A STUDY ON EVALUATION OF PUBLIC WORKS FOR SNOW AND ICE CONTROL OVER ROADS IN JAPANEASE SNOWY REGIONS IN LIGHT OF UNDERSTANDING AND EVALUATION BY PEOPLE IN NON-SNOWY REGIONS

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1. Abstract

This paper provides the first study on benefits of Snow and Ice Control for arterial roads in snowy regions[1] in Japan to include influences on non-snowy regions.

In Japan, Snow and Ice Control has been considered necessary social services for balanced development of the entire Japan, and the costs have been born by the national treasury. Nevertheless, benefits of the Services only for people in snowy regions have been measured in previous studies, because Snow and Ice Control are provided specific to snowy regions. Therefore, in this study, we validate the benefits of Snow and Ice Control to include how the Services impact on people all over Japan. This validation was carried out after confirming that people in non-snowy regions have a certain level of understanding about necessity of the Services, such as Snow removal and Improvement of Road Structure, through questionnaire surveys.

In this paper, we estimate the benefits of the Services in the form of money value, as well as measure the level of understanding of people about Snow Removal, by analyzing results of our two questionnaire surveys. For evaluating wide range of the benefits, including direct and indirect ones, the Contingent Valuation Method (CVM)[2] is used to estimate the benefits in the form of money value.

The average WTP value for the Services is estimated at about ¥4,000/year･household. The estimated benefits of the Services based on this WTP value are about ¥170 billion to ¥190 billion. This indicates that the benefits of the Service are sufficient enough compared to the actual annual costs of the Services, about ¥120 billion.

We also examine several factors that may cause the difference in respondents' attitudes. Main factors may include the following: where they live (they live in a snowy region or non-snowy region); and how well they know about life in snowy regions (they have relatives living in snowy regions, they have lived before in snowy regions, etc).

[1] percentage of snowy regions in Japan: area (230,000 km^2, 62%), population (28 million, 22%)

[2] In Contingent Valuation Method (CVM), respondents are asked in questionnaires how much money they are willing to pay (WTP) for the projects, thereby monetary value for the projects will be estimated.

2. Research Methodology

In this study, we surveyed about what and how people understand Snow Removal on arterial roads (Snow and Ice Control) and estimated the benefits of Snow and Ice Control Services in the form of money value. In order to estimate various types of benefits, including direct and indirect ones, the Cognitive Valuation Method (CVM) is used in estimation process. In CVM, respondents are asked the WTP amounts for a specific project, based on which benefits of the Services will be estimated.

Relating to the benefits, we also include questions in the questionnaire that would explain the factors to cause difference in evaluation between people in snowy and non-snowy regions, and wide variety of evaluation among people in non-snowy regions.

We carried out surveys twice, both of which were conducted: one in 2000 and the other in 2001.

The first survey was conducted in February 2000 by mail survey sending questionnaires to 2,000 households randomly selected nationwide from telephone directories. 546 respondents replied to our questionnaire. (Response rate was 28.2%. Out of 546, 125 replies were from snowy regions and 421 from non-snowy regions).

The second survey was conducted from February 1 to March 31, 2001 on a publicly opened Web site. 5,919 people send us back replies, out of which 1,617 were from snowy regions and 4,302 from non-snowy regions. We designed the second survey to get more respondents and put more suitable question to be easily answered in the online form. Looking through profiles of respondents, we had less elder people in the second survey, but there was not a large difference from those of the first survey in terms of household income and distribution of areas they live.

The following table shows the results of the two surveys:

Table 1. Overview of the surveys in 2000 and 2001

		February 2000	February to March 2001
method		mail survey to randomly selected people	Web survey
number of respondents		546 (28.2% response rate)	5,919
Q	understanding and approval about snow removal	• what is important as benefits of snow removal (4 point scale by each item) • on what location snow removal should be promoted (yes/no by each item)	• which benefit is most important • on what places snow should be removed (respondents can choose multiple options)
	WTP	• CVM • Double-bounded dichotomous choice CVM. To avoid lopsided estimates towards high value, adopted median WTP	• CVM • Payment card approach. To avoid lopsided estimates towards high value, eliminated extremely high values, then adopted average of the WTP amounts. • For snowy regions, questions are also included to ask about snow removal for sidewalks in central urban areas and residential areas.
	factors contributing wide range of WTP amounts proposed by respondents in non-snowy regions	• Difference in proposed WTP amounts in non-snowy regions depends on what kind of relationship they have to snowy regions	
	impacts of snow fall in snowy regions on people's behavior		• Impact on people's behavior, such as stopping going out or changing the transportation they intended to use

3. Benefits of the Services which respondents think important and places with high priority where they think snow removal should be promoted

Using the survey results in 2001, we analyze the difference between people in snowy and non-snowy regions, in terms of places they expect to be improved by snow removal and places with high priority that they think snow removal should be promoted.

