

Strategic Innovation Promotion Program (SIP), Phase 2
Autonomous Driving (System and Service Enhancements)
Commissioned work of the
“Survey on the Environment Development for the Implementation of
Autonomous Driving Mobility Services in New Town Areas”
Summary Report

- Tama New Town (Tama City) -

April, 2019

The Japan Research Institute, Limited
Keio Dentetsu Bus Co., Ltd.

Demonstration at Suwa and Nagayama areas in Tama New Town

*Overview of Tama New Town (Tama NT)

- Vast area covering four cities of Hachioji, Machida, Tama and Inagi with about 2,900 ha, 14 km east to west and 2 to 3 km north to south.
- Largest new town in Japan with a population of 220,000.
- Plan decided in 1965, and move-in started in 1971.
- Located in hilly areas with no means of transportation within NT, problems related to transportation such as the difficulty of going out for the elderly and the child-rearing generation have become apparent.

*Target Areas (Suwa and Nagayama complex)

- The area is located in the south of Keio Nagayama Station and Odakyu Nagayama Station and has a population of 27,000.
- It is the first residential area of the Tama NT, and aging and deterioration are progressing. The area near the station was rebuilt with private capital, while the other areas are expected to face further aging and population decline.
- Although route buses run on the main roads to the station, their profits have deteriorated due to a decline in demand for commuting to work and school. There is also a serious shortage of drivers, and it is necessary to recover profits and take measures against the shortage of drivers.

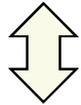


Challenges in NT Mobility and Service Hypothesis for Social Implementation

*Opinions on current mobility services

1 Residents in the Suwa and Nagayama areas

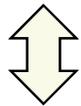
- As getting older, often feel that stairs, slopes and steps are hard.
- Those who do not feel an inconvenience for moving on a slope or stairs at present are anxious about the future decline of physical strength.



Urban space improvement is required for NT regeneration

2 Users and operators of public transportation

- At present, there are no complaints about the existing route buses.
- As there is a great demand for shopping at supermarkets around Nagayama Station, there are many requests for a direct route between the housing complex and Nagayama Station.

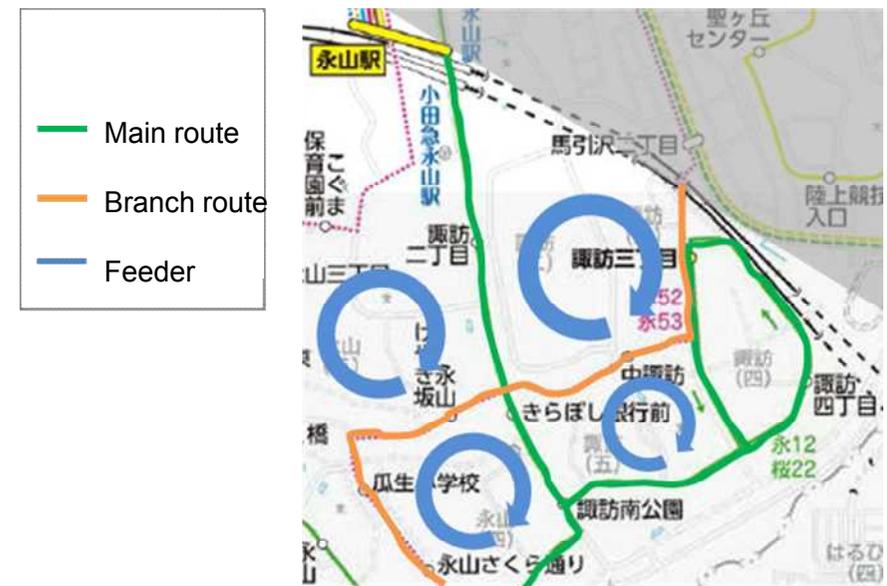


On the other hand, a decline in commuting demand and a shortage of drivers are serious problems

*Service hypothesis at the start of the survey

- Viewing future main route automation in mind, we started survey on the hypothesis that we would promote the social implementation of the autonomous driving mobility services from the automation of feeders as an immediate step.
- It is assumed that automated feeders will be able to capture the needs of elderly people to move within the community, and that social acceptability will be enhanced by becoming a daily means of mobility for residents.

Figure: Relationship between Main route, Branch route, and Feeder



Results 1: Route, Outline of Demonstration, etc.

*Route Summary

- Routes were established within each housing complex of Suwa and Nagayama (roads within housing complex are “deemed public road”).
- Enabled to move between housing complexes across main roads.

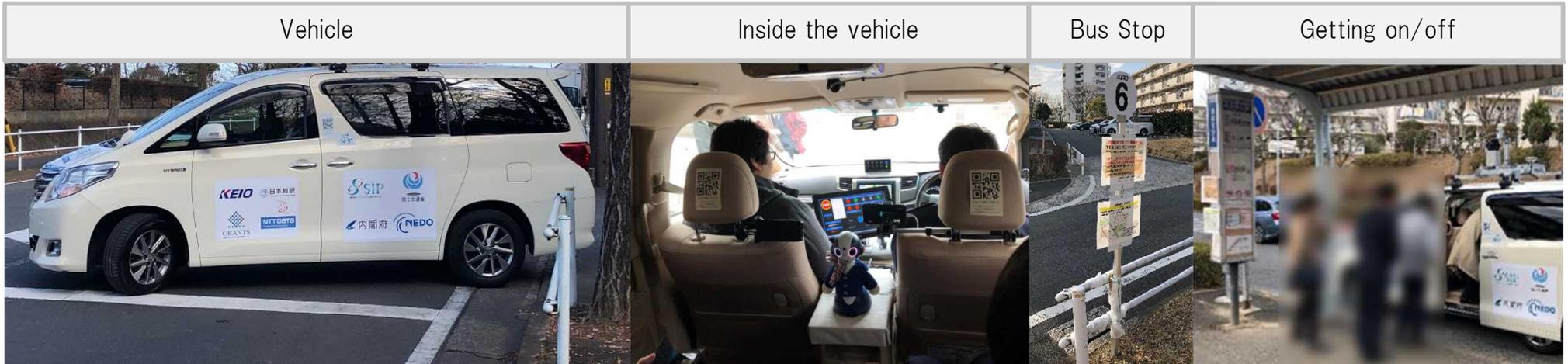


*Outline of Demonstration

Operation pattern, Running Extension	Pattern A (terminal) Total 1.4 km
Operating method, get on/off method	Constant route method. It runs between designated get on/off points only when there is a call.
Period	February 18, 2019 – February 24, 2019
Target	Mainly elderly people in the areas
Vehicle	Toyota Alphard
Operation system	Operation management system provided by NTT DATA
Autonomous driving level	Gunma University’s level 4 autonomous driving technology (driver gets on while driving)
Safety management	Driver always rides

Results 2: Demonstration

*Operation conditions



*How to use

1 Reservation Method

- Adopt on-demand boarding system
- Call the vehicle by phone or on the Web

2 Specifying time

- Not allowed to specify boarding time
- Operator informs the estimated arrival time
- Vehicle will depart if no passengers arrive after a while.

3 Other services

- Coupons for shopping centers located in local shopping districts and the destinations of existing bus routes are distributed in the vehicle

App's screen



Results 3: Areas

*Running conditions

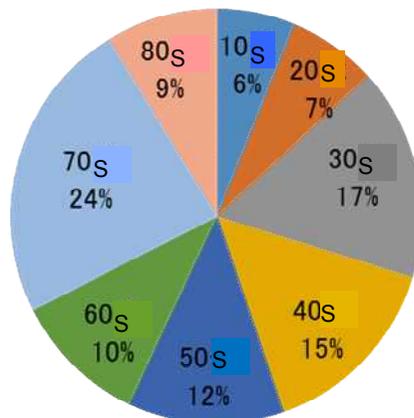


Results 4: Trend of Users at Demonstration

*Trend of users

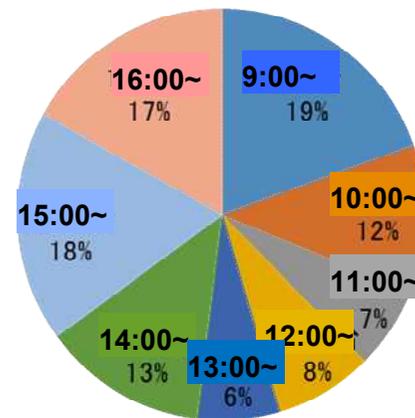
- During the period (one week), the total number of passengers was 211, of which 114 people, excluding those concerned, were users
- The figures below show the trends in the use of the services, in order to examine the status of social acceptability development and issues in the housing complex.
 - More than 40% of the users were in their 60s or older, indicating a certain level of interest from older age groups
 - Calls for services were mostly 9 o'clock and 15 to 16 o'clock. It can be said that there were many utilization in the time zone where the residents moved on a daily basis
 - The most common reason for going out was Shopping (17%). However, Others accounted for about 80%, and more than 90% of them answered that they just wanted to ride it, indicating their strong interest in autonomous driving services
 - About 80% of calls were made via phone, far outpacing app usage

Age group
(N=114)

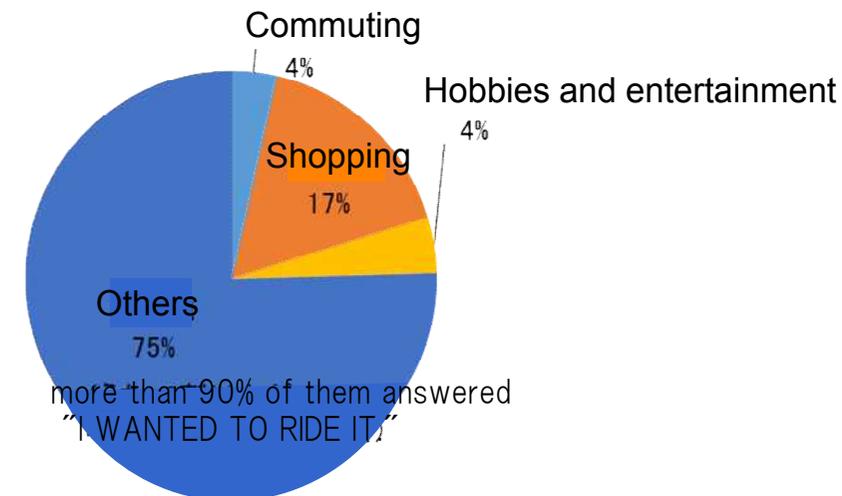


Hour
(N=77)

*Call frequency base
There may be multiple passengers in one call



Purpose
(N=114)



