

GREATER SAPPORO ITS EXPERIMENTAL PROJECT - SMART SAPPORO SNOW-INFO EXPERIMENT -

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1. Abstract

In the Sapporo metropolitan area, it is extremely important that the reliability and punctuality of winter road traffic be ensured, toward maintaining normal civic, social and economic activities.

The Hokkaido Development Bureau and the Civil Engineering Research Institute carried out an ITS experiment in the Sapporo metropolitan area, with cooperation from the area's road administrators and other organizations and citizens. The experiment used advanced information and telecommunications technology including the Internet, and mobile terminals. The experimental Project consisted of the Road Information Sharing Experiment and the Car Commuter Monitoring Experiment.

The Road Information Sharing Experiment aimed at developing systems for enhanced measures against snow and ice problems through coordination between organizations responsible for winter road surface management. In the experiment, attempts were made to share winter road information among road administrators, using an experimental model involving an extranet and an electronic mailing list. A post-experiment questionnaire survey of participants in the experiment revealed a strong recognition among them that the Internet-based technology used in the experiment could be extremely useful for realizing efficient information sharing among different organizations.

In the Car Commuter Monitoring Experiment, weather and road surface information was distributed to car-commuting monitors who were advised, where appropriate, to use public transportation. The monitoring experiment was carried out as part of a larger review on appropriate ways to control winter traffic demand in line with current weather conditions toward alleviating traffic congestion. In the experiment in the winter of 2000/2001, road weather information was delivered to monitors via their Internet-accessible mobile phones. These monitors subsequently filled out a questionnaire to indicate whether the information provided affected their commuting behavior in any way. The questionnaire indicated that accurate and timely provision of weather and road information could prompt road users to change from cars to public transportation and to exercise staggered commuting, all of which could be effective toward alleviating winter traffic congestion.

2. Introduction

With a population of over 2 million, Sapporo and its environs form one of Japan's largest metropolitan areas. It is quite unusual even by global standards for a metropolitan area of that size to

have the roughly 5 m of annual snowfall that metro Sapporo has. Road administrators here must meet the great challenge of ensuring the reliability and punctuality of winter road traffic under such severe climate, an essential requirement for maintaining the area's normal social and economic activities.

In January 1996, the area was hit by a record snowfall. More than 50 cm of snow (approximately 1 m in some districts) fell in just two days, obstructing road traffic and paralyzing the city. Even without such an extreme, the high concentration of urban infrastructure and ever-increasing number of vehicles contribute to chronic congestion on roads in the Sapporo metropolitan area. This is especially true downtown in winter, when the travel speed during the morning commuting hours typically drops to approximately half that for periods without snow accumulation on roads. Amid the recent progress in advanced information and telecommunications technology, the intelligent utilization of information is beginning to be recognized as a key to resolving the road traffic issues described above.

The Greater Sapporo ITS Experimental Project was carried out to verify the effectiveness of information distribution and sharing in resolving road management and traffic issues in cold, snowy regions and, based on the results, to further review potential methods for the efficient utilization of related information.

3. Greater Sapporo ITS Experimental Project

Following the record snowfall of January 1996, the Civil Engineering Research Institute pointed out the importance of establishing better coordination among organizations through information sharing. The Institute also noted the necessity of providing accurate and timely information to road users in order to realize snow-resistant road traffic management and to enable swift action in response to heavy snowfall and other snow- and ice-related road problems. Acting on this advice, a liaison committee was set up comprising the area's road administrators (Hokkaido Development Bureau, the Hokkaido government, the City of Sapporo, Japan Highway Public Corporation) and the area's weather organizations. Under the leadership of the committee and with the cooperation from the

