PRIVATE-PUBLIC PARTNERSHIP IN THE SLOVENIA WINTER ROAD MAINTENANCE

Peter Pengal*, Mirjam Galičič**, Cveto Gregorc**, and Jure Miljevič**

* Ministry of Transport, Directorate of the Republic of Slovenia for Roads
Tržaška 19, Ljubljana, Slovenia
TEL. +386-1-4788-035/FAX +386-1-4788-036
E-mail: peter.pengal@gov.si

** OMEGAconsult, d.o.o.
Gregorčičeva 7, Ljubljana, Slovenia
TEL. +386-1-2000-170/FAX +386-1-2000-184
E-mail: mirjam.galicic@omegaconsult.si
cveto.gregorc@omegaconsult.si
jure.miljevic@omegaconsult.si

1 Abstract

Winter maintenance (WM) is a complex and expensive service which represents a greater amount of roads maintenance costs in every country with relatively severe winters. In Slovenia, current estimates show that about 60% [8] of maintenance costs are due to winter maintenance. The central question is therefore: *How to make the winter maintenance service more cost effective?* There are two important basic issues which we may expect to contribute towards a more effective WM service. First, the organizational scheme of WM, and second, the extent of knowledge of actual winter conditions in (climatic) subparts of the country. Both issues are considered here. A concessionary system for both regular and winter maintenance was proposed already in [5] and [6]. Here a new organisational scheme for roads maintenance is presented in connection to the accompanying data, in particular weather data for WM. Important weather (climatic) variables are briefly described, and a possible consideration of risk estimation for the case of seasonal snowfall is presented. As far as socio-economic costs are concerned the analysis is simplified and limited to the Vth and the Xth TEN corridors. A detailed consideration is given for a few so-called critical points along the corridors. A possible method for congestion times and costs estimates for an extreme winter weather event at a critical point is described, and proposals for these extra costs sharing are given. Also, a possibility of weather related accidents at critical points is briefly mentioned.

2 Introduction

The lack of funds for building, rehabilitation and maintenance of motorways and other state roads network is not only a problem of undeveloped countries and economies in transition but also a significant problem in the majority of most advanced countries. The state budgets are simply incapable to fulfil so quickly increasing demands of transport sector. It seems that Public-Private-Partnership is one of the possible solutions. Several models of how to include private capital were already prepared and implemented all over the world but very different results were achieved. In this contribution we want to examine the possibilities of introducing a separate PPP for winter maintenance operations.

In the paper, a possible new framework of winter maintenance system will be shown. Its constitutional parts will be listed in *Chapter 3*. A possible grouping of similar road segments according to technical, traffic, climatic, and terrain characteristics will be proposed.

In *Chapter 4*, we will present two stripes of the state territory, which together represent a small area part, but bear a significant (international) transport importance, namely the Vth and the Xth TEN corridors. The two corridors will be shown on a map and critical points will be defined along them.

In *Chapter 5*, we will concentrate on weather (meteorological) conditions, which—along with the required *level of service (*LOS)—determine the extents of WM service, and its costs. Important meteorological variables will be briefly presented and justified as the most influential source of information on winter severity and the related WM costs. The amount of the expected fixed costs for the winter maintenance will be estimated on the basis of long-term average values of meteorological variables that determine the severity of an average winter for different parts (climatic types) of Slovenia. Variable costs and risk sharing will be described by terms of variation of individual values of meteorological variables.

In *Chapter 6,* a few critical points along the two corridors will be considered. At these points, extreme winter conditions combined with traffic and terrain characteristics can close the direction in a relatively short time. A possible method of estimation of congestion times and related costs will be described. Finally, characteristics of critical points will be re-examined and possible new viewpoints will be suggested.

Finally, the paper contents are briefly summarized, and the most important conclusions are listed in *Chapter 7*.

The final purpose behind all the efforts described in the article is an attempt towards achieving a more effective winter maintenance service.

The project on privatisation of Slovene road maintenance is under elaboration and will be completed in the next two years. We expect that the first concessions will be granted in the first half of 2002. We hope that this project would be interesting also for some other states that are dealing with similar (WM) problems.

It would be advantageous to have a detailed analysis of different points of possible separate WM system at disposal before the concessionary maintenance system is adopted.

