

A Survey User Acceptance for Congestion Countermeasures at Expressway Sag Sections by Utilizing V2I Communication

Koichi Iwatake, Kazufumi Suzuki, Hideyuki Kanoshima, Hiroshi Makino

ITS Division, National Institute of Land and Infrastructure Management

Asahi 1, Tsukuba City, Ibaraki Pref.

TEL 029-864-4496, FAX 029-864-0565

iwatake-k924a@nilim.go.jp suzuki-k92td@nilim.go.jp kanoshima-h92ta@nilim.go.jp

makino-h87bh@nilim.go.jp

ABSTRACT

Although traffic congestion around toll gates has been reduced with the popularization of ETC units for the Japan's expressways, congestion arising on sag sections corresponds to approximately 60% of all the congestion occurring on expressways, such that the devising of effective countermeasures is seen as being a priority. In this paper, we studied the attitudes of expressway users towards the efficacy of lane utilization optimization service and vehicle to vehicle gap optimization services as measures for mitigating congestion, and examined their degree of understanding.

Keywords: ITS, Lane Utilization Optimization, ACC, C-ACC

1. INTRODUCTION

Approximately 60% of the congestion occurring on the expressways connecting the cities of Japan occurs in sag sections. NILIM is conducting research on resolving congestion at sags using vehicles equipped with ACC (Adaptive Cruise Control), which maintains a constant interval between vehicles. Some of Japan's automotive manufacturers are developing CACC (Cooperative Adaptive Cruise Control), which more precisely maintains intervals vehicles using vehicle to vehicle communication.

At ITS World Congress Tokyo 2013, held at Tokyo Big Sight in October 2013, we invited congress participants to test drive on expressway to show lane utilization optimization services, and vehicle interval optimization services using ACC and CACC. In addition, after the test drive, we conducted a questionnaire survey related to traffic smoother services to verify the level of receptivity to such services, such as the effectiveness of such services for solving congestion, the level of understanding of the services, and the inclination to cooperate with mitigate congestions. In this paper, we report the verification results.

2. Survey Method

At ITS World Congress Tokyo 2013, we invited congress participants (referred to below as “passengers”:They rode with a car.) to test drive of vehicles equipped with ACC and CACC to experience its performance and information related to traffic smoother services provided from the ITS spots. Specifically, we first showed test drivers an orientation video (Figure 1) related to congestion mechanisms at sags and traffic smoother services before departing from Tokyo Big Sight. The vehicles followed the Bayshore Route from Rinkai Fukutoshin IC to Haneda Airport IC, turning around in the Haneda Airport parking lot before returning to Tokyo Big Sight. This demonstration was conducted using three ACC-equipped vehicles and four CACC-equipped vehicles (three vehicles for testing and one lead car). Each demonstration had two passengers per vehicle. Figure 2 shows an overview of the demonstration, including the driving route, service data provided on the metropolitan expressway and the locations at which information was provided. This figure shows the provided services for the outbound (Rinkai Fukutoshin IC -> Haneda Airport IC) ACC-equipped vehicle and an inbound (Haneda IC -> Rinkai Fukutoshin IC) CACC-equipped vehicles.



Figure 1. Orientation video content.

