, for taxi subsidy users, non-users and private car owners/users, respectively, as shown in Table 5. However, after collection, we found that 6 people were living in the areas where TSS has not been introduced, so the valid sample was 294. It is to be noted that the questions asked in this survey were in light of the situation before the COVID-19 pandemic.

3.3.2 Actual condition of elderly mobility in depopulated area

The differences in socio-demographic background and level of public transport accessibility have great influence on shaping the travel patterns of the elderly. Figure 1 shows the calculation results of the annual outing frequency for the three groups in Table 5. Compared to non-TSS users, TSS users go out slightly less frequently, but do so more frequently for work/farm and hospitals/nursing care facilities. The overall annual frequency of outings has decreased by about 8% compared to the situation before the COVID-19 pandemic.

Among all basic outing activities by different trip modes, taxi usage was examined to evaluate whether TSS policy plays a positive role in mobility demand. Table 6 shows the frequency of going out by taxi. According to our survey, TSS users go out more frequently than non-TSS users. Even though the total number of outings of non-TSS users is higher than TSS users, the number of trips by taxi is higher for TSS users compared to those who do not receive the subsidy.

In this survey, the purpose for using and not using taxi was asked. TSS users use taxi for various purposes, such as shopping, visiting hospital, and city hall, while the other two groups have low percentages for these purposes. On the contrary, the other two groups use taxi for social outings, such as events and functions. High price was the highest ranked factor for not using taxi; however, for TSS users, it was low compared to the other two groups.

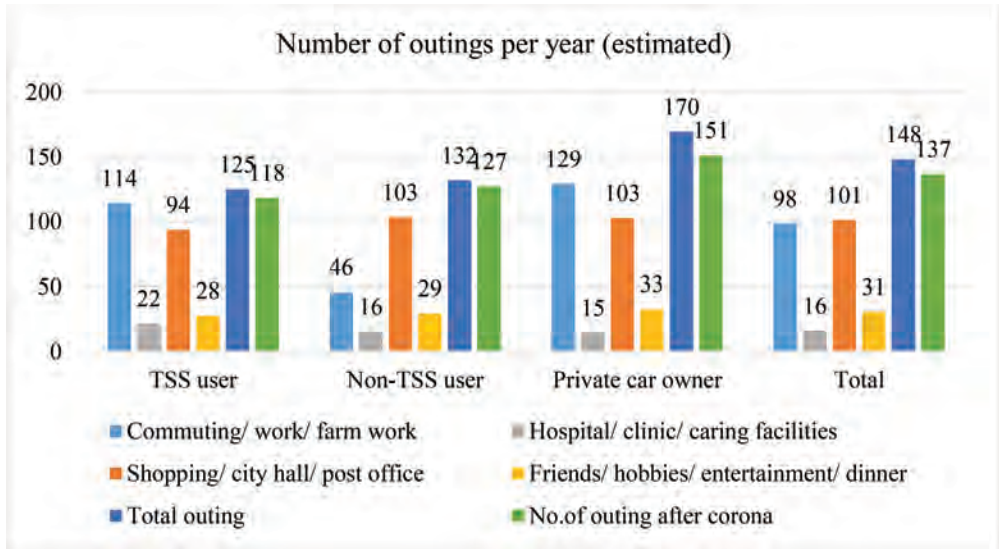


Figure 1: Number of outings/year (estimated).

Table 5: Structure of focus groups.

Abbreviation	Category explanation	Collected sample	Valid sample
TSS users	People over 60 years who cannot use car, motorcycle, or moped, and are receiving TSS subsidy	60	54
Non-TSS users without PC	People over 60 years who cannot use car, motorcycle, or moped, and do not receive TSS subsidy	100	100
Non-TSS users with PC	People over 60 years who can go out by themselves, have driving license, and do not receive TSS subsidy	140	140
Total		300	294

PC: Private Car Owner, TSS: Taxi Subsidy Scheme User

Social inclusion and independence achieved by transport accessibility are among the factors contributing to the quality of life, especially for the elderly, and thus need to be assessed. In this survey, the dissatisfaction degree of outing by purpose was analysed as well.

