A STUDY ON HEDGING THE RISK OF SNOW REMOVAL COST FLUCTUATION

Kunihiro Kishi* and Keiichi Satoh**

*Graduate School of Eng., Hokkaido University
North 13 West 8, Sapporo, Japan
TEL & FAX +81-11-706-6216
E-mail: kishi@eng.hokudai.ac.jp

**Graduate School of Eng., Hokkaido University
North 13 West 8, Sapporo, Japan
TEL +81-11-706-6209/FAX +81-11-706-6216
E-mail: kkaku@eng.hokudai.ac.jp

1. Abstract

For local governments in cold, snowy regions, snow removal is an important public service. However, it differs in some ways from other public works. The cost of snow removal fluctuates greatly each year, since it is influenced by snowfall. Therefore, local governments have been forced to make a supplementary snow removal budget each year.

In addition, introduction of PFI to public works has been considered in Japan in recent years. If PFI is to be introduced to snow removal, we must consider risk-sharing, because the degree of cost fluctuation relates to an investor's risk. Because snow removal costs fluctuate greatly, application of PFI to snow removal presents particularly daunting challenges.

In Sapporo, the average of snowfall is about 480cm. Heavy years see 600 cm of snowfall and light years see 300. Fluctuation is very great. Snow removal in Sapporo has made progress since the 1972 Sapporo Winter Olympics. Its cost also has increased with increasing road extension and number of cars. It has been about 10 billion yen / year, recently.

This study proposes snow removal insurance to hedge the risk of snow removal cost fluctuation, toward enabling PFI's application to snow removal. The case of Sapporo is considered. We analyze the relationship between snow removal cost and snowfall volume, and we show how the introduction of insurance levels the snow removal cost. In the case study, the largest fluctuation before the insurance was introduced was 6 billion and the insurance reduced this to 4 billion yen, a 33.3% decrease.

2. Introduction

For local governments in cold, snowy regions, snow removal is an important public service. However, it differs in some ways from other public works. The cost of snow removal fluctuates greatly each year, since it is influenced by snowfall. Therefore, local governments have been forced to make a supplementary snow removal budget each year.

In addition, introduction of PFI to public works has been considered in Japan in recent years. If PFI is to be introduced to snow removal, we must consider risk-sharing, because the degree of cost fluctuation relates to an investor's risk. Because snow removal costs fluctuate greatly, application of PFI to snow removal presents particularly daunting challenges.

This study proposes snow removal insurance to hedge the risk of snow removal cost fluctuation, toward enabling PFI's application to snow removal. The case of Sapporo is considered.

We analyze the relationship between snow removal cost and snowfall volume, and we show how the introduction of insurance levels the snow removal cost.

3. Snowfall and Snow Removal in Sapporo

3.1 General Snowfall Condition

Figure 1 shows snowfall in Sapporo for each fiscal year from 1953 to 1997. Heavy years see 600 cm of snowfall. Light years see 300. The average is about 480cm. Fluctuation is very great.

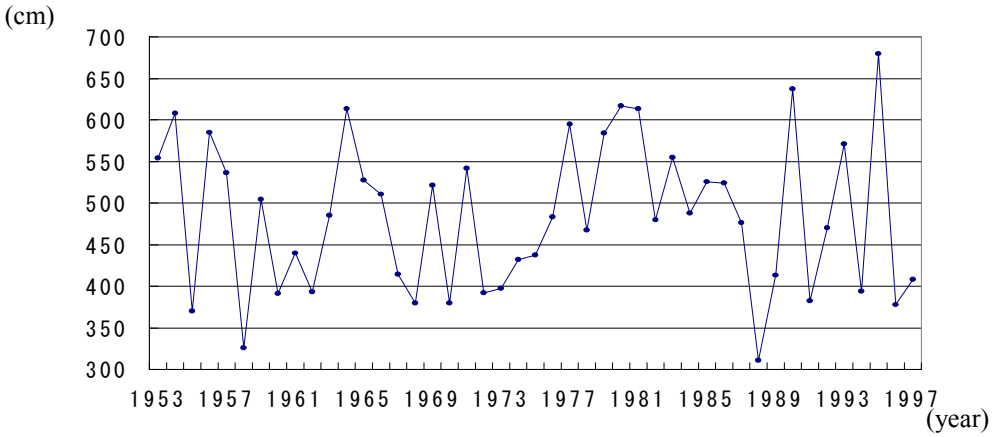

Figure 1. Yearly snowfall in Sapporo

3.2 "Snow Sapporo 21 plan"

The chances which the snow removal in Sapporo greatly developed are the heavy snowfall in 1967 and the 1972 Sapporo Winter Olympics. The heavy snowfall in 1967 caused traffic jam in Sapporo, and the traffic function recovered by snow removal with the Self-Defense Force. And for the smooth progress in the Sapporo Olympics, the head office of snow removal countermeasure was established and it tackled the rapid snow removal.

In Sapporo, the total guideline of "Snow Sapporo 21 plan" has proceeded as follows.

(1) Establishment of the level of snow removal

The level of snow removal is established by the importance of each road.