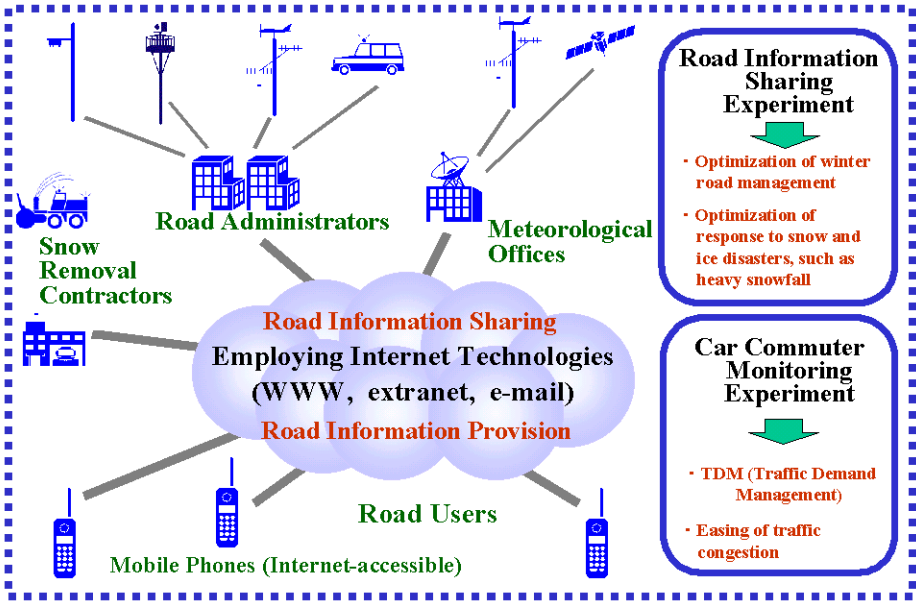
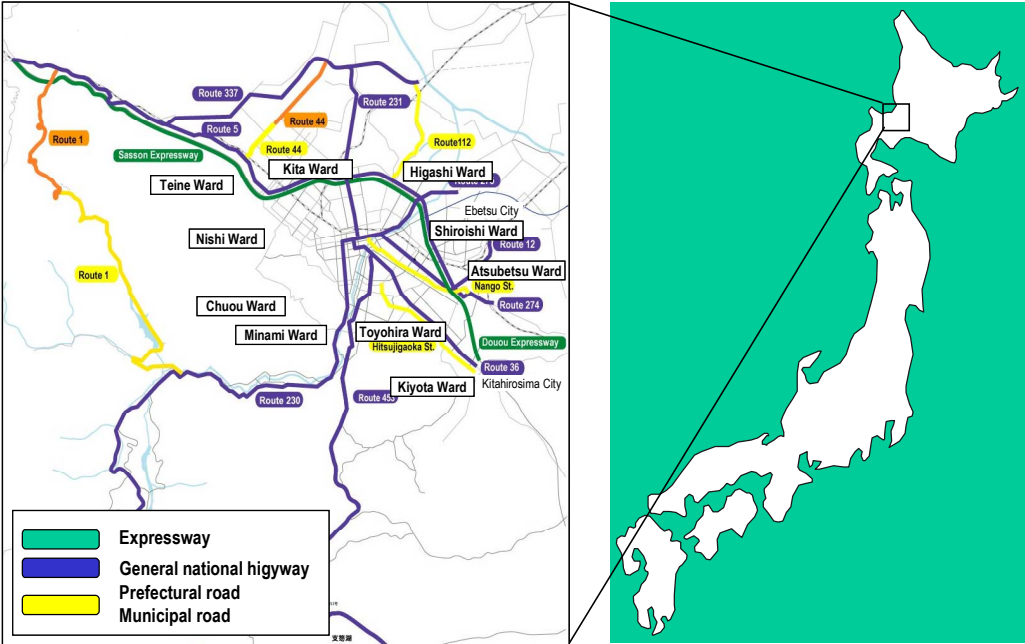


Figure 1 Outline of Greater Sapporo ITS Experimental Project

citizens in the metropolitan area, the ITS experiment was carried out using advanced information and telecommunications technology including the Internet and Internet-accessible mobile phones.

In the ITS experiment, information on roads (roadwork, traffic regulation, snow removal operations, etc.) and weather, as well as ITV images, were shared using an Internet technology-based platform. Two experiments were carried out. In one, the Road Information Sharing Experiment, the area road administrators shared information including an electronic mailing list via extranet for use in their respective road management operations. The Car Commuter Monitoring Experiment related to traffic demand management and used car-commuting monitors to whom information on weather and road surface conditions was distributed via their mobile phones (Figure 1). The monitoring experiment covered Sapporo and its environs, which measure approximately 30 km east-west by approximately 50 km north-south (Figure 2).

Figure 2 Area Covered by the Greater Sapporo ITS Experimental Project



4. Road Information Sharing Experiment

In this experiment, the area road administrators shared information on roads and weather to enhance efficiency and coordination in scheduled snow clearing/dumping operations as well as in emergency situations such as heavy snowfall. Table 1 shows the information shared among the road administrators for the experiment.

