Cross-ministerial Strategic Innovation Promotion Program(SIP) Phase 2
Automated Driving for Universal Services

Research on assessment of the impact of automated driving on society and the economy and on measures to promote deployment

Report summary version　March 2023

The University of Tokyo / Doshisha University

This report documents the results of Cross-ministerial Strategic Innovation Promotion Program (SIP) 2nd Phase, Automated Driving for Universal Services (SIP-adus, NEDO management number: JPNP18012) that was implemented by the Cabinet Office and was served by the New Energy and Industrial Technology Development Organization (NEDO) as a secretariat.

Purpose

Purpose of 2nd Phase SIP-adus project

Practical development and widespread diffusion of automated vehicles will help to resolve a variety of issues facing society, such as reducing traffic accidents, alleviating traffic congestion, ensuring mobility for vulnerable road users, resolving the shortage of drivers for logistics and transport services, and reducing costs, with the aim of achieving a society in which everyone is able to enjoy a high quality of life.

Purpose of this study

I **Basic consensus of public and private entities regarding the premises for quantification.**

II **Quantification of socioeconomic impact of automated driving.**

III **Study of measures to promote automated driving and provision of information to support decision-making.**

Overview of Research Study

I **Basic consensus**
of public and private entities regarding the premises for quantification

II **Quantification**
of socioeconomic impact of automated driving

III **Provision of information**

A. Relating to assessment of socioeconomic impact
Qualitative organization of overall approach

B. Organization of preconditions
for diffusion and impact assessment simulation models

C. Organization of promotion measures (scenario formulation)

D. Estimation of diffusion rate corresponding to promotion measures in multiple scenarios

E. Estimation of no. of traffic accidents, traffic congestion and CO_2 emissions

i . Estimation of impact on traffic accidents
ii . Estimation of impact on traffic congestion and CO_2 emissions

F. Assessment of impact on domestic economy overall

i . Quantitative assessment from the perspective of resolving the driver shortage in logistics and transport services
ii . Quantitative assessment from the perspective of the productivity of Japanese economy and the ripple effects of automated driving on production, etc.

G. External communications

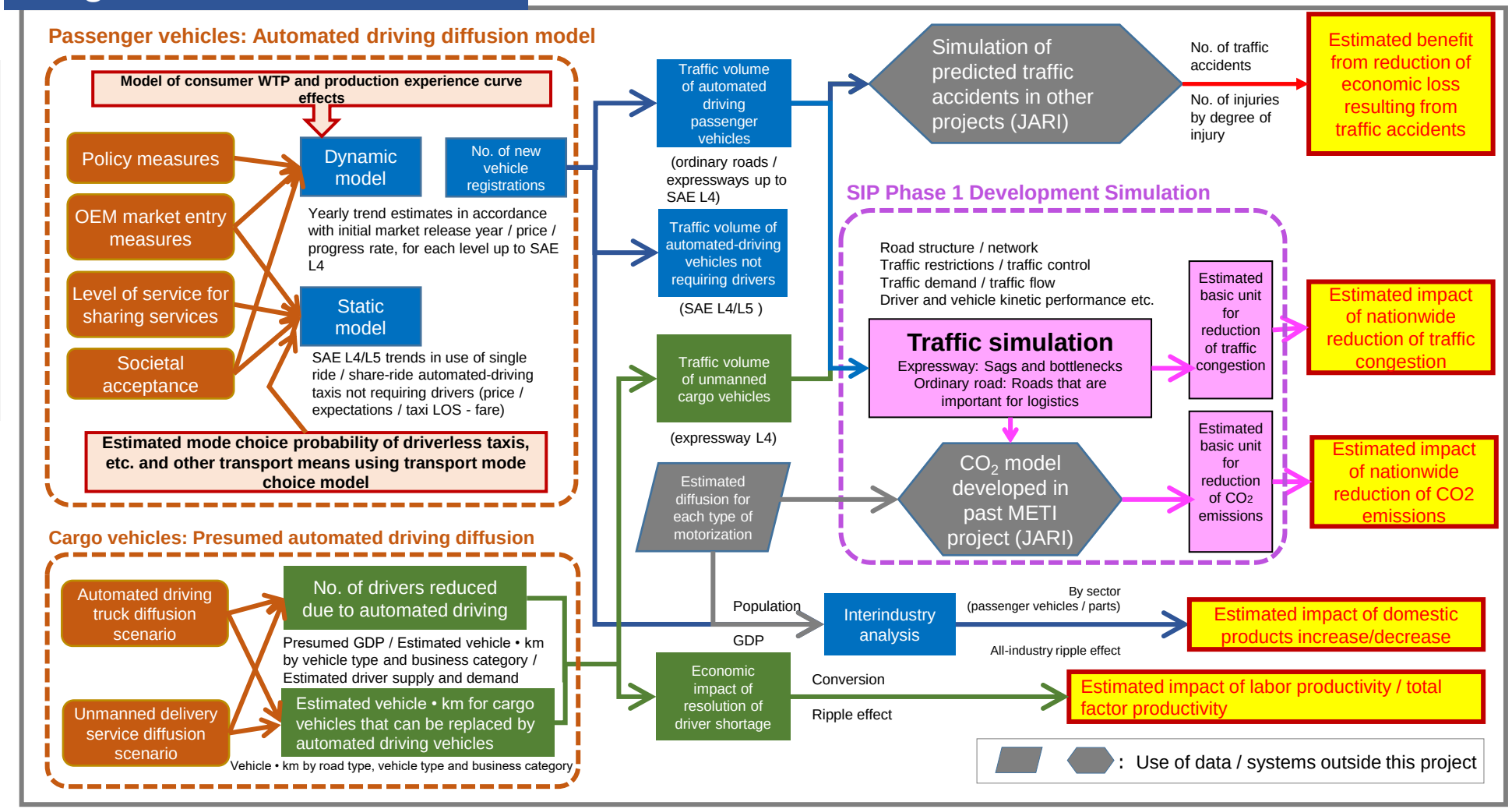
Approach

Past achievements

Cross-ministerial Strategic Innovation Promotion Program(SIP)
Automated Driving Systems
Analysis of social and industrial aspects in preparation for advancement and deployment of automated driving systems
(FY 2016 - 2017)

Cross-ministerial Strategic Innovation Promotion Program(SIP) Phase 2
Automated Driving for Universal Services
Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others
(FY 2018 - 2021)

Integrated model framework



Use of models constructed in
“Study of the Impact of Automated Driving on Reducing Traffic Accidents and on Others" conducted in previous years (FY 2018-2021)

Holding of Discussions (1/2)

In order to achieve "A. Qualitative organization of overall approach" "B. Organization of preconditions for diffusion and impact prediction simulation models" and "C. Organization of promotion measures (scenario formulation)," discussions were held using the monthly meeting of the Business Promotion Working Group (WG) of SIP-adus. An overview of the discussions is presented below.

Date	Issues	
August 19, 2021	**Report at time of commissioning**	Project objective, content and methods, schedule and organization
September 16	**Discussion of method and scope of discussions**	Premises and approach to discussions, discussion of scope, discussion of outcomes
October 21	**Shared image of success** **Discussion of premises for calculation (1)**	Image of success, discussion of privately owned vehicles x accidents, discussion of privately owned vehicles x congestion
November 18	**Discussion of premises for calculation (2)**	Discussion of privately owned vehicles x CO_2 emissions, discussion of main road transport x driver shortage, discussion of intraregional transport x driver shortage
December 16	**Discussion of premises for calculation (3)**	Premises for diffusion models, premises for calculation of accidents, premises for main road transport, premises for intraregional transport
January 20, 2022	**Discussion of premises for calculation (4)**	Premises for diffusion models, premises for calculation of congestion
February 17	**Discussion of premises for calculation (5)**	Premises for diffusion models, discussion of CO_2 emissions, economic impact, lifestyle changes
March 17	**Summary of discussions held during fiscal year** **Sharing of plans for next fiscal year**	Reflecting back on discussions held up to now, shared image of research output, future plans

Note: Discussions through the WG were not sufficiently in-depth with regard to some aspects of the organization of preconditions. Accordingly, more in-depth discussions and exchanges of views were held separately on an individual basis with key figures and relevant entities. The individual discussions were held with OEM automobile companies, automotive journalists, persons in the logistics field, the contractors of other SIP-adus projects, the U. S. Department of Transportation research institute and so on. Separate exchanges of views were also held with German specialists by means of workshops with specialists on Japan-German collaboration.

Holding of Discussions (2/2)

In order to achieve "D. Estimation of diffusion rate corresponding to promotion measures in multiple scenarios," “E. Estimation of no. of traffic accidents, traffic congestion and CO_2 emissions," "F. Assessment of impact on domestic economy overall" and "Research output" discussions were held using WG. An overview of the discussions is presented below.

Date	Issues	
June 23, 2022	**Report and discussion of analysis results (1)** **Discussion of external dissemination (1)**	Reconstruction of diffusion model, report on exchange of opinions with ministries and agencies, traffic accidents, reduction of traffic congestion, reduction of CO_2 emissions, logistics Report on discussion of lifestyle changes, discussion of materials for external communications
July 14	**Report and discussion of analysis results (2)** **Discussion of external dissemination (2)**	Reconstruction of diffusion model, traffic accidents, logistics Report on discussion of lifestyle changes
August 25	**Report and discussion of analysis results (3)** **Discussion of external dissemination (3)**	Traffic accidents, reduction of CO_2 emissions Report on discussion of lifestyle changes
September 15	**Report and discussion of analysis results (4)** **Discussion of external dissemination (4)**	Traffic accidents Discussion of materials for external communications
October 20	**Discussion of external dissemination (5)**	Discussion of materials for external communications
November 24	**Report and discussion of analysis results (5)**	Domestic economy Reconstruction of diffusion model, traffic accidents
December 15	**Report and discussion of analysis results (6)** **Discussion of external dissemination (6)**	Discussion of materials for external communications Automobile maintenance industry
January 26, 2023	**Final report**	Summary of past activities Plans for future external communications

Objectives and Overview

Objectives

To **prepare a rough draft of the overall qualitative objectives** for the items to be included in the assessment of the socioeconomic impact of automated driving, as well as the preconditions for the quantitative calculations to be conducted for these items and the highly feasible promotion measures, etc. for which sensitivity analysis were conducted. The rough draft was based on the achievements of the previous project and the suggestions expressed by the committee of experts in the previous project.

Overview

- **The framework for discussions, including the scope of the discussions, the approach to discussions, the main points to be discussed, was discussed and decided in the WG.**
  - The discussions needed for the series of projects were conducted primarily using the WG. However, it was necessary to consider the framework for discussions before detailed discussions regarding each item.
  - It was decided to include lifestyle changes produced by automated driving in the scope of the discussion, along with the diffusion of privately owned vehicles, reduction of traffic accidents, alleviation of traffic congestion and resulting reduction of CO_2 emissions, resolution of the shortage of logistics drivers, and economic impact. The discussions of lifestyle changes were held using a separately organized mobility business innovation contest.
  - Moreover, it was also decided to use the approach of holding discussions from the standpoint of both inputs and outcomes, and to focus on the essential points for analysis rather than the premises for detailed calculation and computational constraints.
- **The approach to final research output was also discussed.** In addition, it was decided to share achievements produced through student education in addition to the initially anticipated communication and content provision at academic events and SIP-related events.

Discussion Scopes for the Project

	Input		Outcome Area	
1	Privately owned vehicles	×	Accidents	Discuss and disseminate in this project
2		×	Congestion	
3		×	CO_2 emissions produced by congestion	
4	Main road logistics	×	Driver shortage	
5	Economic impact			
6	Privately owned vehicles	×	Lifestyle changes	Discuss and disseminate through the "Mobility Business Innovation Contest" to be held separately.
7	Mobility services	×		

Through discussions in the WG,
the contents to be discussed and disseminated in this project were determined.

External Communication Strategy

Target		Overview of communication methods

Specialists / industry personnel	● Persons involved in projects, administration or research relating to mobility, transport, logistics, movement, urban planning etc.
	● Persons taking some types of action in individual areas that relates to automated driving.
		● **Reporting at academic events or SIP-related events**
		  ● e.g. Reporting of achievements at academic meetings or international conferences.
		  ● e.g. Reporting of achievements at SIP-adus WS or other SIP-related events
		● **Provision of content at academic events or SIP-related events**
		  ● e.g. Provision of content at SIP-adus WS or other SIP-related events
		● **Provision of information to serve as the basis of policy discussions**

General	● Persons not directly involved in the development, introduction and use of automated driving vehicles.
	● Persons with no detailed knowledge of, or interest in, automated driving.
		● **Sharing of achievements through student education**
		  ● e.g. Explanation of project achievements to students through student education by means of the Mobility Business Innovation Contest (M-BIC)
		  ● e.g. Use of achievements in other research and educational activities
		● **Provision of information to SIP-sponsored events designed for the general public (tie-ups with the Public Acceptance team)**
		  ● e.g. Provision of information to serve as the basis for SIP-cafe content creation
		  ● e.g. Provision of information to serve as the basis for citizen dialogue content creation

External Communication Strategy of research output will also be organized.
Content and information will be provided, primarily to specialists and industry personnel.

Objectives and Overview

Objectives

To achieve a general consensus on the preconditions to be used when estimating various impacts and to also study changes to the preconditions and models as needed, using the models developed in the previous project, in accordance with the overall objectives organized in "A. Qualitative organization of overall approach relating to the assessment of socioeconomic impact.'