Among all the choices, going out for the purpose of less time constraint and infrequent items, such as hospital/medical examination and visits to acquaintance, TSS users showed less dissatisfaction compared to non-TSS users.

Table 6: Outing frequency by taxi.

Focus group	2–3 times/ week	Once/ week	2–3 times/ month	Once every two or three months	Once or twice/year	Available, but rarely use
TSS user	1.9%	7.4%	1.9%	11.1%	3.7%	40.7%
Non-TSS user	0.0%	0.0%	4.0%	5.0%	6.0%	46.0%
Private car owner	0.7%	0.0%	2.9%	2.1%	5.0%	66.4%

3.3.3 Awareness of TSS policy

Similar to how it is important to have the opinions of the local municipalities (being the sponsors and financial supporters of the policy) and taxi-business operators (being the service providers), the opinion of daily TSS users is also vital for improving system efficiency. It was found that, among the users, unlike local governments and business operators, there is a high demand for improving the discount rate. The increase in the number of distributed tickets (number of usage time) is a common request item with local governments and business operators.

3.4 Improvement of subsidy system and intention for flat-rate type taxi

We estimated the increase in outings as a result of expansion of subsidy scheme provided to TSS users. Figure 2 shows the intention of TSS users to increase the frequency of going out by taxi when the subsidy system and flat-rate taxi are provided. Focusing on the rate at which taxi outings are more than tripled, the flat-rate method gets the highest response, but with lower price. Second highest is the half price of the burden plus the upper limit of usage time.

Two types of choices (20 times with 6000 Yen and 20 times with 10,000 Yen) were given to all respondents to determine their intention to purchase a flat-rate taxi ticket. For the first option, 40% of respondents who were not eligible for TSS were willing to purchase a flat-rate taxi ticket.

Furthermore, for reducing operational costs and ensuring mobility, a method of limiting taxi subsidy to shared taxis is under trial; thus, the intention of using shared taxi was investigated. It appears the result for shared taxis is not desirable: 24% of the TSS users would “use if it is cheap, while 45%–50% would “use if there is no reservation.” However, for non-TSS users, making reservations was a significant factor preventing them from using a shared taxi. They showed strong resistance to certain items, as more than 50% responded that they “will not use if it requires reservation”. Overall, approximately 50% of respondents were inclined to avoid the sharing method.

Even though elderly people with TSS showed more positive attitudes and satisfaction for daily life outings than elderly without TSS, because of the individual use, the result is still inefficient. Although the introduction of shared taxis for this issue seems practical, making reservations would be a challenge because a lot of the elderly have no digital literacy, especially in remote areas. In such a case, along with the implementation of policy, workshops for teaching how to make reservations, how to use the application, etc. need to be sponsored by local municipalities.

