

ASSESSING NEW WINTER MAINTENANCE MANAGEMENT APPROACHES AT THE MINISTÈRE DES TRANSPORTS DU QUÉBEC

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SUMMARY

The ministère des Transports du Québec (MTQ) manages 31,800 kilometres of roads, and is responsible for winter maintenance on those roads. For the past 10 years, the MTQ has faced two major problems in the area of winter maintenance: lack of competition for contracts in some regions, and a general increase in the cost of contracts.

In an effort to respond to these two issues, a working committee that was formed specifically for this purpose focused on developing solutions aimed at mitigating them. This resulted in the development of new contractual clauses that favour the opening of the market and the establishment of a new risk-sharing arrangement with contractors.

A monitoring plan was developed in order to ensure proper evaluation of the various solutions that were implemented within the context of pilot projects. After the first two years of a pilot project that was originally intended to last three years, the MTQ is in a position to share certain significant findings concerning the project as a whole with the international community.

KEYWORDS

WINTER MAINTENANCE / CONTRACT / CONTRACTUAL CLAUSE / MANAGEMENT /
MANAGEMENT APPROACH / SEVERE WINTER CONDITIONS

1. INTRODUCTION

The MTQ manages 31,800 kilometres of roads, and is responsible for winter maintenance on those roads. The majority of these winter maintenance activities are contracted out to local suppliers (contractors or municipalities - 82 % by contract and 18 % by MTQ personnel). Contracts are generally awarded for a one-year term following a call for tenders, with the possibility of being renewed for two additional years. Over the course of a winter, this amounts to 665 snow- and ice-removal contracts (323 with municipalities and 342 with contractors) that are awarded on a fixed-price basis.

Through these contracts, the MTQ assigns the responsibility as principal contractor for snow and ice-removal operations to the suppliers. Accepting this role as principal contractor implies that a supplier is responsible for carrying out all of the work and that it assumes a strict liability to perform the work. Therefore, suppliers must direct and supervise the work effectively. They bear sole responsibility for the resources, methods, techniques, sequences, procedures, and coordination of the work. In addition, they must

take all necessary measures to eliminate dangers at the source and to ensure the protection and safety of all individuals and any movable or immovable assets or property that is susceptible to damage during the execution of the work.

In 2005-2006, the cost of snow removal, including materials and equipment management, reached \$204.6 M, which represented an increase of 19 % over the 2002-2003 fiscal year.

This increase in winter road maintenance expenses was particularly high in the territory managed by the Direction générale de Québec et de l'Est (DGQE) during the period from 1998 to 2006. In fact, winter maintenance expenses increased by 68 % during that period.

In parallel with this increase in winter maintenance costs, a decrease in competitiveness was observed in the snow-removal / ice-removal market beginning in 1998, especially in certain regions of Québec. In fact, during the 2005-2006 fiscal year, the MTQ received only one conforming proposal for one out of every three calls for tender issued, on average.

These main findings brought about a repositioning at the MTQ with respect to this type of activity. A working committee was set up at the DGQE in order to provide a basis for discussions surrounding this departmental repositioning exercise and to identify solutions to the current problems.

2. MANDATE OF THE COMMITTEE

The working committee was charged with the mandate of identifying innovative solutions that would make it possible to slow the increase in the costs of winter maintenance contracts and to foster a competitive environment that is favourable to the entry of new contractors into the market. The study was also to include exploration of various solutions for achieving a new risk-sharing arrangement between the MTQ and the contractors. Finally, pilot sites were selected for the application and testing of these solutions in order to ensure validation of the effects of the solutions under consideration. The planned duration of these experiments was limited to three years, after which time it would be possible to draw clear conclusions with respect to their impact on the market.