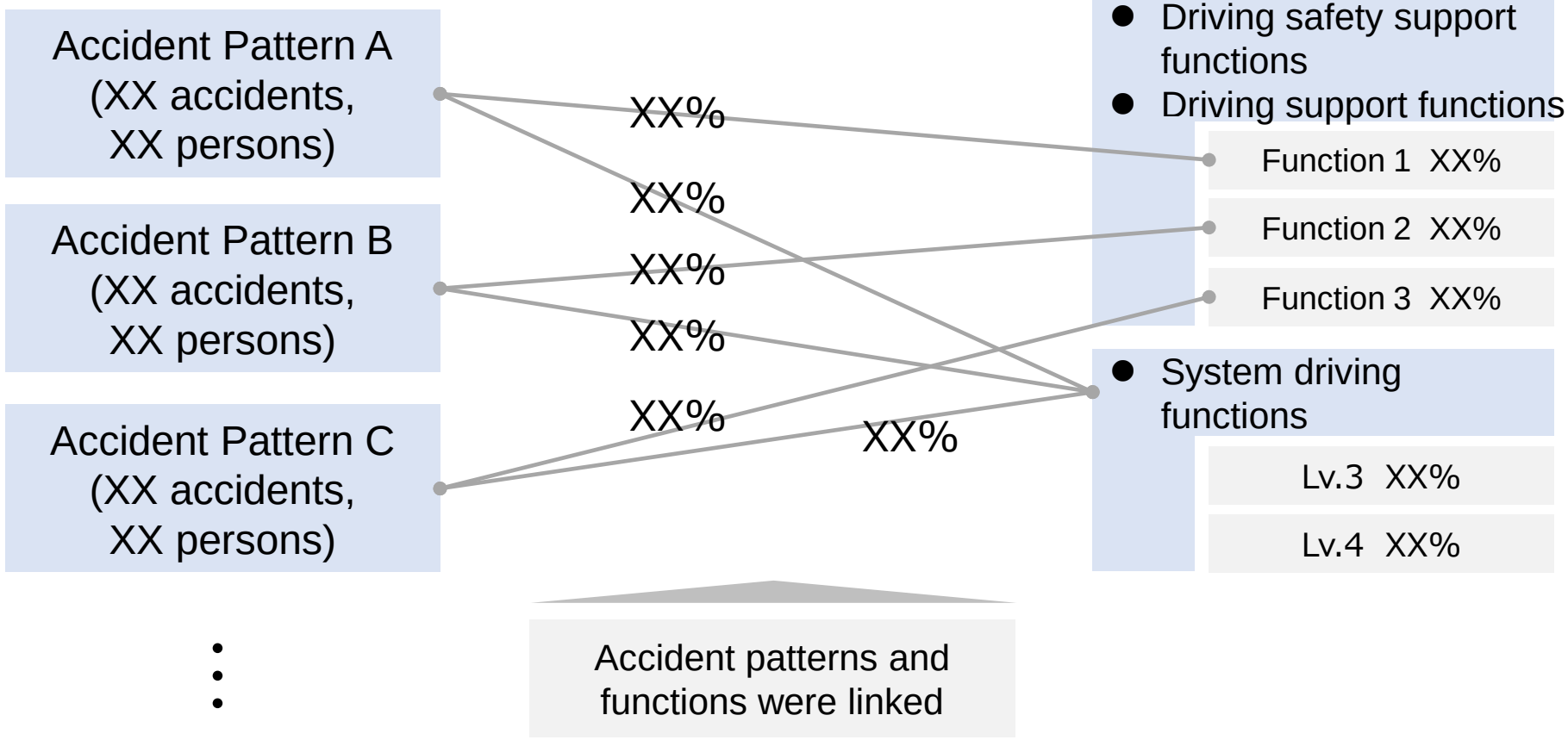
Overview

- The following points were agreed upon as a result of discussions at the WG and separate detailed discussions with WG members.
  - It was decided to adopt a policy of calculating **traffic accidents** by linking automated driving functions that have been organized into detailed categories and accidents that can be prevented as a result, and multiplication by the diffusion rate of automated driving.
  - In calculating the reduction of traffic congestion, in general it was decided to follow the content of discussions up to now and prior research, but also to reflect the latest developments and add updates in places. Participants also agreed to use a longer setting for the vehicle interval of automated vehicles than that of existing manually operated vehicles.
  - Participants agreed that data relating to the **use rate for functions** needed for calculating traffic accidents and traffic congestion was shared in coordination with the 2nd Phase SIP-adus "Study of strategy formulation and assessment to foster societal acceptance.“
  - With regard to calculating the **reduction of CO_2 emissions**, a shared understanding was reached with regard to the policy of calculating the effect of the reduction of CO_2 emissions resulting from reduced traffic congestion due to changes in driving behavior as a result of automated driving.
  - With regard to calculations relating to resolution of the shortage of **logistics** drivers, a shared understanding was reached regarding the policy of limiting the scope of calculation for this project to main road logistics on expressways. Furthermore, through interviews with key figures, the specific operations envisioned in these calculations were organized.
  - It was decided that the methods in the previous project will be followed with regard to **economic impact**, but the input data will be updated with the most up-to-date data.
  - With regard to "**lifestyle changes**" which was added as an area of discussion in “A. Qualitative organization of overall approach relating to the assessment of socioeconomic impact," the policy of pursuing separated discussions using the Mobility Business Innovation Contest (M-BIC) sponsored by the contractors was confirmed.

The timing of marketization, price, driving control characteristics and so on for each automated-driving vehicle category also constitute one category for “B. Organization of the premises of simulation models for diffusion.” However, as the details are noted in "D. Estimated diffusion rate for promotion measures in multiple scenarios," they are omitted in this chapter.

Traffic Accidents

No. of traffic accidents and no. of fatalities for each accident pattern × Accident avoidance rate for each accident pattern and function × Diffusion rate for each function



Potential for reducing traffic accidents
(possibility that traffic accidents can be reduced)

Functions including driving safety support functions were linked with accident patterns and the effectiveness in reducing accidents was estimated, taking into account the diffusion rate of functions.

Traffic Congestion

Basic policy

Following the discussions up to now

+

Reflect the latest situation, and update partially

The discussions that have been conducted for the past 10 years will be followed. Prior research will be cited as much as possible.

- The impact on congestion of changes in vehicle interval distance due to ACC will be analyzed.
- Vehicle behaviors, such as settings of the time clearances, basically follows previous research.

Update in accordance with the vehicle / function diffusion models

- Vehicle / function diffusion models will be updated based on the discussions of this project .

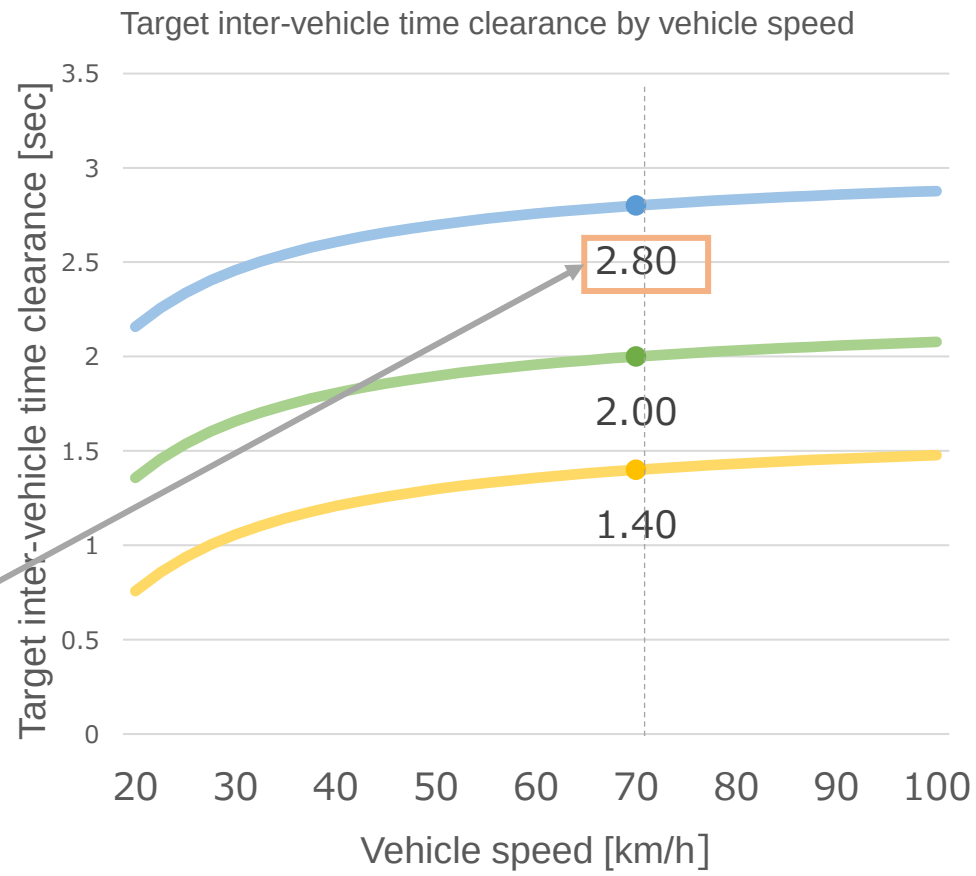
Consideration of use rate

- Information related to function use rate has already been linked from other SIP projects.

Add a pattern that increase the inter-vehicle time clearances

- It was pointed out that, in the previous phase, the possibility that early automated-driving vehicles have a longer space clearance than manned-driving vehicles due to safety reasons.

Example of setting the inter-vehicle time clearance



With regard to congestion, participants agreed that the content of discussions up to now and prior research will be followed, but the latest developments will be reflected, and updates will be added in places.

CO_2 Emissions Resulting from Congestion

Scope refinement

- **Participants agreed to calculate changes in CO_2 emissions resulting from changes in congestion volume, which will be calculated as a part of congestion.**
  - Increase or decrease of CO_2 emission throughout the life cycle of automated-driving vehicles, fuel and electricity costs, the impact of EV conversion, changes in traffic demand will not be calculated.
  - However, if EV conversion has an impact on the CO_2 reduction effect described below, only this effect will be considered.
- **Participants agreed to further narrow the scope despite the aforementioned changes in CO_2 emissions.**
  - The primary focus will be on CO_2 reduction on expressways.
  - The CO_2 reduction effect due to the effect of traffic congestion reduction resulting from the behavioral changes caused by automated driving will be calculated.

Calculation procedures

	Assumptions of behaviors of automated-driving vehicles	Calculation of congestion reduction	Calculation of energy consumption reduction
Des-cription	Prevention of unconscious deceleration due to sags improvement of acceleration / deceleration behavior during traffic congestion	Calculation of the effect of reducing congestion by preventing unconscious deceleration Calculation of the effect of eliminating congestion by improving acceleration and deceleration Calculation of the effect of accident congestion reduction effect of accident reduction due to automated driving	**Calculation of the amount of energy consumption reduction by vehicle types** • Gasoline vehicles XX% • HV, PHV XX% • EV XX%
(Major) Input data			Energy consumption by speed and acceleration by vehicle types

Participants agreed to limit the scope when calculating CO_2 emissions resulting from congestion and calculate the reduction in CO_2 emissions resulting from reduced congestion on expressways.

Main Road Logistics (1/2)

Background situation

- **Needs: Replace trucks on long-distance sections with large volume of cargo with unmanned vehicles**
  - The adverse working environment for long-haul truck drivers (e.g. not being able to go home every day) has led to the driver shortage. Meanwhile, it is comparatively easy to attract drivers for sectors that are close to intraregional delivery.
  - Tokutsumi (special consolidated freight carrier) route vehicles could be replaced with unmanned vehicles.
- **Infrastructure construction**: There is comparatively little difficulty in introducing unmanned operation **in sectors with shoulders as emergency evacuation areas.**

Assumptions for calculation

- **Vehicle-only expressways connecting major cities (not including urban expressways) will be given priority for conversion to unmanned operation.**
  - First, prioritize the development between Tokyo-Nagoya and Nagoya-Osaka, except for areas with poor shoulders such as the Metropolitan Expressway.
  - After that, the area centering on motorways between metropolitan cities will be gradually expanded.

- **For the time being, it is assumed that human workers are expected to be required for freight operation in the warehouses.**
  - Even now, there are many places where the drivers handle freight operations in the warehouse.
  - There is a trend to accelerate the matching of cargos and trucks to avoid empty transportation. Based on that premise, in the future one truck will have to handle freight operations in many places, and it is highly possible that it will be difficult to handle everything automatically.
- **For the time being, logistics facilities that currently exist will need to be used.**
  - In the future, it may be possible to use logistics facilities that are linked directly to vehicle-only roads. However, it will take a long time to transfer all functions to such facilities.

- **For the time being, unmanned operation will be provided only on vehicle-only expressways, and calculations will not be conducted for placement on ordinary roads.**
  - The presumption is that facilities for changing between unmanned and manned operation that are linked directly to vehicle-only expressways will be constructed.
  - For the time being, it is assumed that the facilities will be those that are comparatively small in scale, such as driver boarding locations and platoon driving docking stations. In the future, these can be provided with warehousing functions.

With regard to main road logistics, the needs of logistics companies and other background circumstances will be organized based on interviews, in order to derive hypotheses for calculation based on this information.

Main Road Logistics (2/2)

Background situation

- Private trucks are more numerous in terms of the number of trucks owned, but **commercial trucks are more numerous in terms of kilometers traveled.**
- The greatest need for unmanned vehicles is on the part of companies that operate vehicles on regular routes.

Assumptions for calculation

- Calculations will be conducted for **commercial trucks.**

- In the current configuration, vehicles are only profitable if they have been operated for as long as possible after amortization is complete. There is little need to replace vehicles with the latest models after a short period of time.
- Conversely, to a **certain extent subsidies can be anticipated for replacing vehicles with carbon neutral vehicles**, so some elements exist that can promote vehicle replacement purchases.

- **The premise is that there will be subsidies or tax incentives for replacement with the latest models.**

- **It is possible that small-scale companies may be integrated with one another or form groups.**
  - Approximately 90% of logistics companies are small companies. Even now, the inefficiency of small-scale companies is a problem.
  - If we assume that transport will include some unmanned operation sectors, it is difficult to believe that a trip will be completed entirely by a single small-scale company. It is very possible that, for example, a large company will conduct transport operations by grouping together small-scale companies.

- Companies that own vehicles eligible for replacement are presumed to be those with the capacity to conduct vehicle replacement purchasing.

With regard to main road logistics, the needs of logistics companies and other background circumstances will be organized based on interviews, in order to derive hypotheses for calculation based on this information.

Economic Impact

Direct impact		Indirectly affected industries
Change in transportation condition	**Accidents**	● **Damage and injury response**: Vehicle maintenance, insurance, medical care, lawyers ● **Regulations etc.**: Police, court
	Congestion & Environment	● -
Change in transportation demand	**Movement of goods** (Logistics)	● **Main road logistics**: Material / product transportation ● **Intraregional Delivery**: Package delivery service Current scope of productivity analysis (quantitative assessment from the standpoint of resolving the driver shortage in logistics operations is converted to productivity)
	Movement of people (Travel behavior)	● **New transportation demand**: Public transport, retail, education, real estate ● **In-car time utilization**: Retail, advertising, digital media
	Other than the movement of goods and people (vehicles themselves, etc.)	● **Movement automation**: agriculture, real estate management, security ● **Spatial movement**: nursing, medical care
Supplier change	**Vehicle & Vehicle Operation**	● **Hardware**: Automobile manufacturing, sensors, communications equipment ● **Software**: System, IT Scope of current inter-industry analysis
	Infrastructure	● **Public infrastructure**: Road maintenance, communications infrastructure, electricity transmission ● **Private infrastructure**: Parking lot, gas station

The scope of analysis and method to be used to assess economic impact will be finalized upon submission.

Objectives and Overview

Objectives

To organize highly feasible policies, etc. for promoting automated-driving vehicles at individual ministries and agencies, private companies etc. and reach general consensus with the WG and so on, in accordance with the overall policy noted in "A. Qualitative organization of overall approach relating to the assessment of socioeconomic impact," **set the objective to formulate multiple scenarios for estimation and sensitivity analysis.**

Overview

- As a result of the discussions at the WG, it was decided to adopt a policy of establishing "without cases," "backcast cases," "base scenarios," "promotion scenarios," and "breakthrough cases" as scenarios/cases for conducting sensitivity analyses. The results of these analyses were compared to derive a message for external communications.
- The scenarios relating to traffic accidents, traffic congestion and the resulting CO_2 emissions as well as logistics were prepared in accordance with the aforementioned policy, and a tentative plan was submitted to the WG. Furthermore, participants shared the policy of working to refine this tentative plan while continuing to pursue model calculations.