Table 1 Shared Information

	Time of information input	Traffic regulation information	Roadwork information	Weather information
Scheduled information	Every Friday	Scheduled roadwork	Snow dumping information	<ul style="list-style-type: none"> • Weather information • ITV images • Weather forecast
Emergency information	Heavy snowfall, snowstorm and other emergency	Traffic regulation currently in force and scheduled	Snow removal operations in progress and scheduled	

The Road Information Sharing System (Figure 3) consists of the Web Page for Input (where information is input) and the Web Page for Viewing (where information is shared). The information that has just been input by the road administrator can be sent automatically to relevant parties. For example, using this feature emergency information such as blowing snow-induced road closure can be sent simultaneously to all relevant parties via their mobile phones. The Web Page for Viewing can be accessed via any Internet-accessible terminals and offers information such as that on scheduled snow removal operations and roadwork, and traffic regulation, all presented visually as maps (Figure 4). Clicking on links will guide you to sites that offer real-time weather information and ITV images.

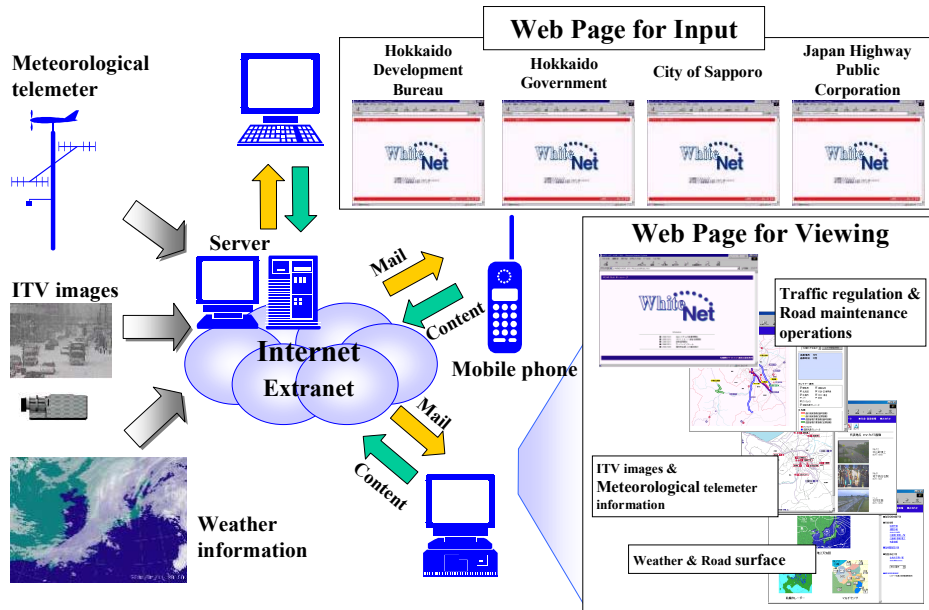


Figure 3 Outline of Road Information Sharing System

Specific information on No. 76	
Road administrator	Hokkaido Government
Route	Otaru-Jozankei Prefectural Route
Event	nighttime traffic suspension
Reason	snow removal and icy road surface
Section	Asari Dam - Asari Pass
Start time and date	19:00:00, November 6, 2000
End time and date	08:00:00, April 20, 2001
E-mail	none
Remarks	traffic was suspended between 19:00 and 8:00

Figure 4 Web Page. Road information is presented visually as maps, using route lines of different types and colors. Information is available in greater detail by browsing the pages. Searching by route as well as by information type is possible.

The post-experiment questionnaire survey revealed the following. Approximately 90% of the participants found the traffic regulation information provided on the web site to be useful. More than 80% of the participants found the sharing of the weather sensor information from various organizations and the ITV images to be useful; therefore, these participants responded that they required this information.

5. Car Commuter Monitoring Experiment

In winter, the roads in the Sapporo metropolitan area frequently become congested, especially during the morning commuting hours, due to the emergence of very slippery snow/ice-covered road surfaces and heavy snowfall. The experiment attempted to resolve the chronic traffic congestion by employing traffic demand management methods that were based on weather conditions. Specifically, information on weather and road surface was provided to car commuters to help prompt them, where appropriate, to change to public transportation or exercise staggered commuting, as this was thought to lead to the dispersion of traffic congestion (Figure 5). The experiment consisted of two phases: The preliminary phase was carried out during the 1999/2000 winter, followed by the full-scale experiment phase of the 2000/2001 winter. This paper primarily describes the results of the full-scale experiment phase. Table 2 outlines the two experiment phases.