3. DESCRIPTION OF COMMITTEE'S WORK ACTIVITIES

In order to respond quickly to its mandate, the working committee focused its activities on six specific issues. These issues, which are listed below, were intended to enable the working committee to organize its work activities in such a way as to respond effectively to the concerns of MTQ management:

1. Development of a competitive environment
2. Evaluation of various approaches to risk sharing between the MTQ and snow-removal contractors
3. Development of new forms for snow-removal contracts
4. Testing of new forms for the fall of 2008

5. Upholding of winter maintenance standards in order to ensure the same quality of service to the public
6. Delivery of an annual report and a final report, including analyses and recommendations for the MTQ's Winter Maintenance Management Committee

3.1. Technology watch

A technology watch was initiated in order to begin the work and to bring the members of the working committee up to date with respect to the subject of competitive environments and management methods used by other road administrations in the area of winter maintenance. This technology watch took the form of an analysis of the specifications books and contract documents used by all Canadian provinces and a number of municipalities.

This analysis made it possible to identify certain solutions that favour risk sharing between the road administration and the contractor. These risk-sharing arrangements also seemed to work in the interest of both parties, which was a non-negligible advantage in the Québec context.

3.2. Identification of scenarios that facilitate the reduction of risk transferred to suppliers

Three solutions for effecting a substantial reduction of the risks transferred to suppliers through fixed-price turnkey winter maintenance contracts were identified. Implementation of these solutions is intended to set up the following risk-sharing arrangements between the MTQ and suppliers:

- Risk sharing based on the number of hours of operation and the consumption of de-icing materials
- Risk sharing based on the amount of snowfall in centimetres

These two types of risk sharing were selected after a specific analysis carried out by a committee of experts. This analysis made it possible to assess the profitability level of each type of risk sharing on the Québec context. Based on this analysis, the importance of the MTQ giving preference to risk sharing based on the number of hours of operation and the consumption of de-icing materials became clear. In addition, the evaluation of several other solutions did not result in a clear choice among them, and therefore, the members of the working committee sought the advice of the MTQ authorities, who decided in favour of testing risk sharing based on the amount of snowfall in centimetres.

3.3. Identification of scenarios that facilitate the opening of the market

The members of the working committee identified a certain number of criteria in the MTQ's regulations respecting the qualification of suppliers as being restrictive for a significant number of contractors. Some of these regulations cannot be changed, because they serve to limit access to the market for contractors with limited experience. Therefore, it was decided to limit the activities of the working committee in this area.

In light of this, a single action was selected, involving the development of a new contractual clause that allows contractors to use subcontractors to carry out a portion of their contract.

3.4. Development of new contractual clauses

Option 1: Risk sharing based on the number of hours of operation and the consumption of de-icing materials: *description of the principle of risk sharing based on hours of operation.*

In order to formalize risk sharing based on the number of hours of operation, a contractual clause was developed and inserted into the contracts that were selected for testing this approach. For each of the contracted areas selected, the client (the MTQ) estimates the cumulative annual number of hours of operation. The mean annual number of hours of operation (MHO) is estimated by calculating the mean of the number of annual hours of operation for the last three years. This number is then used as a basis of comparison for determining the appropriateness, and more importantly, the amount of any adjustment to be paid to the contractor.