(2) Improvement of snow removal facilities

The snowmelt tanks and road heating systems are improved.

(3) Multi-zone snow removal system

Areas in Sapporo are divided on the bases of neighborhood associations, roadway snow removal, sidewalk snow removal and snow transport are carried out at every area.

(4) Snow removal partnership system

Sapporo City and residents pay snow removal cost together. Residents, private sector and Sapporo city cooperate in snow removal.

3.3 Snow Removal Cost

Snow removal in Sapporo has made progress since the 1972 Sapporo Winter Olympics. Its cost also has increased with increasing road extension and number of cars. It has been about 10 billion yen / year, recently (Figure 2). By examining snow removal work and settlement amount of each snow removal work item since fiscal 1989, when the effects of economic growth and the change of road extension, etc. became negligible, we analyzed the relationship between snowfall and snow removal cost.

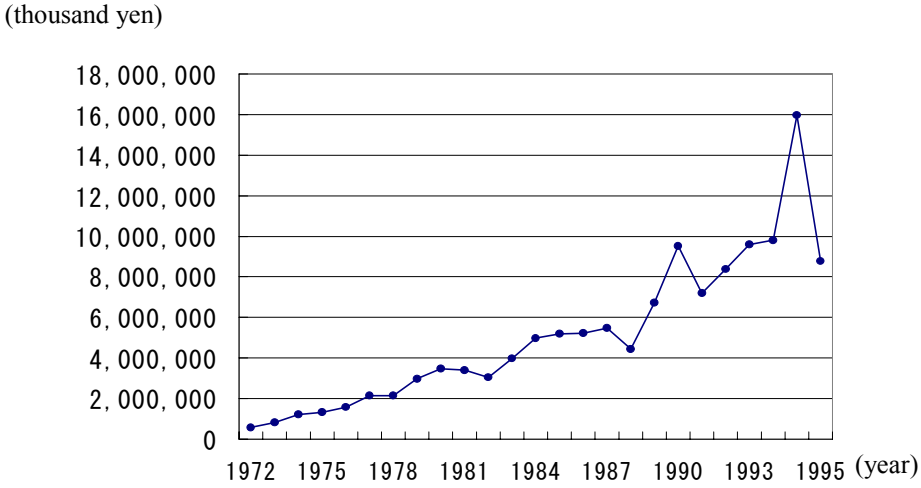

Figure 2. Snow removal cost in Sapporo

Table 1 shows the cost of each snow removal work item per its execution length. It is shown that snow transport cost exceeds snow removal cost. And snow transport cost tends to be expensive in heavy snowfall year. The fluctuation of sidewalk snow removal cost is smaller than that of roadway snow removal and snow transport cost.

Table 1. Cost of snow removal and transport (thousand yen / km)

	1989	1990	1991	1992	1993	1994	1995	1996
Yearly snowfall (cm)	413	637	382	470	571	394	680	378
Roadway snow removal	391	515	461	416	358	536	662	552
Sidewalk snow removal	269	346	235	241	294	283	286	269
Snow transport	1,946	2,990	1,852	2,844	2,752	2,219	4,289	1,376

4. Introduction PFI to Snow removal

4.1 The type and advantage of PFI in the snow removal

In this study, we propose that PFI(Private Finance Initiative) should be utilized for the snow removal. The private sector manages everything in snow removal and the local government pays cost that has been allocated as the snow removal cost until now for the private sector. By introduction of this system, local government pays fixed money for the private sector according to the contract, and it does not have to make a supplementary snow removal budget. That is advantageous that the expenditure for snow removal becomes fixed. From the viewpoint of private sector, when there is small amount of snowfall, the income by snow removal also becomes small. But they can make a fixed income by the contract of PFI every year.

On the other hand, until now snow removal cost is being paid based on the annual contract between local government and private sector. That has obstructed VFM(Value for Money). By the introduction of PFI, the evaluation of the snow removal level become strictly, and the quality of snow removal must be improved under the fixed cost. It is considered that leads to VFM.

4.2 Risk and Responsibility of PFI in Snow Removal

About risk and responsibility of PFI in snow removal, private sector takes the risk for management and local government takes the risk that private sector keeps the appropriate level of snow removal.

For the risk of snow removal management, there is a risk of the accident and the amount of snowfall. It can be said that the biggest risk is “fluctuation of snowfall”.

This study clarifies snow removal insurance decreases the fluctuation of snow removal cost and becomes incentive for private sector to accept the order for snow removal.

5. Concept of Snow Removal Insurance

To introduce snow removal insurance, the compensation for snow removal must equal the total insurance fee paid every year, over the long term (Figure 3). The bars in Figure 3 are the totals of snow removal cost in each year under the present method. The rectangle represents the total fee for snow removal insurance. The two areas, i.e., the total cost, are equal. This satisfies the principle of equivalence of income and expenditure, the fundamental principle of insurance. In practice, there would be a basic fee and an additional fee (profit, etc.), whose sum would be the insurance fee. In principle, the insurance fee should match insurance payment. However, cost will slightly exceed payment because of the additional fee.