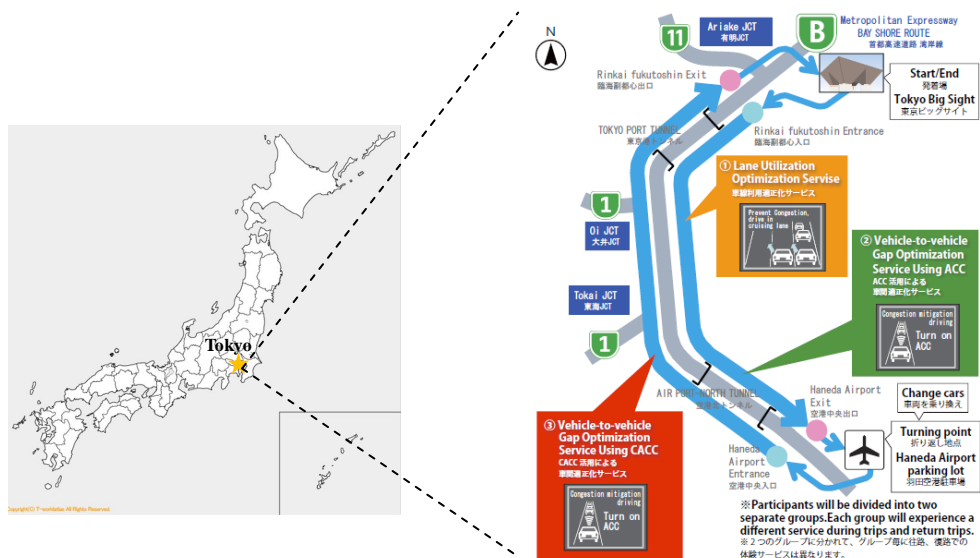


Figure 2. Outline of the demonstration.

Passengers riding the ACC-equipped vehicles on the outbound route had lane utilization optimization services and vehicle interval optimization services by ACC. On the return route, they had vehicle interval optimization services by CACC. Passengers of the CACC-equipped vehicles on the outbound route had vehicle interval optimization services by CACC, and then had lane utilization optimization services and vehicle optimization services by ACC on the return route. After arriving at Tokyo Big Sight, they were given a questionnaire regarding their level of understanding of the services they experienced.

3. Questionnaire Survey Results

3.1 Verifying Level of Understanding of Traffic Smoother Services and Inclination to Participate in Congestion mitigated

The survey was conducted over three days with a total of 90. The professions of them are shown in Figure 3. Since this survey was conducted at the ITS World Congress, the respondents also included participants from abroad. In addition, because persons related to the automotive and telecommunications industries comprised approximately 60% of the passengers, many participants understood traffic smoother services. 11% of passengers were age 20–29, 23% were age 30–39, 33% were age 40–49, 27% were age 50–59, and 6% were age over 60.

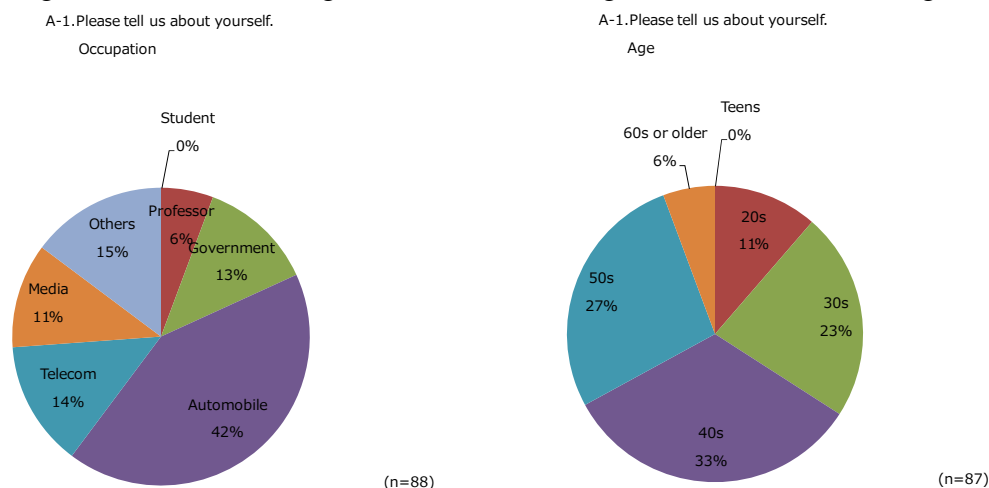


Figure 3. The Passenger professions.

Figure 4 shows the answer on effectiveness of traffic smoother services at countermeasures for congestion at highway sags. 95% of passengers answered either “1. effective” or “2. somewhat effective.”

On the other hand, the passenger answered “4. Somewhat ineffective” (N=1). Next, we discuss the level of understanding of the three services test drivers experienced in this test: “lane utilization optimization services,” “ACC vehicle interval optimization services,” and “CACC vehicle interval optimization services.”

Effectiveness for countering congestion traffic smoothing service at highway sags.