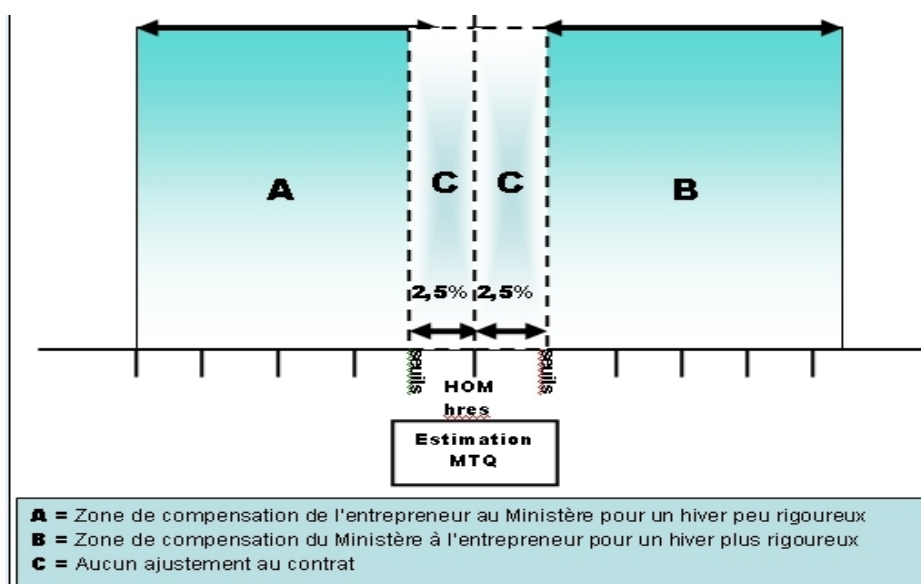


Figure 1 – Illustration of the contract adjustment method

As illustrated in Figure 1, the MTQ adjusts the amount of the contract based on a comparison of the number of hours of operation with the MHO plus or minus 2.5 %. If the number of truck operating hours within the contracted area during the winter season (excluding the pre-season and the post-season) exceeds $MHO + 2.5\%$ hours, the MTQ pays the contractor a fixed rate of \$43.76 / hour for the excess hours.

Similarly, if the number of truck operating hours within the contracted area during the winter season (excluding the pre-season and the post-season) is less than $MHO - 2.5\%$ hours, the MTQ permanently deducts a fixed rate of \$43.76 / hour for the number of hours below this threshold. The adjustment is added to or deducted from the last instalment paid.

In order to ensure proper monitoring of the number of hours of winter maintenance operations carried out during the contract period, the MTQ required the installation of an automated vehicle tracking system in each vehicle. Therefore, the number of hours of operation carried out over the course of a season was calculated from data collected using this tool.

3.4.1. Description of the principle of risk sharing based on the consumption of de-icing materials

The MTQ can make an upward or downward adjustment to the amount of the contract based on the following data:

➤ History of the contracted area

Mean consumption for the contracted area over the five (5) years preceding the contract, denoted as HC (mean consumption of de-icing materials within the contracted area, in tonnes). If the contractor considers this quantity to be inaccurate (either too low or too high), it must adjust its price accordingly, in compliance with the provisions of the paragraphs below.

➤ Service Centre history

Mean consumption of de-icing materials for the contracted areas within the territory served by the Service Centre over the five (5) years preceding the contract (MCS).

➤ Consumption within the contracted area

Consumption of de-icing materials during the contractual season within the contracted area under consideration (CC).

➤ Service Centre consumption

Total consumption of de-icing materials for all of the contracted areas within the territory served by the Service Centre (CGCS).

➤ Price of de-icing materials

The selling price of salt, as indicated in the article "Prices of materials sold by the MTQ", in dollars per metric tonne (PF).

Calculation of adjustments:

➤ If $CC > HC$, and $CGCS > MCS$

In this case, the MTQ reimburses to the contractor for the quantity sold above HC, up to a maximum equal to this quantity adjusted in proportion with the increase observed throughout the territory served by the SC. This adjustment is calculated using the following formula:

$$Ajustement = (CC - HC) * PF \quad Ajustement \max = HC * \left[\left(\frac{CGCS}{MCS} \right) - 1 \right] * PF$$

➤ Conversely, if $CC < HC$, and $CGCS < MCS$

In this case, the value of the history of the contracted area (HC) is adjusted in proportion with the decrease observed throughout the territory served by the SC (adjusted historical value) using the following formula:

$$HCa = HC * \left(\frac{CGCS}{MCS} \right)$$

In this case, the MTQ deducts an additional amount that corresponds to half of the quantity sold below the value of HC, but not exceeding 50 % of the difference between the value of HC and the adjusted historical value. Therefore, this deduction is calculated using the following formula:

$$Retenue = \left(\frac{HC - CC}{2} \right) * PF \quad Retenue_{max} = \left(\frac{HC - HC_a}{2} \right) * PF$$

In all other cases, there is no adjustment to or deduction from the contracted amount.

Option 2: Description of the principle of risk sharing based on the amount of snowfall in centimetres.

The MTQ makes an upward or downward adjustment to the amount of the contract if the amount of snowfall during the winter season (excluding the pre-season and the post-season) is less than 260 cm or more than 300 cm, based on data provided by Environment Canada for Jean-Lesage International Airport in Québec City.

