SMART SAPPORO
SNOW INFORMATION EXPERIMENT
- Toward Winter Weather-based Traffic Demand Management -

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SUMMARY

In winter 2002/2003, we conducted the Smart Sapporo Snow Information Experiment in the Greater Sapporo Area. The aim of this experiment is to mitigate winter urban traffic problems by using advanced information technologies, such as the Internet and mobile terminal devices. It was shown that the provision of detailed road and weather information can be effective in achieving smoother traffic.

INTRODUCTION

The Greater Sapporo Area has a large population (two million) and extremely heavy annual snowfall (about 5 m). In winter, snowfall and road surface freezing perennially exacerbate traffic congestion. It is important to assure reliable and punctual winter road traffic so that the region may enjoy socioeconomic stability.

Toward this, the Civil Engineering Research Institute of Hokkaido has been working in a joint research group to conduct experiments on the provision of snow related road and weather information using RWML (Road Web Markup Language), which is based on XML (Extensible Markup Language), with the cooperation of regional road administrators, other administrative organs, and local residents since the winter of 2001/2002(1,2).

These experiments demonstrated that the provision of specific road and weather information was effective in mitigating urban traffic problems in winter. Also, they have shown that the use of an XML data format enables the information provider to efficiently construct systems for the collection of data from information sources distributed across the Internet, to compile the collected data according to user needs, and to provide users with the compiled data. This affords flexibility in adapting to specification upgrades.

This report outlines the experiments conducted in winter 2002/2003 and the potential of winter traffic demand management through the provision of snow information (Figure 1).

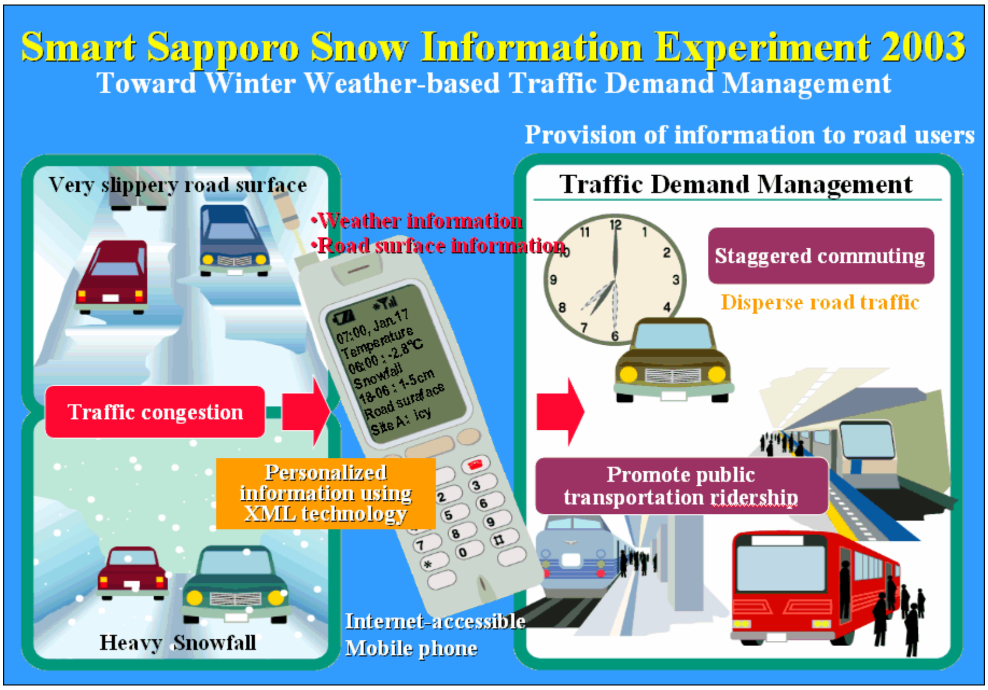

Figure 1 Winter Weather-based Traffic Demand Management

OUTLINE OF THE EXPERIMENT

Objectives

The experiment aims to study the degree to which the provision of road and weather information via advanced information technology can promote smoother traffic and afford other benefits in winter.

Outline of experiment

The experiment period was from December 4, 2002, to February 28, 2003 (about three months). XML-based RWML was employed to select, collect, and compile data from information sources distributed across the Internet according to monitors' needs. The compiled information was provided on the commuting route's road condition for the next morning, overnight snowfall in the monitor's neighborhood, and other items. This information was posted on the web and e-mailed to personal computers and mobile phones of the monitors. The methods of information provision differed from intended users (commuters, travelers in Sapporo, professional drivers traveling in Sapporo and its environs.) (Table 1)

The purpose of providing car commuters with weather and road surface information is to reduce traffic congestion in winter by encouraging commuters to use public transportation and by implementing traffic demand management according to weather condition.

Information on the area chosen by the monitor was provided via web to commuters' mobile phones and personal computers twice a day (early in the morning and early in the evening). The information included that on snowfall, weather, temperature, and road surface conditions of the area chosen by the monitor from the ten wards of Sapporo, and four cities neighboring Sapporo. The information provided in the evening (18:00) included snowfall between 18:00 and 6:00 of next day, weather forecast for 6:00 of next day, and the forecast low temperature of next morning. The information provided early in the morning (6:30) included the temperature at 6:00 and the overnight snowfall from 18:00 of previous day to 6:00. In addition, information on the surface conditions of major roads was offered at 8:00 and 16:00.

