

COMPREHENSIVE RISK MANAGEMENT IN ROAD MAINTENANCE – RISK ASSESSMENT AND HANDLING IN ROAD MAINTENANCE CONTRACTS IN FINLAND

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ABSTRACT

The Finnish Transport Agency (formerly the Finnish Road Administration) is responsible for preparing the maintenance policies for the road network. The transport and infrastructure units of the Centres for Economic Development, Transport and the Environment (formerly Road Regions) carry out the operational activities and management of regional roads. These units are responsible for the planning of regional road maintenance, tendering of maintenance contracts and monitoring implementation.

In Finland the annual budget for road management is approximately € 530 million, of which € 450 million is used for maintenance. The operative units carry the risks connected with the implementation of maintenance contracts, such as risks in connection to increased cost level, road user safety and occupational safety during contract implementation.

Comprehensive risk management refers to risk assessment and preventive measures at all times during the planning, tendering and implementation phases of the road maintenance contracts. The risks of the regional contracts can be divided into operational and safety risks. Operational risks are connected to the contract contents and presented work output. Safety risks are connected to the risks facing employees and other road users, which can result from the work itself (for example snow ploughing in the winter), or from external factors such as in the maintenance of railroad level crossings (hazard from the trains colliding with an employee or equipment).

The Centre for Economic Development Transport and the Environment for North Savo made a risk assessment of the regional maintenance contracts and identified fundamental safety risks for example in the work carried out near water systems, risks connected with traffic when working on the road, and risks from machines. The operational risks of a maintenance contract were connected to the accuracy of the baseline information such as the number of traffic signs needing repair and the true condition of the gravel road network at the beginning of the contract cycle.

The participants evaluating the comprehensive risk assessment process found the assessment of operational risks more challenging than the assessment of safety risks, which was considered easiest.

1. INTRODUCTION

The Finnish Transport Agency (formerly the Finnish Road Administration) is responsible for the maintenance policies of the road network in Finland. The transport and infrastructure units of the Centres for Economic Development, Transport and the Environment (previously Road Regions) are responsible for operational and regional activities. These units are responsible for the planning, and organising of competitive

tendering for maintenance contracts, and controlling implementation. In Finland the annual management expenditure for public roads is approximately € 530 million, of which some € 450 million is used for maintenance. The operative units carry risks connected to the implementation of maintenance contracts, such as risks resulting from an increase in the cost level, risks connected with road user safety and occupational safety during the contract cycle.

In 2009 the Finnish Road Administration (currently the Finnish Transport Agency) carried out a project, which aimed at improving the risk management of the maintenance contracts of the road network. A comprehensive picture of the risks connected to maintenance and maintenance contracts was established in the project. Two seminars were organized during the project cycle and the participants represented the client (orderer), contractor and consultants. In the seminars a risk chart was created, which divides risks into three categories: risks inherent in the planning phase, risks in the tendering phase, and risks in the implementation phase of a maintenance contract. The project also produced a method for risk assessment and management during the different phases of the maintenance contracts. [1]

In 2010 a continuation project was launched by the Centre for Economic Development Transport and the Environment for North Savo. The objective of the new project is to test the model in the maintenance contracts opened for tender in 2011. Figure 1 presents the comprehensive risk assessment process of a regional maintenance contract. Comprehensive risk assessment refers to risk assessment in the different phases of the service contract covering operations and safety.

RISK MANAGEMENT IN ROAD MAINTENANCE SERVICE CONTRACTS					
METHOD	1 PLANNING	2 COMPETITIVE BIDDING	3 IMPLEMENTATION		
Risk Management of Road Maintenance Service Contracts	Risk Chart & Risk Management Plan (national level risks) Finnish Transport Agency ELY-Centre opening competition ELY-Centre managing contract implementation	Risk Chart & Risk Assessment (service contract level risks) ELY-Centre inviting tenders Party responsible for the region	Risk Chart & Risk Management Plan / Risk Diary ELY-Centre managing contract implementation Contractor	Measured quality	Service level experienced by customers
RESPONSIBILITY					
Identification of safety risks	Safety Document (Government Decree VNa 205 / 2009) (In accordance with the identification system, Finnish Road Administration's internal publications 38/2008)		Safety Plan		
RESPONSIBILITY	ELY-Centre opening competition ELY-Centre managing contract implementation		Contractor		

Figure 1. Risk management during the different phases of a regional maintenance service contract. [2] (ELY-Centre = Centre for Economic Development Transport and the Environment)

In Figure 1 the risks have been divided into two categories: risks inherent in the operational content of the regional contract and implementation and safety risks.