Definitions of Cases / Scenarios

A "scenario" is defined as a sensitivity analysis of diffusion promotion measures based on a diffusion simulation; and a "case" is defined as qualitative analysis and examples.

		Definition	Sample Message
Without cases		● **Introduce functions if introduction of them is mandatory; not introduce if introduction is not mandatory.**	● Mandated AEB will continue to be provided in vehicles for which it is mandated.
Backcast cases (Multiple Patterns)		● **Draw multiple patterns of the ideal future and back-calculate the diffusion of functions necessary to realize that future** ● This is an assumption at a certain point in the future; calculations are not performed in chronological order.	● If the goal is to reduce accidents by 90%, for instance, the diffusion rate of vehicles equipped with XX function must be XX%.
Scenarios from the viewpoint of diffusi-on	**Base Scenario**	● **Driving safety support functions and automated driving functions are introduced at the most feasible introduction speed that can be currently ed from the perspective of vehicle suppliers.**	● On the other hand, if it diffuses in the current market, the reduction rate for 50 years will be only XX%, resulting in a huge gap as compared to the "backcast" case.

	Diffusion Promotion Scenario	● **Promotional measures that can be promoted by government decisions**
		  ● (due to tax / subsidy) Change of selling price / early launch of sales
		  ● (due to regulation / deregulation) Mandatory & Review of legal system and administrative jurisdiction
		  ● (Logistics related) Promotion of infrastructure development
			● If XX function can be diffused and expanded to XX% by making it mandatory by XX, this effect can be expanded to XX%.

Breakthrough cases		● **Significant changes in the socio-economic environment**
		  ● e.g. Changes in social norms
		  ● e.g. Technological and institutional innovation (technological innovation accompanying the progress of VR and AI, etc.)
		  ● E.g. Changes in driving operation such as low speed driving
			● Furthermore, innovations such as XX and XX can be considered as method and situation changes for more closely approaching the "backcast" case.

Case / scenario definitions will continue to be improved in order to visualize impact while incorporating views from the WG.

Objectives and Overview

Objectives

To revise the diffusion simulation models developed in the previous project, in accordance with the organization of preconditions for study of various impacts and diffusion measures, etc. Additionally, to use the revised models to estimate the number of vehicles diffused, etc., taking into consideration new sales and replacement of old vehicles, for each passenger vehicle automated driving function and vehicle type category, in order to analyze the impact of promotion measures and conduct a sensitivity analysis for important parameters.

Overview

- **Revised the diffusion simulation model by revising the classification method of automated vehicles and conducting consumer surveys.**
  - Reviewed the types of automated vehicles (automated vehicle categories) in the diffusion simulation model developed in the previous project and established new categories.
  - Conducted a questionnaire survey to investigate consumers' purchase intentions based on the established categories.
  - Revised the diffusion simulation model based on the questionnaire, and calculated the diffusion of automated-driving cars by 2050.

Diffusion of Private Cars: Detailed Function List

Tentative category in the previous project

Category	expressways	Ordinary roads
C0	Below SAE Lv.1[1]	Below SAE Lv.1[1]
C1	SAE Lv.1 Driver Assistance	SAE Lv.1
C2	SAE Lv.2 Partial driving automation	SAE Lv.1
C3	SAE Lv.3 Conditional driving automation	SAE Lv.2
C4	SAE Lv.4 High driving automation	SAE Lv.3 on the main roads
C5	SAE Lv.4 High driving automation	SAE Lv.4 on the main roads
C6	SAE Lv.4 / 5 Equivalent Full driving automation	

Functions classifications proposed in this project

Driving safety support	Restricted acceleration in the event of an accelerator pedal / brake pedal error		
	Lane departure warning		
	Inter-vehicle distance warning		
	AEB[2]	Vehicle Target	(1) Short distance ahead
			(2) Omnidirectional long distance
		Pedestrian & bicycle Target	(1) Pedestrian
			(2) Crossing bicycle
			(3) Omnidirectional long-distance bicycle
Driving support	ACC[2]		(1) Vehicle-only roads
			(2) Ordinary roads
	LKAS[2]		(1) Vehicle-only roads
			(2) Ordinary roads
	Lane change assist		(1) Vehicle-only roads
			(2) Ordinary roads
System driving	System driving Lv.3		(1) Vehicle-only roads during congestion
			(2) Vehicle-only roads
			(3) Ordinary roads
	System driving Lv.4		(1) Vehicle-only roads
			(2) Ordinary roads

Note 1: Category C1 vehicles are equipped with collision damage reduction brakes, acceleration reduction system in the event of accelerator pedal / brake pedal errors, lane departure warning system and vehicle interval distance warning system. Here levels beneath C1 are described as "Below Level 1." Note 2: AEB: Autonomous Emergency Braking (indicating a collision damage reduction brake). ACC: Adaptable Cruise Control. LKAS: Lane Keep Assist System.

Regardless of SAE level, detailed functions were set suitable for impact calculation

Function Details (1/3) Driving Safety Support

Functions and activation scenarios categorized according to difficulty level of technology

Assuming a reasonable installation start time

	Driving safety support functions							
	Restricted acceleration in the event of an accelerator pedal / brake pedal error	**Lane departure warning**	**Inter-vehicle distance warning**	**AEB** (vehicle target) **(1) Short distance ahead**	**AEB** (vehicle target) **(2) Omnidirectional long distance**	**AEB** (pedestrian & bicycle target) **(1) Pedestrian**	**AEB** (pedestrian & bicycle target) **(2) Crossing bicycle**	**AEB** (pedestrian & bicycle target) **(3) Omnidirectional long distance bicycle**
Activation scenarios	When a vehicle is stopped, the accelerator pedal is suspected to be mistakenly operated, and there is a high possibility of a collision in the front.	When vehicle has departed the lane or has come close to doing so	When there is a high likelihood of a collision with the vehicle in front		- When a vehicle is turning right and there is a high likelihood of a collision with a vehicle coming from the other direction - When there is a high possibility of a side collision at the time of encounter	When there is a high possibility of a collision with a pedestrian	When there is a high possibility of a collision with a bicycle crossing in the front	- When there is a high possibility of a collision with a bicycle coming from a distance (e.g. collision with a bicycle running in the oncoming lane when turning right, collision with a bicycle coming in the front, entanglement when turning left) - When there is a high possibility of a side impact collision at the time of encounter
Function	Engine power control and brake control	Driver warning		Automatically control the braking device				
Time to start installing in mass-market vehicles (Mass-market vehicles: Model of about 3 million yen without options)	Already realized	Already realized	Already realized	Already realized	Already realized	Already realized	Already realized	**2025**
Timing for making mandatory	-	-	-	After FY2021	-	After FY2021	After FY2024	-

Functions and activation scenarios are categorized in detail based on the difficulty level of the technology and the scope of impact (contractor interpretation based on interviews).

Function Details (2/3) Driving Support

✓ : Expected to be activated
- : Outside ODD

● Note 1: Sidewalks and vehicle lanes are clearly separated by fences and plants, etc. However, it will be a mixed space at intersections and at left or right turnings.
● Note 2: Vehicle flow at normal speed. ● Note 3: Stand-alone activation without using dynamic maps or V2X.

Presumed appropriate ODD patterns

Assuming a reasonable installation start time

				Driving support functions						
				ACC[3]			LKAS[3]		Lane change assist[3]	
				(1) Vehicle-only road	(2) Ordinary road without signal recognition	(3) Ordinary road with signal recognition	(1) Vehicle-only road	(2) Ordinary road	(1) Vehicle-only road	(2) Ordinary road
Road Classification・Congestion situation	Vehicle-only road	On the main line	Congestion	✓	✓	✓	✓	✓	✓	✓
			Non-congestion[2]	✓	✓	✓	✓	✓	✓	✓
		On-ramps and off-ramps (when going straight)	-	✓	✓	✓	✓	✓	✓	✓
		On-ramps and off-ramps (when merging or diverging)	-	-	✓	✓	-	-	✓	✓
		Toll booth	-	-	-	-	-	-	-	-
	In rest area / parking area		-	-	-	-	-	-	-	-
	Ordinary road (Main road)[1]	When going straight (Other than signalized intersections)	Congestion	-	✓	✓	-	✓	-	✓
			Non-congestion[2]	-	✓	✓	-	✓	-	✓
		When going straight (At signalized intersections)	-	-	-	✓	-	-	-	-
		When turning	-	-	-	-	-	-	-	-
	Ordinary road (Other than main road)		-	-	-	-	-	-	-	-
Time to start installing in mass-market vehicles (Mass-market vehicles: Model of about 3 million yen without options)				Already realized	2025	2030	Already realized	2025	2025	2030

ACC for ordinary roads on which no signal recognition is available is theoretically possible as a function, but may actually increase danger, so not studied in this project.

Functions and activation scenarios will be categorized in detail based on the difficulty level of the technology and the scope of impact (contractor interpretation based on interviews)

Function Details (3/3) System Driving

✓ : Expected to be activated
- : Outside ODD

● Note 1: Evacuation spaces where vehicles can stop in the event of an emergency (road shoulder, etc.) have been constructed. Driving is possible only in the lane adjacent to the evacuation space. ● Note 2: Sidewalks and vehicle lanes are clearly separated by fences and plants, etc. However, it will be a mixed space at intersections and at left or right turnings. In addition, pedestrians and bicycles are prohibited from entering the lane. On this road, when the system is driving, accidents caused by the entry of pedestrians will not result in vehicle negligence. ● Note 3: Vehicle flow at normal speed.

Presumed appropriate ODD patterns

Assuming a reasonable installation start time

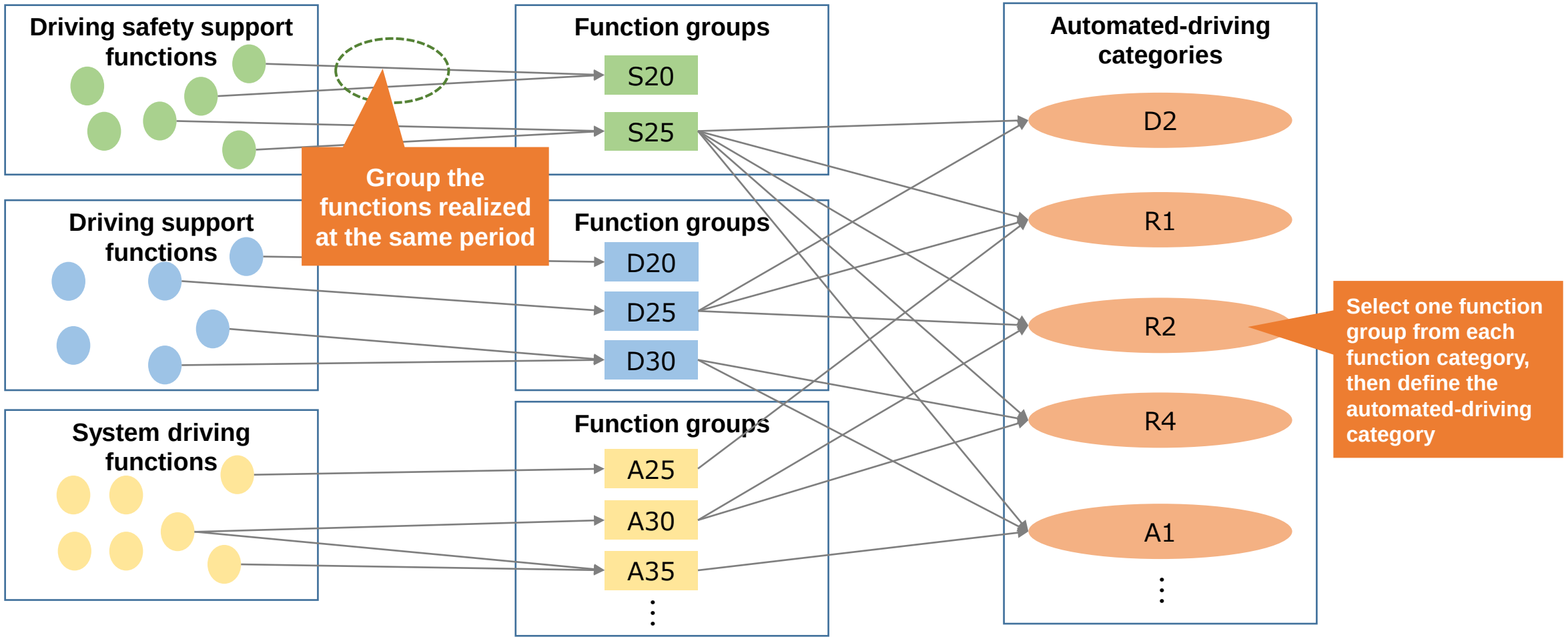
				System driving functions					
				System driving (Lv.3 equivalent)				System driving (Lv.4 equivalent)	
				(1) Vehicle-only road during congestion	(2) Vehicle-only road	(3) Ordinary road during congestion	(4) Ordinary road	(1) Vehicle-only road	(2) Ordinary road
Road Classification • Congestion situation	Vehicle-only road	On the main line	Congestion	✓	✓	✓	✓	✓	✓
			Non-congestion[2]	-	✓	✓	✓	✓	✓
		On-ramps and off-ramps (when going straight)	-	-	✓	✓	✓	✓	✓
		On-ramps and off-ramps (when merging or diverging)	-	-	-	✓	✓	-	✓
		Toll booth	-	-	-	-	-	-	✓
	In Service area / parking area		-	-	-	-	-	-	-
	Ordinary road (Main road)[1]	When going straight (Other than signalized intersections)	Congestion	-	-	✓	✓	-	✓
			Non-congestion[2]	-	-	-	✓	-	✓
		When going straight (At signalized intersections)	-	-	-	-	✓	-	✓
		When turning	-	-	-	-	✓	-	✓
	Ordinary road (Other than main road)		-	-	-	-	-	-	-
Time to start installing in mass-market vehicles (Mass-market vehicles: Model of about 3 million yen without options)				2025	2030	2035	2040	2035	? (2045)

Level 3 only when there is a congestion on an ordinary road.
Since it has a possibility not to be released as a product because it is not attractive, it will not be considered in this project.

Functions and activation scenarios will be categorized in detail based on the difficulty level of the technology and the scope of impact (contractor interpretation based on interviews)

Establishment of Automated Driving Categories

(1) Technologies will be divided into three categories: driving safety support functions, driving support functions and system driving functions.
(2) Within each category, functions that can be achieved during the same five-year time period will be grouped together.
(3) From each of the three categories, each function group will be selected and automated driving categories will be defined as combinations of functions that can make up a vehicle.