Road surface forecast for 0:00 and 8:00 of next day was supplied at 18:00.

The users registered as monitors were provided with weather information on the area chosen by the monitor twice a day (early in the morning and early in the evening) by e-mail according to individual needs. The number of the monitors registered to receive e-mails was 615. Each registrant was allowed to choose specific weather conditions under which to receive e-mails.

Table 1 Outline of the experiment

Experiment period	December 4, 2002, to February 28, 2003 (about three months)
Experiment area	The ten wards of Sapporo, and the cities of Otaru, Ebetsu, Kitahiroshima, and Ishikari
Experiment	
Provision of Snow-Related Information to Commuters by E-mail	Information on snowfall, temperature, and road surface conditions was provided to commuters twice a day (early in the morning and early in the evening) via Web. E-mails were sent to monitors who wished to receive snowfall and temperature information (615 monitors registered for this).
Provision of Sapporo Snow Information on the Web	Weather information at transportation hubs, ski areas, and other places in the city was provided on the Web.
Snow-related information exchange among residents on the Web	Residents posted snowfall and road surface conditions in their neighborhoods and whether they would use public transportation. These reports were compiled for release over the Web.
Information on snowstorm in suburban areas	Information on snowfall or snowstorm in suburban areas was provided to drivers (pre-departure and while traveling).
Provision of Information to Businesses on the Web	For professional drivers traveling in Sapporo and its environs, road and weather information on their travel routes was offered on the Web.

EXPERIMENTAL RESULTS

Outline of the questionnaire survey

Monitors who registered to receive e-mails were surveyed by questionnaire during and after the experiment. The questionnaire during the experiment sought to survey changes in travel behavior, i.e., how and why the behavior changed. We drafted one questionnaire for drivers and another for non-drivers. Driver respondents numbered 74, and the instances of travel behavior numbered 2,989.

The post-experiment questionnaire investigated how travel behavior was changed by the information, and the level of satisfaction with weather and other information (e.g., how such information helped winter commuting). In addition the questionnaire asked monitors to evaluate information provided in the experiment and whether they would change their travel behavior if the provided information were improved. The questionnaire asked them to rate which combinations of provision method and information type (weather, road surface, traffic congestion) they wished to use to avoid traffic congestion during winter. The value of these types of information was evaluated according to the rating. For the post-experiment questionnaire survey, too, we drafted one for drivers and another for non-drivers. Table 2 shows that 252 monitors, including 96 drivers, responded to the questionnaire (response rate: 49%).

To explore the potential of traffic demand management through the provision of winter weather information, this report discusses the results of the driver questionnaire.

Changes in travel behavior based on the provided information

In view of the questionnaire results, driver travel behavior is examined here.

- Figure 2 shows that 57% answered that the information was useful and that it prompted them to change their decision on when to leave home, what transportation mode to use, and the like. Thanks to the provided information, 46% of the monitors answered that they could commute without frustration.
- Of the 55 monitors who changed their decision on what transportation mode to use, 4 (7.3%) changed to public transportation. In contrast, 38 (69.1%) changed only their departure time from home based on the information, the top response regarding what decision was changed (Figure 3).

Table 2 Outline of the questionnaire survey

	Questionnaire during the experiment	Post-experiment questionnaire
Outline	At the start of the experiment a questionnaire was sent by post. The monitors were asked to fill out the questionnaire regarding their commuting behavior. The questions differed for drivers and non-drivers.	At the end of the experiment, a questionnaire was sent by post. The monitors were asked to send it back enclosed with questionnaire during the experiment. The questions differed for drivers and non-drivers.
Questions	• Transportation mode for commuting • Alternative transportation mode in case of change • Reasons for changing • Duration of commute	• Change in travel behavior • Level of satisfaction with the currently provided information • Evaluation on the information provided • Willingness to change travel behavior • Value of information
Respondents	Drivers: 74 (Total instances of travel behavior: 2,989) Non-drivers: 128 (Total instances of travel behavior: 5,436)	Drivers: 96 Non-drivers: 156
Response rate	41% (252 of 615 monitors responded.)	