3 Current roads maintenance scheme in Slovenia and its possible improvements

Due to the importance of winter maintenance (WM) and its particular characteristics, we think that winter maintenance is worth to be considered to a certain extent separately inside the frame of regular maintenance system. Concessionaires would be the same as those who overtake the regular maintenance, but financing should be separate. If applicable, the territory of Slovenia would be divided either in the same way or slightly different[1] as compared to territory division in the regular maintenance system [5].

3.1 Current roads maintenance scheme

In Slovenia, there are now three main groups of roads. Each of them is under a separate managing system. In Table 1 below, the roads' groups are listed along with their approximate total length, and the institution responsible for their maintenance (the road authority) [6].

Table 1. Roads groups in Slovenia, their lengths and managing institutions.

Roads group	Total length [km]	Road authority
state roads	6100	DRSC[2]
motorways	360	DARS[3]
municipal roads	31000	municipalities

A schematic description of the current Slovene roads maintenance (RM) organization of a group of roads[4] is given in Figure 3.1.

[1] Certain road segments which cross climate zones borders may be divided among concessionaires if this turns out to be more economically justified.
[2] Direkcija Republike Slovenije za ceste, *Directorate of the Republic of Slovenia for Roads* (under the Ministry of Transport).
[3] DARS, the Slovene motorway company.
[4] The scheme mainly refers to the state roads group but it could be easily ascribed to other two groups of roads.

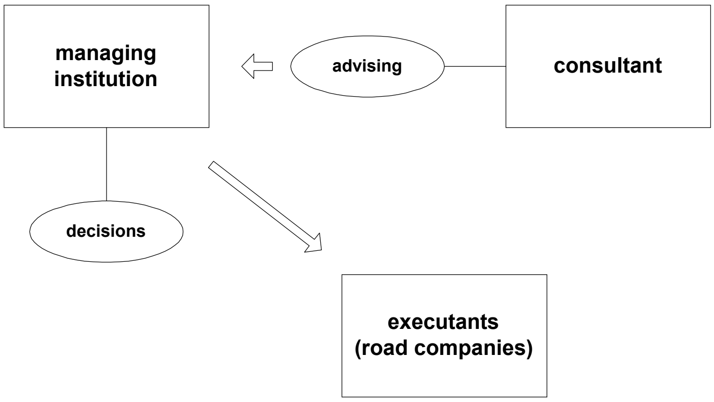

Figure 3.1. Current state of roads maintenance organizational scheme. WM is fully joined with regular maintenance, both from organizational as well as from financial point of view.

3.2 New roads maintenance scheme

In Figure 3.2, a newly proposed scheme for the road maintenance system is shown. Its detailed financial and legal background is given in [5]. Here, the emphasis is at the WM part, and various fields from which relevant data should be gathered, properly stored and interpreted are exposed.