Correspondence of Automated Driving Categories and Detailed Functions

		Driving safety assist		Driving assist			System driving[3]					Time of market entry
		S20	S25	D20	D25	D30	A25	A30	A35	A40	A45	
		Forward short distance sensing[1]	Omnidirectional long distance sensing[2]	ACC, LKAS on national expressways and limited highways	ACC, Lane change assist on national expressways and limited highways, LKAS on ordinary roads	ACC, LKAS, Lane change assist on ordinary roads	Lv.3 on national expressways and limited highways during congestion	Lv.3 on national expressways and limited highways	Lv.4 on national expressways and limited highways	Lv.4 on national expressways and limited highways, Lv.3 on ordinary roads	Lv.4 on ordinary roads	
Without safety support functions	S0											Existing
Equipped with safety support functions only	S1	△										Existing
Driving support vehicles	D1	✓		✓								Existing
	D2	✓	✓	✓								2025
	D3	✓	✓	✓	✓							2025
	D4	✓	✓	✓	✓	✓						2030
Limited automated vehicles	R1	✓	✓	✓	✓		✓					2025
	R2	✓	✓	✓	✓		✓	✓				2030
	R3	✓	✓	✓	✓	✓	✓					2030
	R4	✓	✓	✓	✓	✓	✓	✓				2030
Advanced automated vehicles	A1	✓	✓	✓	✓	✓	✓	✓	✓			2035
	A2	✓	✓	✓	✓	✓	✓	✓	✓	✓		2040
	A3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	2045

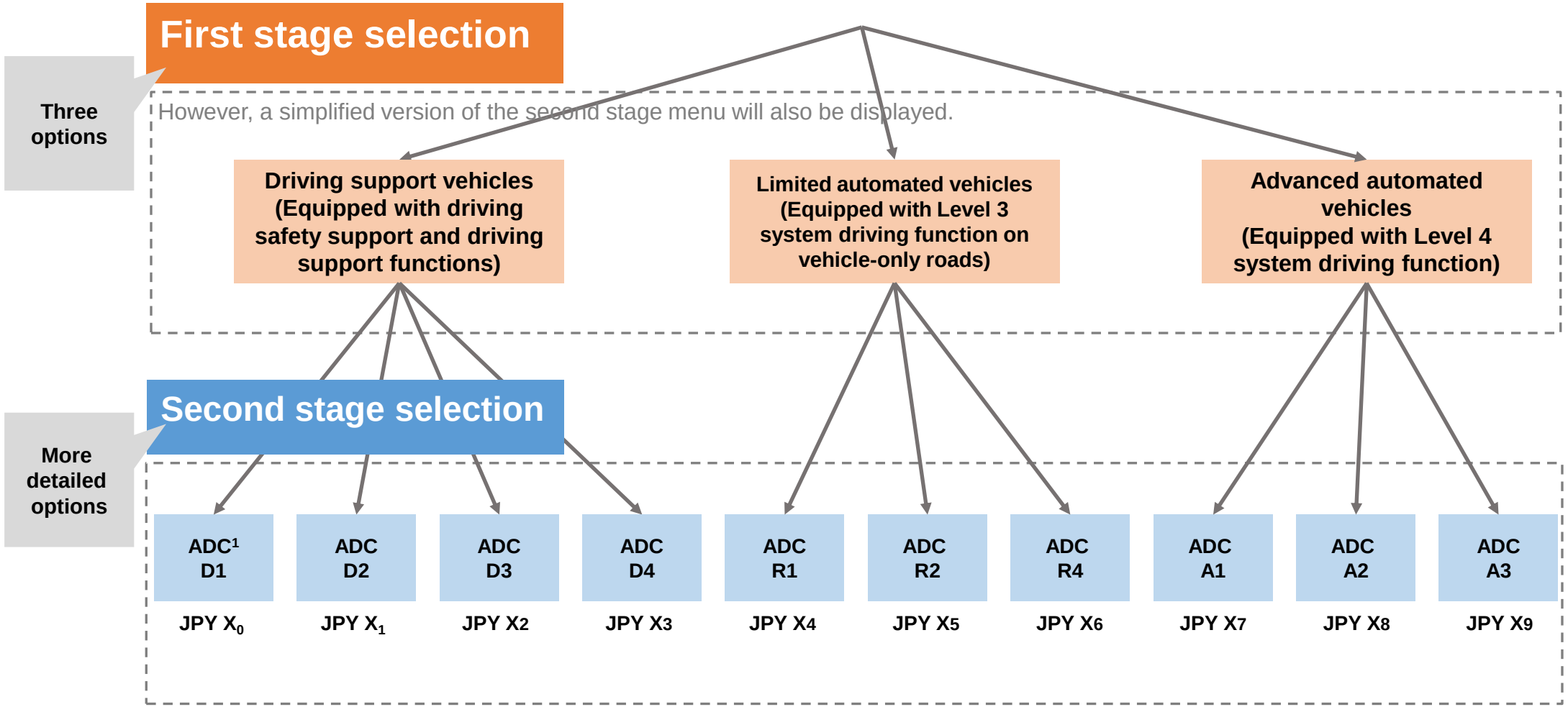
✓: Equipped △: Partially equipped

1. Acceleration control for pedal error, lane departure warning, lane distance warning, AEB for vehicles (short distance in front), AEB for pedestrians, AEB for bicycles crossing the road
2. AEB for vehicles (all-around, long distance), AEB for bicycles (all-around long distance bicycle)
3. General roads where system operation can be used are those with at least one lane in each direction, where sidewalks and roadways are separated by fences, plantings, etc.

The function groups that have been defined will be combined to organize and consolidate automated driving categories.

Diffusion of Privately Owned Passenger Vehicles: Conducting Consumer Questionnaires

New options presented to consumers



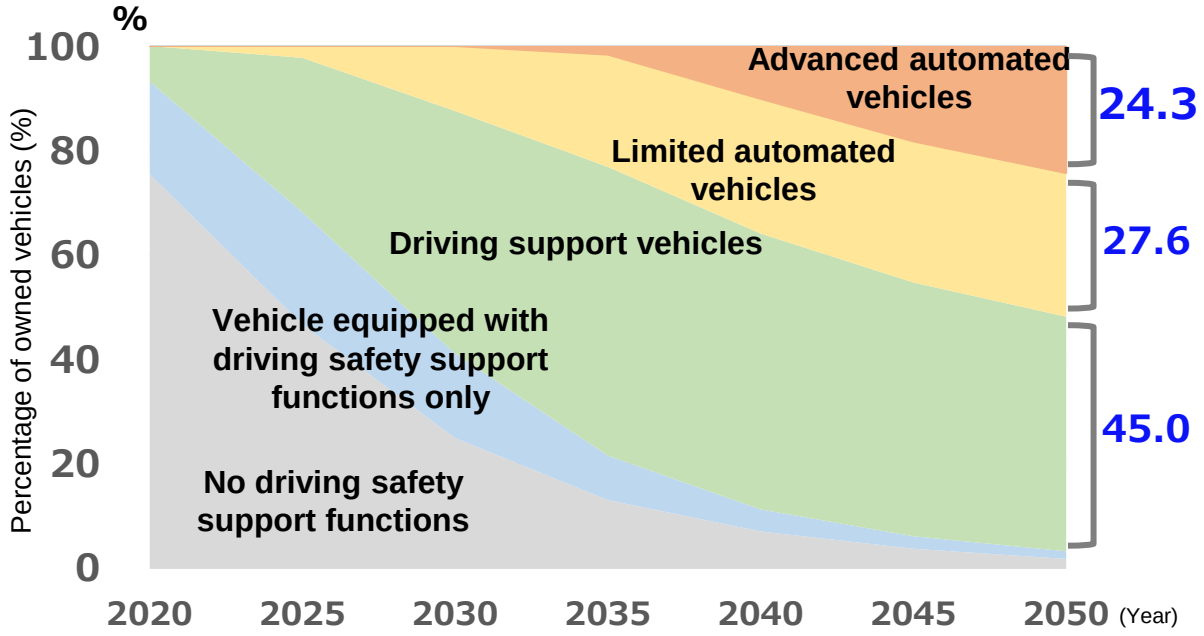
Note 1: Automated Driving Category

Design consumer questionnaires based on organized automated-driving car categories

Diffusion of Privately Owned Passenger Vehicles: model output

Base Scenario

- A simulation model was built to calculate future diffusion, based on interviews with automobile manufacturers and the results of an online survey of more than 8,000 respondents.

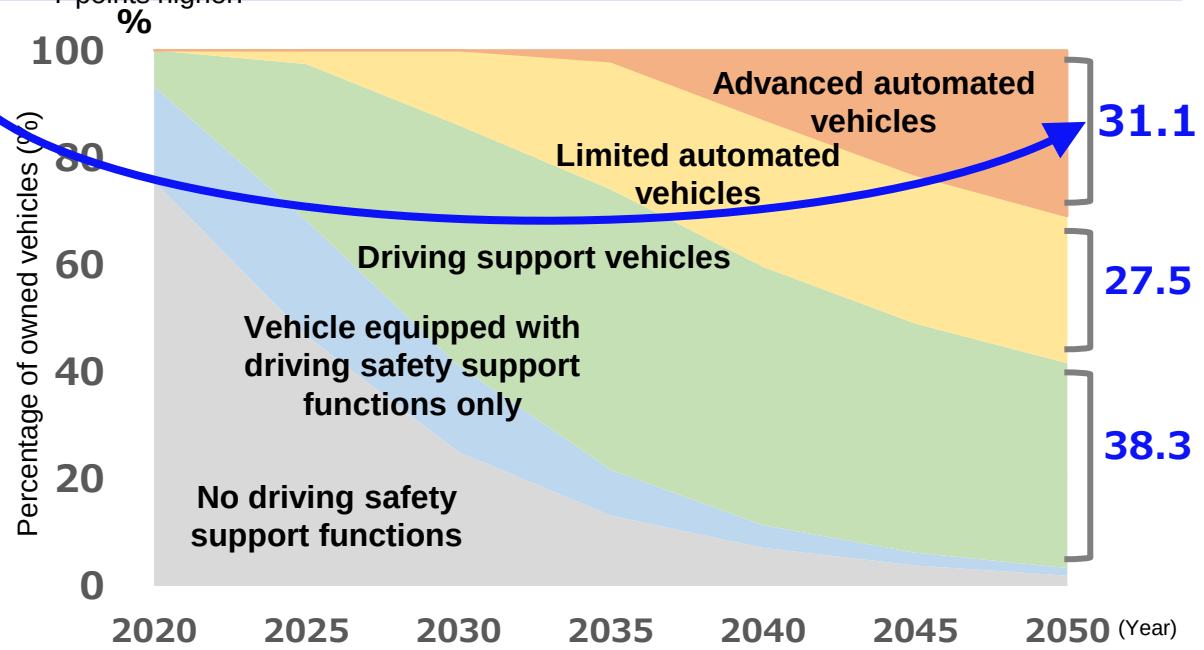


Assumptions for estimation

- Automated-driving vehicle categories, time of market entry, and price were established by The University of Tokyo and Doshisha University based on various references, etc.
- An online survey (8,157 respondents) was conducted. A survey and analysis were conducted regarding what type of vehicle consumers will choose when they purchase a new vehicle, in a situation in which automated-driving vehicles with different functions coexist at the same time. The results of analysis were used to construct an automated-driving vehicle diffusion simulation.
- The scores for acceptance of automated driving and the scores for expectations of automated driving will increase according to the diffusion rate of automated driving vehicles (total of limited automated vehicles and advanced automated vehicles) in the previous year. Regarding this point, both the scores are assumed to increase to the 80%ile value when the diffusion rate of automated driving vehicles is 100%.

Diffusion Promotion Scenario

- This scenario presumes that a variety of measures will be conducted to increase the degree of acceptance and anticipation with regard to automated driving, and the prices of automated driving capabilities will be reduced thanks to subsidies, etc.
- The diffusion rate of "advanced automated-driving vehicles" in 2050 will be approximately 7 points higher.



Assumptions for estimation

- Through various measures, scores for acceptance of automated driving and scores for expectations of automated driving vehicles increase to the 60%ile value by the start of automated driving vehicle introduction (2025). Thereafter, the scores for acceptance of automated driving and the scores for expectations of automated driving will increase according to the diffusion rate of automated driving vehicles (total of limited automated vehicles and advanced automated vehicles) in the previous year. Regarding this point, both the scores are assumed to increase to the 90%ile value when the diffusion rate of automated driving vehicles is 100%. In addition to that, the prices of automated driving capabilities are assumed to be reduced by 50% thanks to subsidies, etc.

The results of calculation show that if the degree of acceptance and expectation with regard to automated-driving vehicles are high, the diffusion rate of "advanced automated-driving vehicles" will increase.

Objectives and Overview

Objectives

To estimate each type of impact based on the content organized in "A. Qualitative organization of overall approach relating to the assessment of socioeconomic impact" through "D. Estimated diffusion rate corresponding to promotion measures in multiple scenarios" and make it the input for "G. External communications."

Overview

- For "i. Estimated impact on traffic accidents," calculations were performed based on organized assumptions.
  - Based on the conditions organized in “B. Organization of preconditions for diffusion and impact assessment simulation models,” analysis was conducted on 154 accident patterns, in which the person principally implicated drove a four-wheeled vehicle, out of 210 traffic accident patterns classified and organized in the "Survey on Analysis Method to Estimate Traffic Fatalities Reduction Effect by Automated Driving System" in FY 2008.
- For "ii. Estimated impact on traffic congestion and CO_2 emissions," calculations were performed based on organized assumptions.
  - Impacts on traffic congestion that should be assessed and can be suitably assessed was identified, based on the preconditions for the behavioral characteristics, etc. of automated-driving vehicles due to technical innovation, which were organized in "B. Organization of preconditions for diffusion and impact prediction simulation models." Subsequently, the models developed in the previous project will be used to estimate the impact of the reduction in traffic congestion nationwide and the impact of the resulting reduction in CO_2 emissions.

Assumptions for Estimation of Reduction in Traffic Accidents

Target of analysis

154 traffic accident patterns in which the person principally implicated drove a four-wheeled vehicle, out of the 210 traffic accident patterns (covering 80.7% of the accident fatalities in 2017) categorized and organized in the FY 2018 "Survey on Analysis Method to Estimate Traffic Fatalities Reduction Effect by Automated Driving System."

Note: The person principally implicated refers to the person among those involved in a traffic accident that is most responsible for the accident. If two or more persons are equally responsible, the " person principally implicated" is the one whose bodily damage is least serious.

Baseline year

The number of accidents in 2014 was used as a baseline.
The effectiveness in reducing accidents thanks to the diffusion of automated-driving vehicles only was isolated and calculated.