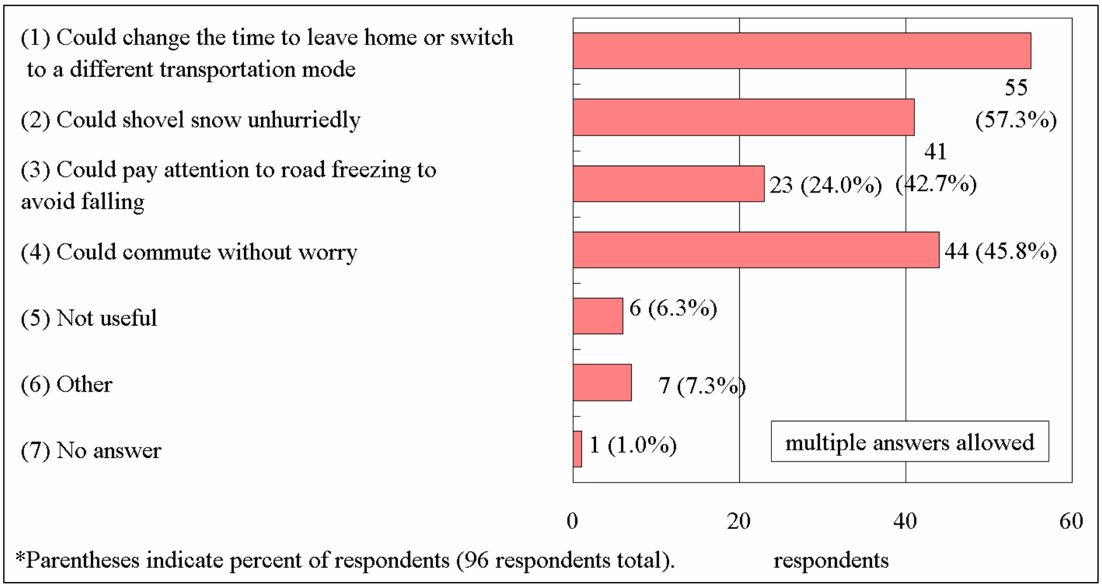

Figure 2 Reasons why the provided information was useful to drivers

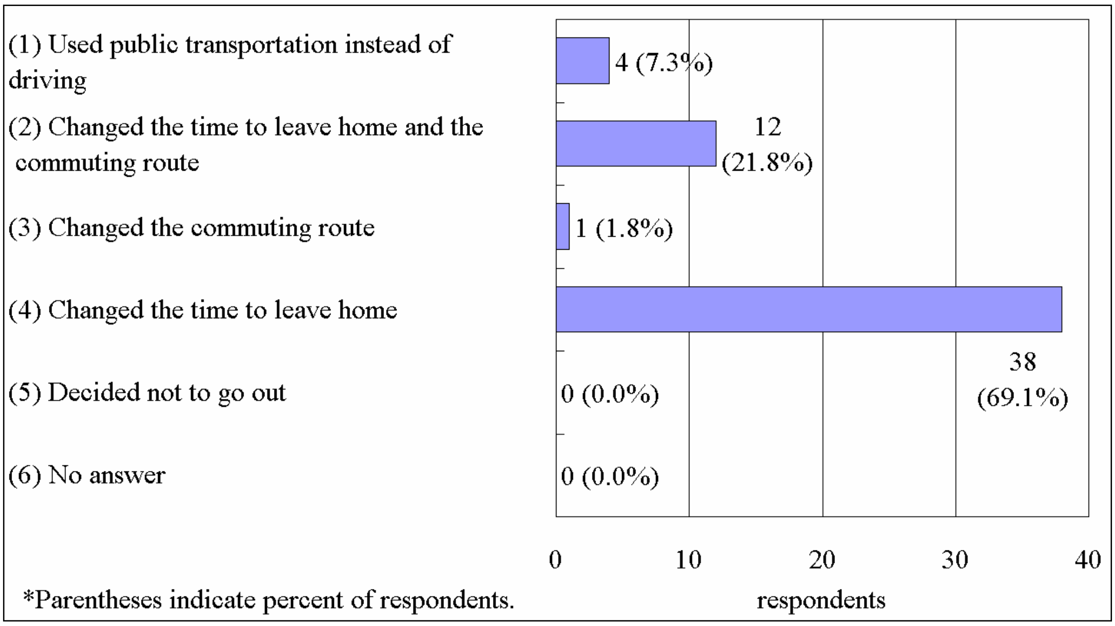

Figure 3 Whether commuting behavior was changed based on the information provided

Changes in travel decisions based on weather conditions

During the experiment (87 days), 2,989 instances of travel behavior were collected. This number averages 34 monitors offering one piece of information per day.

1) Overall trends of changes in travel behavior

- The 2003 winter was warm with little snowfall. There were 100 travel behavior changes attributed to provision of weather and road surface information (3% of total). The majority of those changes (58 changes) were changes in the time to leave home (Figure 4).
- Regarding the information that prompted their change in travel behavior, 58% of respondents cited information on "snowfall and weather conditions in the neighborhood" provided by e-mail or via Web. This is the largest percentage. The next largest (46%) was Snow-Related Information to Commuters provided on the Web during the experiment. This percentage exceeds that of other sources, such as TV/radio news, and other websites (Figure 5).
- Figure 6 shows that 55% of travel behavior changes were prompted by the information provided in the experiment (Snow-Related Information for Commuters, or information exchanged between residents on the Web). This means that many of the monitors used the information provided in this experiment.

2) Changes in travel decisions according to winter weather conditions (Figure 7)

- Regarding the effect of weather conditions on changes in travel decisions, the greater is the snowfall from the previous day, the more monitors changed their travel decisions. When snowfall exceeded 15 cm, approximately 15% of the monitors changed their travel decisions.
- Among the monitors, 40 - 80% changed their travel behavior based on the provided information. With snowfall of 15 cm or more, the information was used with particularly great frequency in travel decision-making.