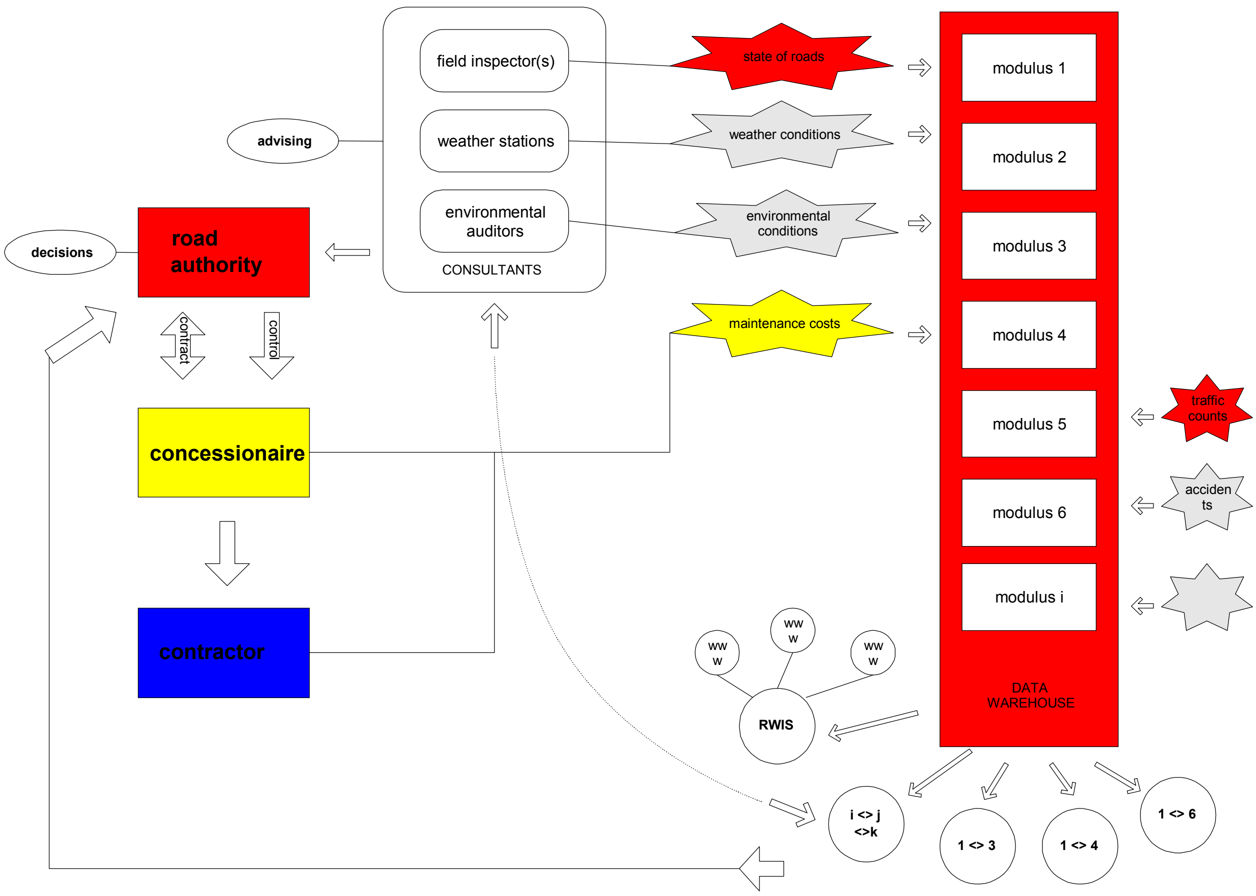

Figure 3.2. Possible new (concessionary) state roads maintenance organisational scheme[5]. Description is given in the text. RWIS stands for *Road Weather Information System*.

[5] This scheme originates from yet unpublished work of OMEGAconsult, Ltd.

In the left part of Figure 3.2, the main three bodies of the RM organisational scheme are given in coloured boxes: the *roads authority* in red, *concessionaires* in yellow, and *contractors* in blue colour. Different experts which will be hired by the roads authority are named *consultants*. Three sorts of them, namely field controllers, meteorological service, and environmental auditors are written in the frame. In the right part of Figure 3.2, data originating from different involved or independent parties are collected together in the form of *data warehouse* moduli. Numerous analyses of data from the data moduli listed in the above scheme have to be performed immediately in order to provide a solid background for the contract terms derivation. Later on, analyses which will help the roads authority in its (informed) decision making, should be carried out in reasonable time intervals.

In this article, the consideration will be limited to evaluation of weather (climate) data or related events. We will describe a possible method of analysis of available weather data, and its impact on risk sharing to be specified in the contract. In particular, we will examine winter weather related events at a few points along the Vth and the Xth TEN corridors.

We believe that the scheme of roads maintenance described above would represent a step towards achieving WM key objectives which are: traffic safety, traffic fluency, maintaining of required LOS for different road categories, and minimization of environmental impacts.

3.3 Winter maintenance costs per road unit length

When the managing institution starts negotiating with concessionaires, it has to know at least approximately what are upper and lower limits of expected maintenance costs. The first approximation would be based on current maintenance costs where total road network costs would be distributed to individual concessionaires according to the share of roads every concessionaire is to maintain. The second approximation would take in account that maintaining costs differ from road to road depending on the climate zone.

An important point that has to be exposed is the necessity of **grouping of road segments into classes** for the purpose of achieving effective winter maintenance[6]. Road segments should be classified according to at least the following characteristics: terrain and climatic characteristics, traffic load information, state categorization of roads, and technical characteristics of roads (geometry, pavements, etc). Additional criteria may enter on the basis of preliminary analysis.

It is expected that reasonably good estimates of average winter maintenance costs per unit length of a classified road segment will be calculated in this way. After a period of winter maintenance in new organisational frame with well kept records, improvements to individual road segments classification will emerge as well as better estimates of WM costs per unit length of classified roads.