Respondents chose one item that they think most important as benefits of snow removal. The results in the following chart 1 indicate that there was not a great difference between the two regions as to what they think important regarding the benefits. Direct benefits, such as "safe and comfortable driving" and "pedestrians' safety and comfortableness," were chosen as the top, then indirect benefits, such as "smooth delivery of goods and services and rescue operations in emergencies" and "preventing communities from being isolated by heavy snowfall". In both regions, "ensuring nationwide traffic flow" was not ranked high. The item, "preventing communities from being isolated," was considered more important in snowy regions. This seems to reflect experiences of people in snowy regions.

Chart 1. What are the most important benefits of snow removal?

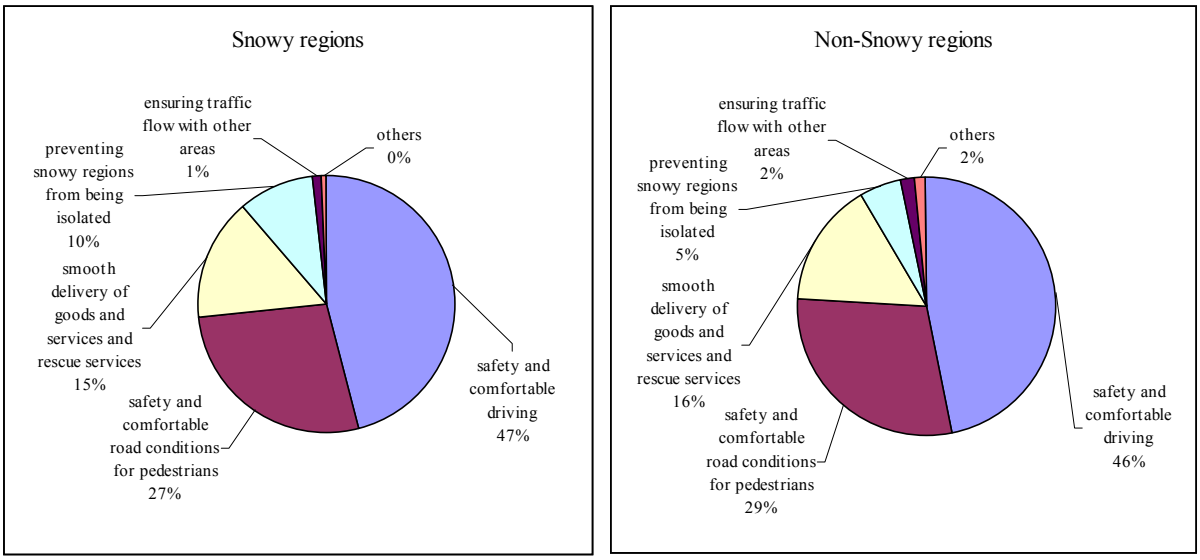


Table 2 shows the places where respondents think snow removal should be promoted. They could choose as many as items that they think important. Respondents chose "areas for daily life" as the top, which was followed by public spaces such as "areas in front of stations and commercial districts," "arterial roads," and "surrounding areas of elderly-care facilities." "Roads leading to remote villages in the mountains" and "tourist sites in snowy regions" were not ranked so high. However, in snowy regions, the percentage of respondents who chose "daily life space such as residential areas and surrounding areas of school" as prioritized place for snow removal exceeds by 25% that of non-snowy regions. On the other hand, snow removal needs among people in non-snowy regions are high for public spaces, such as "areas in front of stations," "tourist sites," and

“arterial roads” because these are the places where many people use, including both of those from snowy and non-snowy regions. The needs among people in non-snowy regions are 5% to 12% higher than that of people in snowy regions. These results indicate that people in snowy regions think it more important to implement snow removal in “spaces for daily life” than the others expected, and that people in non-snowy regions put more emphasis on snow removal in public spaces than the others expected.