3) Changes in travel decisions according to temperature

- Temperature-based travel behavior changes were made by 2 - 6 % of respondents. Even when the temperature was very low, the percentage was not much higher.

- Among the monitors, 0 - 70% changed their travel behavior based on the information e-mailed to them. When the temperature was below -8ºC, a fairly high percentage (64%) of the monitors used such information.

Travel decision tends to be influenced by large snowfall, but not by temperature change. No specific weather conditions affected use of the provided information much more than others for travel decision change. Under all the conditions, including severe weather, the e-mail information was more likely to be used. The information provided in this experiment was considered in more than 50% of travel decision changes. Information provision helps in all weather conditions.

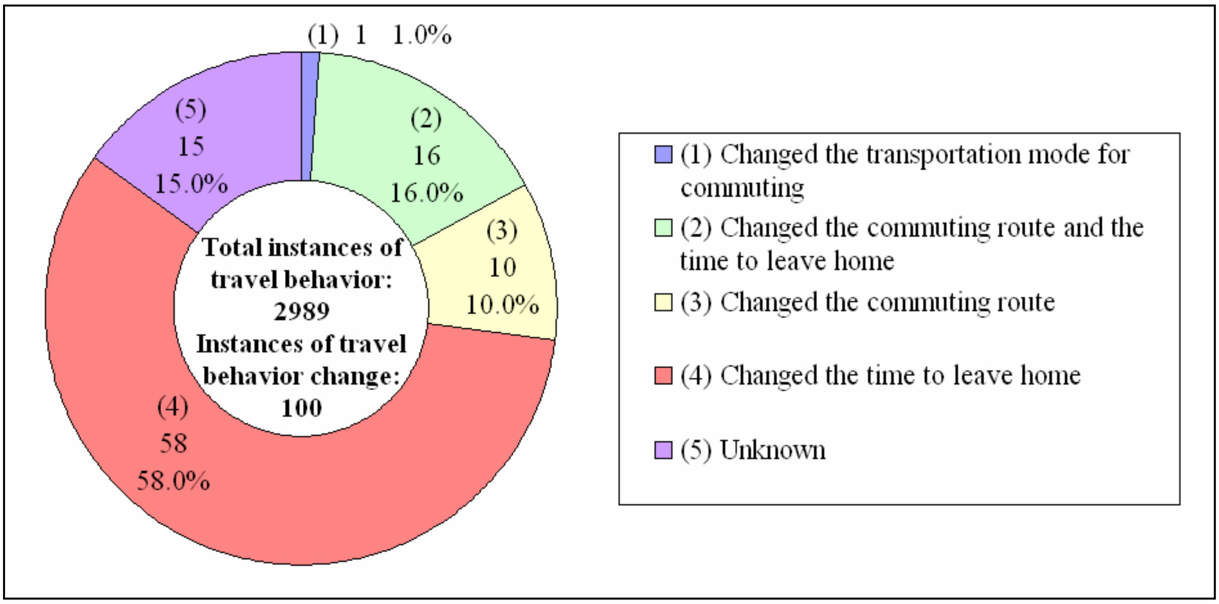

Figure 4 Changes in travel decisions based on weather and road conditions

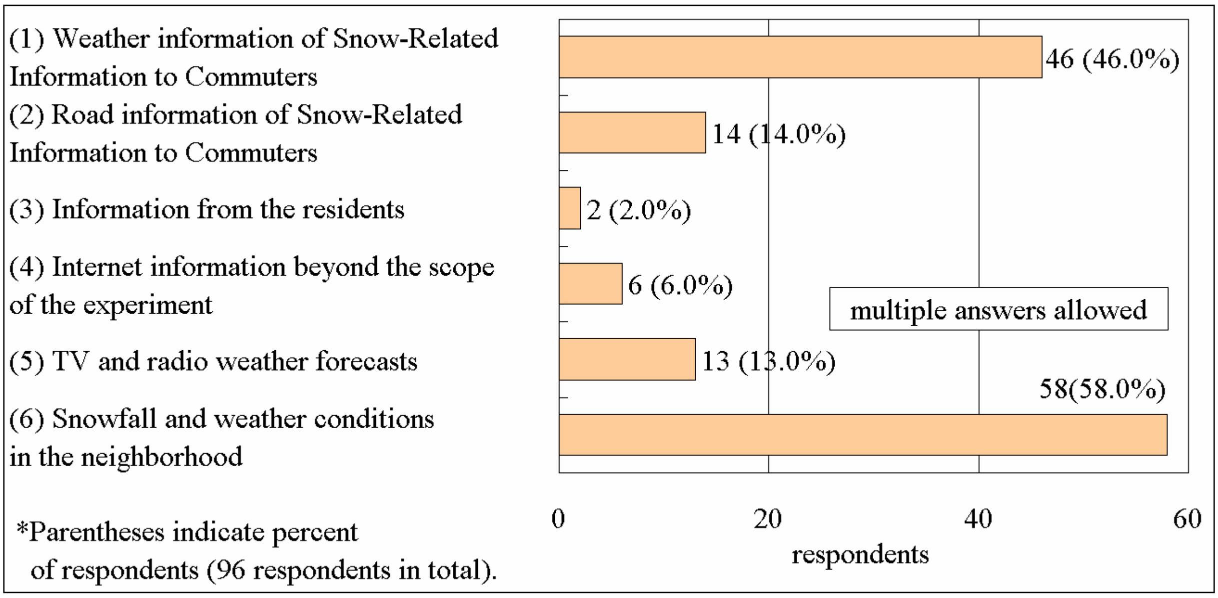

Figure 5 Information useful for travel decision-making

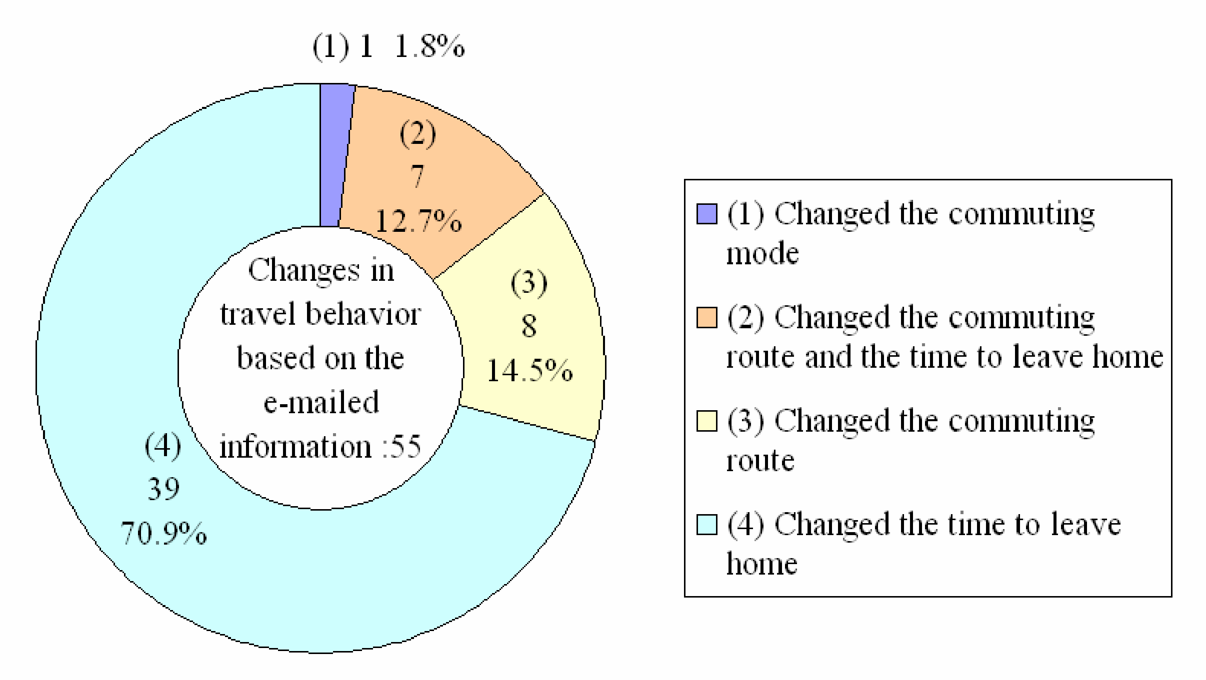

Figure 6 Changes in travel behavior based on the e-mailed information