3.4 WM in the new roads maintenance scheme: organisation and financing

The newly proposed roads maintenance scheme is shown in the left part of Figure 3.2. Organisationally, WM is included into general roads maintenance system. The concessionaire is the same for both regular and winter maintenance. If necessary, the concessionaire may hire a specialist (e.g. a foreign company, or a specialized contractor from another concessionaire) if extra circumstances appear during the winter.

The important difference we propose here is a separate financing for the WM part. WM costs are therefore allocated separately from the regular maintenance costs. A possible method of winter maintenance costs calculation and risk sharing is given in Chapter 5.

We suppose private financing and/or loan raising for roads maintenance may be more interested for certain routes (e.g. TEN corridors) knowing the importance of their continual permeability also during specific winter circumstances. Therefore concessionaires who maintain the Slovene parts of two TEN corridors may expect to gain additional (low interest) foreign loans to be able to assure the required LOS during winter.

---

[6] The basis of procedure has been recently set at OMEGAconsult, Ltd.

4 V^th^ and X^th^ TEN corridors and their critical points

The Vth and the Xth TEN corridors cross Slovenia approximately from north to south, and from east to west. They represent two important European transport routes. The two corridors are drawn as thick red lines in Figure 4.1.

Table 2. Characteristics of critical points.

No.	Description	Road segments	steep slope	snowdrift threat	ice threat	strong winds
1	Mežakla	0003, 0603		+	+	
2	Medvedjek	0220	+	+		
3	Trojane	0292, 0291	+			
4	Verd	0053, 0653	+			
5	Razdrto	0057, 0657		+		+
6	Gabrče	0059, 0069			+	
7	Divača	0058, 0658			+	
8	Sežana	0068, 0668			+	+

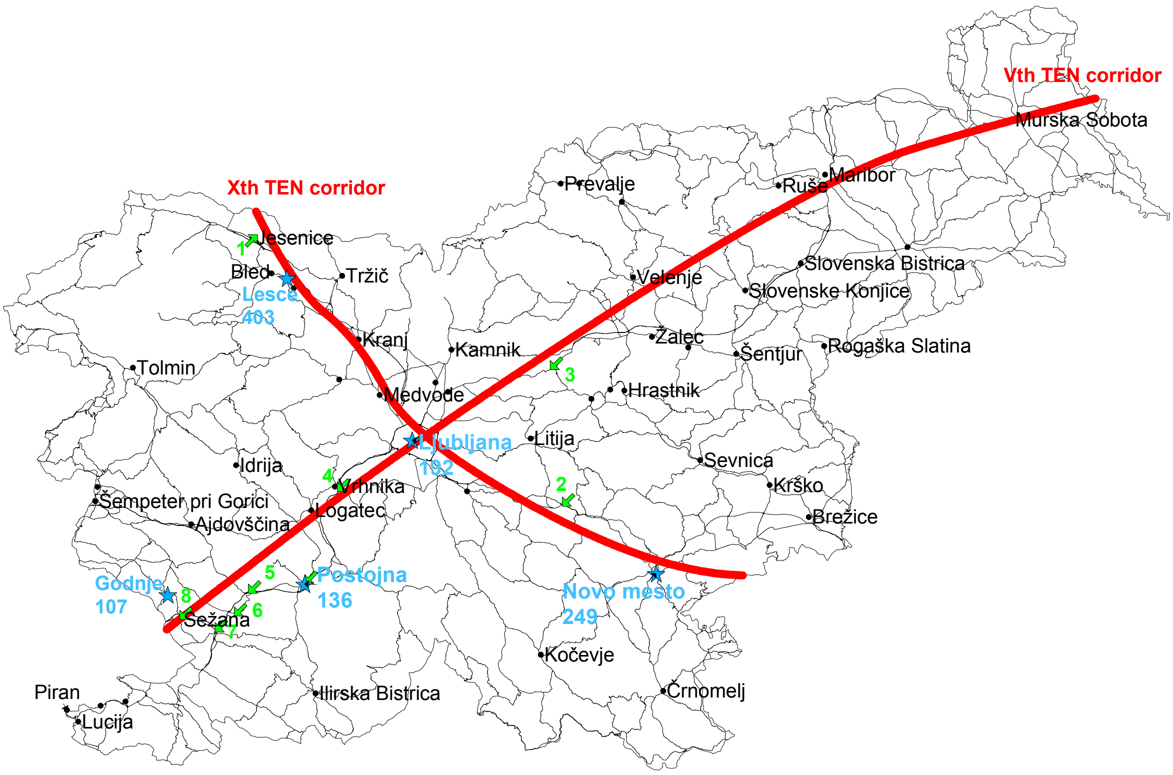

Figure 4.1. V^th^ and the X^th^ TEN corridors with a few critical points along them (green arrows labelled by numbers), and the five meteorological stations (blue stars labelled by stations' names and numbers).