Results 5: Passenger Questionnaire

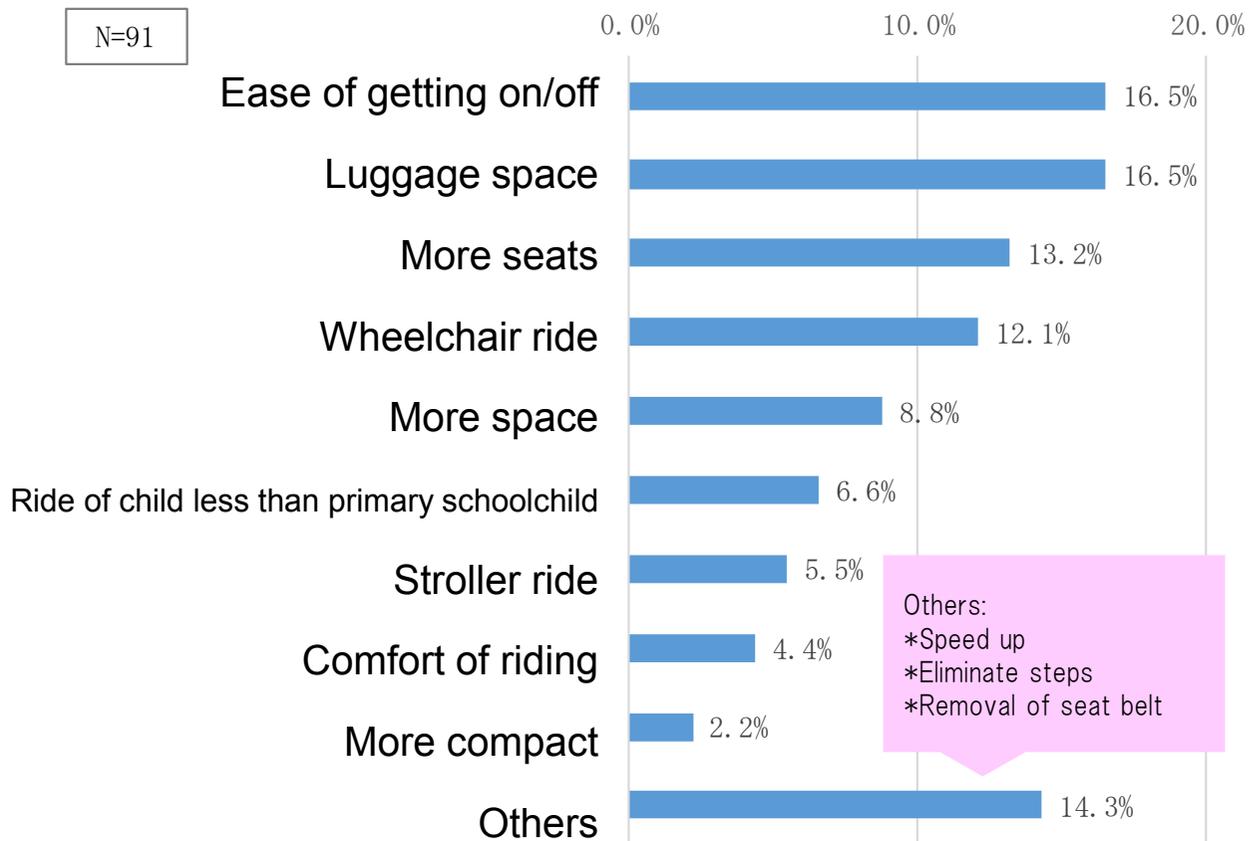
*Outline of the Questionnaire Survey for Passengers Participating in the Demonstration

Passenger Questionnaire	
Purpose	<p>Conducted the questionnaire survey in order to understand the following items</p> <ul style="list-style-type: none"> • Purpose of using the autonomous driving services • Intention regarding social implementation, awareness of mobility issues, etc.
Target	<ul style="list-style-type: none"> • All users of the demonstration
Method	<ul style="list-style-type: none"> • The staff handed out the questionnaire to all the passengers • They fill out questionnaires and send them by mail
Date of implementation	<ul style="list-style-type: none"> • Distribution: February 18, 2019 to February 24, 2019 • Collection and aggregation: March to April, 2019
Number of copies collected	<ul style="list-style-type: none"> • Out of 114 copies distributed, 56 were collected (excluding related parties)

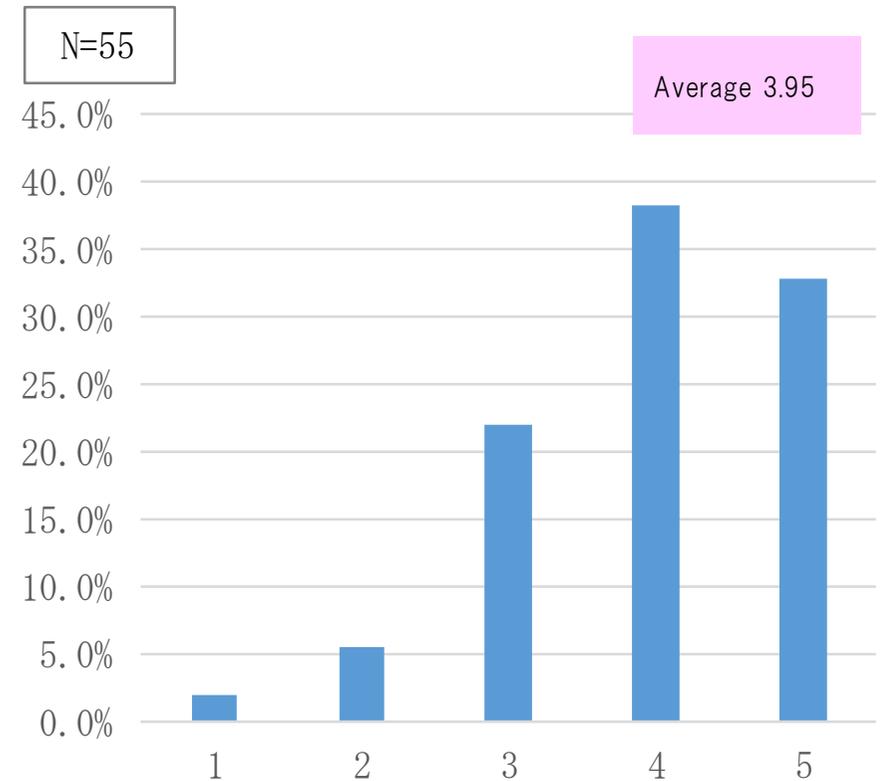
Results 5: Passenger Questionnaire – Vehicles

Ride comfort was rated 3.95 on average in 5 grades. In addition, improvements such as reducing the load on getting on/off and increasing the space in the car were clarified.

What kind of improvement requests do you have regarding this autonomous driving vehicle? (multiple answers allowed)



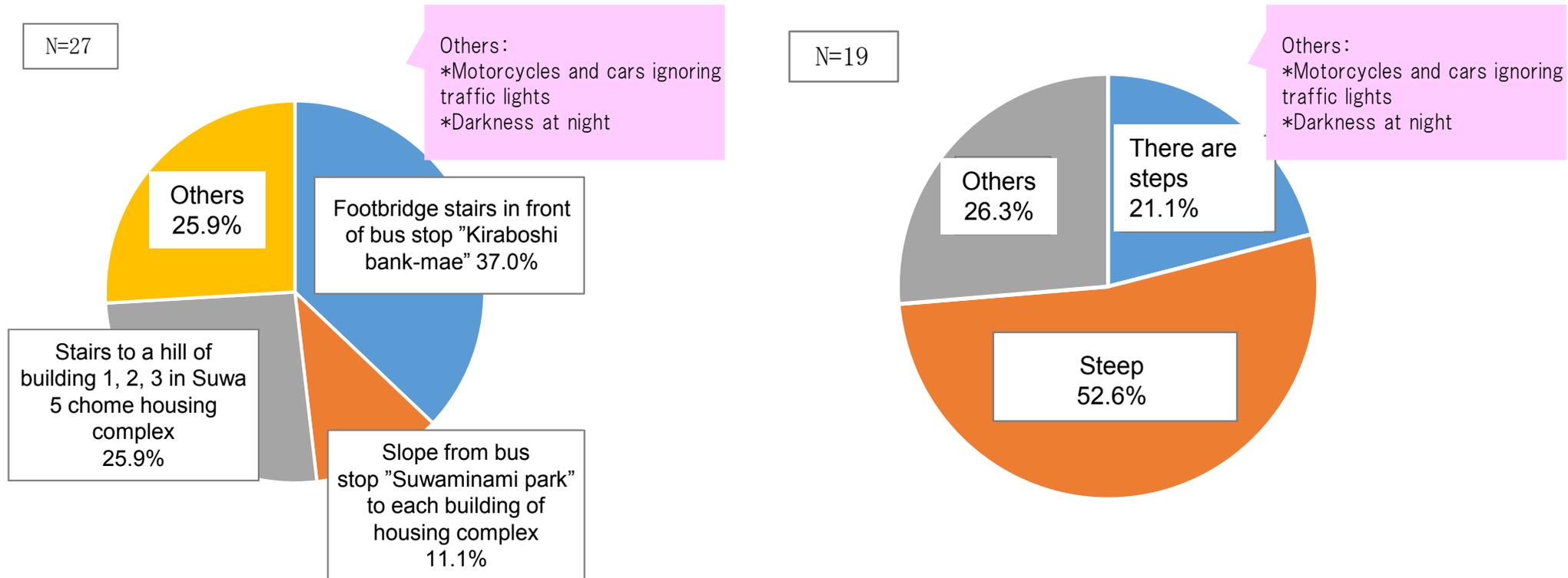
How was the riding comfort of the vehicle?



Results 5: Passenger Questionnaire - Locations of Danger/Failure in NT

The total of “There are steps” and “Steep” was 73.6% of the places where residents felt difficulty in moving. The specific three places occupied 74.0%.

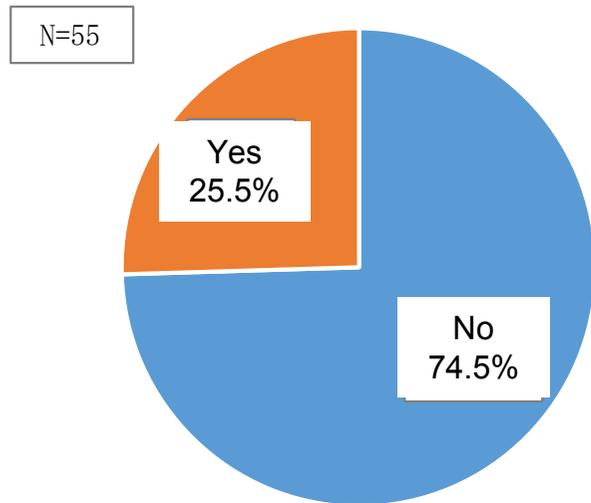
Is there any place in the area that you feel difficult to move on foot? If so, please tell me the place and the reason.