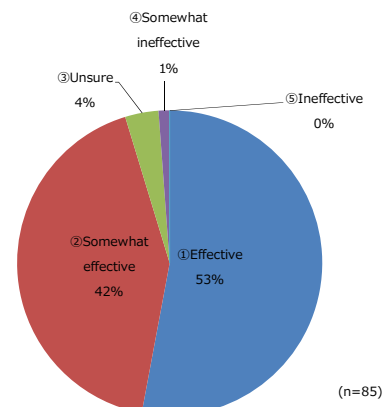


Figure 4. Effectiveness of traffic smoother services.

In “lane utilization optimization services,” 97% of passengers answered either “I understand” or “I somewhat understand.” On the other hand, 1% of passengers answered “I don’t understand”. Figures 5, 6 show the level of understanding of each service that is “ACC vehicle interval optimization services” and “CACC vehicle interval optimization services.”

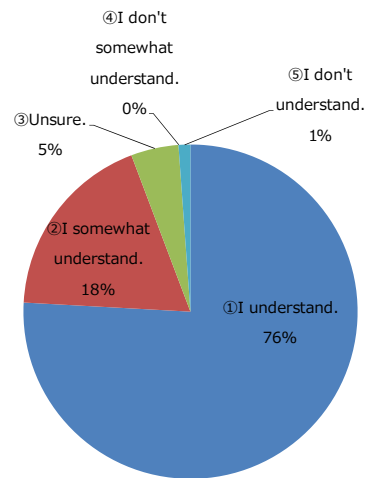
In “ACC vehicle interval optimization services”, 94% of passengers answered either “1. I understand” or “2.I somewhat understand”. On the other hand, 1% of passengers answered “I don’t understand”. Next, In “CACC vehicle interval optimization services”, 98% of passengers answered either “1.I understand” or “2.I somewhat understand”. On the other hand, 1% of passengers answered “I don’t somewhat understand”.

3.2 Verifying Inclination to Introduce ACC and CACC

In this survey, we verified intent after informing the passengers that ACC and CACC systems cost approximately 200,000 yen. Figures 7 and 8 show the verification results.

In inclination to purchase ACC, 90% of passengers answered “1.I would like to use it.” Or “2.I would somewhat like to use it”. Most passengers answered that they would like to introduce it “because it would be useful for long-distance driving.” The next highest reasons were “it would be effective for mitigate congestion” and “it would be effective for preventing accidents.” Passengers expect ACC to function in terms of comfort, traffic smoothing, and safety.

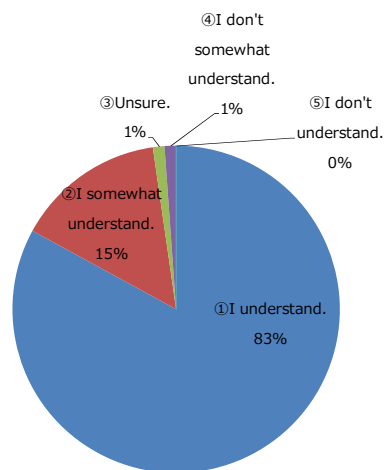
ACC Vehicle interval optimization service associated with ITS spots



(n=87)

Figure 5. Receptive for ACC vehicle interval optimization services.

CACC vehicle interval optimization service associated with ITS spots



(n=88)

Figure 6. Receptive for CACC vehicle interval optimization services.

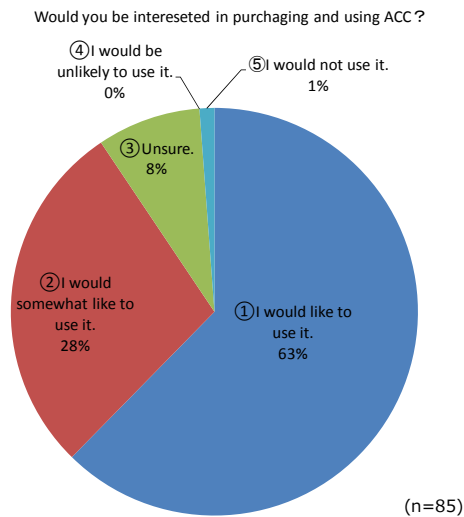


Figure 7. Inclination to purchase ACC.