Data source

No. of accidents: FY 2018 "Survey on Analysis Method to Estimate Traffic Fatalities Reduction Effect by Automated Driving System"
No. of fatalities and serious injuries: Traffic Accident General Database (J-TAD macro) compiled by ITARDA (Institute for Traffic Accident Research and Data Analysis)

Setting of accident avoidance rate

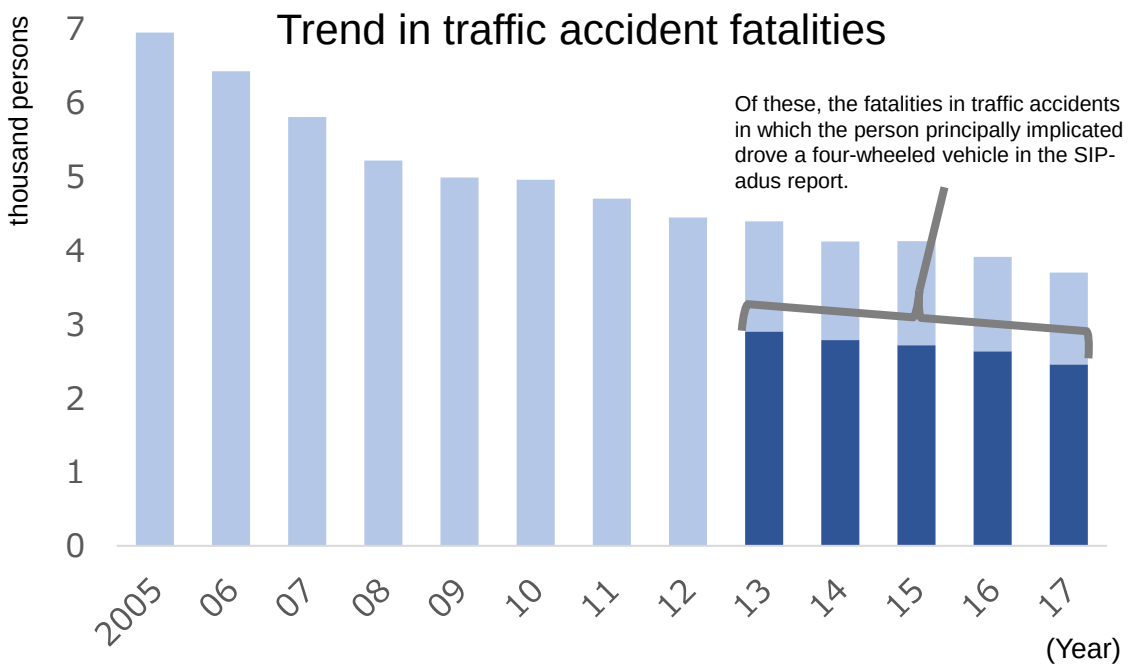
The ASV Phase 6 Progress Report was used to set functions effective in avoiding traffic accidents and the accident avoidance rate for each of the aforementioned accident patterns.

Note: For the accident avoidance rate, the ASV Phase 6 Progress Report says that "it conducts analysis based on the ideal conditions of 100% rate of operation and 100% rate of diffusion. In the real world, however, the rate of operation will be lower, as it will be affected by environmental conditions, driver attributes, the state of traffic flow and so on. Accordingly, the calculations in this report must be viewed as reference values only."

Results of Estimation of Reduction in Traffic Accidents

Trend in no. of traffic fatalities up to now

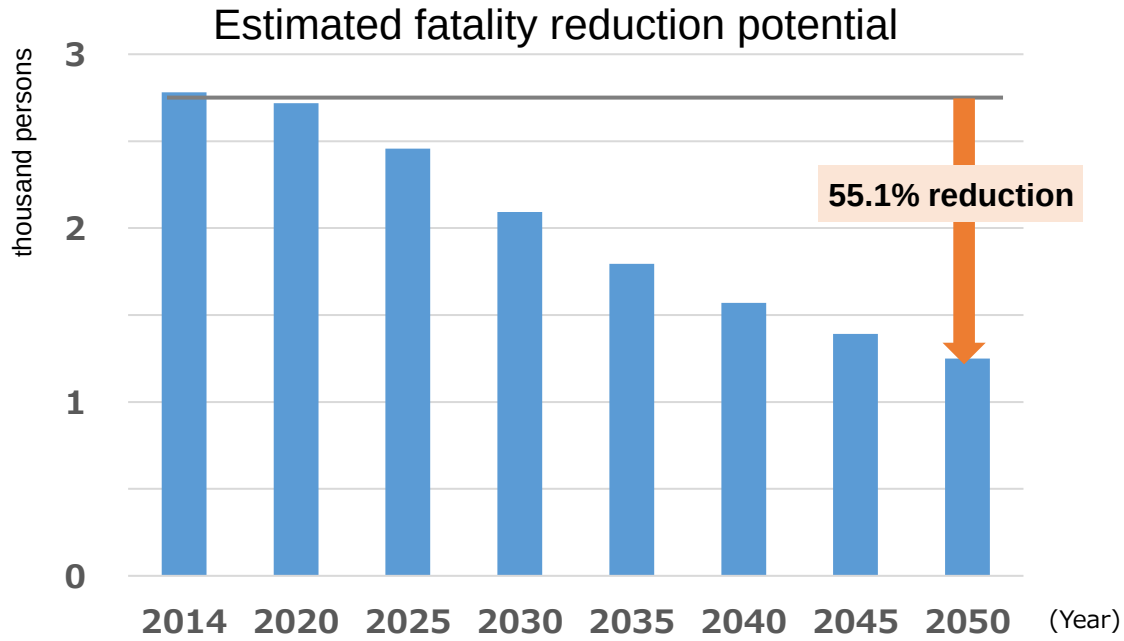
Even now, the number of traffic fatalities has been declining due to ongoing improvements in safety functions, infrastructure construction, safety education etc.



Source
- National Police Agency, Fatalities within 24 hours, in the Situation of Traffic Accident Fatalities within 30days in 2020 (Statistics about Road Traffic), https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00130002&tstat=000001027459&cycle=7&year=20200&month=0; SIP-adus, Cabinet Office, FY 2018 Survey on Analysis Method to Estimate Traffic Fatalities Reduction Effect by Automated Driving System.

Effect of diffusion of automated-driving vehicles

The diffusion of automated-driving vehicles has the potential to reduce traffic accident fatalities by 55.1% in 2050 (as compared to 2014 Base Scenario).



Note1: Numbers in graph are estimates based on the potential degree of reduction of the 154 patterns of traffic accidents in 2014, based on the diffusion status of automated-driving vehicles each year. The automobile traffic volume is assumed to be constant at the traffic volume in FY 2014. (Estimated using Traffic Accident General Database (J-TAD macro) compiled by ITARDA)
Note 2: It is presumed that automated-driving vehicles will not produce new types of accidents that have not occurred with conventional vehicles.
Note 3: Values in the figure for 2020 are estimates and are different from real-world values.

The calculations show that the diffusion of automated-driving vehicles has the potential to reduce fatalities by half.

Assumptions for Estimation of Effect on Traffic Congestion (1/2)

Selection of locations and setting of sections

- **Two expressway locations were selected where traffic congestion occurs frequently.**
  - The conditions under which congestion occurs are thought to be different for two-lane sections and 3-lane sections, so one of each was selected.
  - A cause of typical traffic congestion is the decrease in speed at "sag" locations where the gradient changes.
- **In order to evaluate the congestion at each location, sections that include the start and the end of congestion were established.**

Section with 2 lanes in each direction

- The target was a sector measuring approximately 5 km on the inbound lanes of the Kan'etsu Expressway on either side of the Shibugawa-Ikaho IC. In this sector, the deceleration component in the uphill sector from the Shibugawa-Ikaho IC where the sag causes congestion was considered.
- For the traffic volume, a day on which congestion actually occurred due to heavy traffic in the area near the target sector was selected. (24 hours from 4:00 a.m. Sunday, March 4, 2018 to 4:00 a.m. of the following day, the target of the previous case study)

Map source: Prepared by contractor based on map from Geospatial Information Authority of Japan.

Section with 3 lanes in each direction

- The target was a sector measuring approximately 16 km on the Tomei Expressway outbound lanes starting before the Yokohama Aoba IC and extending to just before the Ebina SA. In the simulation, the deceleration component in the uphill sector with a 2.5% uphill grade starting from the Yamato Sag was considered.
- The traffic volume was presumed to be that for a weekday in October, held in the Road Transport Census as well to constitute average traffic conditions.(24 hours from 4:00 a.m. Thursday, October 19, 2017 to 4:00 a.m. of the following day, the target of the previous case study)

Other assumptions for estimation

- MicroAVENUE (by i-Transport Lab. Co., Ltd.), which has used to assess impact in previous SIP-adus projects, was selected.
- The time required from the start point to the end point is subtracted from the time required when traveling the distance from the start point to the end point at 80 km/h, and the result is counted as the lost time if it is greater than 0 (The reference value of 80 km/h is based on past MLIT data).
- For the Kan-etsu Expressway, the period from 15:00 to 23:00 was defined as the congestion period, and the lost time during this period was totaled.
- The effect of easing/worsening traffic congestion is calculated by subtracting the lost time when the diffusion rate of automatic guided vehicles/ACC is 0% from the calculated lost time.

Assumptions for Estimation of Effect on Traffic Congestion (2/2)

What is ACC?

Adaptive Cruise Control (ACC) is a type of driving support function. A system comprising a dedicated on-board sensor and a CPU automatically controls the steering and braking of the vehicle.

- If there is a vehicle traveling in front, the sensor detects this and maintains a constant distance from that vehicle (follow-the track driving).
- If there is no vehicle in front, the speed is maintained at a value set arbitrarily by the driver.

Setting of following distance

It is entirely likely that, to ensure safety, the following distance (inter-vehicle time clearance) for automated-driving vehicles will be set to a longer distance than in the case of manually operated vehicles.

Calculations using an inter-vehicle time clearance setting that is longer than in the case of a manually operated vehicle

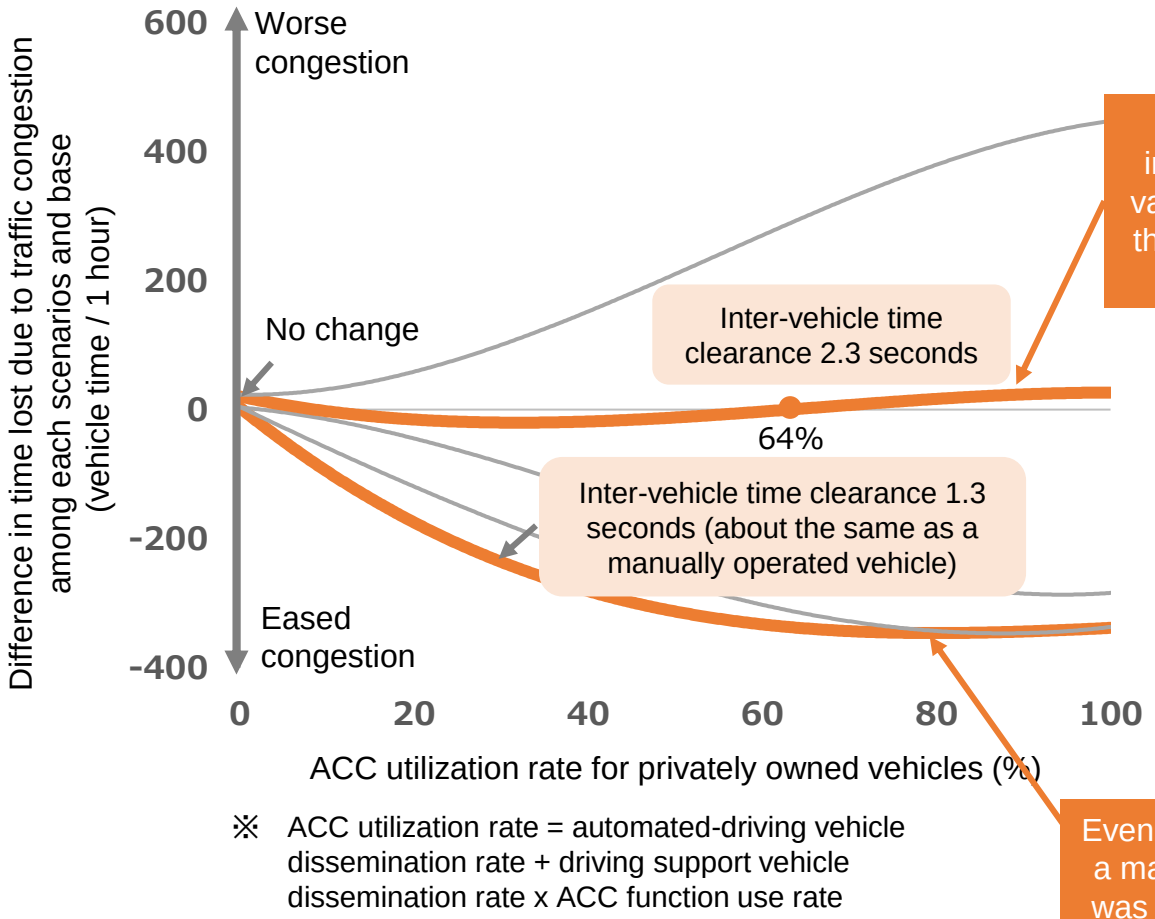
Inter-vehicle time clearance: 1.3 seconds	Same as a manually operated vehicle
Inter-vehicle time clearance: 1.7 seconds	Longer than a manually operated vehicle
Inter-vehicle time clearance: 2.0 seconds	
Inter-vehicle time clearance: 2.3 seconds	
Inter-vehicle time clearance: 2.6 seconds	

※ "Inter-vehicle time clearance" is based on time and a point passed by the vehicle in front. It is the time at which one's own vehicle reaches the same point.

Calculations are performed with various values used for the proportion of ACC and automated-driving vehicles and following distance settings, and the time lost due to traffic congestion is evaluated. A longer following distance setting than in the case of a manually operated vehicle is used (to estimate only behavior and the effect of following distance).