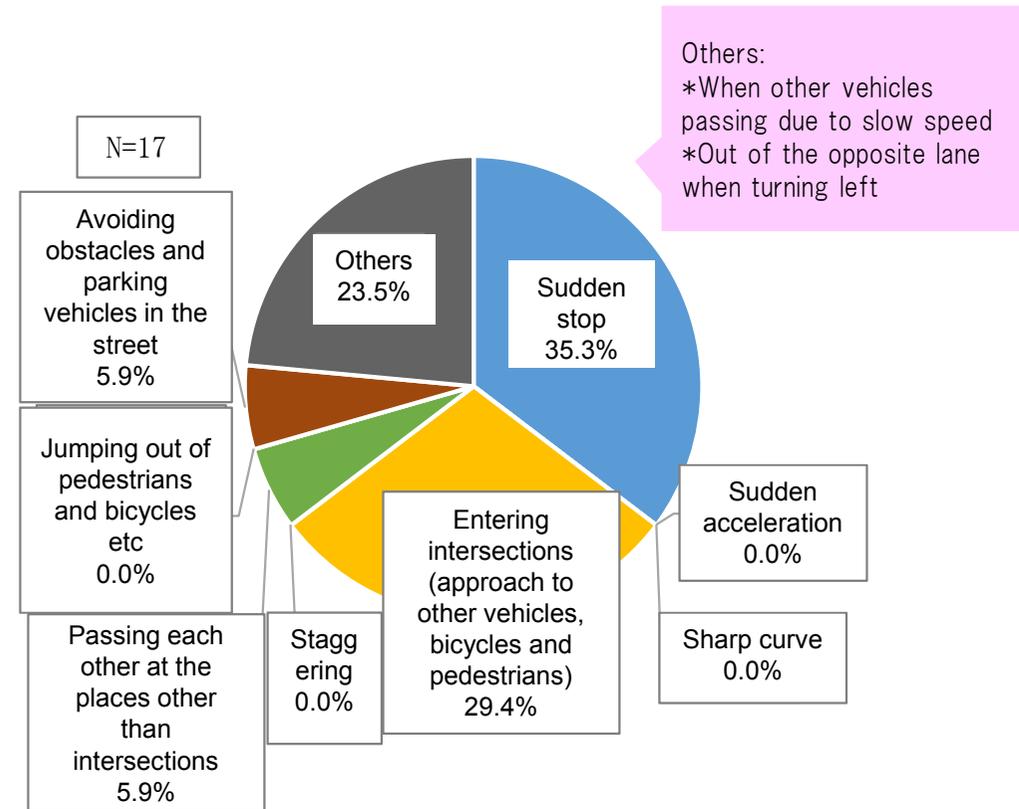
Results 5: Passenger Questionnaire - Interference with Existing Public Transportation

The percentage of passengers who felt danger was 25.5%. Specifically, there were cases of interference with existing traffic, such as passing vehicles due to slow speed, avoiding on-street parking, and approaching other vehicles at intersections.

Did you feel danger while riding?



(We ask only the person who selected “Yes” on the left question.)
What kind of scene did you feel danger?

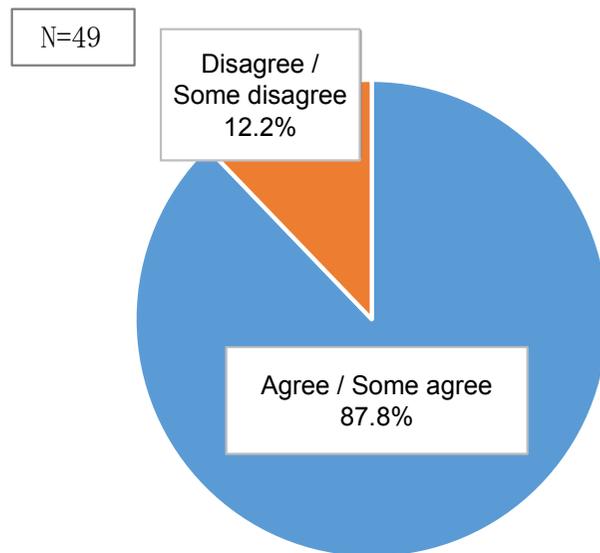


Results 5: Passenger Questionnaire - Opinions of Residents

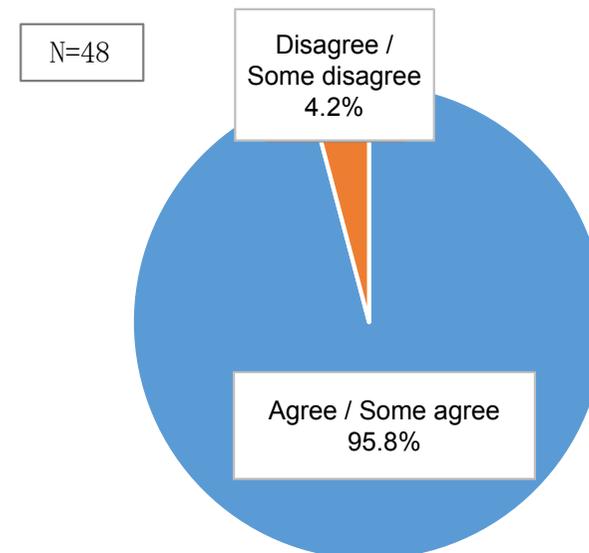
A comparison between before and after participation in the demonstration showed a 7.7 point improvement of favorable answers, indicating that the social acceptability of the community has improved to a certain extent.

Have you changed your opinion about introducing autonomous driving public transportation into your community before and after participating in this demonstration?

[Before]



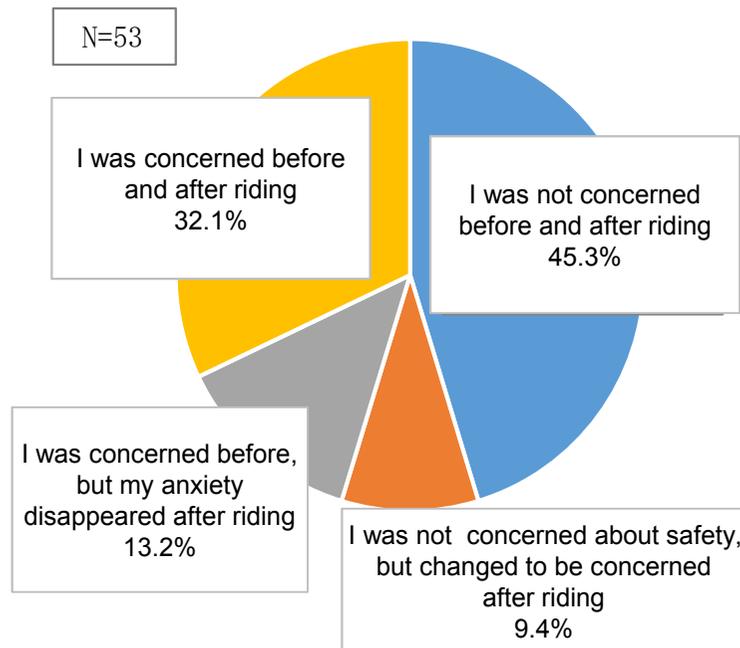
[After]



Results 5: Passenger Questionnaire - Opinions of Residents

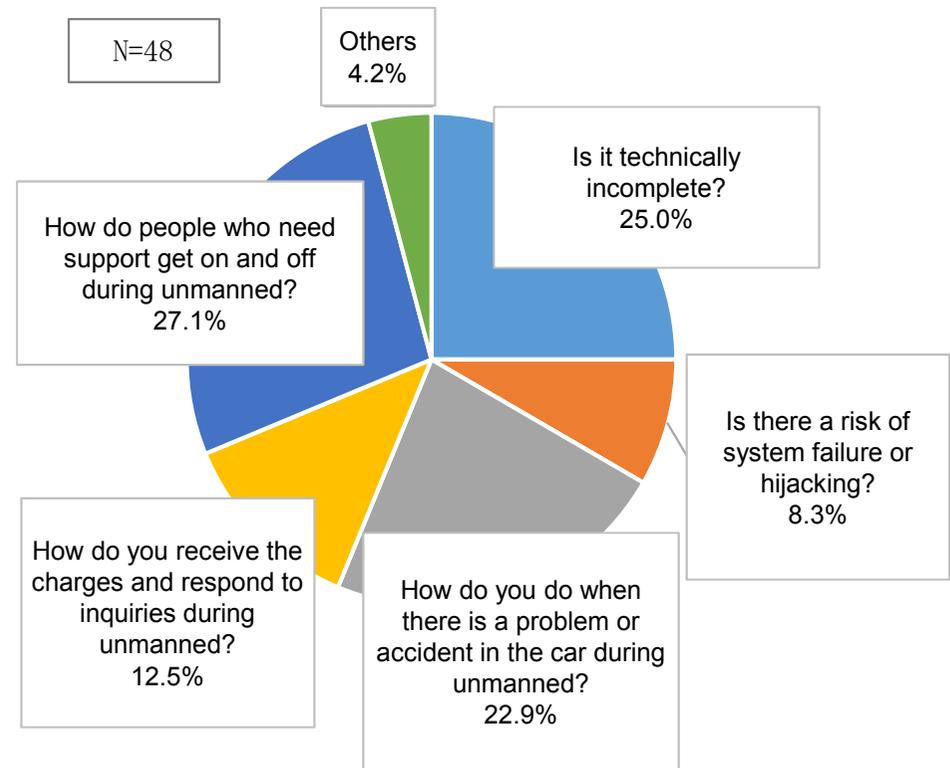
The percentage of people who are concerned about safety after riding is 41.5%, and 62.5% of them are concerned about being unmanned. This point should be considered in the implementation of the autonomous driving services.

Were there any changes in your safety concerns before and after participating in this demonstration?



(Only those who answered “Anxiety” after riding” with the question on the left.)