We have identified a few critical points along them[7]. Critical points are marked with green arrows in Figure 4.1 and labelled by numbers[8]. At these points, a subgroup of the following conditions would typically meet: heavy traffic, (steep) road slope, a lot of snow (possible snowdrifting), ice threat, strong winds.

[7] A more detailed analysis would reveal other similar points, and—for example—give a ranking among them.
[8] When necessary, we will refer to individual critical points by these numbers.

The actual roads under corridors that entered in the consideration were motorways or the next highest order roads if a motorway does not exist there yet. The first of the above observations, relatively heavy traffic, is already a consequence of this selection[9] and is included in the list above for the sake of completeness only, while other four conditions refer either to the terrain or weather (climate) characteristics. Further on, we will deal with climatic conditions at critical points.

In Table 2, all the critical points shown in Figure 4.1 are listed and described. Land and weather characteristics which may represent threats at these points are ticked by crosses at every table field if relevant.

5 Key meteorological variables and a possible method for WM fixed and variable costs estimates

The key meteorological variables that have to be analysed well before the contract is fixed in order to obtain typical costs estimates are the following:

- seasonal[10] snowfall
- seasonal temperature (average, minimal, maximal)
- number of days with snowfall per season
- number of days with snow coverage per season
- seasonal precipitation
- depth of snow coverage
- wind speed.

We will define a (winter) *season* as a time interval spreading over December, January and February.

The selection of variables is based on experiences, discussions with meteorologists, and literature, e.g. [1]. In this article, the seasonal snowfall will be analysed for the last meteorological reference period, i.e. seasons 1961/62 to 1990/91. Below, the analysis of data [9] for five meteorological stations[11] will be given. The five stations were selected so that they are the closest existing meteorological stations to the two TEN corridors. The location of stations is shown in Figure 4.1 (stations' names are written in blue colour).

The long-term average value of any of the above listed variables[12] is a key parameter in fixed costs estimates. Variable's spread around the average value needs to be considered for the sake of variable costs estimates. Also the extent of extreme events and their frequency (return period) contribute to the amount of variable costs. The related risk allocation is a matter of negotiation where the managing institution will always have to be aware of their responsibility towards taxpayers.

In Figure 5.1[13], the seasonal amount of snowfall at weather station No. 107 (Godnje) is drawn as a curve where season is labelled by the year so that year i includes January and February of year $i+1$, and December of year i. The blue line in Figure 5.1 represents the average seasonal snowfall while lighter blue lines above and below it represent ± (1 standard deviation) values. The average seasonal snowfall is 16 cm, while its standard deviation is 11 cm. In 30 years, 5 seasons with almost no snow occur, and 4 seasons with at least twice the average snowfall are experienced. This means that approximately every 7 years, we may expect an extreme winter in which new snow removal costs would be approximately twice as high as usually. Also, approximately every 7 years we may expect a winter with almost no snow. This period of time (7 years) is three times shorter than the proposed concession period (20 years, [5]), which seems acceptable.

---

[9] We have chosen heavy traffic roads by purpose, because they are obviously of most importance for the country, as well as for Europe in this case since we consider the TEN corridors.

[10] It may happen that a shorter time interval, a month or even a shorter period, turns out as a more appropriate one.

[11] Currently existing meteorological stations are not road meteorological stations, but the national (Agency for the Environment) meteorological stations. For future, in particular if the Ministry of Transport decides to establish a RWIS, an option of mounting new weather stations across the state territory might be considered. These would be owned by Ministry of Transport or its specialized contractor, but serviced and maintained by a meteorological institution. All meteorological stations would serve as information sources for a central (road) weather database which could also be a basis for eventual Slovene RWIS.

[12] Or a proper combination of them.