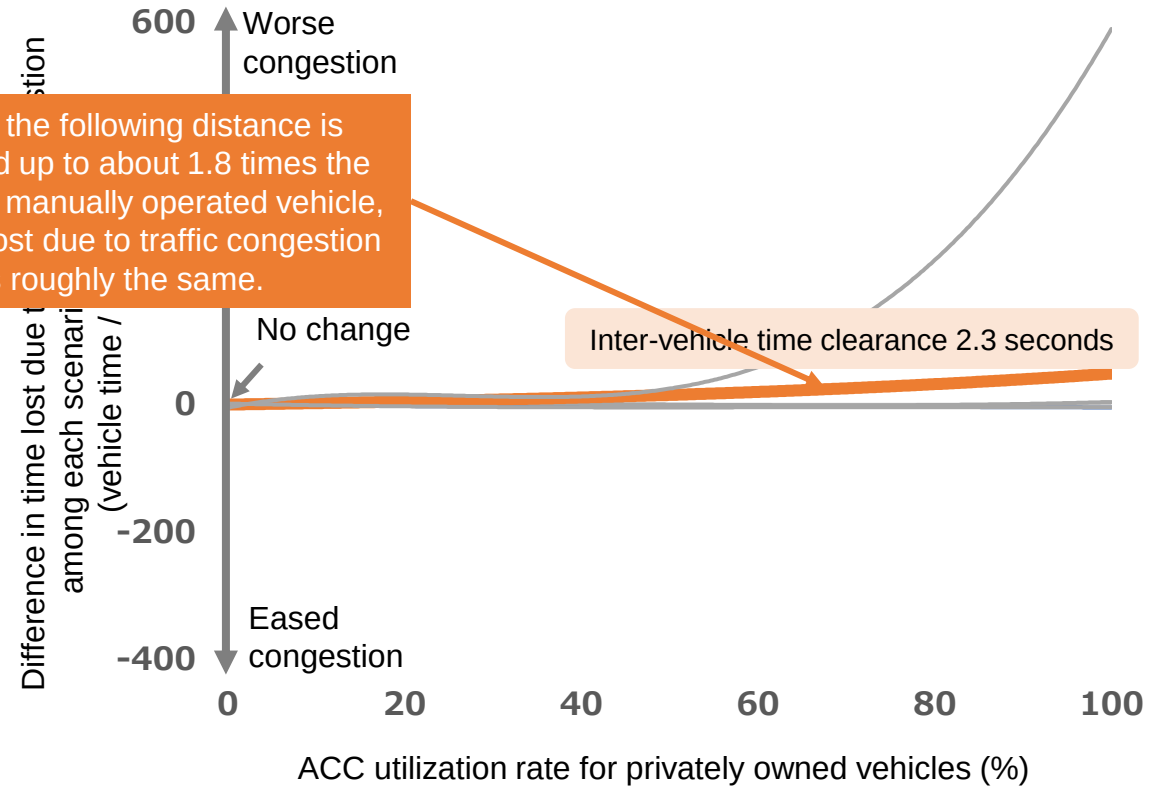
Estimation of Time Lost due to Traffic Congestion

In the case of a two-lane section



※ ACC utilization rate = automated-driving vehicle dissemination rate + driving support vehicle dissemination rate x ACC function use rate

In the case of a three-lane section



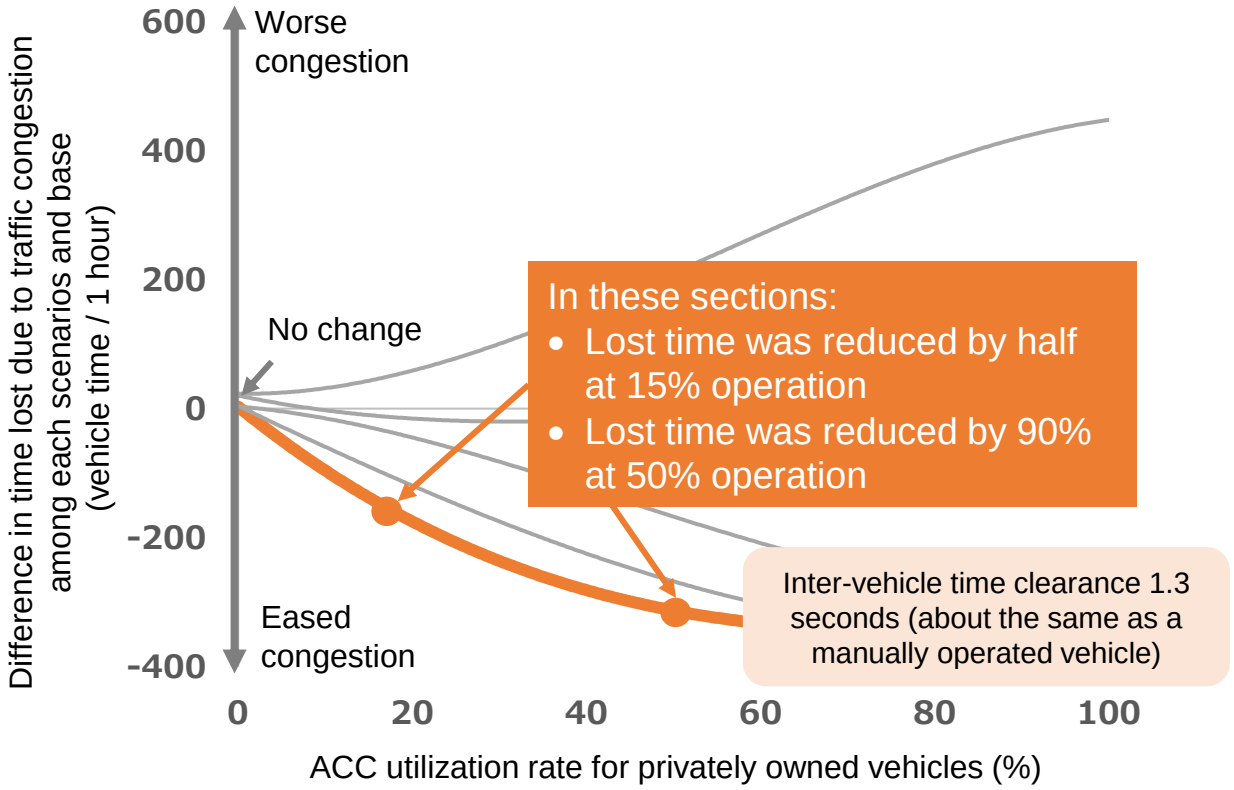
Even if the following distance is increased up to about 1.8 times the value of a manually operated vehicle, the time lost due to traffic congestion is roughly the same.

Even with the same following distance as that of a manually operated vehicle, traffic congestion was greatly reduced depending on the section.

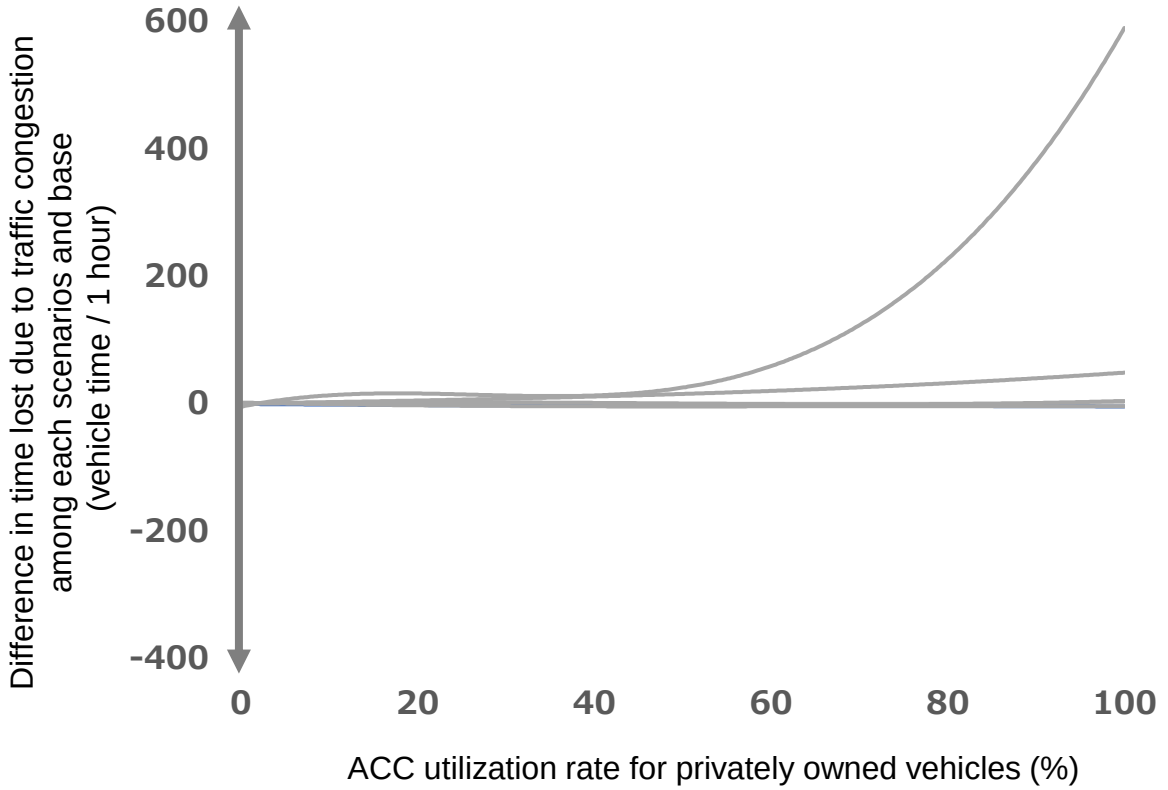
Automated-driving vehicles execute fewer quick decelerations and accelerations as compared to manually operated vehicles, so vehicle behavior is stabilized. Moreover, even if the following distance is increased up to about 1.8 times the value of a manually operated vehicle, congestion is eased and is not exacerbated.

Estimation of Time Lost due to Traffic Congestion

In the case of a two-lane section



In the case of a three-lane section



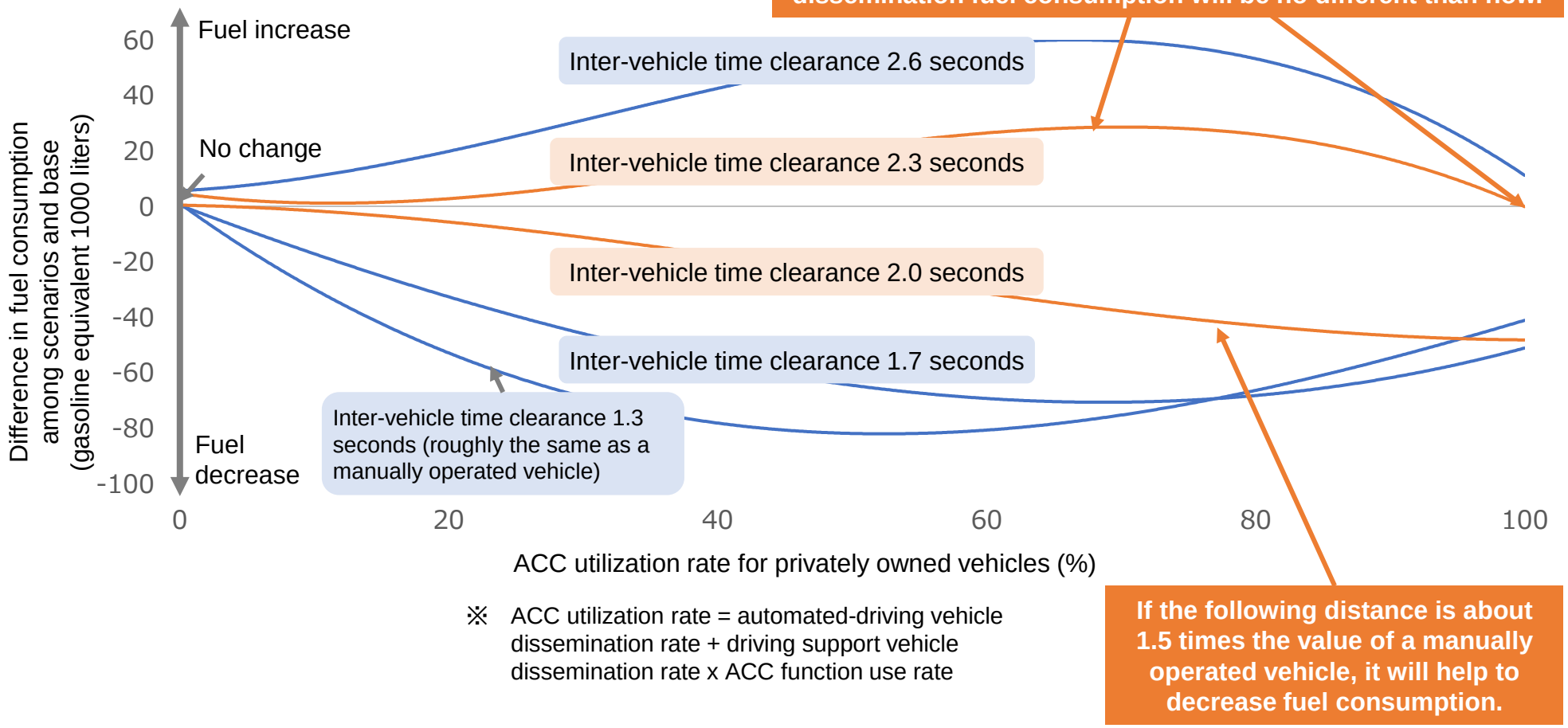
※ ACC utilization rate = automated-driving vehicle dissemination rate + driving support vehicle dissemination rate x ACC function use rate

Even with the same following distance setting as for a manual operated vehicle, use of ACC by a passenger vehicle for 15% of the time reduced the time lost due to congestion by half, and use for 50% of the time reduced it by 90% in some sections.

Estimation of Fuel Consumption during Traffic Congestion

Assumptions for estimation

- **Simulations of the amount of traffic congestion in a 2-lane section were converted to fuel consumption.**
- Vehicle fuel consumption for the same number of vehicles and the same sections as in the base case was totaled.
- The results are simple calculations that do not take into consideration the impact of differences in fuel consumption due to gradients.
- The Pioneer Corporation model will be used for calculation.

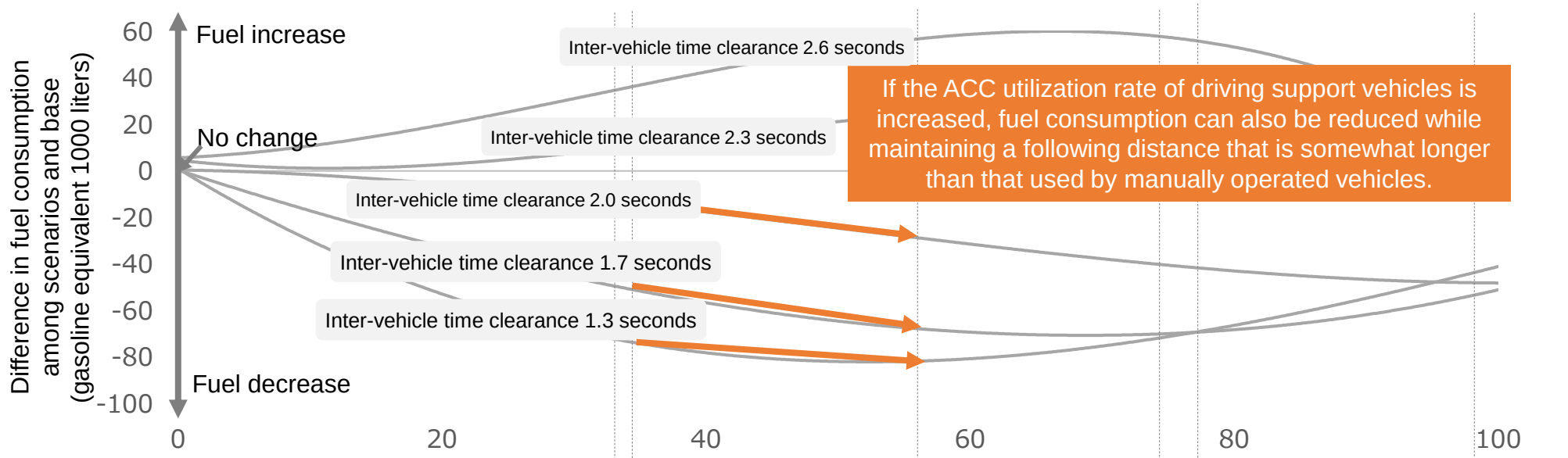


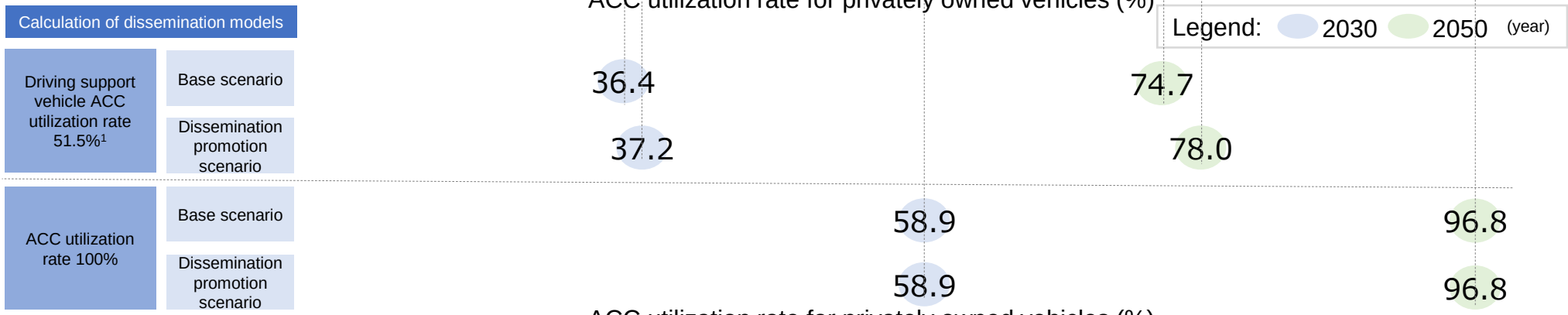
Traffic congestion calculations are covered into fuel consumption. With a following distance of up to about 1.5 times the value of a manually operated vehicle, the dissemination of automated-driving vehicles will help to decrease fuel consumption in some sections.