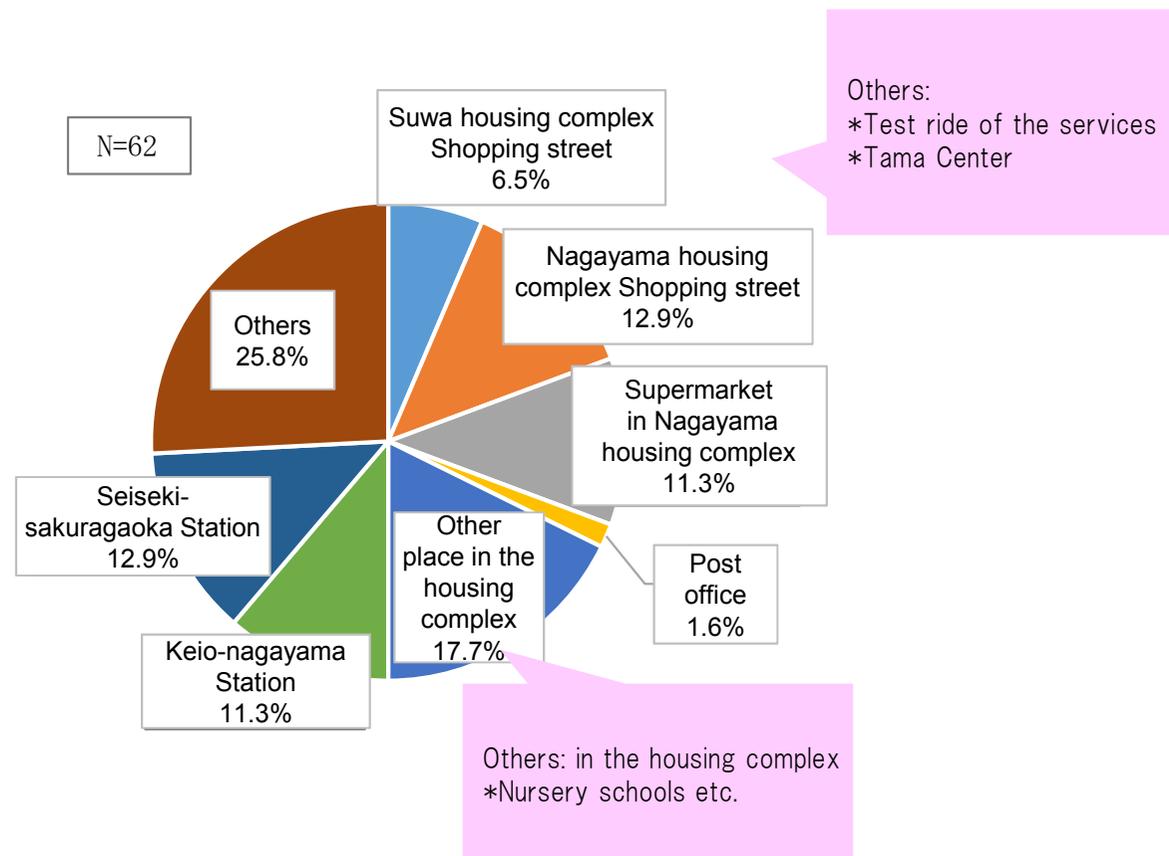
What were you worried about?



Results 5: Passenger Questionnaire - Purpose of Travel

The services were used for transportation to various facilities in addition to commercial facilities in the housing complex, such as shopping districts and supermarkets, which occupied 30.7%.

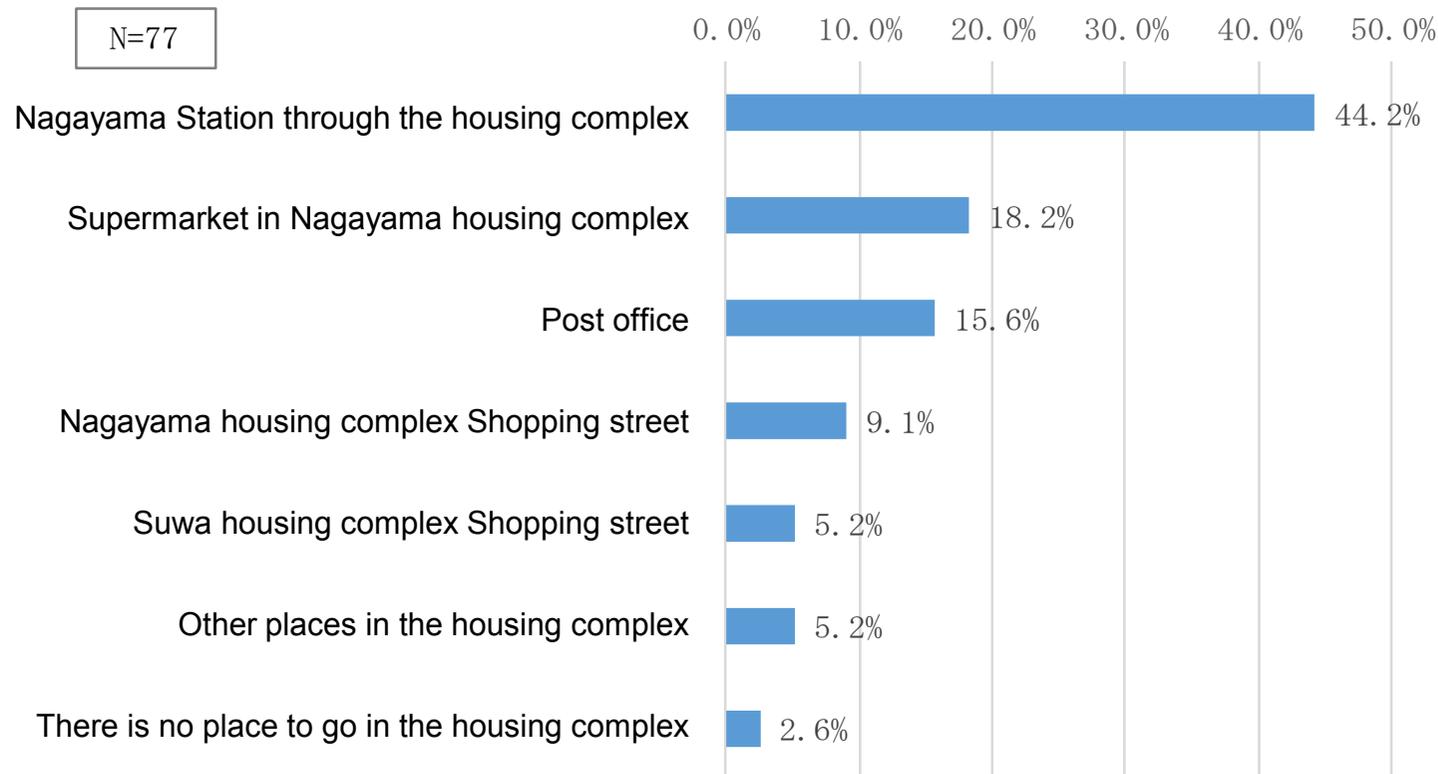
Please tell me the destination of this trip.



Results 5: Passenger Questionnaire - Transportation Routes

As for the desired destination, Nagayama Station accounted for 44.2%, supermarkets in the housing complex accounted for 18.2%, and post offices accounted for 15.6%, indicating the need for transportation from the housing complex to stations, supermarkets, post offices, etc.

The autonomous driving vehicles are designed for short-distance travel within the housing complex, including sidewalks. Where would you like to go in the housing complex? (multiple answers allowed)



Results 5: Passenger Questionnaire - Reservation, Dispatch, and Operation System

Among passengers aged 60 or older, 63.3% wanted to use the scheduled operation system and 97.9% wanted to make a reservation by telephone. It is necessary to consider the operation method in order to promote usage of people aged 60 and over.

Preferred operation system by age group



- Calling operation system
- Scheduled operation system
- I can't say either way

Reservation method by age group

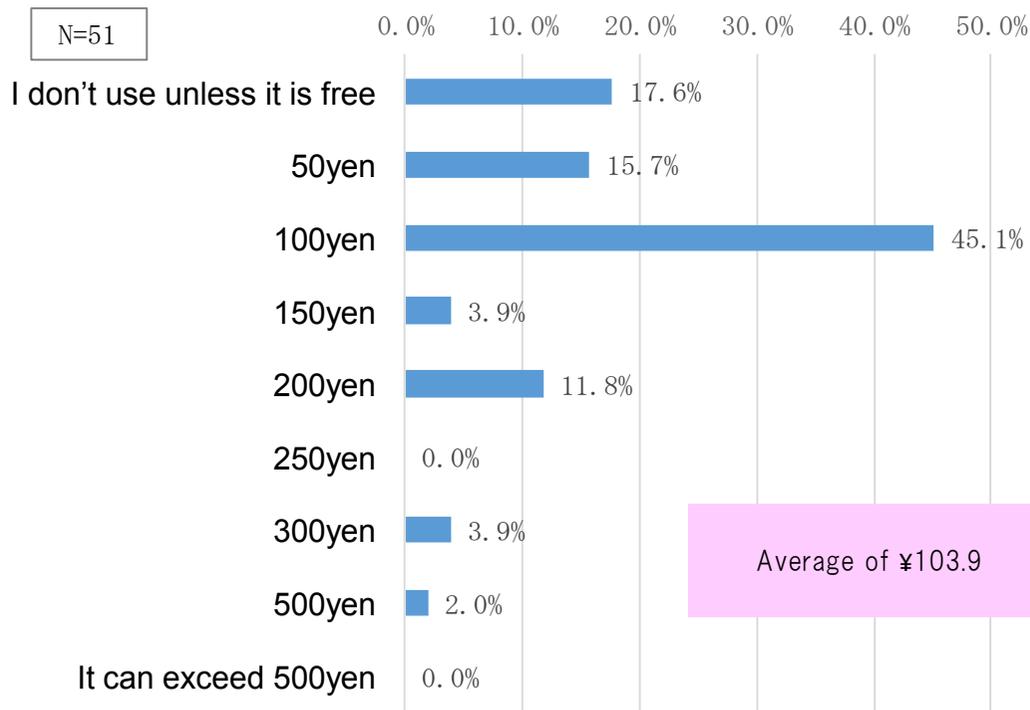


- Smartphone
- Telephone

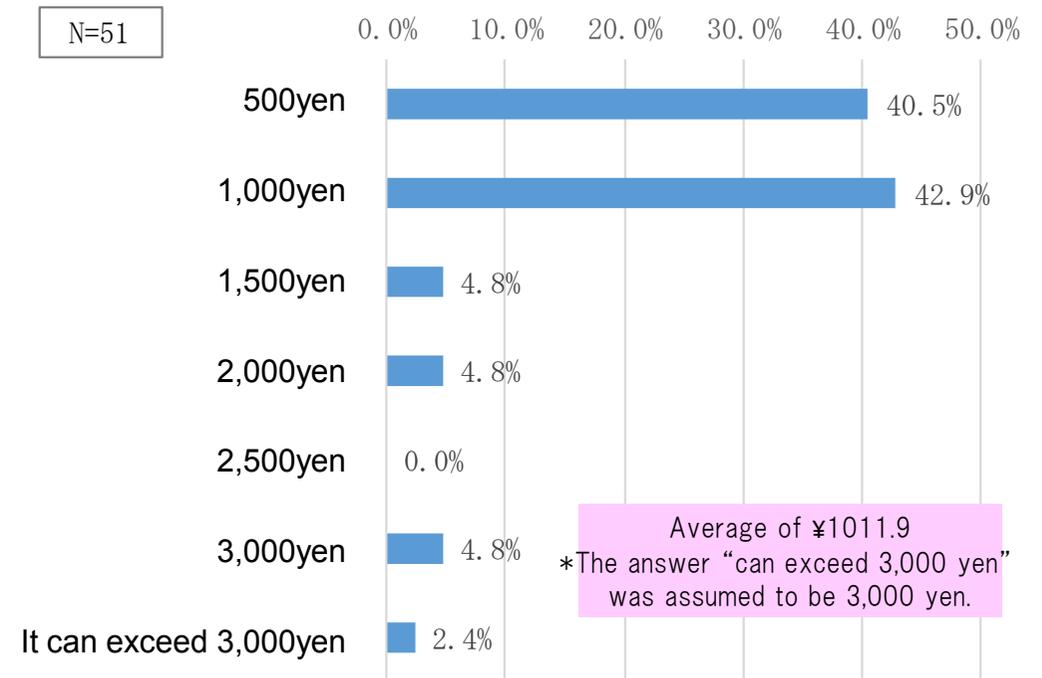
Results 5: Passenger Questionnaire - Service Fee

As for the fee per one time, 100 yen was the most frequent and the average was 103.9 yen. The most frequent monthly figure was 1000 yen, with a hypothetical average of 1011.9 yen. It is desirable to consider this matter in the future based on the results and costs.