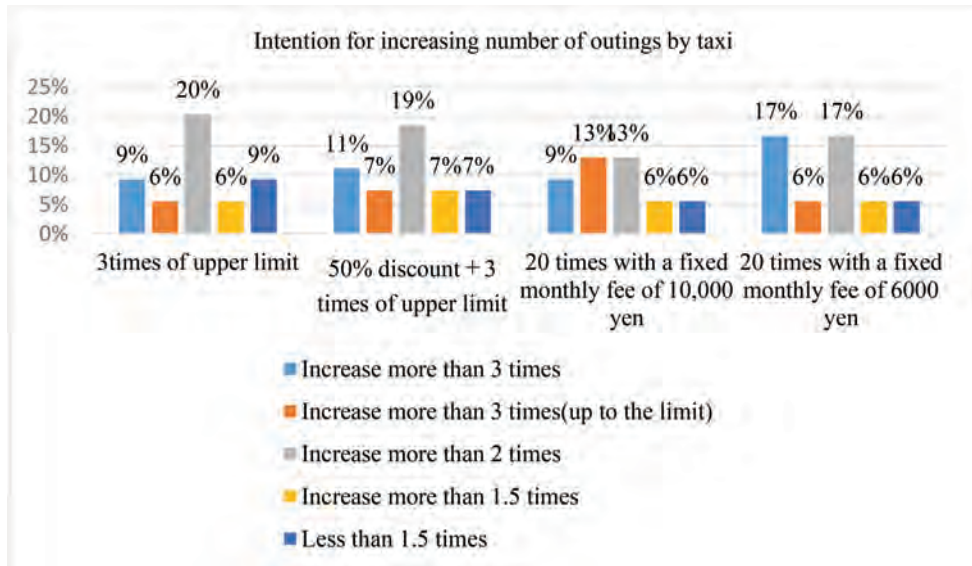


Figure 2: Intention for increasing number of outings by taxi.

4 DISCUSSION

In this study, the actual situation of the implementation of TSS as a support policy for the mobility of the elderly in depopulated areas is examined by three perspectives: local governments, taxi business operators, and elderly (taxi users). The policy-related contents like annual distributed tickets, subsidy amount, and discount rate along with the problems and expectations regarding system improvements were discussed.

Based on the survey of local governments in depopulated areas, we examined the status of TSS as a mobility support service for the elderly. Issues affecting the system and the intention for improving the system were analysed. TSS is widespread as a support for traffic vulnerable group and those who have returned their licenses, and the burden on residents is often not a large expense. There is a high demand for increasing the number of usage time, but the increase in the burden on public funds upon increasing the number of target users is a concern. Therefore, a balance between the budget and demand of users must be considered by developing a method for selecting the target persons and the appropriate subsidy amount (upper limit of the number of usage time) within the appropriate level of the burden on public funds. Even requests for increasing the usage time and number of target users are common among both business operators and taxi users. However, as is evident from the results of our survey, arbitrarily increasing the number of users is inefficient as it will only increase the financial burden on the government. Boosting usage efficiency by supporting the people really in need of transport is important because in certain areas with different socio-demographic background, some target users have a higher demand for outings, while some do not go out very often. Instead of increasing the usage time, setting an additional application procedure for tickets after the completion of distributed tickets is a better strategy.

According to the results of the survey of small- and medium-sized taxi operators in depopulated areas based on the management situation and issues and expectations and requests

for the TSS, TSS has contributed considerably to business management. Additionally, many business operators wish to increase the number of usage time and people eligible for subsidies. The demand for expansion of TSS is the second highest after the COVID-19 preventive safety measures.

We analysed the contribution of TSS to mobility of the elderly living in depopulated areas and investigated their intention to use carpooling, flat-rate taxi, and vehicle dispatch services through a web survey. It was found that TSS users use taxi for various purposes and are less likely to be influenced by high price compared with non-TSS users. There are high demands for increasing the maximum number of usage times and increasing discounts. In other words, it is suggested that the taxi subsidy system should be the “ideal public transportation” by narrowing down the target users and improving the service. For flat-rate service, if the price per service is reduced to 300 Yen, the purchase intention will increase considerably. The reservation-type carpooling system will be used by less than 50% of the people if it is cheap or without reservation. By flexibly setting the financial cost on the user according to their needs, combined usage of shared taxi service with TSS and an upgraded vehicle allocation system is suggested.

A well-organized transport system not only means a “transportation tool”, but it also plays a large role in motivating regional revitalization by reconnecting people and regions. To secure and maintain public transportation in regions, it is important to work with the sense of “what is the purpose for maintaining” and sense of independent responsibility of “maintaining by ourselves”. To achieve this goal, it is important for all parties concerned to hold sufficient discussions. Thus, maintaining a mutual balance and coordination between these three stakeholders is vital. Among them, local municipalities play a central role in considering the ideal form of local public transportation, which is suitable according to their own geographical, social, and economic condition. They also play a collaborative role with related parties and demonstrate leadership. In particular, because it is necessary to improve the effective usage of the regional public transport system, the local governments will be requested to support the expenses required for efforts such as dissemination of information about public transportation services to improve the collaboration among parties.