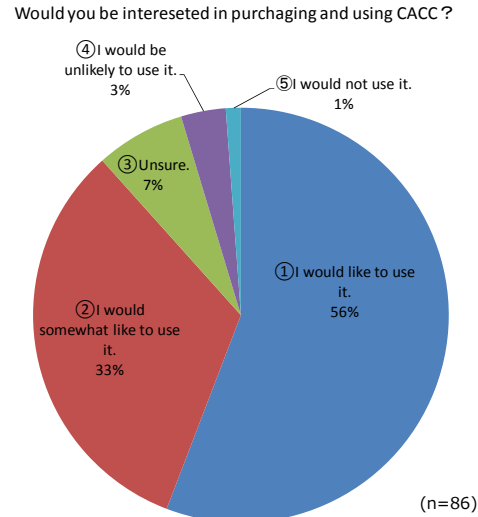


Figure 8. Inclination to purchase CACC.

Next, inclination to purchase CACC, 89% of passengers answered “1.I would like to use it.” Or “2.I would somewhat like to use it”, regardless of occupation. Most passengers answered that they would like to introduce it “because it would be effective for mitigate congestion.” The next highest reasons were “it would be effective for preventing accidents” and “it would be helpful for driving during congestion,” in that order. As ACC, passengers expect CACC to function in terms of comfort, traffic smoothing, and safety.

4. Verifying Effective Consciousness for Traffic Smoother Services/ Level of Understanding of Vehicle Interval Optimization Services and Inclination to Introduce ACC and CACC

We verified the trend that is effective consciousness for traffic smoother services/ level of understanding of vehicle interval optimization services and inclination to introduce ACC and CACC using for cross tabulation. This verifying is that passengers who think traffic smoother services effective for mitigate congestion and understand ACC/CACC vehicle interval optimization services wants to purchase ACC and CACC.

Figure 9, 10 show the relation of effective consciousness for traffic smoother services and the purchase of ACC/CACC. Over 80% of passengers that answered “1.effective”, “2.somewhat effective” for traffic smoother services, answered “1.I would like to use it”, “2.I would like to somewhat use it”. Passengers who think that traffic smoother services are effective for mitigating congestions have positive intentions to purchase ACC.

Besides, over 85% of passengers who answered “1.effective”, “2.somewhat effective” for traffic smoother services, answered “1.I would like to use it”, “2.I would like to somewhat use it”. Passenger who thinks that traffic

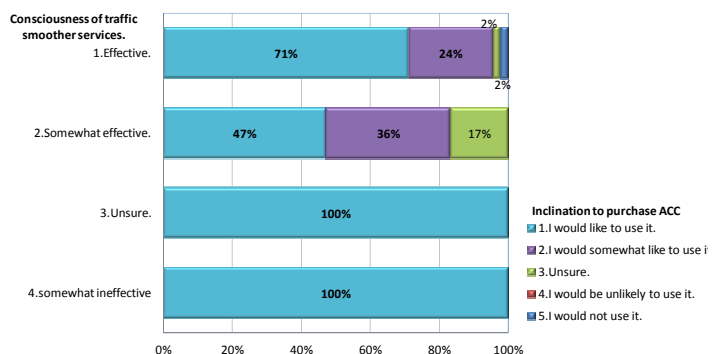


Figure 9. The trend of consciousness of traffic smoother services and inclination to purchase ACC

smoother services are effective for mitigating congestion have positive intention to purchase CACC.

Figure 11 shows that the trend of receptiveness for ACC vehicle interval optimization service and inclination to purchase ACC, and Figure 12 shows that the trend of receptiveness for CACC vehicle interval optimization service and inclination to purchase CACC.

Over 80% of passengers who answered “1.I understand”, ”2.I somewhat understand” for ACC vehicle interval optimization, answered “1.I would like to use it”, ”2.I would like to somewhat use it”. Passengers think that traffic smoother services are effective for mitigating congestions have positive intentions to purchase ACC.

On the other hand, passengers who answered that “1.I understand.” for ACC vehicle interval optimization answered “5. I would not like to introduce it.” He gave reasons such as “I have doubts about the reliability of the devices” and “the system is still insufficiently precise at this time.”

Besides, over 80% of passengers who answered “1.I understand”, ”2.I somewhat understand” for CACC vehicle interval optimization, answered “1.I would like to use it”, ”2.I would like to somewhat use it”. Passengers who think traffic smoother services are effective for mitigating congestions have positive intentions to purchase CACC.