Table 2. In which place do you think snow removal is promoted (Respondents chose as many items as they liked)

places respondents think where snow removal is promoted (% in N, N = number of respondents)	%/N in snowy regions N=1617	%/N in non-snowy regions N=4302
surrounding areas of facilities for the elderly or the disabled	52.8%	44.8%
expressways and highways	34.5	46.8
areas in front of stations and commercial districts	39.5	43.7
roads leading to villages in the mountain areas	21.8	20.9
tourist sites or roads to tourist sites	17.8	24.8
spaces of daily life, such as residential areas and surrounding areas of school	78.9	53.9
others	0	1.4

4. Willingness to pay (WTP) for snow removal and Service’s Benefit-Cost ratio

In order to estimate the benefits of current snow removal operations for arterial roads, we estimated WTP amounts with the CVM. In other words, we assumed the WTP should represent the benefits of the Services.

In the questionnaire format, for the purpose of offering them with accurate information of the Services, we first noted to respondents that the current comprehensive road-related services nationwide cost about ¥180,000 per household a year. We, then, asked the respondents how much money they were willing to pay (WTP) for snow removal operations from that amount. At the same time, we added that snow removal is only part of the road-related services by itemizing the service operations, including highway construction and maintenance operations, and that snow removal operations would decrease the expenses for the other operations.

4-1. First survey (mail survey)

In the first survey, we conducted a mail survey by sending to randomly selected 2,000 households, and got 546 replies.

In the questionnaire, we used the double-bounded dichotomous choice CVM. In the first stage, respondents were required to say yes/no to each of the proposed amount of money to be used for the Services: ¥500, ¥1,000, ¥5,000, ¥10,000, ¥20,000, and ¥50,000 per year. In the second stage, for the respondents who had approved (yes) a certain amount of payment, we asked them whether the higher amount of payment would be acceptable for them. And for the respondents who had disapproved of a certain amount of payment, we asked them whether the lower amount of payment would be acceptable. Assuming that distribution of the replied WTP amounts should form a random effect

model and a logit model, we estimated coefficients of the utility function (i.e., the curve showing approval rate of the proposed amount), making use of the maximum likelihood method. As a result, the following equation was obtained. Respondents who rejected the payment itself answered "no" in both stages, but we included them in the estimate for convenience:

P (yes) = 1/{1 + exp (-6.06 + 0.722 ln (T))}
T: proposed WTP amounts (yen/year・household)

Either median WTP value or mean WTP value can be defined as the WTP amount. In this survey, however, we observed that a certain proportion of the respondents approved the high amount of proposed payments, which pushed up the mean WTP value. Therefore, we decided to adopt the median WTP value (i.e., a WTP value at which acceptance rate becomes 50%) to avoid overestimation. The estimated median WTP value was ¥4,427/year・household. The estimated annual benefits for the entire Japan based on the median WTP are ¥194.3 billion/year (= ¥4,427/year・household x 43.9 million households), and the Cost-Benefit ratio (B/C) is about 1.6 (= ¥194.3 billion / ¥123.6 billion).

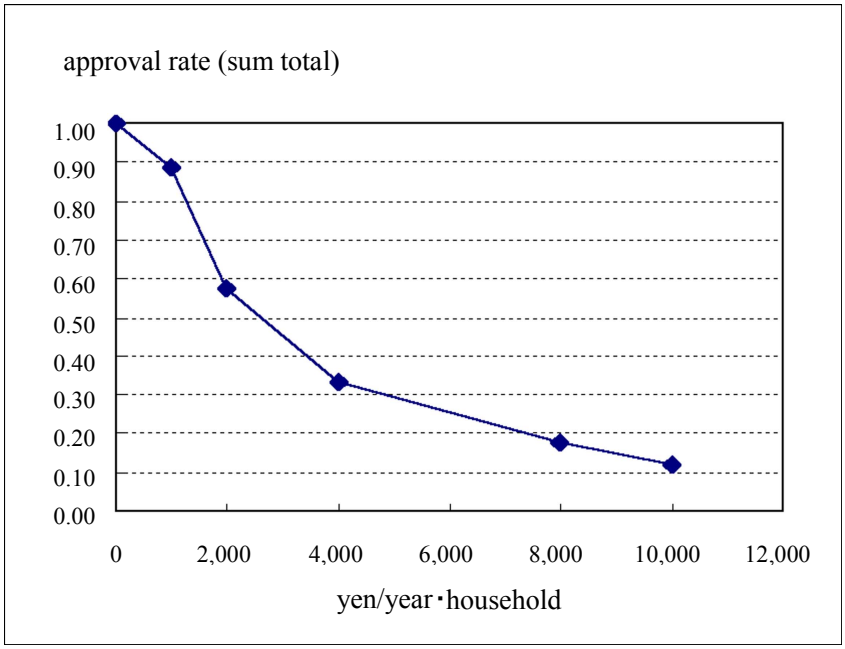
4-2. Second survey (Web survey)

In the second survey, we set up a Web site for conducting questionnaire to enlarge sample size for the purpose of raising the survey accuracy. We noticed from respondent profiles that fewer elder people sent us the replies in the second survey, but overall characteristics of respondent geographical distribution and household income were not greatly different from those of the entire Japan. So we think the group of respondents for the survey reflects the characteristic trait of the Japanese population.