How much do you think you would like to pay for each ride if the autonomous driving service is launched?



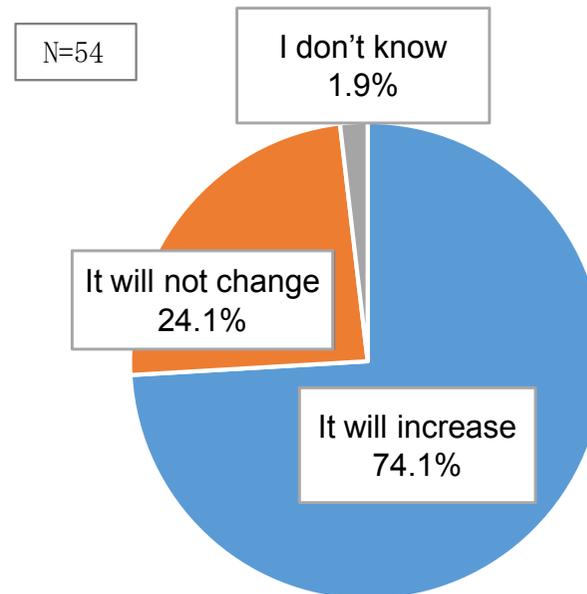
How much do you think you can pay for unlimited rides with monthly fixed fees?



Results 5: Passenger Questionnaire - Intention to Use Coupons

With the distribution of coupons of retail stores, 74.1% of the respondents said that they think the travel to Seiseki-Sakuragaoka will increase, suggesting the possibility of promoting the use of stores by distributing coupons in the vehicles.

Do you think the chances of going to Seiseki-Sakuragaoka will increase if coupons and discount tickets of retail stores in the area are distributed on the vehicle like this time?



Results 6: Residents Questionnaire Survey

*Outline of Questionnaire Survey for Residents of Suwa and Nagayama Danchi

Questionnaire survey of residents	
Purpose	<p>Conducted this questionnaire survey in order to understand the following items</p> <ul style="list-style-type: none"> • Impressions of Self-Driving Vehicles in Demonstration Tests • Investigation of transport issues • verification of social acceptability
Target	<ul style="list-style-type: none"> • All residences in the experimental areas of Suwa 5-chome and Nagayama 4-chome
Method of investigation	<ul style="list-style-type: none"> • Who conducted the survey posted questionnaires to all houses in the experimental area • Residents fill out the questionnaires and send them by mail.
Date of implementation	<ul style="list-style-type: none"> • Distribution date: March 12, 2019 • Collection deadline: April 5, 2019 • Data collection period: March to April 2019
Number of items collected	<ul style="list-style-type: none"> • Collected 404 out of 2,000 distributed

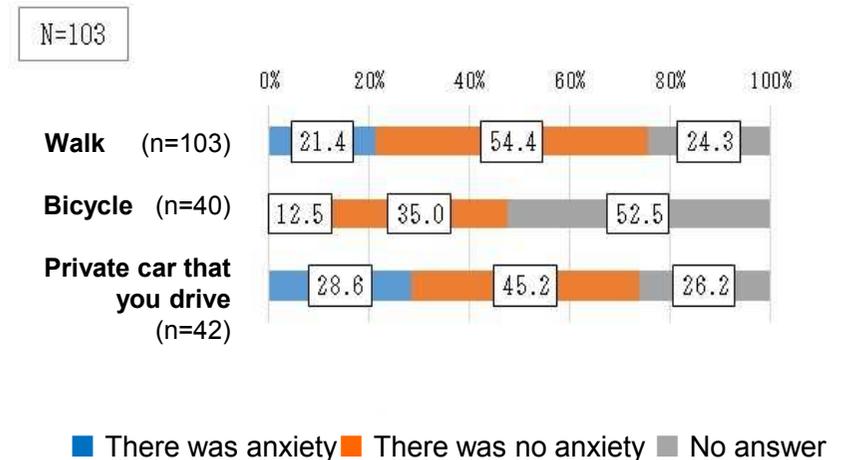
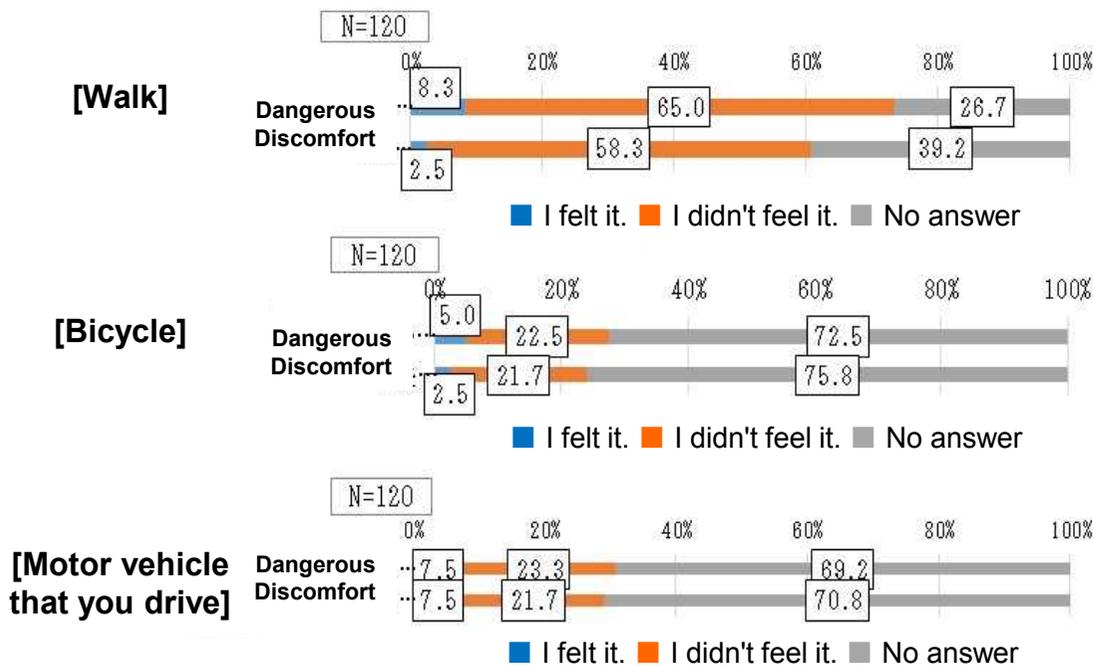
Results 6: Residents Questionnaire Survey: Safety of Automatic Operation from the Viewpoint of Surrounding People

With regard to the safety of self-driving vehicles from the viewpoint of surrounding people, 2% to 9% feel that self-driving is dangerous. In addition, even before the experiment, 29% of the users of private cars were concerned about the safety of automatic driving, and it is necessary to consider measures to gain the understanding of residents from the viewpoint of safety when implementing mobile services.

Please tell me your transportation method when you encounter a self-driving vehicle during the experiment.

Also, at that time, please tell us if you felt it dangerous or discomfort for a self-driving vehicle to run on the same road space. (The following is an example of an answer.)

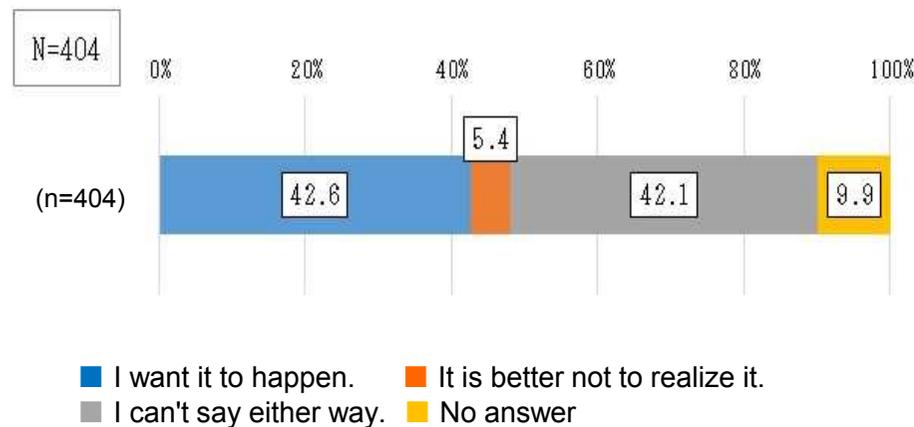
Were there any concerns about the safety of self-driving vehicles before you saw them during the experiment? Please tell us about the safety from the outside of the self-driving car.



Results 6: Residents Questionnaire Survey: Needs for automated transportation services

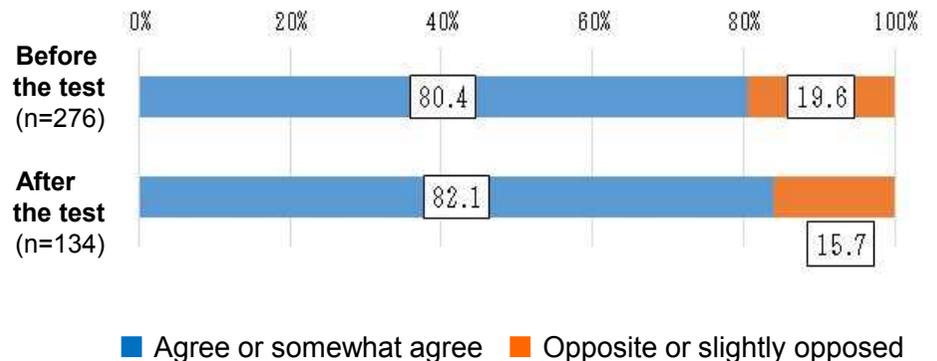
The survey also showed that 42% of respondents want to realize short-distance mobile services using automatic driving. In addition, the number of people who support the introduction of self-driving public transportation before and after seeing self-driving vehicles increased from 80% to 82%, and the social acceptance has been improved through demonstration tests.

If automatic driving is realized, it is expected that mobile services will be able to be provided even in short-distance travel, such as within a housing complex, because there are no restrictions on drivers. Would you like us to offer short-distance mobile service using automatic driving in this area?