Estimation of Fuel Consumption during Traffic Congestion

Assumptions for estimation

- **Simulations of the amount of traffic congestion in a 2-lane section were converted to fuel consumption.**
- Vehicle fuel consumption for the same number of vehicles and the same sections as in the base case was totaled.
- The results are simple calculations that do not take into consideration the impact of differences in fuel consumption due to gradients.
- The Pioneer Corporation model will be used for calculation.





Note 1: ACC utilization rate (actual performance) is 51.5% (quoted from Yukiko Miyagi "Survey and evaluation in preparation for fostering social acceptance," Cross-ministerial Strategic Innovation Promotion Program (SIP) Phase 2 (Expansion of Systems and Services) interim performance report, September 30, 2021)

Note 2: ACC utilization rate = automated-driving vehicle dissemination rate + driving support vehicle dissemination rate x ACC function use rate

To increase effectiveness,
it will be important to determine how the disseminated functions should used.

Objectives and Overview

Objectives

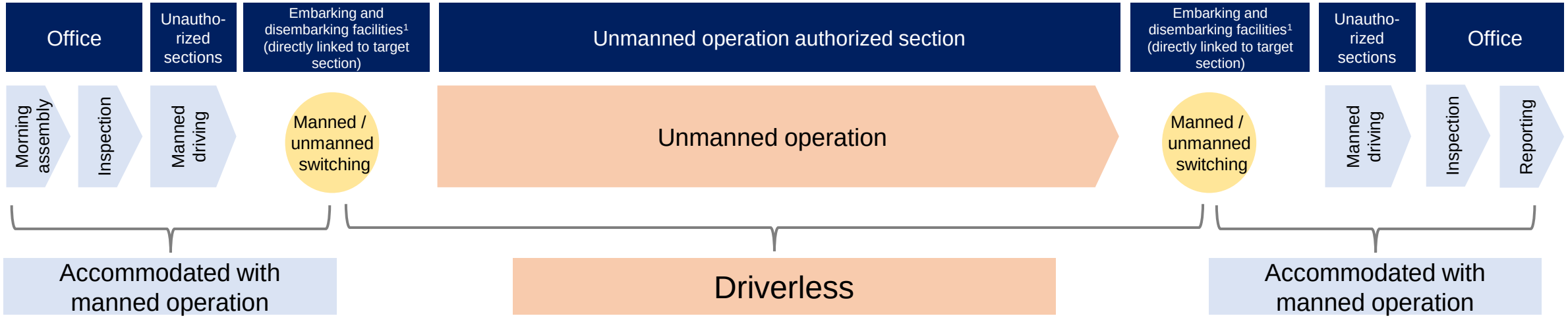
To estimate each type of impact based on the content organized in "A. Qualitative organization of overall approach relating to the assessment of socioeconomic impact" through "D. Estimated diffusion rate corresponding to promotion measures in multiple scenarios" and make it the input for "G. External communications."

Overview

- For "i. Quantitative assessment from the perspective of resolving the driver shortage in logistics and transport services," calculations were conducted based on the organized assumptions.
  - Set up scenarios under which driverless trucks can run, based on the conditions organized in "B. Assumptions for the diffusion and impact forecasting simulation model.“
  - Based on the scenarios set up, estimate the manpower shortage of truck drivers.
- For "ii. Quantitative assessment from the perspective of the productivity of Japanese economy and the ripple effects of automated driving on production, etc.," calculations were conducted.
  - The method developed in the previous project was followed. Specifically, the shift to automated-driving vehicles and the change in parts due to electrification were estimated, and then interindustry tables were used to estimate the impact of the parts change on domestic products and employment in the automotive industry and Japanese industry overall.
  - Although the estimation method followed the method used in the previous project, input data was updated to make the data consistent with "A. Qualitative organization of overall approach relating to the assessment of socioeconomic impact" through "E. Estimated no. of traffic accidents, traffic congestion and CO_2 emissions."

Assumptions for Estimation of Alleviation of Truck Driver Shortage (1/2)

Assumptions for truck transport in this model



- Even now, the loading ratio for the trucks for truck transport is being improved, and increasing the loading ratio by reshipment at logistics centers is not taken into consideration.
- It is possible that additional staff may be needed for switching between manned and unmanned driving, monitoring during operation, conducting vehicle maintenance etc., but such staff will be procured from outside the current truck driver personnel market, and these are not considered to be personnel who are needed as drivers.
- However, in many cases the current pattern is that the driver conducts loading, so this scenario also presumes that this will be done by the driver.

Note 1: For the time being, driver embarking and disembarking facilities and platooning docking stations etc., without the need to provide warehouse functions.

The specific situations in truck transport in which automated driving will be used were envisioned.

Assumptions for Estimation of Alleviation of Truck Driver Shortage (2/2)

Approach to settings

- Driverless operation will be permitted only on expressways (automobile-only roads connecting major cities, not including urban expressways).
- On the expressways, sections that cover 25%, 50% and 75% of the traffic volume on a vehicle-kilometer base have been established as cases.
- In general, these have been established as driverless permit sections in order of highest spot traffic volume. If sections are interrupted in the middle, those sections are connected.
- For only the 50% case, additional reference cases have been established for the routes for double-linked trucks.

Set cases

25% coverage case

- Set for Tokyo - Nagoya and Nagoya - Osaka.
- Does not include cases such as the Metropolitan Expressway where there is no shoulder.
- 6.3% of total highway length.

50% coverage case

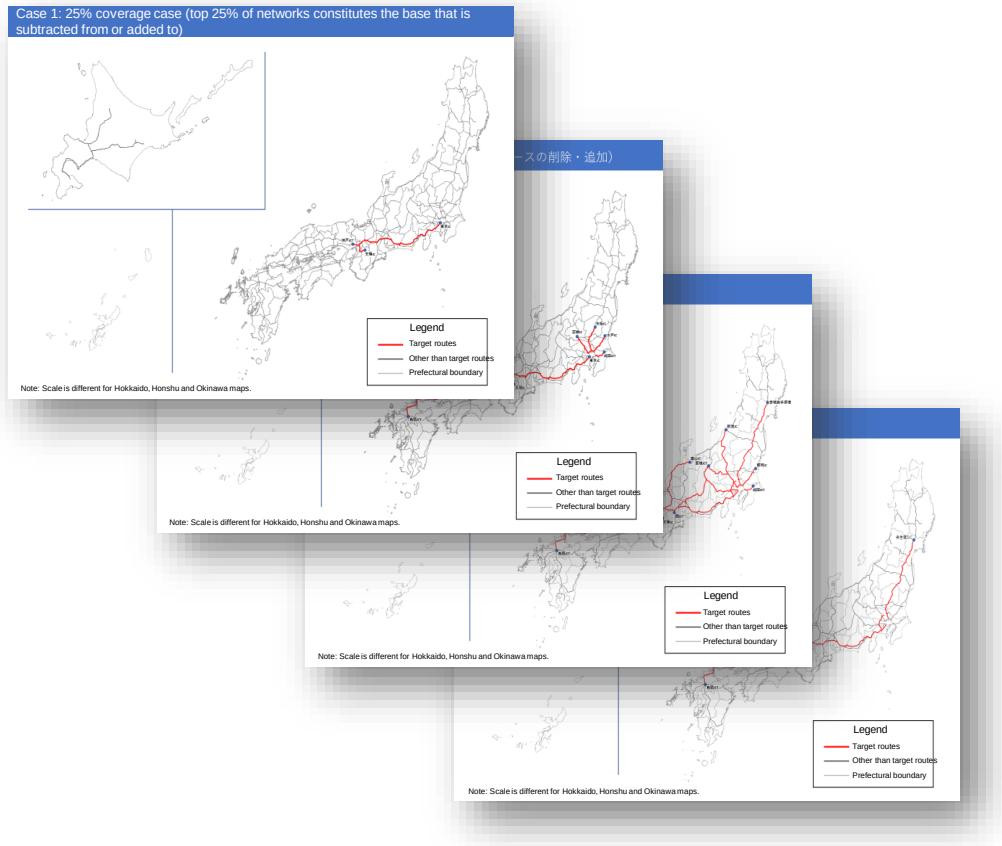
- Set for Tokyo - Fukuoka and primarily major expressways in the Kanto region.
- 17.6% of total highway length.

75% coverage case

- This setting also considers the expressway network and presumes an extension of permit sections, including the Chuo Expressway among others.
- 34.8% of total highway length.

50% coverage case that takes into consideration double-linked trucks

- Set in order to consider routes for double-linked trucks.
- Can be connected to remote locations.
- 17.7% of total highway length.

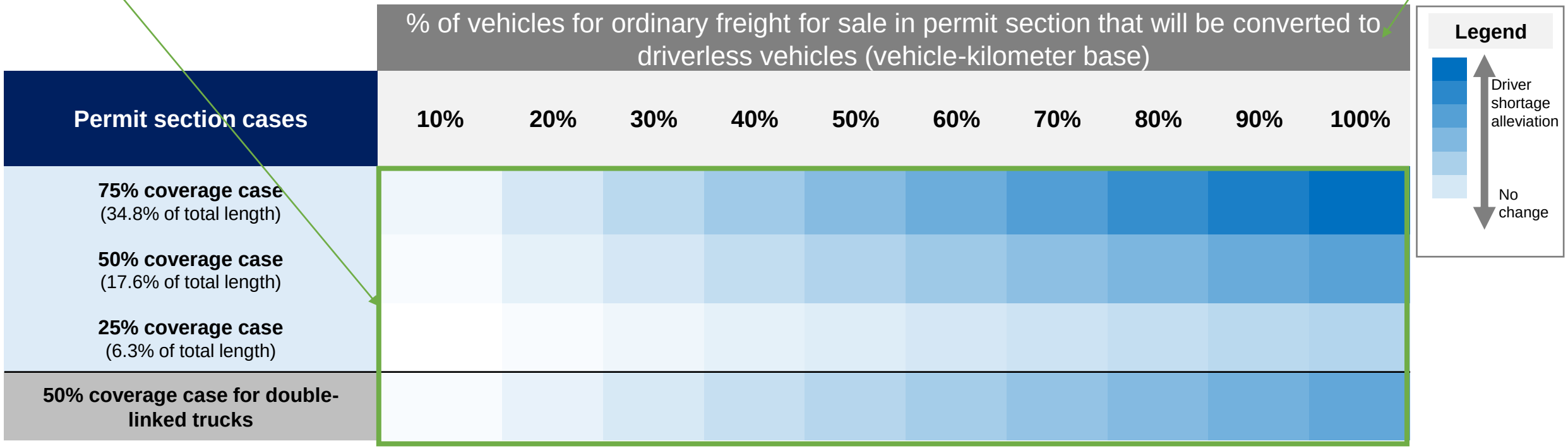


Driving permit scenarios for driverless trucks have been prepared, taking traffic volume into account.

Results of Estimation of Alleviation of Truck Driver Shortage

Driver shortage alleviation ratio (results of estimation for 2040)

$$\text{Alleviation ratio (\%)} = \frac{\text{Quantity replaced by driverless transport in the case of ordinary freight for sale (persons)}}{\text{Driver shortage in the case of ordinary freight (persons)}} = \frac{\text{No. of drivers for target ordinary freight for sale in each permit section (persons)}}{\text{Driver demand in the case of ordinary freight (persons) - Driver supply in the case of ordinary freight (persons)}} \times \text{Replacement ratio}$$



The degree of driver shortage alleviation is calculated by combining infrastructure construction (permit sections) and the dissemination rate. With either "wide-area permitting x low dissemination rate" or "narrow-area permitting x high dissemination rate," a certain degree of driver shortage alleviation can be anticipated.

Calculation Method

Approach to Analysis of Economic Ripple Effect

1

- Necessary parts will be estimated based on "what functions should a vehicle in a certain automated driving category be equipped with?“
- The vehicle part configuration for base model parts will be estimated based on the 2019 Updated Input-Output Tables.

2

- The economic ripple effect will be estimated, taking into consideration indirect impacts.

Approach to economic ripple effect

Demand of passenger vehicle increase

Direct effect
- (1) Production of passenger vehicle increase

+

First order Indirect effect
- (2) Production of passenger vehicle parts increase

+

- (3) Production of things that produce passenger vehicle parts increase

+

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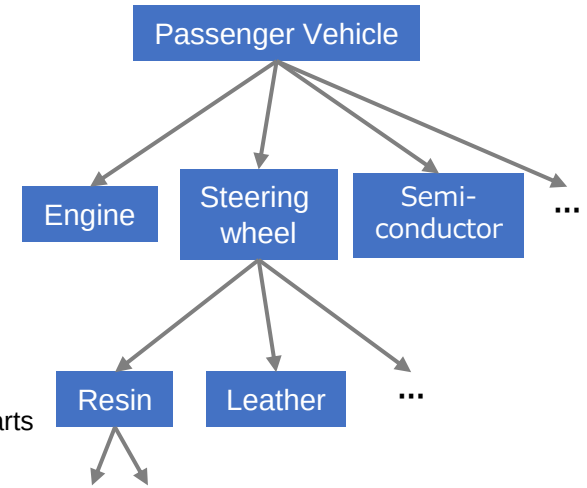


Results

- Estimated economic ripple effects of the shift to automated passenger cars based on changes in the number of new vehicle registrations by automated vehicle category resulting from diffusion simulations based on each scenario.
- Domestic production value in the passenger car sector and all industries increases due to an increase in the cost of parts per passenger car.
- However, the rate of increase will decrease due to lower component costs accompanying the increase in the cumulative production of automated vehicles (experience curve effects).