[13] The following analyses method and presented results originate from preliminary research work of OMEGAconsult, Ltd.

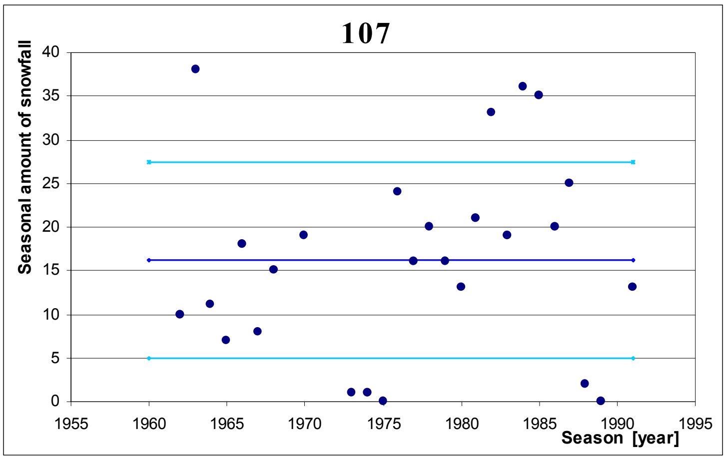

Figure 5.1. Seasonal amount of snowfall for a meteorological station No. 107.

Results of the above presented analysis for all 5 weather stations seasonal snowfall data are collected in Table 3. For every dataset the average seasonal snowfall and its standard deviation are given in centimetres. The remaining columns towards right are, consecutively: the number of upper extreme events, the approximate average's multiple of snowfall at upper extreme events, the upper extreme event return period, the number of lower extreme events, and the number of missing data points in the 30-years period.

Here we consider a few single meteorological stations' data only. In practice, charts made by meteorologists will be used with contours separating classes of typical average seasonal snowfall. Every concessionaire's territory will be cut into several classes[14] of average seasonal snowfall by these contours. For every snowfall class, the total length of state roads will be measured and classified by their importance[15]. Knowing the average seasonal snowfall, and the price of a unit of snow removal (e.g. a 10 cm thick m^2 snow layer removal), one can calculate the expected average amount of money used for snow removal on a certain road segment.

Table 3. Seasonal snowfall analysis for five meteorological stations.

Station number	Station name	Average seasonal snowfall [cm]	Av. seas. snowfall standard dev. [cm]	No. of upper extreme events	Approx. average's multiple of upper extr. events	Extreme return period [years]	No. of lower extreme events	No. of missing datapoints
107	Godnje	16	11	4	2	7,5	5	4
136	Postojna	63	39	4	2	7,5	4	0
192	Ljubljana	78	47	3	2	10	5	0
249	Novo mesto	88	52	5	2	6	5	0
403	Lesce	95	60	4	1,5	7,5	5	18

In the contract between the managing institution and the concessionaire the expected (fixed) annual costs for the snow removal will be specified based on the average values obtained as described above. According to statistics, the small oscillations for the years between ± (1 standard deviation) values will mutually cancel out. The risk sharing enters when we want to include the extreme situations. The lower extremes are of course fine for concessionaires, because the annual amount of snow removal money will be a benefit for them while the upper extremes represent a concern of both concessionaires and the managing institution. The concessionaires may enter financial problems if they take over all the risk. On the other side, the managing institution would not dare to transfer all the risk to concessionaires, because transportation over the state territory has to be possible even during an extreme winter. A possible solution to the *variable costs—risk sharing problem* would be as

[14] See also the Chapter 3.3.
[15] As due to the categorisation of roads in Slovenia, and the corresponding required LOS.

follows. A concessionaire insures itself for the case of an extreme winter. The unspent income gained during the lower extreme winters may represent a good part of insurance costs.

Additionally, it has to be defined in the contract that the proposed risk sharing applies only for the extreme winters with not more than twice as much snowfall as on average. Extremely heavy winters[16] that appear maybe once per century are not taken in account here. It will need to be stated in the contract that such events are treated as elementary accidents.

At the end of this chapter we have to add that the presented analysis is a simplified one, since the only parameter considered was the seasonal snowfall. For example, no information on the frequency of occurence of snowfall events per season is included. Finally, a single consideration of different winter weather phenomena may be described in the form of a *winter index* ([2]).