On the other hand, some passengers who answered that “1.I understand.” for CACC vehicle interval optimization answered “4. I would be unlikely to use it,” “5. I would not like to introduce it.”

Reasons given included

“because the devices are expensive” and “the system is effective only when other cars are also equipped with CACC, so I would like to introduce it once the system has spread” and “because CACC equipped vehicles are not currently in use, I would not like to introduce the system in the initial stages.”

According to the above results, in this verifying, it was confirmed that most of passenger have positive ideas for traffic smoother services and have intentions to purchase ACC/CACC.

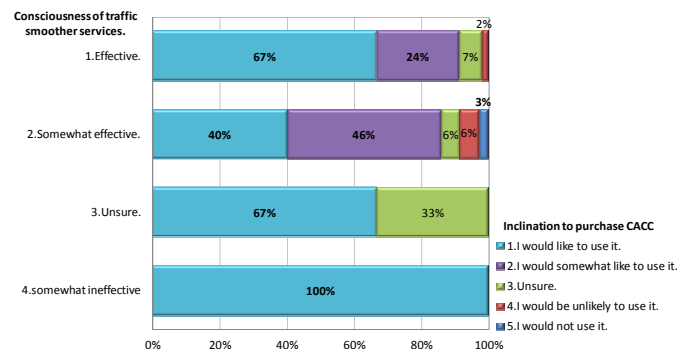


Figure 10. The trend of consciousness of traffic smoother services and inclination to purchase CACC

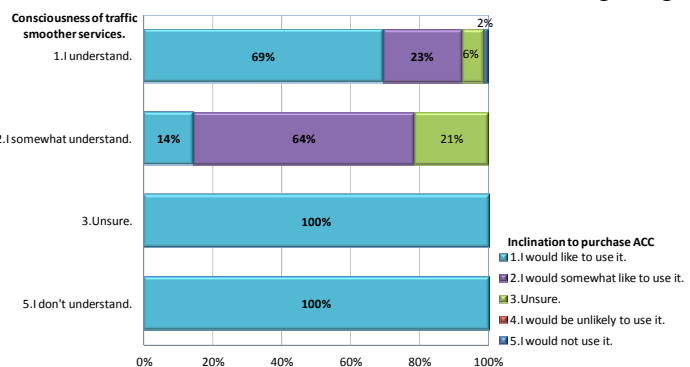


Figure 11. The trend of receptiveness for ACC vehicle interval optimization service and inclination to purchase ACC

On the other hand, some participants have concerns on systems reliability and effectiveness at the initial phase when the systems are not widely spread.

5. Summary and Future Work

We found the survey revealed that most of participants have positive ideas for traffic smoothing services through the test ride on actual roadways. One of the reasons may be that most participants belong to automotive and telecommunications industries and are familiar with the systems.

On the other hand, it will be necessary to modify the services so as to be easily understood by ordinary people as some test drivers could not understand the contents of the systems. Also, it was confirmed that the passengers confirmed to have positive ideas for traffic smoother services and have intentions to purchase ACC/CACC.

However, it is necessary to improve the reliability of the systems and ACC/CACC as some passengers have concerns on it. Also the spread of CACC will be desirable so as that vehicle to vehicle communication functions between vehicles equipped with the device. For that, the merit of ACC and CACC should be promoted in terms of traffic smoothing and safety and their price should be affordable.

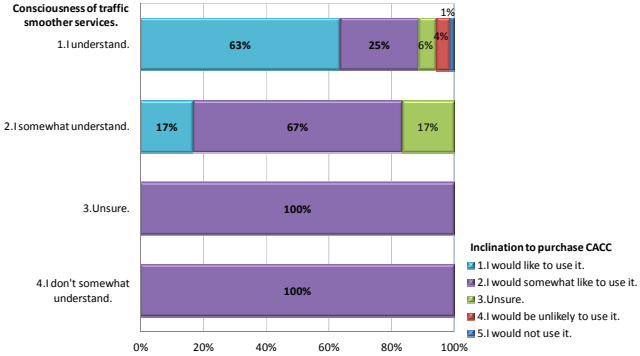


Figure 12. The trend of receptiveness for CACC vehicle interval optimization service and inclination to purchase CACC