Do you agree with the introduction of public transportation using self-driving vehicles in the area? Are you against it? Please let me know your intention to be introduced in the area whether you ride or not.

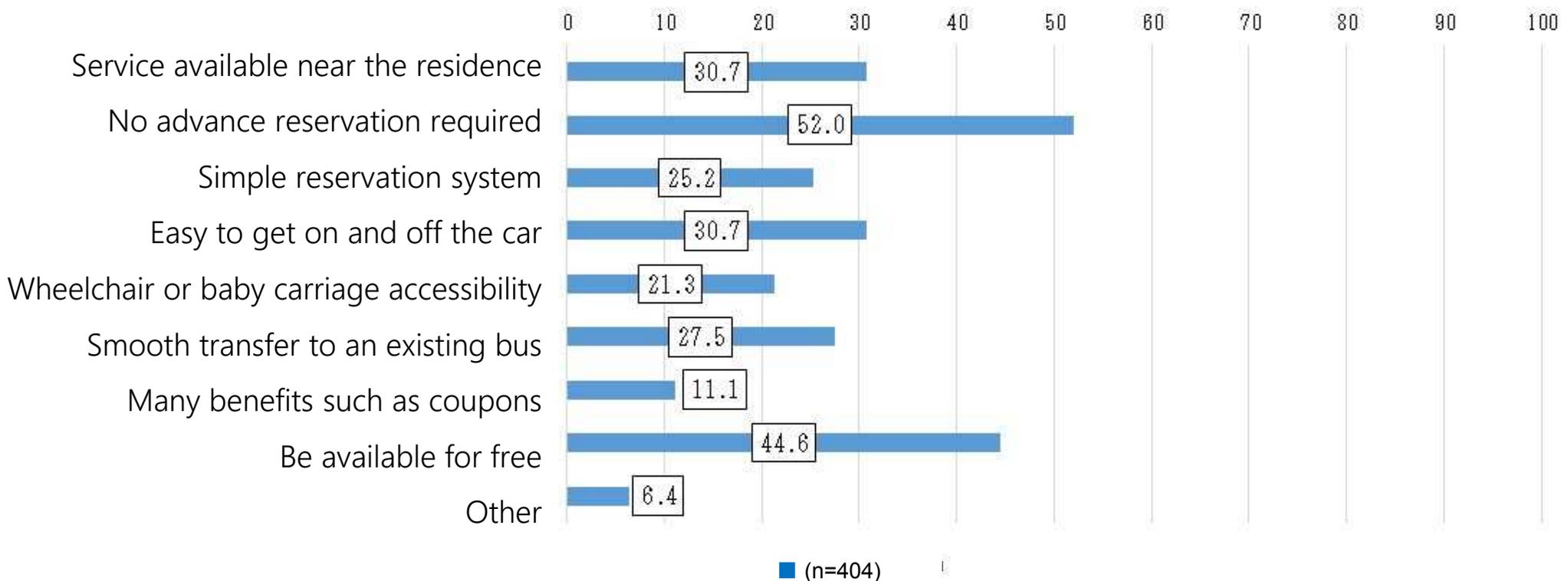
If you saw a self-driving vehicle during the test, please answer before and after each. If you did not see the self-driving vehicle during the experiment, please answer [Before seeing a self-driving vehicle] only.



Results 6: Residents Questionnaire Survey: Factors Required for Short-Distance Movement Service in Housing Complex by Automatic Operation

Strictly Confidential

There are many opinions about the convenience and cost of using services, such as "No advance reservation required (52%)" "Free (45%)" and "Easy to get on and off the car (31%)" as factors necessary to make people want to use short-distance service within a housing complex by automatic driving.

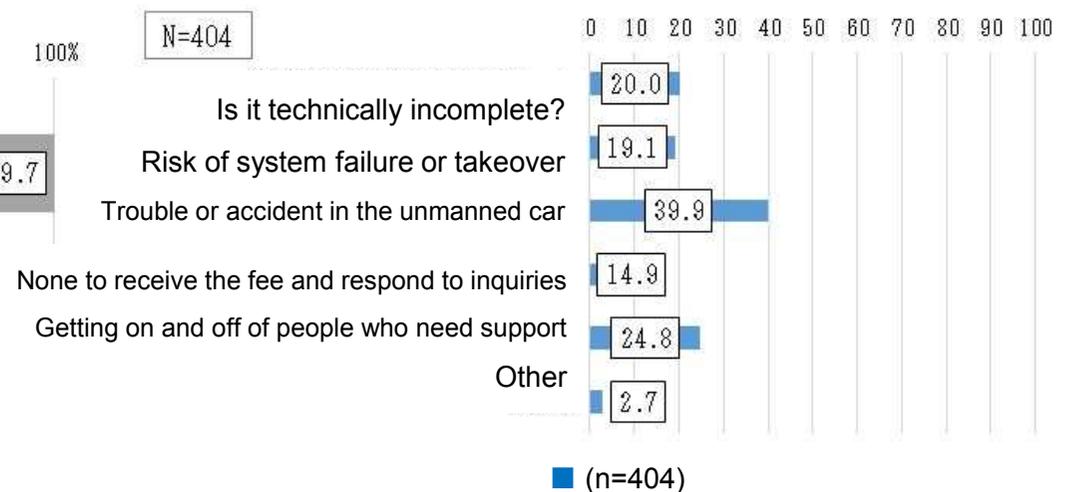
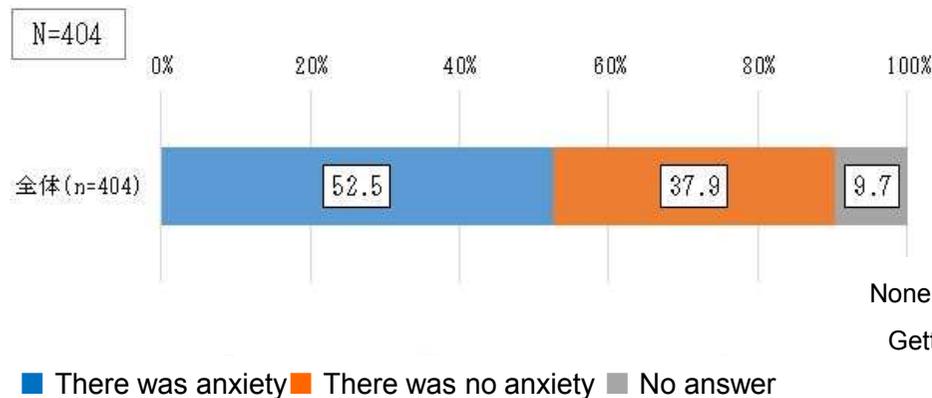


Results 6: Residents Questionnaire Survey: Anxiety about Riding in Self-Driving Vehicles

More than half of the people feel uneasy about getting on a self-driving car. There are many concerns about the service itself, not about the safety of transportation as a mobile service, such as troubles in the train or getting on and off of people who need support, because it is unmanned.

Are you worried about getting on a self-driving car?

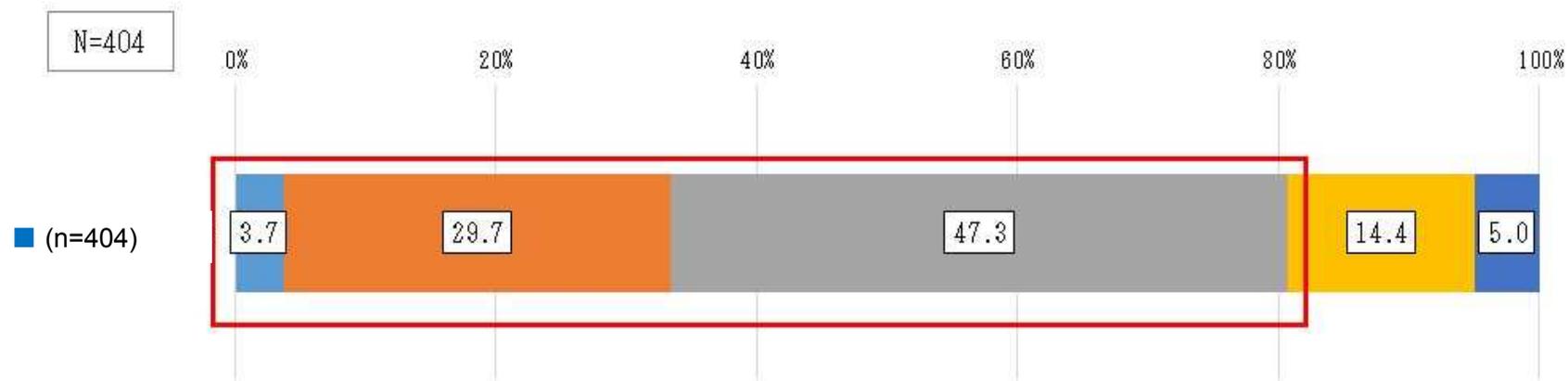
What are you worried about?



Results 6: Residents Questionnaire Survey: Dissemination to residents through **residents' briefing sessions and briefing sessions**

In the demonstration region, over 80% of the respondents said that they were aware of this demonstration experiment (Red Frame Reference), and publicity activities such as explanatory meetings for residents and debriefing sessions were effective for informing residents. On the other hand, 47% of the respondents said that they knew about the demonstration experiment but did not use it, so it is necessary to consider measures to promote the use of the demonstration experiment.

Did you know that a demonstration experiment of a short-distance mobile service using self-driving vehicles was conducted at the Suwa-Nagayama Housing Complex from February 18 to 24?