Note 1: Direct effect + First order indirect effect
Note 2: The effect of changes in production volume was not included. Only the effects of automated driving and electrification was presented

Objectives and Overview

Objectives

To communicate the various estimated benefits to specialists and the general public, based on the external communications policy determined in A. "Qualitative organization of overall approach (relating to assessment of socioeconomic impact)."

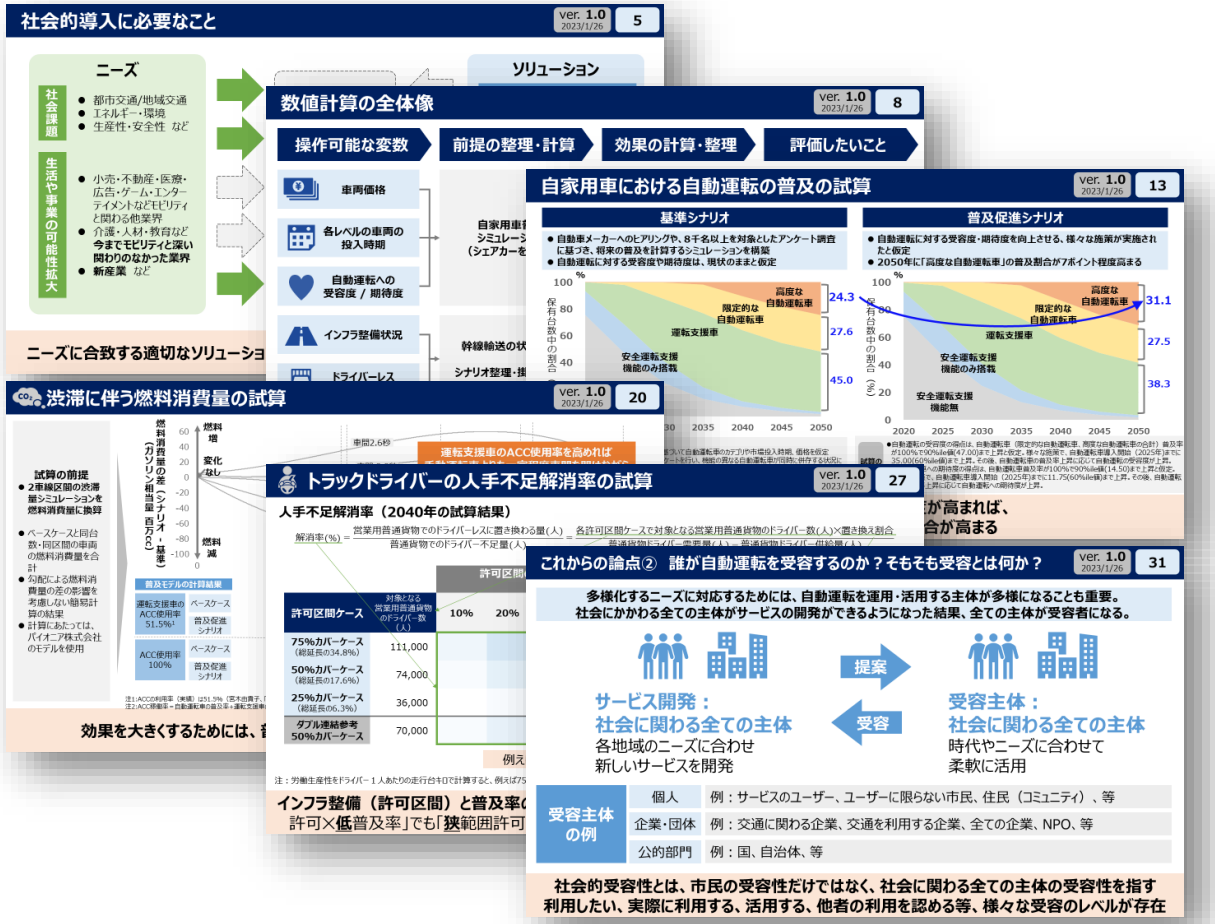
Overview

- Reference materials and videos were prepared as the external communications content.
- A variety of events were used to communicate research results to specialists, industry representatives and the general public, based on the external communications policy determined in A. "Qualitative organization of overall approach (relating to assessment of socioeconomic impact)."
  - For specialists and industry representatives, external communication was conducted using SIP-adus events, academic conferences and so on.
  - For the general public, external communication was conducted using special events sponsored by contractors (mobility business innovation contest, on-campus events).
- A community was fostered to hold various exchanges of views and consider the future of automated driving.

Prepared Content

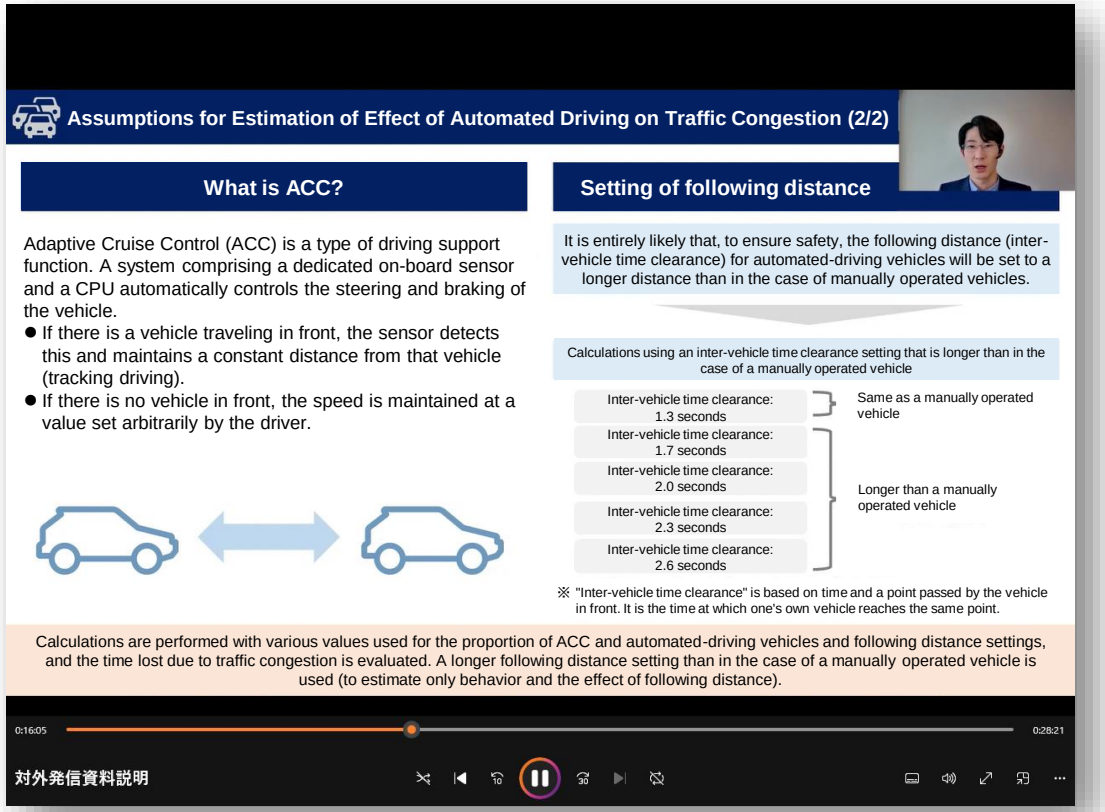
External communication reference materials

- Visual presentation materials were prepared to make it easy to understand for the general public as well.
- The content was improved through working group discussions.



External communication videos

- Explanatory videos were prepared to enable the meaning of the external communications reference materials to be more accurately conveyed, and to bring the content to a wider audience.



External Communications that were Conducted

Month	SIP-related events	Academic conferences, etc.	Student contests, etc.
August, 2022			● Student Contest 1st workshop
September		● Presentation at ITS World Congress session (details will be presented later)	● Student Contest 2nd workshop
October	● Poster presentation at SIP-adus Workshop Poster Session ● Presentation at "Impact Assessment" session at SIP-adus Workshop		● Student Contest Interim presentation session ● Student Contest 3rd workshop ● Presentation on UTmobI talk show
November		● Presentation at Transport Research Arena session (details will be presented later)	● Student Contest 4th workshop
December			● Student Contest final judging session
January, 2023			● Presentation at UTmobI Forum
March	● Poster and video presentations at SIP Exhibition & Symposium on Automated Driving		

Communicated to attendees at SIP-adus events

International exchange of views with specialists around the world

Discussion of changes to lifestyles and communication of information to the general public

Presentations at Academic Conferences, etc.

ITS World Congress

(2022/9/18-22 @Los Angeles)

Exchange of views between specialists in Japan, the U. S. and Europe regarding the impact of automated driving on society and social acceptance

Transport Research Arena

(2022/11/14-17 @Lisbon)

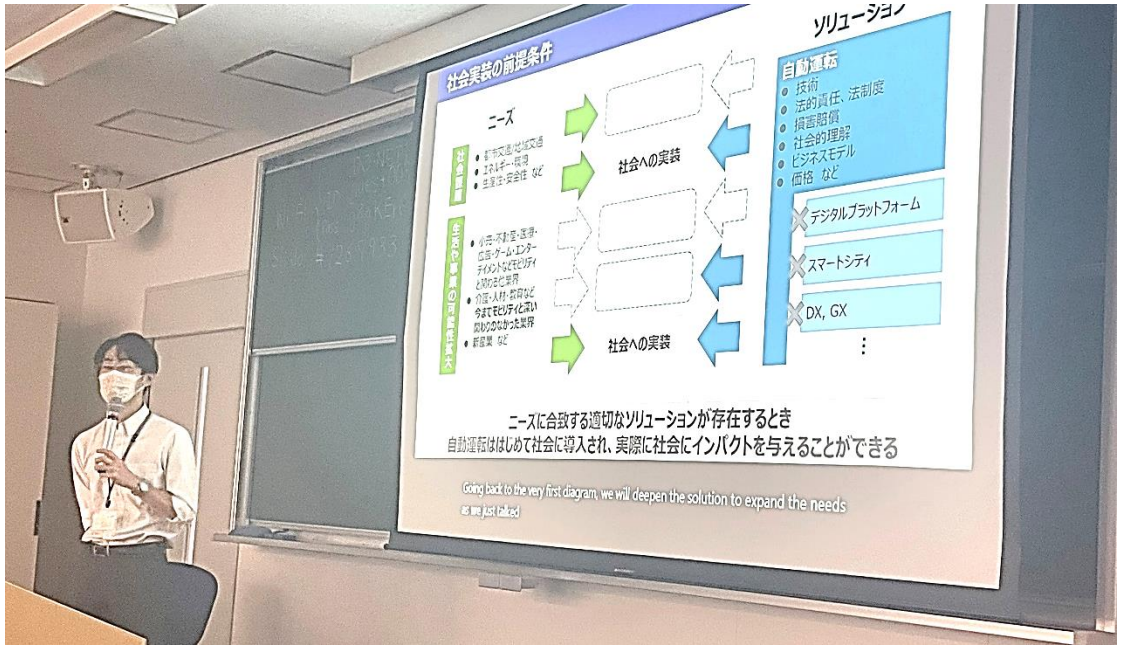
Presentations and exchange of views regarding issues at hand regarding automated driving going forward and the importance of international cooperation

Based on the achievements of this project, exchanges of views were held at various global conferences.

Presentations at Student Contests

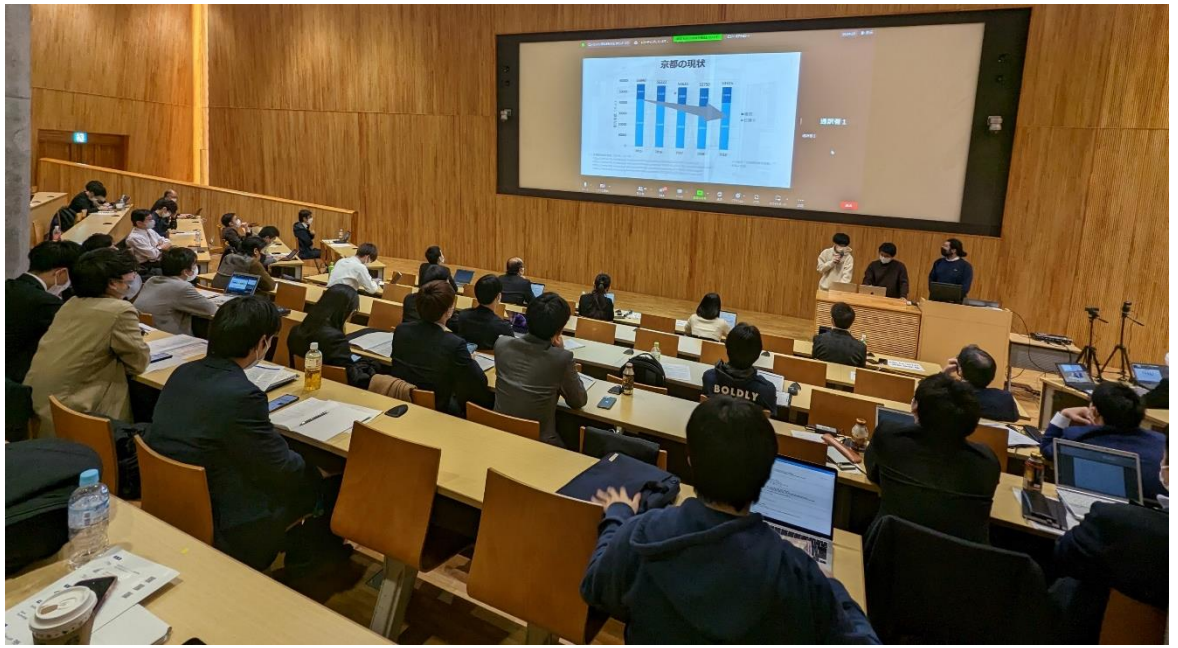
Workshops

Information based on the achievements of this project was presented to participating students and personnel from supporting companies and ministries, and discussions were held based on this information.



Final Review Session

Ways of using automated driving in the future were presented, based on a discussion of changes to lifestyles. The review session was held online and was opened to the general public.



Based on the achievements of this project, a community to consider the future of automated driving was fostered.

Joint Japan-German Publication

Joint Workshop

A comparison of automated driving in Japan and Germany was held and analysis results were shared in order to discuss the content of the publication.

Publication

A publication will be issued based on the achievements of the workshop.

CONTENTS

- Chapter 1: Introduction
- Chapter 2: Setting the Scene for Automated Mobility: A Comparative Introduction to the Mobility Systems in Germany and Japan
- Chapter 3: Governance, Policy and Regulation
- Chapter 4: Business analysis and prognosis regarding the shared autonomous vehicle market in Germany
- Chapter 5: Social Acceptance of CAD: Conceptual Issues and Empirical Insights
- Chapter 6: Transportation Effects of CAD in Germany
- Chapter 7: Transportation Effects of CAD in Japan
- Chapter 8: Overall Comparison between Germany and Japan in relation to social impact of CAD

A workshop was held on the joint publication that represents the achievements of cooperative research activities conducted by Japan and Germany.

Research on assessment of the impact of automated driving on society and the economy and on measures to promote deployment

END