6 Estimates of congestion times and related costs for a few critical points along the Vth and the Xth TEN corridors

In this chapter, extreme events at critical points along the two TEN corridors are considered. A possible method of congestion times derivation and the congestion related costs estimation is described in the first part. In the second part of the chapter, further possibilities of critical points description are considered, in particular a possibility to distinguish winter road weather related accidents.

6.1 Extreme (winter weather) event at a critical point

The transportability of the two corridors is of great importance both for Slovenia and for Europe. If congestion triggered by winter weather appeared one would expect that related costs are large since a large snowdrift removal may take hours. Numbers of vehicles have to wait for the removal on a heavy traffic load road. In this section, a description of a possible estimate of congestion related costs is given.

Suppose an extreme event happens at the critical point. Let the extreme event be a heavy snowfall. As a consequence, traffic is slowed down. In the worst case, traffic stops. Consider the situation where personal cars could still move on slowly (e.g. at half the normal speed) if heavy vehicles are removed from the road. Heavy vehicles can be excluded so that they are urged to park in the closest possible withdrawal place[17] along the road segment. The length of a road segment is known, as well as the number of withdrawal places per road kilometre. Suppose that at the time the extreme event happens, a certain number of vehicles with a known percentage of heavy vehicles enter the road segment in one hour. Suppose further that every heavy vehicle withdraws to the first empty withdrawal place along the road.

From the exemplary data written above, one can estimate the time in which a 10 km long road segment[18] with 5 withdrawal places per kilometre will be congested if there are 100 heavy vehicles per hour entering the road segment. A simple linear formula[19] would yield a half an hour congestion time.

In the next step, the (socio-economic) costs due to congestion can be estimated. Variables that have to be known are the temporal distribution and structure of vehicles entering the road segment, and the costs of every hour of waiting for different vehicle classes. The estimated costs must be summed together with other costs related to the extreme event, like the snow removal costs, costs of bypasses, the related accidents costs, etc. Also, the frequency of the (extreme weather) phenomenon has to be taken in account and compared to costs required for the prevention or bypassing the phenomenon.

---

[16] A rough estimate says that a winter with about 5 meters of snowfall in a row of days may happen about once or twice per century.

[17] Say an at least 20 m long and 8 m wide flat free space along the road.

[18] For comparison, the length of the Vth TEN corridor is about 300 km, and of the Xth TEN corridor about half as much.

[19] It was assumed that traffic stops as soon as there are no more withdrawal places available along the road segment.

With actual data, situation at any critical points can be considered as described above, and the total socio-economic costs related to winter weather extreme event can be estimated.

6.2 Possible organisational and financial flows' solutions towards resolving a winter weather related congestion at a critical point

In the section above, it has been shown that an extreme winter weather event at a critical point causes significant socio-economic costs. As soon as the state is aware of them, these extra costs should be balanced. There are two viewpoints that have to be considered, the organisational and the financial one.

ORGANISATION

Currently, road companies in Slovenia receive certain amount of money from the government every year. If state would ask them to assure a high LOS even in the case of an extreme winter event at a critical point, one may suppose that a road company would reply with a request for a larger annual amount of money. This extra money would enable them to be prepared for a possible extreme situation which may happen or may not happen.

In the newly proposed system, the only concern of the state is that the roads are maintained according to agreements. Since concessionaires are paid according to the achieved results (showing up as observed LOS), they are interested in roads maintained according to LOS agreed. Consecutively, they would invest their own efforts into being prepared for a possible extreme winter event at a critical point (they would also look themselves for possible optimal internal organisational solutions, reasonable money allocation, and possible gathering of additional financial resources).

FINANCING

If the above mentioned extra costs are to be properly balanced in the frame of the new roads maintenance organisational scheme, the source of financing have to be addressed as well. To balance the extra costs due to an extreme winter weather event at a critical point, the state (or the state in partnership with other parties included in the roads maintenance organisational scheme) has a few possibilities. Among them are the following:

a) An increased annual state budget as a result of taxes allocation or (preferably) new taxes;
b) Extra resources from mixed origin (taxes, contributions from heavy vehicles road users).