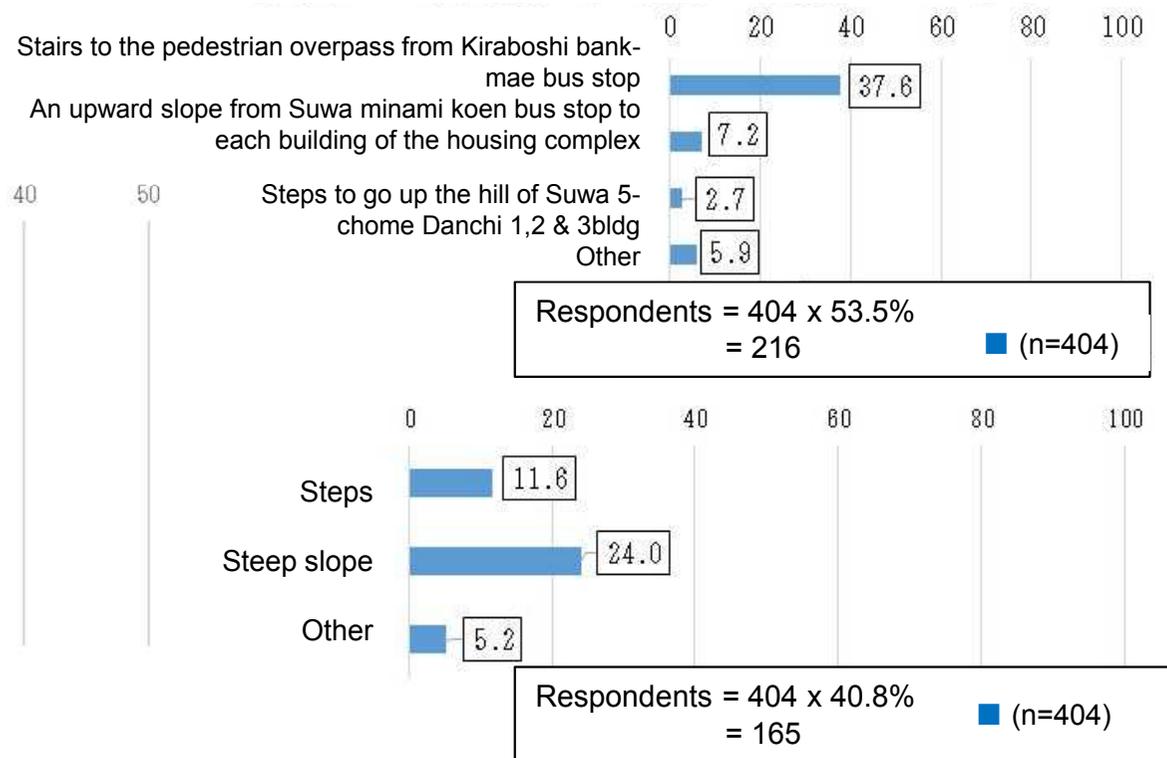
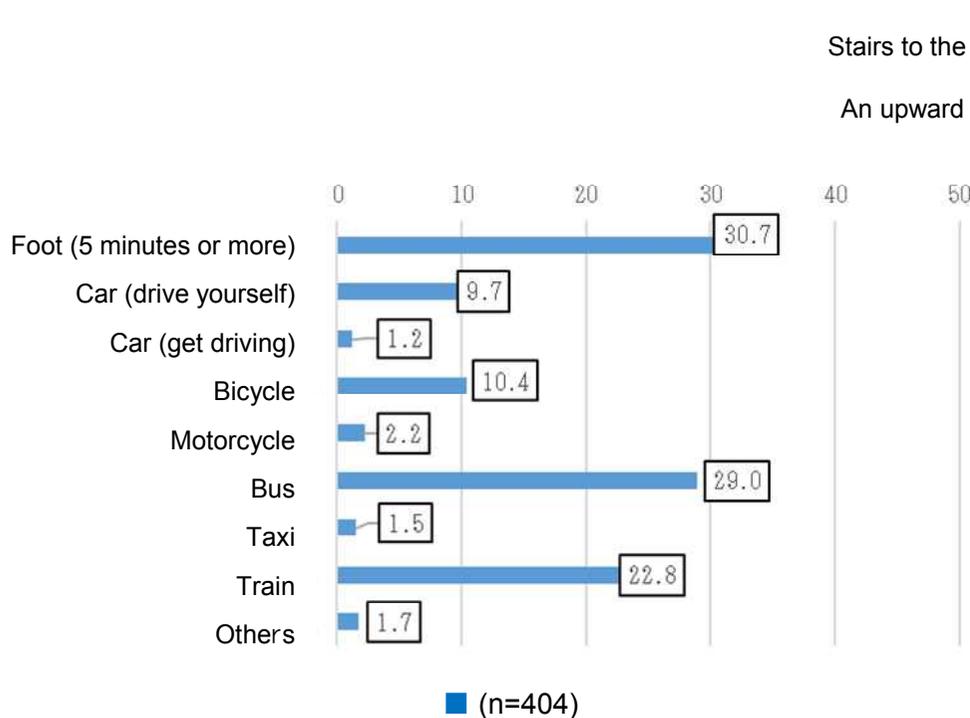
- I actually used it.
- I encountered a scene where a self-driving car was running.
- I saw a leaflet or a bus stop for a self-driving car and knew about the demonstration experiment, but I didn't actually use it or encounter a car.
- I didn't know the demonstration experiment.
- No answer

Results 6: Residents Questionnaire Survey: Purpose of Movement

Currently, in the Suwa and Nagayama areas, walking is the most common means of transportation, followed by bus and train. On the other hand, about half (216, or 53.5% of the 404) of the respondents said that it is difficult to walk within the district due to differences in level or inclination. Due to geographical factors, people walk a certain distance while feeling difficulty in moving, and there is a potential need for public transportation to replace the means of transportation.

What is the most commonly used transportation method for traveling from your house?

Is there any place in the district that you feel difficult to move on foot? If so, please tell me the place and the reason.

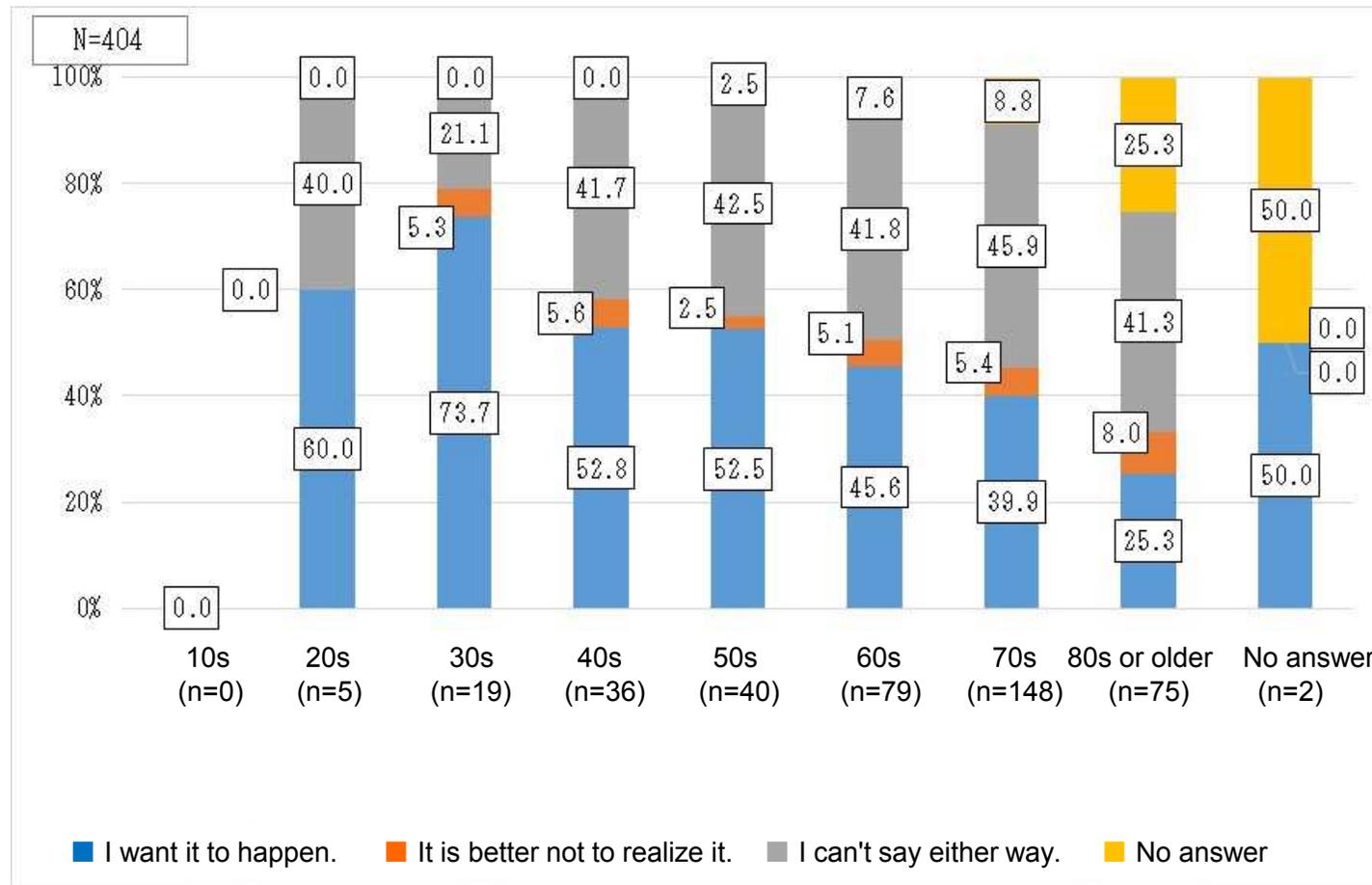


Results 6: Residents Questionnaire Survey: Questionnaire Survey of Citizens' Awareness of Autonomous Driving for Mobile Service