Table 2 Outline of Car Commuter Monitoring Experiment

	Preliminary phase (1999/2000 winter)	Full-scale phase (2000/2001 winter)
Period	January 31 to March 3, 2000 (except weekends and national holidays)	January 15 to February 16, 2001 (except weekends and national holidays)
Number of monitors	49	197
Weather information	<ul style="list-style-type: none"> • 07:00 - Temperature at 06:00 / Snowfall in the daytime • 18:00 - Weather of tomorrow / Temperature of tomorrow morning / Snowfall by tomorrow morning • The above information relates to the central part of the area covered in the experiment. 	<ul style="list-style-type: none"> • 07:00 - Temperature at 06:00 / Overnight snowfall (last night - early morning) • 18:00 - Weather of tomorrow / Temperature of tomorrow morning / Snowfall by tomorrow morning • The above information was made available for each of the ten wards of Sapporo.
Road surface information	Road surface conditions in six locations (inspected visually)	Road surface conditions in 13 locations (inspected visually)
Information provision method	<ul style="list-style-type: none"> • Two e-mail messages were sent to mobile phones early in the morning and early in the evening. • These messages were identical for all the monitors. 	<ul style="list-style-type: none"> • Two e-mail messages were sent to mobile phones early in the morning and early in the evening, and similar information was provided on Web pages that were accessible by mobile phone. • Specific information on specific wards was provided to the monitors as requested.

Figure 6 shows the flow of information in the Car Commuter Monitoring Experiment. Weather information on Sapporo's ten wards was sent from meteorological offices to the information hub. Likewise, road conditions were sent from visual inspectors to the information hub by fax or mobile phone. Based on the information gathered at the information hub, mobile phone Web pages will be updated and e-mail messages will be sent to the monitors' mobile phones.