The amount of the adjustment only covers activities related specifically to snow removal, ice removal, snow hauling, and patrolling of the contracted area. The amount of the adjustment is limited to 15 % of the value of the contract, and is calculated as follows:

$$A = (Qté - Qb) \cdot (ADDP \cdot MC) \cdot 0.1786 \%$$

Where: A: Amount of the upward or downward adjustment (\$): $-15 \% < (A / CA) < + 15 \%$

Qté: Amount of snowfall, based on data provided by Environment Canada for Jean-Lesage International Airport in Québec City

Qb: Base amount for the adjustment: 260 cm if $Q < 260$ cm
: 300 cm if $Q > 300$ cm

ADDP: Proportion of the contract covering only activities related specifically to snow removal, ice removal, snow hauling, and patrolling of the contracted area (%). This value is set at 60 %

MC: Contract amount (\$)

0.1786 %: Adjustment of the value of the 280 cm contract for each centimetre of snowfall in excess of 300 cm or below 260 cm = $(1 / 280) / 2$

Where applicable, the amount of the adjustment is added to or deducted from the last instalment paid.

3.4.2. Opening of the market

In order to open up the market, an amendment to section 6.1 of the Cahier des charges et devis généraux [Project Specifications] for snow-removal and ice-removal (CCDG-DD) was approved. This amendment has the effect of giving contractors the right to subcontract up to 50 % of the amount of a contract. This change allows the market to be opened to small contractors, and therefore, to enhance competition in terms of the awarding of contracts.

3.5. Development of the required technological solutions

A technological solution was developed in support of the process for evaluating risk-sharing arrangements based on the number of hours of operation and the consumption of de-icing materials. As a result, the MTQ required the installation of GPS equipment in all vehicles used within the project, along with a new generation of electronic spreader control units that allow for the collection and transmission of data. Certain other sensors were also tested as part of this project, in order to validate their effectiveness.

These technological solutions were designed to allow for continuous monitoring of the hours of operation performed exclusively within the contracted area managed by the MTQ, and tracking of the use of the materials sold to the contractor by the MTQ. This type of monitoring was necessary for the purposes of calculating the contract adjustments.

3.6. Development of a monitoring plan

The working committee also relied on a monitoring plan for the pilot project. This plan included a number of elements that required monitoring in order to be able to draw clear conclusions concerning the effectiveness of the risk-sharing clauses. The plan included the four types of monitoring that were deemed to be necessary for the project: operational, climatic, financial, and technical.

3.7. Identification of pilot sites

An initial sampling of potential pilot sites was carried out in cooperation with local network managers, who were invited to submit contracted areas where snow- and ice-removal contracts were coming up for renewal.

Next, the members of the working committee selected certain contracted areas with a view to obtaining a representative sampling of all of the roads managed by the MTQ. The seven contracted areas that were selected were located in four different territorial directorates. The table below presents the selected contracted areas.

Table 1 – Synthesis of selected routes

DIRECTORATE	DESCRIPTION OF CONTRACTED AREA	TYPE OF RISK SHARING RECOMMENDED	LENGTH OF THE CONTRACTED AREA (KM)
Mauricie Centre-du- Québec	153, 350, 351 and Saint-Mathieu roads	Number of hours of operation and quantity of de-icing material	94,73
	161 road and de l'Accueil street	Number of hours of operation and quantity of de-icing material	52,59
Capitale- Nationale	136, de l'Aéroport roads and 540 highway	Number of centimetres of snowfall	55,31
	40, 440, 740 and Robert-Bourassa highways	Number of hours of operation and quantity of de-icing material	91,94
Chaudière- Appalaches	175 and 275 roads	Number of hours of operation and quantity of de-icing material	15,84
Bas-St-Laurent Gaspésie	132 road	Number of hours of operation and quantity of de-icing material	16,95
	289 road	Number of hours of operation and quantity of de-icing material	50,61

4. LAUNCHING OF THE PILOT PROJECT

The pilot project got underway with the initiation of the call for tenders process for each site selected. The call for tenders process included an explanatory meeting with discussion pertaining to the changes made to the project specifications. These meetings proved to be very positive for both the MTQ and the contractors who attended them. A contractor was then selected based on the lowest conforming proposal for each contract.