【Strictly Confidential】

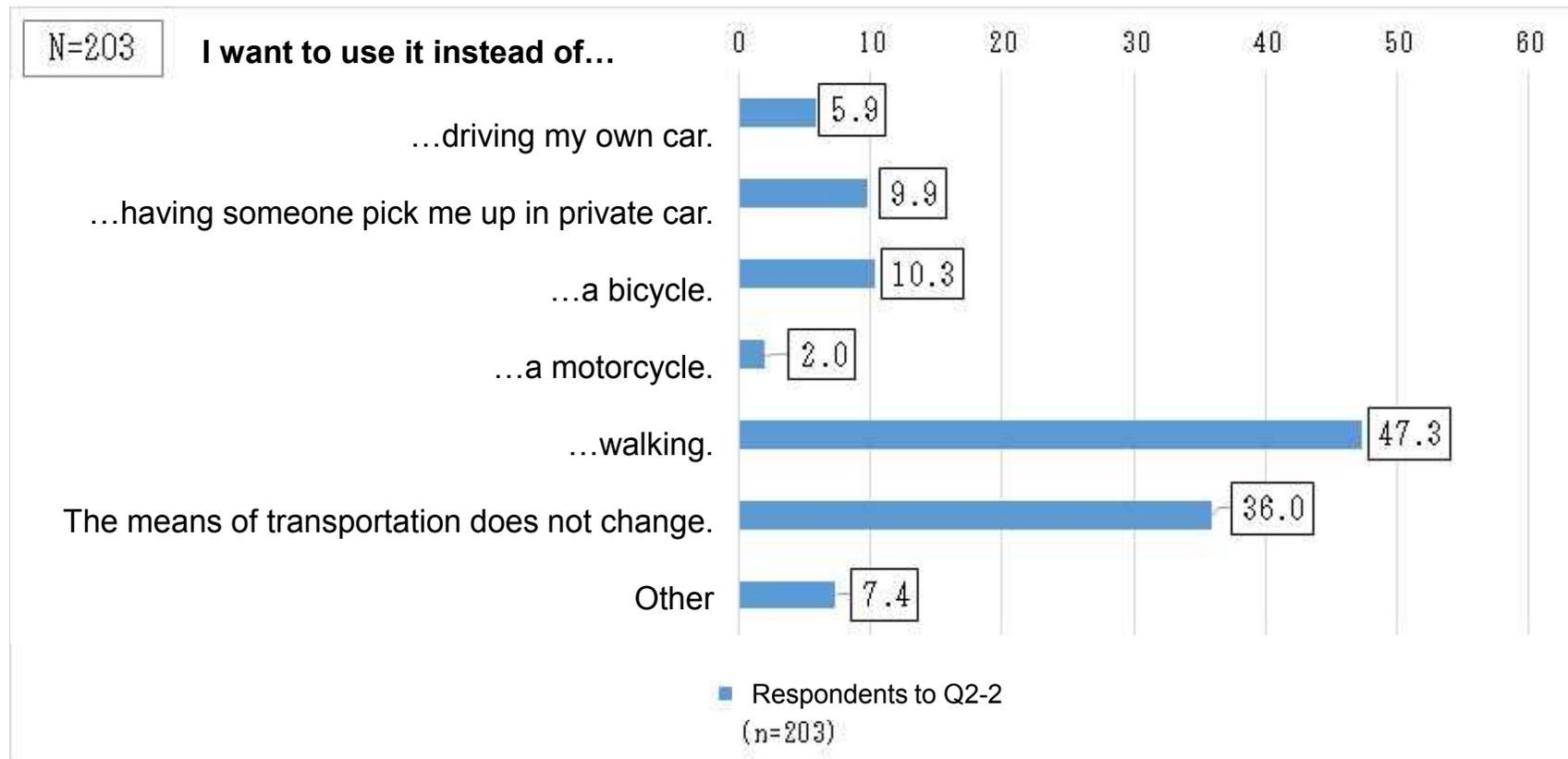
Service

While there are many opinions in favor of the realization of automated mobile services among the younger generation (20s and 30s), the proportion of those wishing to realize automated mobile services has been gradually declining in later age groups, with a significantly lower proportion among the elderly generation (70s and 80s). In the future, for the social implementation of mobile services, it will be necessary to take measures for the elderly generation to deepen their understanding of new technologies such as automated driving technology.



Results 6: Residents Questionnaire Survey: Self-Driving Movement by Individuals who have difficulty walking changes in transportation choice behavior during service implementation

Regarding the respondents who felt difficulty in walking within the Suwa and Nagayama areas, as a result of understanding how transportation choice behavior would change when the automated driving and transportation service was implemented in society, many said that "I want to use it instead of walking." and that "The means of transportation does not change.". In the Suwa and Nagayama areas, it is assumed that there is a potential need for people who are currently on foot when implementing a mobile service. On the other hand, the results of this analysis do not support the hypothesis that people who use automobile transportation may have potential needs due to future anxiety, and further follow-up is necessary.



Results 7: Income and expenditure simulation

*Overview of Cash Flow Simulation

income and expenditure simulation		
Purpose		The purpose of this survey was to confirm the profitability of the automated driving services demonstrated in this survey, identify issues for future social implementation, and qualitatively analyze the direction of the driver.
income and expenditure items	Revenue Item	In addition to fare revenue, which is the consideration for using the service, the company expects advertising revenue in the city model and an increase in fares due to an increase in the use of existing buses in the transit model.
	Expense Item	Transportation and general and administrative expenses are included as expense items. As for the transportation cost, the item generally used in the existing business was adopted by the Keio Railway Bus Co., Ltd., which conducted the experiment.
Remarks		<ul style="list-style-type: none"> The fare to be paid when using the service is calculated based on the results of the passenger questionnaire, but since it is clear that additional consideration is necessary, several patterns were assumed. The case of adopting automatic operation level 4, which realizes full-scale cost reduction and manpower reduction in automatic operation service, was also predicted based on the current balance structure.

Results 7: Income and expenditure simulation: Results

- If the service is provided using a level 3 self-driving vehicle similar to the service demonstrated in this survey, a loss of approximately 40 million yen per year is incurred.
- Even if a level 4 self-driving vehicle is used, the loss will be about 14 million to 20 million yen. In other words, even if autonomous driving technology is established and unmanned driving becomes possible, the current service implementation system and methods are not expected to be profitable.

Level 3 (Place crew members in the driver's seat)

Assuming Level 3, where drivers are assigned to the driver's seats, we calculated the income and expenditure for 1 year by fare pattern (100 yen or 200 yen) and passenger pattern (50, 100 or 30 persons per day).

In the case of 100 yen

In the case of 200 yen

	item	In the case of 100 yen				item	In the case of 200 yen		
		30 persons a day	50 persons a day	100 persons a day			30 persons a day	50 persons a day	100 persons a day
income	Fare revenues	1,095,000	1,825,000	3,650,000	income	Fare revenues	2,190,000	3,650,000	7,300,000
	Advertising revenues	200,000	200,000	200,000		Advertising revenues	200,000	200,000	200,000
	Increased transit revenues	164,579	274,298	548,595		Increased transit revenues	164,579	274,298	548,595
	total	1,459,579	2,299,298	4,398,595		total	2,554,579	4,124,298	8,048,595
expenses	Personnel expenses	27,665,005	27,665,005	27,665,005	expenses	Personnel expenses	27,665,005	27,665,005	27,665,005
	Fuel oil and fat expenses	205,571	205,571	205,571		Fuel oil and fat expenses	205,571	205,571	205,571
	Vehicle repair costs	185,800	185,800	185,800		Vehicle repair costs	185,800	185,800	185,800
	Vehicle-related costs	10,040,934	10,040,934	10,040,934		Vehicle-related costs	10,040,934	10,040,934	10,040,934
	General & administrative costs	3,501,096	3,501,096	3,501,096		General & administrative costs	3,501,096	3,501,096	3,501,096
	total	41,974,678	41,974,678	41,974,678		total	41,974,678	41,974,678	41,974,678
Income and expenditure				Income and expenditure					
		-40,515,099	-39,675,380	-37,576,083			-39,420,099	-37,850,380	-33,926,083

Level 4 (unmanned operation)

The driver's seat was assumed to be unmanned (Personnel such as operation managers are necessary.) level 4, and the income and expenditure for 1 year was calculated for each pattern of fare (100 yen or 200 yen) and passenger pattern (50, 100 or 30 persons per day).

In the case of 100 yen

In the case of 200 yen

	item	In the case of 100 yen				item	In the case of 200 yen		
		30 persons a day	50 persons a day	100 persons a day			30 persons a day	50 persons a day	100 persons a day
income	Fare revenues	1,095,000	1,825,000	3,650,000	income	Fare revenues	2,190,000	3,650,000	7,300,000
	Advertising revenues	200,000	200,000	200,000		Advertising revenues	200,000	200,000	200,000
	Increased transit revenues	164,579	274,298	548,595		Increased transit revenues	164,579	274,298	548,595
	total	1,459,579	2,299,298	4,398,595		total	2,554,579	4,124,298	8,048,595
expenses	Personnel expenses	9,472,349	9,472,349	9,472,349	expenses	Personnel expenses	9,472,349	9,472,349	9,472,349
	Fuel oil and fat expenses	205,571	205,571	205,571		Fuel oil and fat expenses	205,571	205,571	205,571
	Vehicle repair costs	185,800	185,800	185,800		Vehicle repair costs	185,800	185,800	185,800
	Vehicle-related costs	10,040,934	10,040,934	10,040,934		Vehicle-related costs	10,040,934	10,040,934	10,040,934
	General & administrative costs	3,501,096	3,501,096	3,501,096		General & administrative costs	3,501,096	3,501,096	3,501,096
	total	22,126,490	22,126,490	22,126,490		total	22,126,490	22,126,490	22,126,490
Income and expenditure				Income and expenditure					
		-20,666,911	-19,827,192	-17,727,895			-19,571,911	-18,002,192	-14,077,895

Results 7: Income and expenditure simulation : Perspective and Policy for Improving Profitability

- Viewpoint of profitability improvement based on income and expenditure simulation and policy for future study

perspective of improving profitability	Policy for future study
Study of autonomous vehicles suitable for NT	<ul style="list-style-type: none"> • There is room for improvement in profitability through the procurement and maintenance of vehicles suitable for NT at lower prices, such as the introduction of compact mobility, the size of a golf cart. • Cost reduction is achieved by using a vehicle having high durability and a long depreciation period or by using the same vehicle for a long time. (At Level 4, where the ratio of labor costs is low, the impact of the reduction in vehicle costs is significant.)
Reduce labor costs	<ul style="list-style-type: none"> • The ratio of fixed costs will be reduced and costs will be reduced through the development of an operation management system capable of managing multiple vehicles by one person. • The company is considering ways to reduce personnel costs through a detailed review of operational efficiency.
Public support, etc.	<ul style="list-style-type: none"> • Toward the social implementation of automated driving services, in particular, public support such as subsidies is required for the provision of automated driving services by around 2020. • It is also necessary to consider regional cooperation to establish autonomous driving services, such as assistance money from residents.

Results 8: Suggestions for Social Implementation

*In order to implement services in society, it is necessary to verify business feasibility and foster social acceptability by utilizing long-term verification.

	Result of the demonstration experiment	Future initiatives and suggestions for social implementation
Coordination of related parties	<ul style="list-style-type: none"> It took a considerable amount of time to coordinate and explain with local stakeholders and relevant organizations. As it was a short preparatory period, there was a burden on the application procedures necessary for conducting the experiment. 	<ul style="list-style-type: none"> Continue to promote stakeholder consultations through regional councils and community council meetings. Extracting issues and response policies from the current point in time, taking into consideration various procedures at the time of social implementation (commercialization).
Running technology Urban space development	<ul style="list-style-type: none"> There were some problems such as that the next reservation could not be accepted unless the car returned to the waiting area. For safety reasons, the company reduced the speed of the train, but some passengers felt stressed. 	<ul style="list-style-type: none"> Urban space development (Securing a safe place to wait in NT) will be promoted to improve the business environment. Based on the assumption that safety will be ensured, the ministry will update the operational rules while taking into account the state of the business environment.
Social acceptability (Opinions of residents regarding automatic operation, etc.)	<ul style="list-style-type: none"> A certain number of people used the facilities to ease the burden of going out, to avoid bad weather, and to pick up children from nursery schools. There were many opinions that "I wanted to drive a self-driving car." and residents were very interested. 	<ul style="list-style-type: none"> To gain the understanding of more residents and local stakeholders through long-term demonstrations, etc. Based on the results of the residents' questionnaire, opportunities for residents' explanations will be secured.
Matters requiring consideration for social implementation such as ensuring business viability	<ul style="list-style-type: none"> Because of the short period of demonstration, there were some restrictions in grasping the movement demand of the inhabitants and building social acceptability. Cooperation with local stores demonstrated the use of coupons in some areas, but the number of targeted stores was limited. 	<ul style="list-style-type: none"> Establish routes with high demand and consider ways to improve business efficiency through long-term demonstration. Study measures for cooperation with local life data such as passenger movement trends and sales information of local stores.