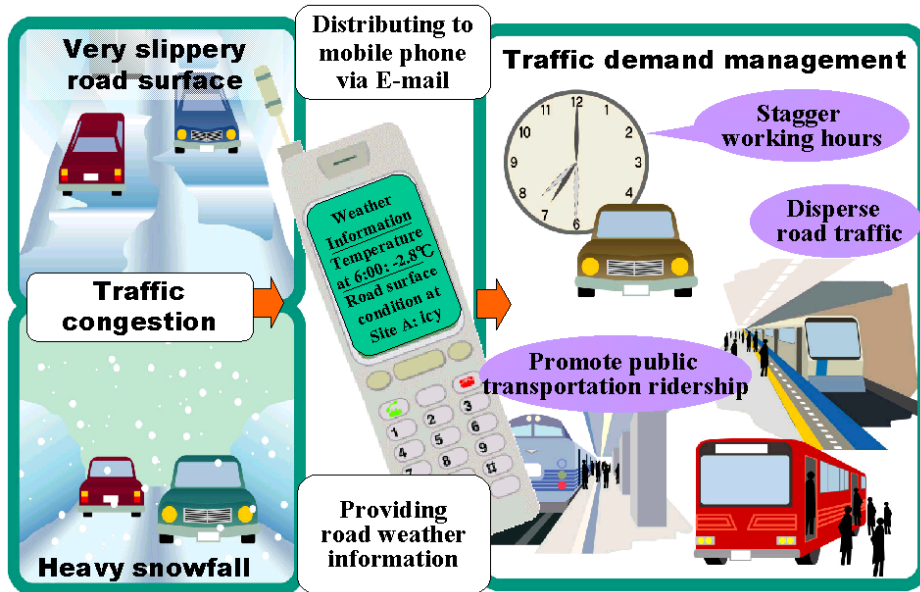


Figure 5 Car Commuter Monitoring Experiment and its Aims

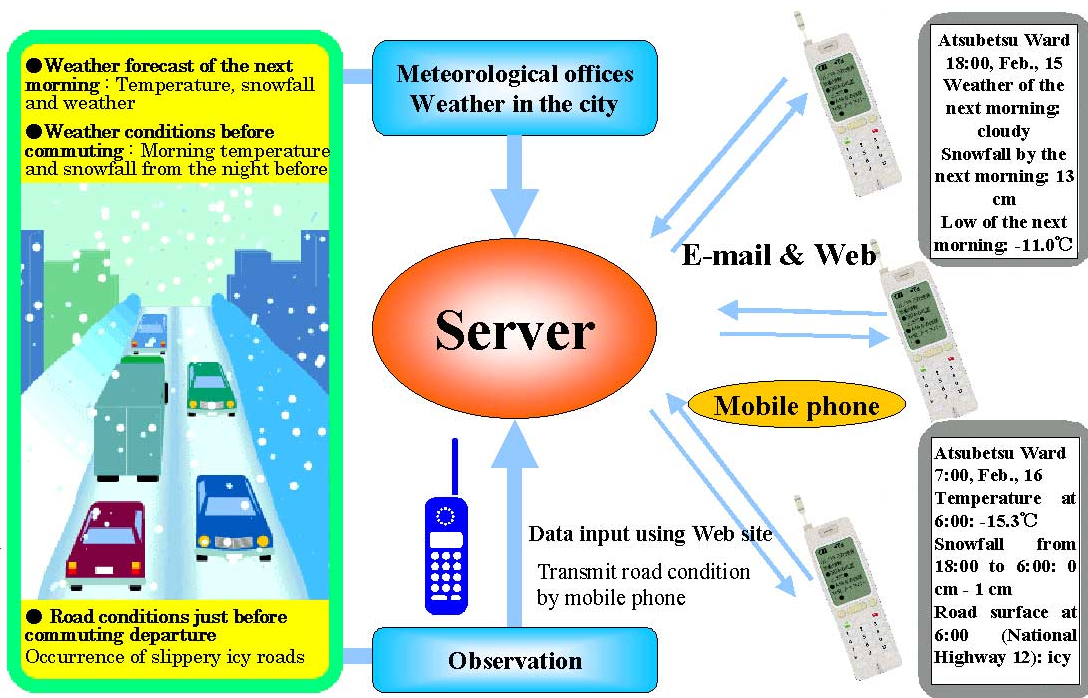


Figure 6 Information Flow for Car Commuter Monitoring Experiment

As part of the experiment, the monitors filled out questionnaires that asked how satisfied they were with information related to car commuting and what kinds of information they would find most useful. Another questionnaire, on the possible impact of commuting-related information in changing commuting behavior, was filled out by the monitors and non-monitors.

Figure 7 shows the relationship between the snowfall and road surface conditions during commuting hours and the monitors' commuting behavior. The bottom bars indicate the number of monitors who changed their customary commuting behavior as a result of the weather/road conditions of the morning. The top bars indicate the snowfall from 21:00 of the previous night to 06:00 of the morning. Figure 7 indicates the following tendencies.

- Greater numbers of the monitors exercised staggered commuting, changing departure times on January 16, 22 and 24, when the overnight snowfall approached or exceeded approximately 10 cm. A similar tendency was indicated in the 1999/2000 winter experiment in which greater numbers of monitors changed from cars to public transportation when the overnight snowfall approached or exceeded 20 cm.
- Continuous emergence of very slippery road surfaces tended to prompt greater numbers of monitors to change their customary commuting behavior.

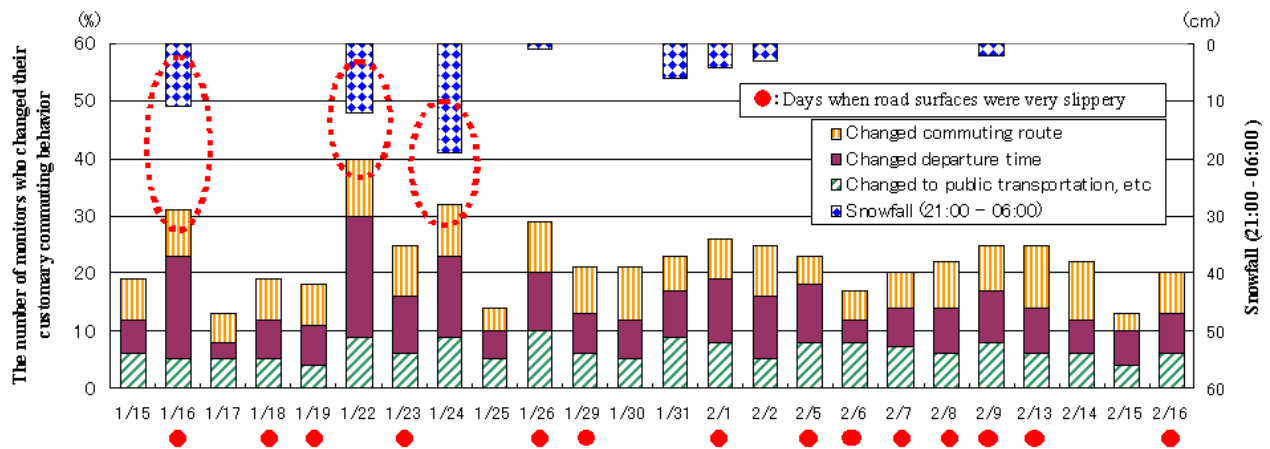


Figure 7 Relationship Between the Snowfall and Road Surface Conditions During Commuting Hours and the Monitors' Commuting Behavior

In the post-experiment questionnaire survey of participants, 68% of the monitors indicated that the information provided was useful for car commuting. Figure 8 shows the reasons that the monitors considered the weather and road surface information to be useful for car commuting.