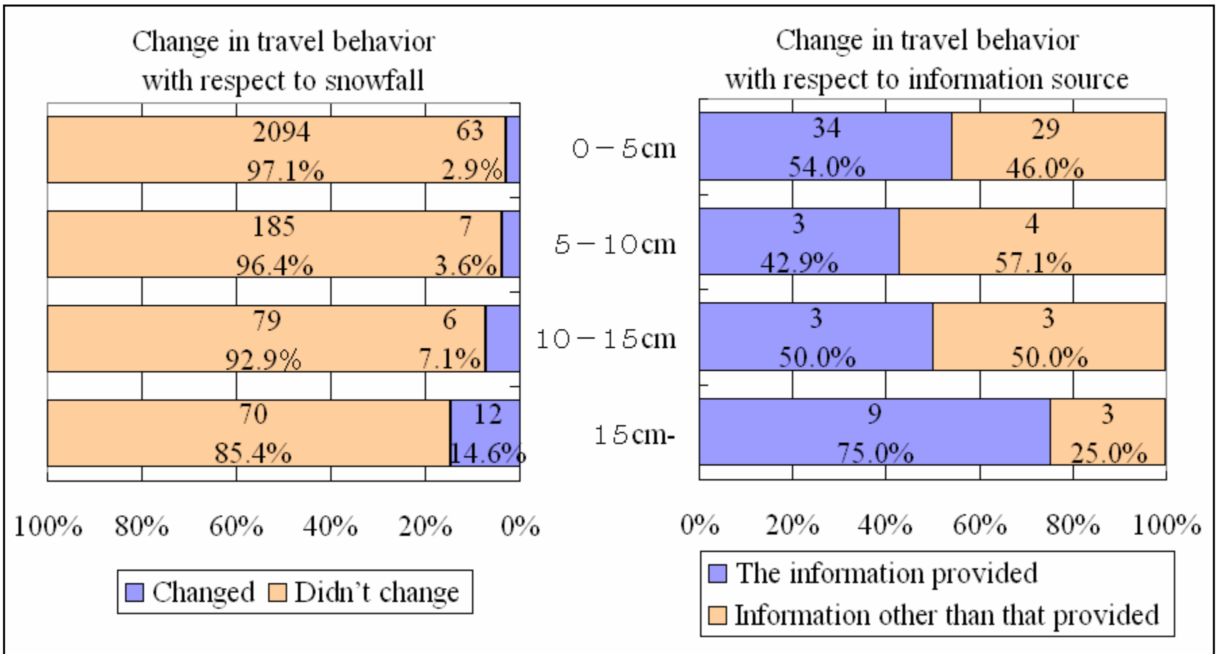

Figure 7 Instances of change in travel behavior with respect to snowfall and information source

Reported likelihood that improved information provision would prompt a change in travel decision

Few monitors decided to use the public transportation instead of driving under all weather conditions. One of the questions in Figure 8 is "If this kind of information provision service were improved, do you think it would prompt you to use public transportation?" Approximately 29% of the monitors answered "Yes."

The attributes of respondents who reported likelihood that improved information provision would prompt a change in travel behavior are analyzed.

- Figure 9 shows the percent of respondents who said they would change from driving to public transportation, according to the increase in commuting time resulting from such change. Among users whose increase is less than 10 minutes, 52% responded that they would be likely to change to public transportation if information provision were improved. The number falls to 26% among users whose increase exceeds 10 minutes.