Before the beginning of the winter season, the selected contractor was required to make his equipment available to the MTQ in order to carry out the installation, calibration, and testing required for introduction of the telemetry equipment and the various sensors. In parallel with this work, training sessions were held for the contractors' workers. This process involving the installation and certification of equipment and training is required at the beginning of each winter season.

5. MONITORING OF PILOT SITES

A monitoring plan was developed that was specific to this pilot project and common to all of the sites. This monitoring plan involves close monitoring of operational, climatic, financial, and technical elements.

5.1. Operational monitoring

In order to provide input for the calculations required to establish the risk-sharing arrangements and to monitor the contracts properly, the members of the working committee created an operational monitoring plan. Pursuant to this plan, MTQ personnel were required to carry out daily monitoring of a number of elements, including number of hours of operations performed within the contracted area, the type of interventions carried out (snow or ice removal) within the contracted area, and the type and quantity of materials spread within the contracted area.

All of the data required for this monitoring was available via the websites of the technology suppliers (telemetry and sensors). Among other things, this monitoring made it possible to adjust the estimated number of hours of operation for one contract in particular, because the MTQ estimate was much too high, which had the effect of penalizing the contractor. The situation was corrected promptly by drafting an amendment to the contract.

5.2. Climatic monitoring

Before the pilot project was launched, each site was geographically located in order to identify its climate zone. It is important to note that, given the wide diversity of climatic conditions encountered within the territory of Québec, 90 distinct climate zones were identified.

After identifying the climate zones, MTQ personnel sought out the best available source of information for each contracted area. It was necessary that these sources of information would allow the MTQ to obtain reliable daily meteorological observations related to the following parameters: air temperature, type and intensity of precipitation, and wind strength and direction. Combined with operational monitoring, climatic monitoring makes it possible to achieve an in-depth analysis of the type of operation required as a function of the progressive meteorological context during a given month. The table below presents a partial summary for March 2008 for a specific contracted area.

Table 2 – Climat and operational synthesis for March
at Jean-Lesage International Airport station

Data source: Jean-Lesage International Airport station (Environment Canada)										
Monitoring for the month of: March 2008										
TD : Capitale-Nationale				Services Centre: Québec				Circuit :		
Day	Air Temperature			Quantity of precipitation			Blowing snow Yes or No	Maintenance operations		
	Maximum (°C)	Minimum (°C)	Mean (°C)	Snow (cm)	Freezing rain	Rain (mm)		Hours of operation	Quantity of de-icing material (kg)	Quantity of abrasives (kg)
1	-4,9	-12,2	-8,6	3,1		0	No	16:21	939	5637
2	-1,5	-11,4	-6,5	0		0	No	03:43	2941	6582
...
30	2,2	-9,9	-3,9	0		0	No			
31	3,1	-5,4	-1,2	11,5		7	No	03:19	0	3434
Total				152,3		9,8		151	22 481	93 412
Mean	-1,3	-12,0	-6,7					1,04 h/cm		
No. of days				23				23		
Winter severity index: 83			Mean winter severity index: 58,7				IRH range: +24,3			

In parallel with this work, the MTQ analyzed the performance of a winter severity index that was developed by the TAC ^[1]. This index takes into account parameters such as air temperature, the number of days of snowfall, and the number of days of freezing rain in order to characterize the intensity of the winter period under consideration. This concept could eventually come into wider use in terms of describing winter severity. Based on the analyzed index, during the last two winter seasons (2007-2008 and 2008-2009), maintenance teams working in contracted areas located in climate zone 3906 had to deal with winters that were significantly more severe than the 1997-2007 average. Figure 2 illustrates this point.