In the above analysis, it should be pointed out that the statistical accuracy of the numerical values for each comparison group is not sufficient; thus, it is necessary to pay attention to the quantitative evaluation. According to the assumption that the confidence level is 95% ($z = 1.96$) and the response ratio $P = 0.5$, eqn (1) is applied for estimating the error e in sample size n when the population is large enough. According to the calculation, in the taxi users survey, the error values are 5.7% ($n = 294$) and 13.3% for the TSS user group ($n = 54$). For non-TSS users without car, the error is 9.8% ($n = 100$), whereas the error is 8.3% ($n = 140$) for those with car.

$$e = z \sqrt{\frac{1}{n} (P(1-P))}, \quad (1)$$

$$e = z \sqrt{\frac{(N-n)}{(N-1)} \times \frac{1}{n} (P(1-P))}. \quad (2)$$

Since the population size N of the other two surveys is finite, the error e can be calculated using eqn (2).

For the municipalities survey, the error is 6.1% ($N = 300$, $n = 140$); for municipalities with population of under 15,000, it is 11.4% ($N = 136$, $n = 48$); for municipalities with population of 15,000–45,000, it is 10% ($N = 91$, $n = 47$); and for municipalities with population of over 45,000, it is 8.6% ($N = 73$, $n = 47$).

Similarly, in the taxi operator survey, for all companies, the error is 3.8% ($N = 1786$, $n = 491$). For companies with less than 5 vehicles, the error is 5.9% ($N = 807$, $n = 207$); for companies with 6–10 vehicles, it is 6.7% ($N = 505$, $n = 152$); and for companies with 11–20 vehicles, it is 7.3% ($N = 473$, $n = 131$).

5 CONCLUSION

As mentioned above, the utilization of taxi subsidy tickets has certain advantages for all three stakeholders: the local government, taxi operators, and the elderly users. Promoting the expansion of TSS to those who need to be secured by an effectively designated selection system of target users is recommended as an improvement measure. Furthermore, individual transportation services have considerable costs; thus, it is impossible to provide services uniformly with subsidies, and acquiring social consensus is difficult as well. Therefore, it is essential to consider using it in combination with a shared system to reduce costs. Considering the provisions of Road Transport Law, utilization for permission of sharing transport has a higher flexibility as it may be easier to position as a public transportation measure. In our survey, nearly 50% of the users are likely to use the sharing method.

In addition, because not all of the elderly who need individual services are from financially poor households, rather than uniformly reducing or exempting fares (a method used in MaaS), using the flat-rate service for a fixed number of individual usage and charging the excess amount can be a viable option. It is also important to improve TSS for accurate selection of the needy and providing support for necessary travel opportunities.

Regarding the sustainability of taxi businesses in depopulated areas, even though there were many requests from businesses to expand subsidies, it is important to improve vehicle utilization efficiency not only for passenger transportation but also for fulfilling various transportation needs such as shopping, hospital visits, nursing centre, and food distribution service. For this purpose, there may be a need to establish a “transportation service dispatch centre” that centrally accepts and dispatches taxis for such transportation needs. Therefore, it is necessary to develop MaaS platforms and business models to ensure business reliability and deal with institutional and contractual issues regarding information monopoly.

Furthermore, as a system to balance the burden and benefits, the direction of intergenerational cost burden such as “transportation insurance” is also considered an important policy. “Transportation insurance” means paying transportation insurance from a young age to secure mobility when at old age. In many local governments, the financial burden of public transportation is mostly within the range of several hundred yen to several thousand yen per capita per year. If the transportation insurance is done per day, the total amount will be several yen to several tens of yen, which can be acceptable as a slight burden. We would like to study the intention and feasibility of such measures as a future issue.

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