There are two possibilities to obtain resources from road users here. To justify the idea, we have to take a look at the structure of vehicles that currently use the existing roads under the two TEN corridors. The 1999 traffic data [3] show that the number of foreign heavy vehicles almost equals the number of domestic heavy vehicles along both corridors. Firstly, heavy vehicles (see Chapter 6.1) largely contribute towards the extents of congesting in the case of an extreme winter weather event. Secondly, it is the time for cargo carried which is most highly valued in the case of congestion. Therefore, we expect that cargo companies are in particular interested to have a congestion removed as soon as possible, or to avoid it if only possible. Heavy (cargo) vehicles might therefore be additionally tolled, either

- at the state level (inter-state agreement between Slovenia and countries for which the V^{th} and the X^{th} corridors are of greater importance), or
- at the individual (vechicle) level.

6.3 Characteristics of critical points and new aspects

The critical points listed in Table 2 were selected on the basis of expert knowledge, but there are surely other critical points along the two corridors, as well as over the rest of the state road network. The main criteria that lead us to this selection were terrain and weather (climate) data.

Another kind of data that may affect the selection of critical points, and consecutively lead to a more precise congestion costs estimates, are accidents data[20]. The question would be: *Are there winter related accidents close to these critical points?* Putting the statement slightly differently: Are

[20] This is also a data modulus in the data warehouse proposed in Figure 3.2.

there accidents that have happened during winter and could have been prevented if the carriage way was treated (maintained) properly[21]?

An answer to this question might follow from a thorough parallel analysis of accidents data and weather data. As follows from the extended work on traffic safety and accidents rates ([7] and references therein), in general there are more accidents in summer than in winter. This is expected since there is typically less traffic in winter than in summer. But if we precisely define the carriage-way conditions that we require for a high category heavy traffic road, and derive an appropriate indicator, the question exposed above may be answered. A preliminary analysis[22] for road segments close to critical points 1, 2 and 3 indicates a positive answer to the question exposed above. If further data analysis confirms this preliminary result, an important point of view will be added to the issues related to winter maintenance.

Other aspects of critical points definition and their characteristics description may enter with further work in this field.

7 Conclusion

A roads maintenance organisational scheme based on concessionary system was proposed for the Slovene RM system. WM would be its part with a separate financing. Meteorological (weather) variables were described which importantly influence the fixed and variable costs of winter maintenance. A background calculation for one of meteorological variables—the seasonal snowfall—and a method description of fixed and variable costs sharing between the roads authority and concessionaire are given. In particular, only the state roads running along the Vth and the Xth TEN corridors were considered, and a few of the so called critical points along them were identified. A possible method for socio-economic costs estimation in the case of winter weather traffic congestion is described, and a suggestion of related organisational-financial resolution to balance them is proposed. Finally, characteristics of critical points are re-examined, and an additional point of view, winter weather related accidents, is briefly considered.

We think that the above addressed problems and methods proposed in this article represent important issues in the process of shaping the new roads maintenance system in Slovenia, in particular its WM part, and may be interesting for other countries, too.

8 References

[1] Improvement of Traffic Flows on TEN Corridors II and IV (TNREG 9703), Topic Study: Recommendations to Improve Winter Maintenance, November 2000

[2] Measuring the Efficiency of Winter Maintenance Practices, R. Decker et al., Fifth International Symposium on Snow Removal and Ice Control Technology, September 5-8, 2000, Roanoke, Virginia, USA

[3] Promet 1999, (Traffic 1999, Annual AADT data for road segments in Slovenia) Ministry of Transport, DRSC, Ljubljana, 2000

[4] Road accidents database, OMEGAconsult, Ltd., Ljubljana, 2000 (source of rough data: Ministry of Internal Affairs)

[5] Slovenia Private Road Maintenance Project, strategy report, Finnra et al., 2001

[6] Analysis of investments into different types of maintenance work on state roads from 1997 to 1999, DRSC, OMEGAconsult, d.o.o., Ljubljana, 2000

[7] Traffic safety analysis for Slovenia, part II, DRSC, OMEGAconsult, d.o.o., Ljubljana, 2000

[8] Modelling and evaluation of different types of regular (and winter) road maintenance systems, DRSC, OMEGAconsult, d.o.o., Ljubljana, 2000

[9] Seasonal snowfall data for the reference period 19961/91 to 1990/91, OMEGAconsult, Ltd., Ljubljana, 2001 (source of rough data: Ministry of Environment – Environmental Agency)

[21] Here we suppose that an important (high traffic load, high category road) is considered, and therefore a clean and dry carriage way is expected.

[22] OMEGAconsult, Ltd.