- Figure 10 shows the percent of respondents who said they would change from driving to public transportation, according to the time required to reach the nearest subway station or bus stop from home. The greater the required time, the greater the likelihood of making such change.
- Figure 11 shows the percent of respondents who said they would change from driving to public transportation, according to the most easily accessible alternative transportation mode. The percent is highest for subway (47%), followed by railway and bus.

These findings indicate that monitors likely to change to public transportation need not endure a significant increase in commuting time. Also, such monitors tend to live in areas easily accessible to the subway, which assures punctuality even at times of heavy snowfall, regardless of the time required to reach the station or bus stop. Many of such monitors are likely to use public transportation even if their time to reach the station or bus stop is long.

If TDM can mitigate traffic congestion and assure punctuality during snowfall, when coupled with improvement of information provision it can increase the likelihood of changing transportation.

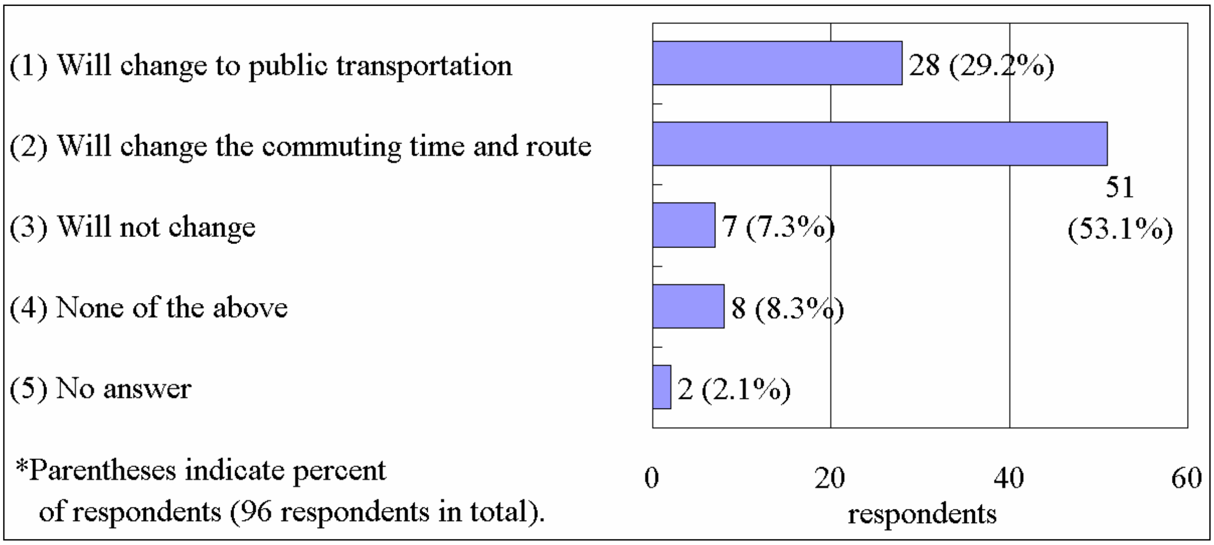

Figure 8 How would your commuting behavior change if the information provision services were improved?