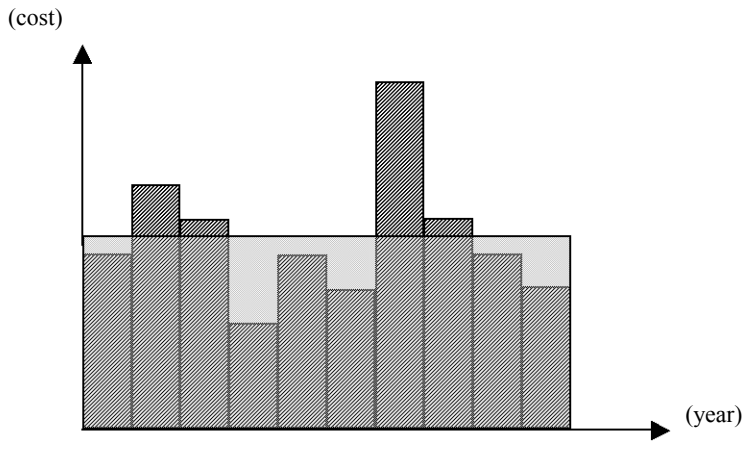

Figure 3. The concept of the insurance

6. Calculation of Snow Removal Insurance

We calculated hypothetical snow removal cost as the product of average snow removal basic unit (23,867,830 yen / cm) in fiscal 1994-1996 and each yearly volume of snowfall in Sapporo from fiscal 1953-1997. We used a hypothetical five-year period that assumed snow removal cost of 8, 10, 12, 12, and 14 billion yen per respective year.

The setting of the insurance assumed three cases: full compensation, compensation with deductible, and compensation with deductible and maximum payment. *Full compensation* describes the case in which the entire snow removal cost is the compensation object. *Compensation with deductible* means that the insurer pays only for costs exceeding a lower limit (the deductible). *Compensation with deductible and maximum* means that the insurer pays only for costs exceeding a lower limit (the deductible) and not beyond an upper limit (the maximum payment). In the cases with deductible, the local government pays the deductible amount every year.

Table 2. Hypothetical case of snow removal insurance (billion yen)
(compensation with deductible and maximum)

Hypothetical snow removal cost	8	10	12	12	14	56
Cost borne by insurer	0	0	2	2	2	6
Cost borne by local government	8	10	10	10	12	50
Insurance basic fee	1.2	1.2	1.2	1.2	1.2	6
Insurance additional fee	0.06	0.06	0.06	0.06	0.06	0.3
Total insurance fee	1.26	1.26	1.26	1.26	1.26	6.3
Total payment	9.26	11.26	11.26	11.26	13.26	56.3

Greatest fluctuation	4	Increase	0.03
% decrease in fluctuation	33.3%	% increase	0.536%

Within hypothetical snow removal cost of each year, the basic insurance fee was set as a fraction of payment. Consider the example of insurance that covers removal cost from 10-12 billion yen and whose additional insurance fee is 5% of the net premium (Table 2). The five-year total of 6 billion yen becomes the object. It is calculated as follows: 2 billion yen (for the first year when snow removal cost is 12 billion yen) + 2 billion yen (for the second year when snow removal cost is 1.2 billion yen) + 2 billion yen (for the year when snow removal cost is 14 billion yen, because the insurance payment maxes out at 12 billion yen). Therefore, snow removal cost borne by the insurer over 5 years becomes 6 billion yen, and insurance basic fee is 1.2 billion yen for each of those years. Additional insurance fees are 0.06 billion yen per year, bringing the five year total of basic fee plus additional fee to 1.26 billion yen per year.

The cost borne by the local government becomes 8, 10, 10, 10, 12 billion yen, for each of the respective years. The total cost borne by local government becomes 9.26, 11.26, 11.26, 11.26, 13.26 billion yen for each of the respective years.

The largest fluctuation before the insurance was introduced was 6 billion yen (14 billion yen - 8 billion yen = 6 billion yen). The insurance reduced this to 4 billion yen (13.26 billion yen - 9.26 billion yen = 4 billion yen), a 33.3% decrease. The cost borne by the local government increased by 0.06 billion yen per year (the additional fee). After introduction of the insurance, the total cost borne by the local government increased by 0.3 billion yen (i.e., 0.06 billion yen × 5), a 0.536% increase.

From the viewpoint of the local government, the percentage decrease in fluctuation should be large and the percentage cost increase should be small. Considering the peace of mind that accrues to the local government when there is no upper limit, there should be no upper limit.

7. Conclusion

In Japan, we have considered that risk should be avoided over the long term. It is important how we choose the risk that will give us the best future return. It is also important to hedge the risk.

The introduction of snow removal insurance levels the yearly expenditure for snow removal. It is shown that this hedges the risk of cost fluctuation and that we can introduce PFI to snow removal.

It is necessary to further hedge the risk of snow removal insurance by issuing it in many cities and by establishing an appropriate level of snow removal.

8. Reffernces

Sapporo District Meteorological Observatory (1954-1998). “Meteorological Phenomenon Monthly Report” (in Japanese).

Construction Bureau, Sapporo City (1990-1995). “Snow Removal Business Report” (in Japanese).