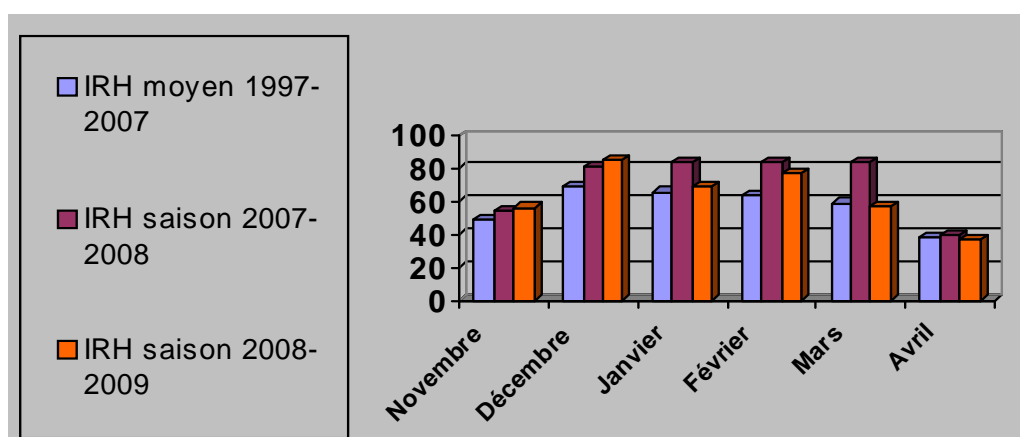


Figure 2 – Comparison of winter severity indices: 2007-2008 and 2008-2009 seasons and 1997-2007 mean.

Given the severity of the first two contractual seasons, the calculations of the adjustments in the risk-sharing clauses should work in favour of the contractors concerned if they are based on the winter severity indicator only.

5.3. Financial monitoring

With respect to the expected benefits in terms of the proposed prices for contracts, the proposed prices for three of the seven contracts that were awarded in the context of the pilot project were lower than the proposed prices for the preceding three years. Two of these contracts were awarded to the same contractor as the previous contract.

The proposal for one other contract was lower than the estimated price (this contracted area had been maintained by MTQ personnel). The three other contracts were awarded to contractors whose proposed prices were higher than the proposed prices for the preceding three years. However, the price increase for two of these three contracts was less than 13 %, which represents an annual increase of 4.3 %.

In addition, four of the seven contracts were awarded at prices below the MTQ-estimated prices. Figure below shows the differences between the proposed prices and the estimated prices.