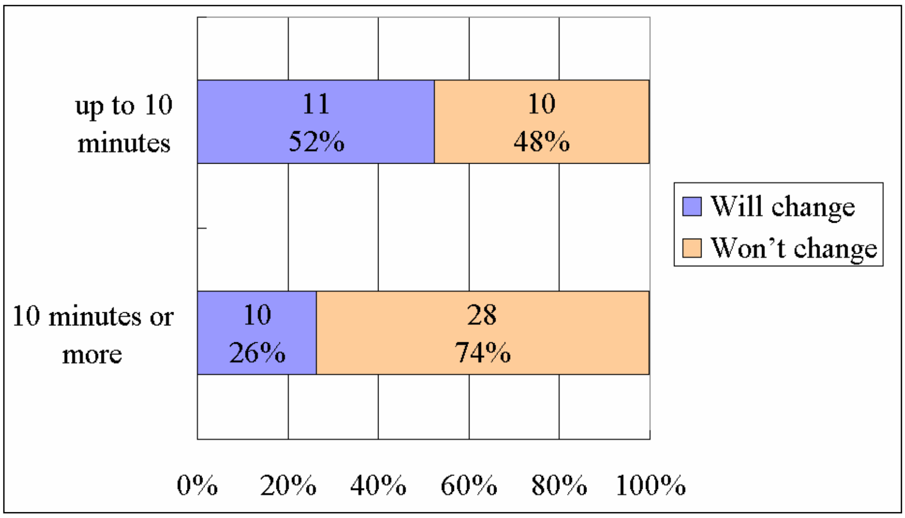

Figure 9 Increase in commuting time resulting from change from driving to public transportation, and willingness to change the transportation mode

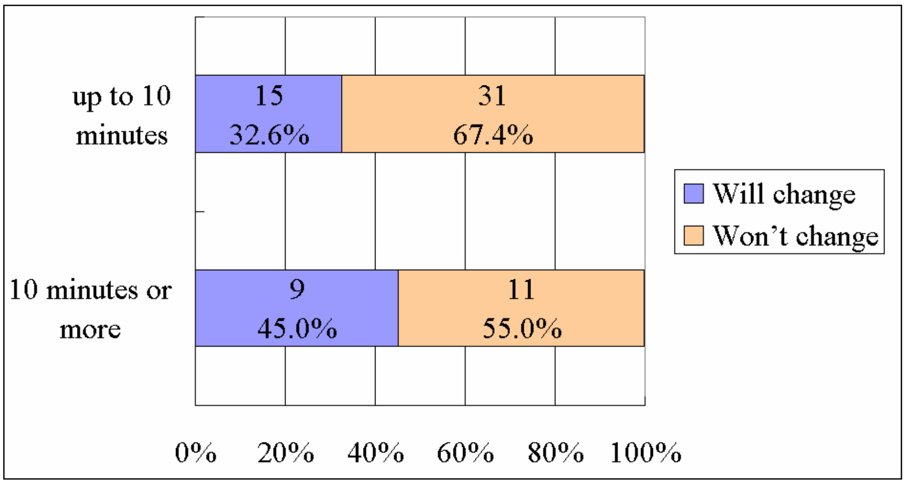

Figure 10 Time required to reach the nearest subway station or bus stop, and commuting mode change

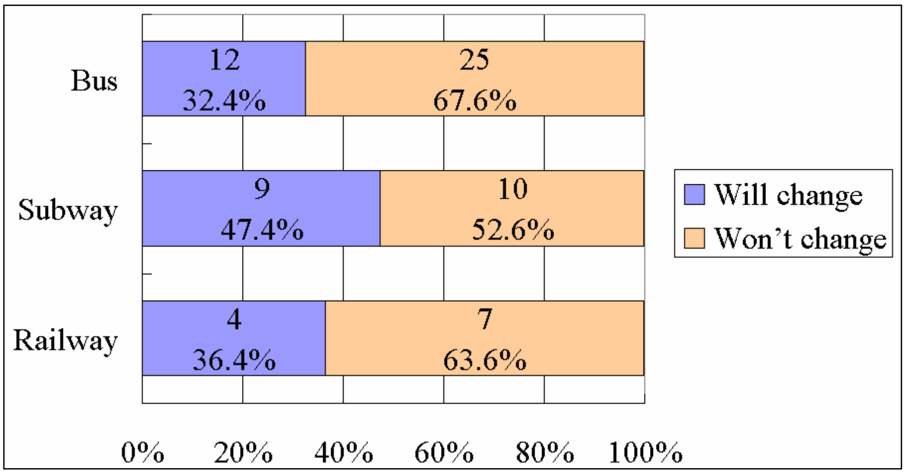

Figure 11 Available transportation mode and transportation change

VALUE OF INFORMATION AND EFFECTIVENESS OF WINTER WEATHER INFORMATION

A questionnaire survey was conducted to determine how valuable the monitors considered the weather and road surface information offered during the experiment. It was conducted after the experiment, and the respondents were car commuters.

Survey outline

Table 3 shows questions in the post-experiment survey of car commuters. Two provision methods were set for three types of information: weather, road surface, and congestion information. One category was traditional means (TV and radio), and the other was the means tested in the experiment (E-mail and Web, or Web only). Eight combinations were made of three information types and two methods of information provision. Car commuters were requested to rate on a scale of 5 how important each combination would be in their travel decision.