In this questionnaire, we adopted the payment card approach: To avoid respondents' biased judgement, we proposed all options (annual payment of ¥1,000, ¥2,000, ¥4,000, ¥8,000, and ¥10,000, and reject payment) at the same time, and asked respondents to choose one of them. In other words, if a respondent's choice was ¥2,000, we regarded ¥2,000 or below as the respondent's approval for payment. If a respondent chose reject of payment, we regarded his WTP amount as ¥0. We used this approach to avoid getting overestimated WTP amounts; in this approach, no high payment card is proposed, all of the proposed payment cards restrict the payment range, and the first option induces respondents to choose "reject of payment".

Chart 2 shows the survey results. This utility curve (approval curve for proposed payments) seems reliable because we got quite large number of respondents. The mean WTP value estimated by obtaining the dimension below the curve with the nonparametric method, and the value was ¥3,892/year・household. The estimated annual benefits for the entire Japan based on the mean WTP are ¥170.9 billion/year (= ¥3,892/year・household x 43.9 million households), and the cost-benefit ratio (B/C) is about 1.4 (= ¥170.9 billion / ¥124.1 billion).

Chart 2. Approval rate of proposed payment for snow removal on arterial roads (nationwide)



According to the results, the estimate of the benefits of snow removal on arterial roads (Snow and Ice Control) based on the WTP values is ¥3,900 to ¥4,200 per year and household, the nationwide benefits are estimated at ¥170 billion to ¥190 billion, and the B/C is 1.4 to 1.6. From these findings, it has been confirmed that the benefits of Snow and Ice Control surpass well enough the costs.

Table 3 below shows the breakdown of the second survey results by region (snowy and non-snowy) and their comparison with the first survey.

Table 3. WTP values by benefit type for each region (yen per year・household)

		national	non-snowy region	snowy region
1st survey (median WTP)	snow removal benefits for arterial roads	4,427	4,113	5,643
2nd survey (mean WTP)	snow removal benefits for arterial roads	3,892	3,748	4,277
	snow removal benefits for urban sidewalks			3,635
	additional expenses for snow removal in residential districts			2,240

The WTP value for snow removal in the first survey differs from that in the second survey. This difference might arises as a result that we posed more detailed questions on Snow and Ice Control, such as snow removal on urban sidewalks, so that replied WTP amounts were dispersed in wider range. The WTP value of ¥3,892 (i.e., snow removal benefits for arterial roads nationwide in the 2nd survey) is an estimate on the safety side. Incidentally, since total costs for Snow and Ice Control Services that was used to estimate the cost-benefit ratio (B/C) include some of expenses for snow removal of urban sidewalks, the cost-benefit ratio is also an estimate on the safety side.

We have mentioned above that nationwide benefits of the Services surpass the Service costs. Nevertheless, if we estimate the Service benefits based on the limited range of WTP amounts replied by people in snowy regions (about 20% of Japan's population) who are the primary beneficiaries of the Services, they do not sufficiently exceed the costs. This is probably because these people take the Services for granted as their legitimate right and indispensable to life in snowy regions, so estimated WTP values become relatively small when compared to the estimated direct benefits. However, in terms of direct benefits of snow removal---improved velocity of vehicles, reduction of traffic accidents, eased traffic congestion, prevention of traffic shut down---, various studies have revealed that great enough benefits can be expected from the costs for the Services. These points indicate that the Snow and Ice Control Services should be financed from the national treasury because these are the services to ensure Japan's civil minimum and funding these services only by municipal governments in snowy regions would be impossible. They also point out that discussions on the Service benefits should not be limited to snowy regions but include contribution to all over the country.

5. Evaluation tendency of the Service benefits based on relationship of respondents in non-snowy regions to snowy regions

As mentioned above, it is important to get a public approval for Snow and Ice Control Services in non-snowy regions. In this section, we examine how to increase the level of the public approval nationwide.