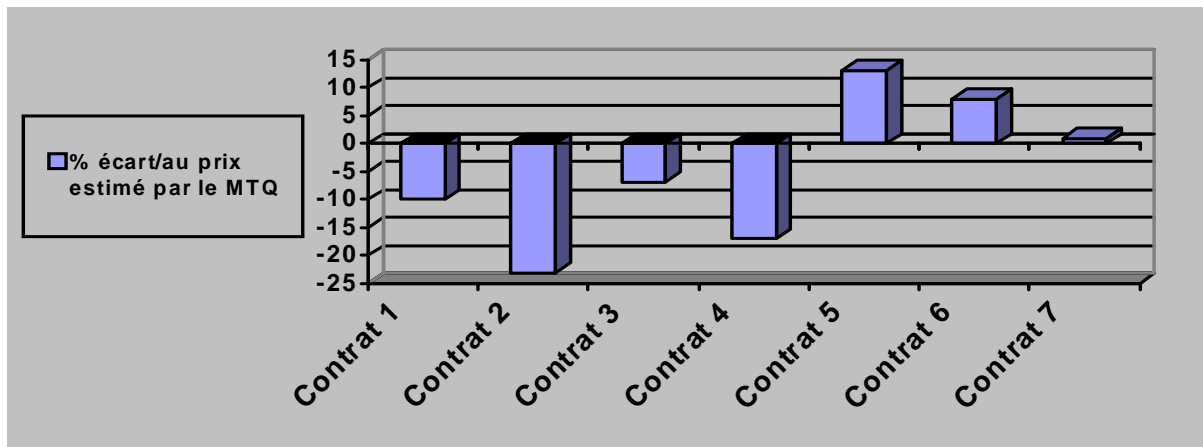


Figure 3 – % difference between proposed price and MTQ-estimated price

With respect to contract adjustments, the MTQ offered contractors special compensation (because of the exceptional winter) during the 2007-2008 season. Therefore, in the context of the pilot project, the most generous compensation was offered to contractors. Four of the seven contracts included in the pilot project were compensated pursuant to the MTQ's special clause, with offered compensation ranging from 6 % to 12 %. Fairly generous compensation was offered to the contractors for the three other contracts based on the new risk-sharing arrangements that were developed. This compensation ranged from 8.8 % to 18.1 %. However, compensation was much less generous for the 2008-2009 season. In fact, there was even an adjustment in favour of the MTQ in the case of Contract 1 as a result of the low number of hours of operation performed. Figure 4 presents a summary of the types of compensation offered in connection with the various contracts for the 2007-2008 and 2008-2009 seasons.

Figure 5 indicates that the new contractual clauses have beneficial effects in terms of reducing costs for most of the contracts. However, this trend does not seem to have manifested itself in the case of Contract 6, which was the only one that applied risk sharing based on the amount of snowfall in centimetres.