Among those who changed their customary commuting behavior, many of them picked the category, "was prompted to depart earlier than normal by the information provided." Among the monitors who considered the information useful, many thought it was so because it "prompted them to pay closer attention to possible freezing of their routes" and because it "gave them the assurance of knowing what to expect." Thus, the information gave them security and also made driving less stressful. Younger monitors tended to more practically utilize the information provided, e.g., by changing their commuting behavior or taking appropriate action for safer driving.

Figure 9 shows the results of two sets of questionnaires regarding the monitors' levels of satisfaction with car commuting-related information. The top graphs show the results of questionnaire survey done prior to the experiment, regarding the monitors' levels of satisfaction with the information then available. The bottom graphs show the results of a different questionnaire, carried out after the experiment, regarding the monitors' levels of satisfaction with the information provided in the experiment.

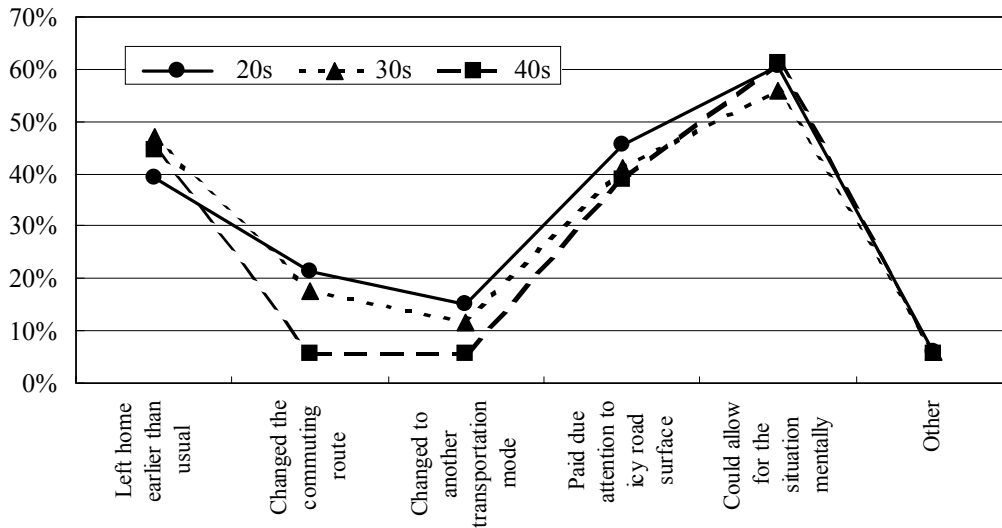


Figure 8 How the Information Helped Car Commuters (by age group)

The first survey, on the information then available, revealed that 39 percent were unsatisfied with the snow-related information and that 70 percent were unsatisfied with the road surface information. The second questionnaire survey, on information provided in the experiment, indicates that in all of the information categories, respondents who were unsatisfied with the information were less than 20 percent and those who were satisfied were more than 50 percent.