Analysis of the survey results employed a conjoint method that was developed in marketing. This method is used to analyze the most suitable combination of characteristics, prices, and designs of new products and services. To identify the value of information based on the rating, we employed this method to analyze that value. In the questionnaire, information provision was assumed to be free for all combinations of provision method and information type. The results were used to compare information on weather (snowfall and temperature) and road surface with traffic congestion service, which is not a free service now.

Survey results

The ratings are roughly the same for each of the three information types. For travel decision-making in winter, the weather and road information is rated as useful as the congestion information, which is currently a pay service.

According to the results of the “Changes in travel behavior in winter,” the respondents were divided into two groups for analysis. One group is respondents who are willing to change to public transportation. The other group is respondents who are unwilling to change their travel behavior but are willing to change the time to leave home and the commuting route. The former group tends to depend on weather information, and the latter group on congestion information.

Promotion of change to public transportation is effective in mitigating traffic congestion in winter. Since car commuters who are willing to change their commuting option tend to depend on weather information, improvement of that information will encourage the use of public transportation (Figure 12).

Table 3 Questions in the survey on the value of information

For each of the eight combinations of information types and provision methods, rate its usefulness on a scale of 5.

	Combination for information provision			Rating *1
	Weather information	Road surface information	Traffic congestion information	1 2 3 4 5
(1)	E-mail and web	E-mail and web	Web	
(2)	E-mail and web	E-mail and web	Traditional means	
(3)	E-mail and web	Traditional means	Web	
(4)	E-mail and web	Traditional means	Traditional means	
(5)	Traditional means	E-mail and web	Web	
(6)	Traditional means	E-mail and web	Traditional means	
(7)	Traditional means	Traditional means	Web	
(8)	Traditional means	Traditional means	Traditional means	

*1: Rating
5: I'd really like to use this combination
4: This combination would be good enough.
3: Fair.
2: I would avoid this combination if possible.
1: I'd really dislike using this combination.

*Shaded boxes indicate new service.

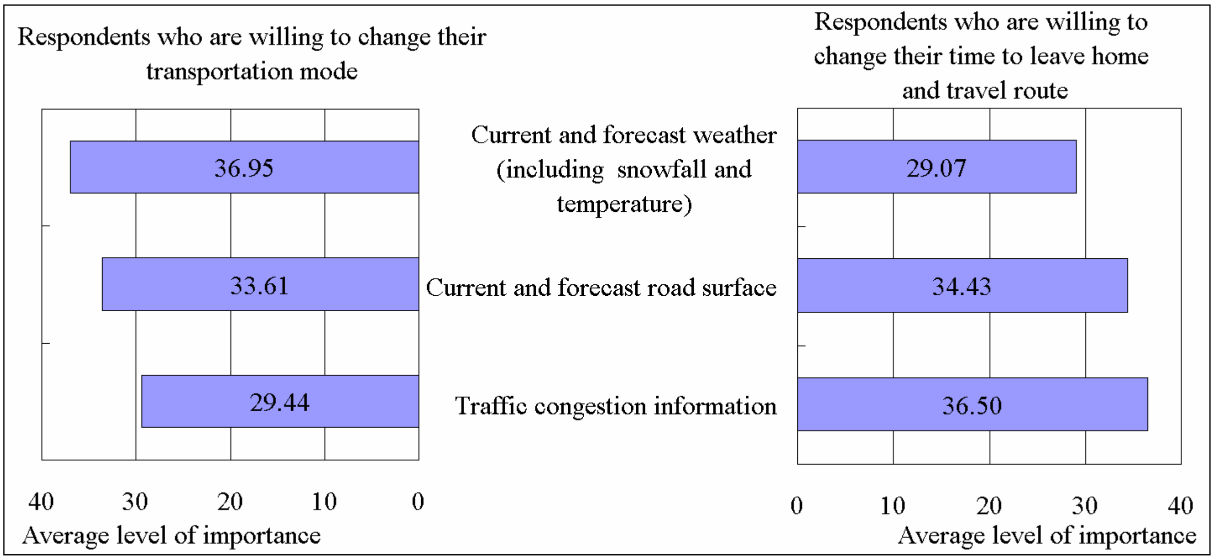

Figure 12 Conjoint analysis results

CONCLUSIONS

The experimental results show that proper provision of winter road and weather information can induce car commuters to change their travel behavior. In particular, proper information provision optimized for weather, road surface and user commuting conditions can encourage staggered commuting and a change from car to public transportation. It could lead to mitigation of traffic congestion and smoother traffic. Also, weather information is the information on which users who are willing to change their travel behavior tend to rely. Improvement of weather information content and provision means is important for the promotion of public transportation use.

In closing, we would like to extend our thanks to member organizations of the Smart Sapporo Snow Information Experiment Committee, the Hokkaido Regional Development Bureau of the Ministry of Land, Infrastructure and Transport, the Hokkaido Government, the City of Sapporo, the Hokkaido Branch of Japan Highway Corporation, Sapporo Information Network Co., Ltd., the Hokkaido Branch of Japan Weather Association, Mitsubishi Electronic Corporation, and local residents who cooperated as monitors.

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