By analyzing the first survey, we examined whether the following levels of relationship of respondents in non-snowy regions to snowy regions are reflected in respondents' WTP values:

1. Experience Level: Respondents whose hometown is in a snowy region, whose relatives live in snowy regions, or who have lived before in snowy regions.
2. Exchange Level: Respondents who have visited snowy regions for their business or leisure.
3. Knowledge Level: Respondents who remember natural disasters caused by heavy snowfall in the past or such PR materials.

The analytical findings are shown in Table 4 below. The following observations will be deduced from those findings:

・ If respondents have any connections with snowy regions, their WTP values tend to be higher.

・ Respondents, especially those who have lived before for their business or who remembers historical disasters in snowy regions, tend to propose higher WTP values.

・ Respondents who have no connection with snowy regions (according to the above categorization) count less than 20%, whereas 80% of all Japan's population live in non-snowy regions.

・ Public relations exercises on impacts of snowfall on society and difficulty of snow removal operations to raise awareness about situations in snowy regions are effective to gain more approval for the Services.

Table 4. WTP values for snow removal replied by respondents in non-snowy regions by their relationship to snowy regions

(yen/year・household)

relationship of respondents in non-snowy regions to snowy regions	respondents who fit the requirements		respondents who do not fit the requirements	
	number	WTP	number	WTP
1. Experience level				
1 their hometown is in a snowy region but not live there now	46	5,104 (*)	375	3,995
2 their relatives live in snowy regions	103	4,932 (*)	317	3,827
3 who have lived before in snowy regions	51	5,751 (**)	369	3,932
2. Exchange level				
4 who visit snowy regions for business	24	unmeasurable	397	3,692
5 who visit snowy regions for leisure	154	4,505 (*)	267	3,893
3. Knowledge level				
6 who remember heavy snowfall disasters	94	7,336 (**)	327	3,424
7 who remember such PR materials	103	7,099 (**)	318	3,444
respondents who fit item 1 to 3	139	5,224 (*)	282	3,633
respondents who fit item 4 or 5	163	4,993 (*)	258	3,617
respondents who fit item 6 or 7	156	6,879 (**)	265	2,983
respondents who fit 1 to 3, 6, or 7	238	5,286 (**)	183	2,886
respondents who fit one of the items 1 to 7	314	4,880 (*)	107	2,376
nationwide	546	4,427		
respondents living in snowy regions	125	5,642		
respondents living in non-snowy regions	421	4,113		

(*) are above the average WTP value of non-snowy regions

(**) are above the average WTP value of snowy regions

6. Conclusion

(1) Benefits of Snow and Ice Control

The average WTP value for the Services is estimated at about ¥4,000/year・household. The estimated benefits of the Services based on this WTP value are about ¥170 billion to ¥190 billion. This indicates that the benefits of the Service are sufficient enough compared to the actual annual costs of the Services, about ¥120 billion.

However, these actual costs can not be covered only by the sum total of the WTP values in snowy regions. Snow and Ice Control should be considered as a national project to ensure Japan's civil minimum, and discussions over the benefits of the Services should be carried out not only from the viewpoint of snowy regions, but include wider viewpoints.

(2) WTP values proposed by respondents in non-snowy regions and their relationship to snowy regions

Respondents who are connected in any way with life in snowy regions tend to propose slightly higher WTP amounts. Especially, knowledge about how snowfall affects life in snowy regions and memories of disasters caused by snowstorms may be effective factors to increase WTP amounts. It will be greatly significant to implement PR exercises about snowfall in the regions to people in the other areas.

(3) Awareness about Snow and Ice Control

Japanese citizens have relatively good understanding about direct benefits of the Services, including reduced travel time for vehicles and pedestrians, and improved safety and comfortableness, and indirect benefits such as improved inter-regional flow of goods and services. However, their awareness of the benefits to national economy is not so profound. Efforts will be desirable to raise awareness about those direct and indirect benefits based on comprehensibility and their effects rippling around the entire nation through Japan's commerce network.

(4) Difference of awareness between people in snowy regions and in non-snowy regions.

With regard to places that should be prioritized for snow removal, there is a slight difference between people in snowy regions and non-snowy regions. The needs among people in non-snowy regions for snow removal in places such as arterial roads, urban areas, tourist sites are greater than the others have expected. On the other hand, the needs among people in snowy regions for snow removal in sites of their daily life are larger than the others have expected. Therefore, it is necessary to keep these differences in mind in expanding snow removal sites.