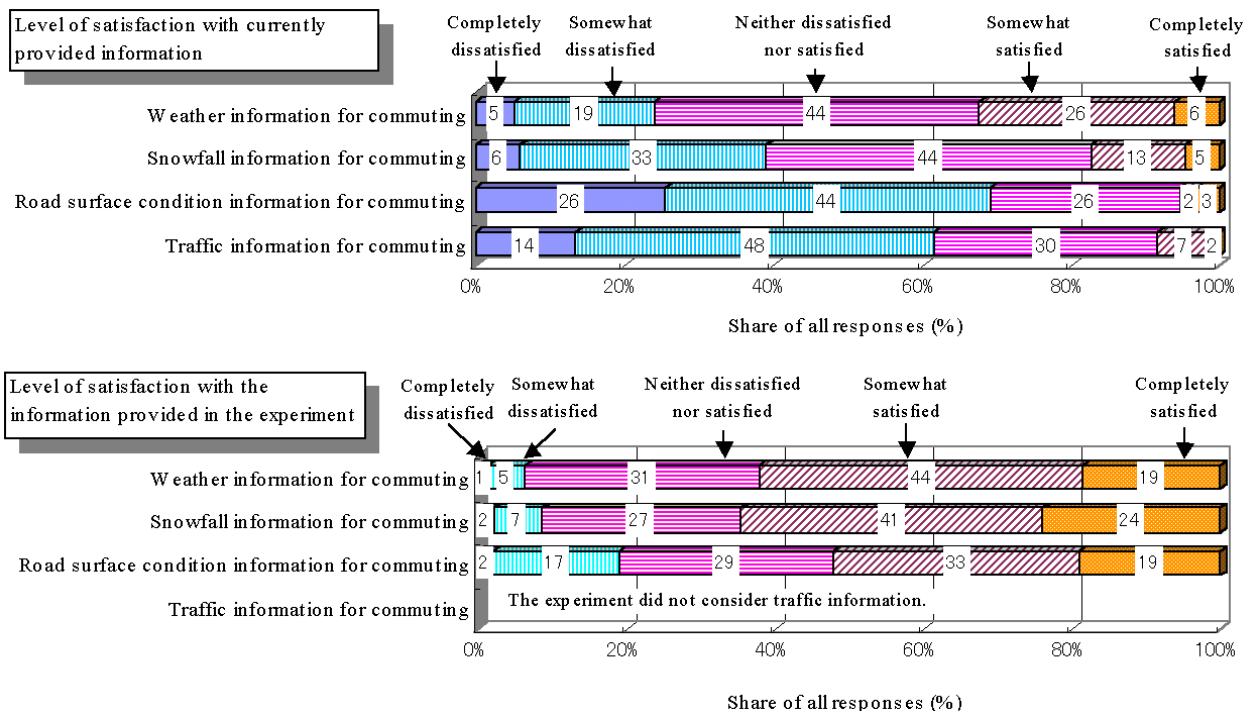


Figure 9 Level of Satisfaction with Car Commuting Information. The upper figure shows how satisfied were the monitors with the information provision system before the experiment. The lower one shows the questionnaire results of the level of satisfaction of monitors after the experiments.

Figure 10 shows the results of a questionnaire survey on the monitors' needs for car commuting-related information. 84 percent of the monitors desire enhancement of information in terms of both quantity and quality, which hints at strong needs among car commuters for road and traffic information.

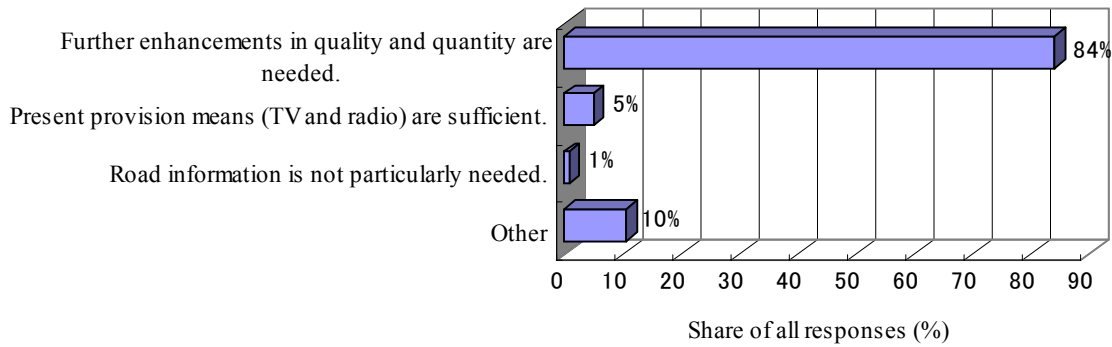


Figure 10 Information Provision Needs of Car Commuters

Figure 11 shows the results of questionnaires in which the monitors and non-monitor car commuters were asked how they would commute if road weather information strongly suggested the emergence of traffic congestion. The graphs on the left show the responses from the non-monitors while those on the right show the monitors' answers. In both categories, most people (69%), chose "change the departure time." Among the non-monitors, those who chose "change to public transportation" and those who chose "change commuting routes" were 10 percent or less for each case. In contrast, more monitors chose these two options, 19 percent choosing to change to public transportation and 43 percent choosing to change commuting routes. The results described above indicate the possibility that provision of adequate road weather information to car commuters combined with active promotion of public transportation use in place of cars and staggered commuting can help to alleviate winter traffic congestion.