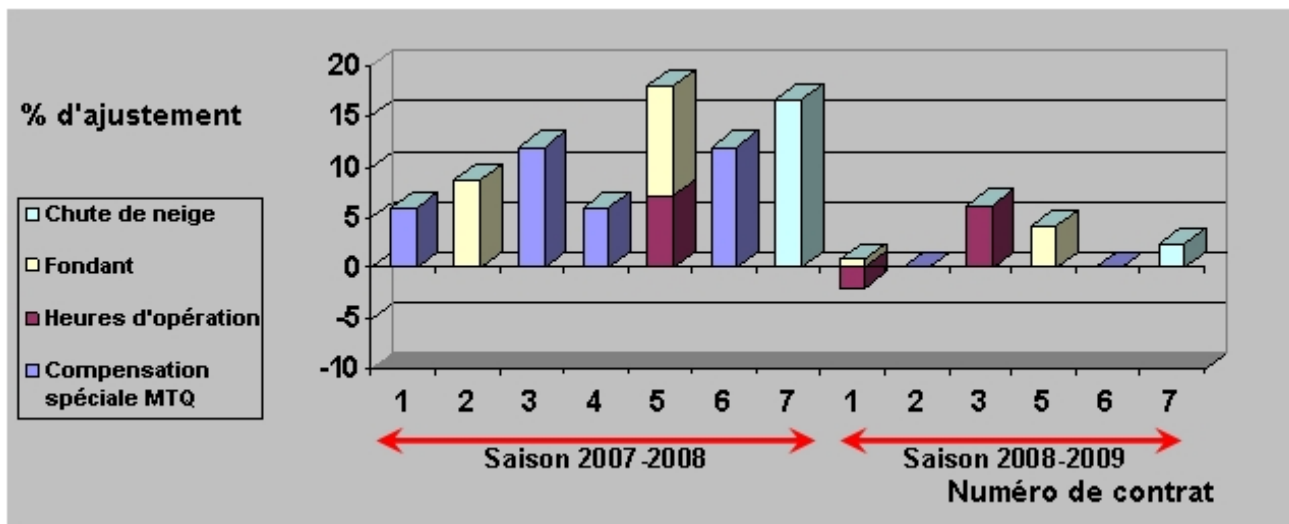


Figure 4 – Summary of adjustments for the 2007-2008 and 2008-2009 seasons

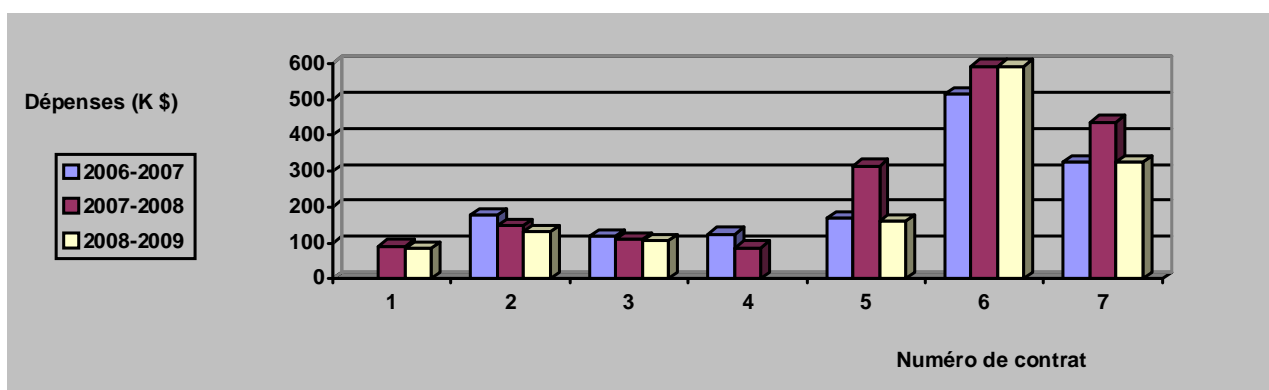


Figure 5 – Change in contract-related expenses

5.4. Technical monitoring

The purpose of this element of the monitoring plan was twofold: first, to allow for an analysis of the various problems encountered by contractors and the MTQ in terms of introducing the new contractual clauses, and second, to facilitate the analysis of the reliability of the technology deployed in support of the project.

The technical staff that was responsible for carrying out the monitoring expressed doubts with respect to the reliability of certain sensors, and questions were raised with respect to the relevance of collecting certain data within the current organizational context, especially in terms of the information obtained by means of sensors mounted on snow-removal equipment (snowplows: one-way and side wing).

After being in effect for two full years, this monitoring plan has led to a number of major findings that will certainly help to better define the MTQ's policies in the future.

6. FINDINGS

The first two years of this pilot project led to certain significant findings related to the various risk-sharing arrangements that were established, and to opening up the market and installing instrumentation on snow-removal vehicles.

Contractual adjustments offer numerous benefits, as manifested in a surge of interest in the snow- and ice-removal contracts offered by the MTQ on the part of contractors. In fact, this interest was evident early in the process, with contractors showing up at the information sessions that marked the start of the call for tenders process in much greater numbers. In addition, new contractors attended, and even submitted proposals pertaining to certain contracted areas.

The establishment of risk-sharing arrangements also made it possible to emphasize the development of a partnership relationship with snow- and ice-removal contractors that had already begun. Although they were skeptical at the outset, the associations that group together the main contractors that work for the MTQ now seem to be in favour of this type of risk sharing between the client and their members. Therefore, the clauses aimed at reducing the risk transferred to contractors are effective in this context.

The risk sharing clauses that combine adjustments based on the quantity of de-icing materials and the number of hours of operation seems to be particularly effective in limiting the increase in contract expenses, and even reducing them.

In terms of technology, the experience that has been acquired has revealed that it is very important to properly define the type of monitoring that the road administration wishes to carry out, and to evaluate the requirements arising therefrom in detail. In fact, the individuals in charge of this pilot project took the opportunity to install a large number of sensors on the snow-removal vehicles in order to test their effectiveness and usefulness for MTQ personnel. Some of these sensors proved to be of limited effectiveness and usefulness within the organizational context at the MTQ. The reliability of some sensors was also questioned by the technical staff who were responsible for carrying out the monitoring of the pilot project. However, the same staff unanimously agreed that the geographic tracking of the vehicles was reliable and useful.

In general, the sources of error related to the technological aspects of the project can be either purely technical or human. The two main sources of technical error are the functioning of the sensors and the processing of the data obtained. In light of this, the development of a protocol and terminology for clearly defining the needs of the administration in this area is recommended. The human aspect plays a role in determining the quality of the data collected, whether as a result of negligence or inadvertence. This aspect must be handled with care, because errors generated in connection with this factor can discredit the entire data-collection process. Given the major impact that this aspect has on the quality of the data, a control process is planned for the final season of the pilot project.

REFERENCES

- [1] Transportation Association of Canada (2007). DEVELOPMENT OF WINTER SEVERITY INDICATORS MODELS FOR CANADIAN WINTER ROAD MAINTENANCE (2007).