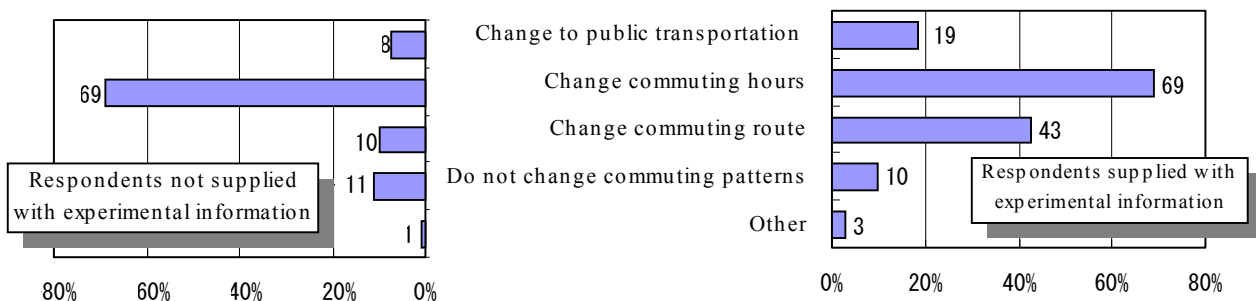


Figure 11 Future Potential of Changes in Behavior of Car Commuters

Figure 12 shows the types of media and devices via which the monitors prefer to receive road weather information. The results were obtained by questionnaire survey. Each survey subject evaluated the importance of each item in each question and assigned a number indicating that importance. In the figures, the degree of importance of each item is given as the average of subjects. In Figure 12, significant differences among age groups were not observed. The results also indicate the following.

The most preferred method of receiving road weather information was "e-mail via mobile phone." The popularity was emphasized by some of the comments written by the monitors in the questionnaires, such as "Mobile phones are handy because you can use them to access information wherever you are." and "I didn't miss the information I needed because the mails were always sent to my mobile phone." This indicates that mobile phones are not only useful for vocal communication but also for Net communication.

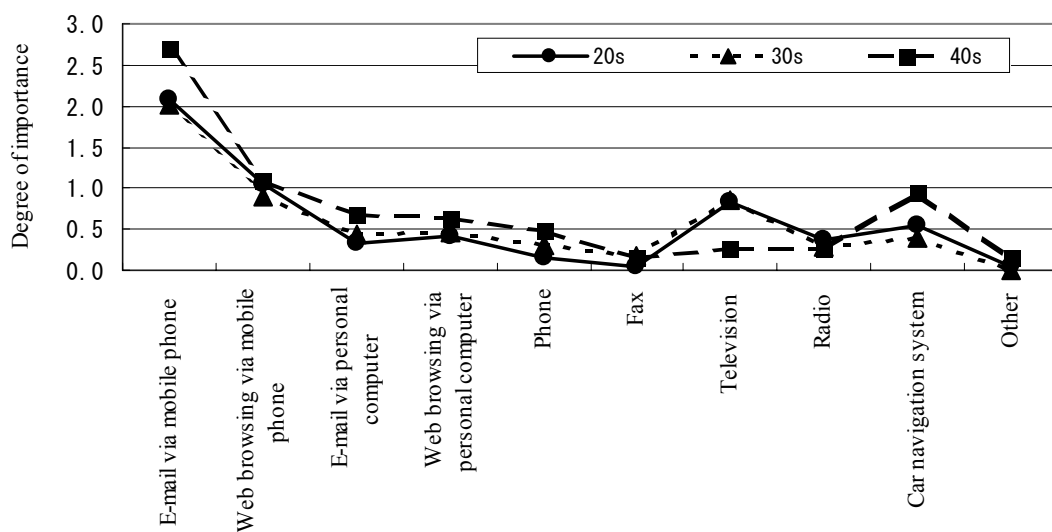


Figure 12 Desirable Devices and Means of Acquiring Road Weather Information

6. Conclusion

The various experiments in this paper suggest that information sharing among road authorities and provision of information to road users are central to resolving winter traffic issues. These experiments also highlighted the benefits of using Internet technologies such as extranet and e-mail. In the questionnaires, the monitors highly rated the usefulness of Internet-accessible mobile phones as an information gathering tool. Considering the rapid increase in mobile phone ownership rate in Japan, use of mobile phones can play a major part in future winter traffic management.

The Greater Sapporo ITS Experimental Project will be developed further. As part of this, another experiment set for the 2001/2002 winter season will involve more organizations in an XML technology-based information sharing/provision trial. The scheduled program will include a trial on an expanded system under which the timing for information provision and the content of the information can be tailored to the specific weather conditions of the time.