In dealing with safety risks, the emphasis is on pre-emptive measures concerning risks to the employees and other road users. Identification of safety risks and preparation of a related safety document and safety plan are statutory and stipulated in Finnish legislation. It is the client (orderer), who is responsible for risk identification and preparation of the safety document.[2] The safety plan is prepared by the contractor based on the risk assessment and safety document made by the client.

Risks in the operation and implementation of road network maintenance include differences in the amounts of work output such as the times of snow ploughing, grass and brush cutting for example.

This paper focuses on the risk assessment of the planning and tendering phases of a maintenance contract, and its impacts on the content of the contract and the tendering process. Risks identified when planning a maintenance contract and preparing its tendering process are recorded and made available to the contractors in the contract documents. Risk management is subsequently monitored during the contract implementation. The contractor has to include the operational risks identified and reported by the client in their financial tender, and the safety risks in their own safety plan applied to the implementation phase. The project's follow-up continues until 2012.

2. REGIONAL MAINTENANCE CONTRACTS OF THE ROAD NETWORK AND THEIR RISKS IN FINLAND

In Finland the length of the public road network totals 78 000 km, of which the share of gravel roads is one third, i.e. 28 000 km. The road network has been divided into 82 regional maintenance contract areas, where the minimum length of road network is 500 km and maximum approximately 2000 km. Regional maintenance contracts were opened to competitive bidding in 2001.

The works included in the regional maintenance contracts can roughly be divided into summer and winter maintenance tasks. Winter maintenance tasks cover such works as ploughing and skid resistance, cleaning traffic signs from snow and levelling packed snow on roads. Summer maintenance tasks include maintenance of green areas, brush cutting, ditch repairs and gravel road maintenance.

The regional maintenance contracts are lump sum contracts with quality management, where the majority of tasks is covered by the lump sum and only a fraction are unit-price tasks based on quantities. Tasks covered by the contract's lump sum include snow ploughing, skid resistance and levelling of packed snow listed above in the winter maintenance tasks. Tasks based on unit-prices include replacing traffic signs.

The regional maintenance contracts are divided into three categories based on how demanding they are: basic contract, difficult contract and very difficult contract. The average annual contract sum varies between € 0.7 million and € 4.0 million depending on how demanding the implementation is (based on factors such as road length, geographic location and traffic volume of the road network). The duration of the maintenance contract is five or seven years. The duration is determined nationally and regionally in such a way that the number of contracts opened to tender yearly is from 9 to 13.

Currently there are a total of seven main contractors in the regional maintenance contracts. Contract tendering is based on a restricted procedure, where invitations to tender are sent to those contractors who meet the financial and operational requirements, in other words to the contractors who meet prequalification requirements. The selection of the winning contractor is based on the so called two-envelope system, where in the first selection round the work and quality plans for the specific contract made by the contractors are evaluated. The contractor describes in the plan for example the machinery and equipment to be used in the implementation of the contract and the employees' competence and expertise of maintenance contracting. The contractor also describes how they are going to satisfy the quality requirements of the contract.

The contractors' tender has to receive a minimum number of points for different requirement classes, which for example in the basic maintenance contract is 400 points. The contractor presenting the tender with the required point level and the lowest price wins the contract. The financial envelopes of the tenders, whose technical points do not reach the required minimum level, are returned unopened to the contractors. The client receives annually from four to six tenders for each maintenance contract depending on the location and length of the road network of the contract. The accuracy of baseline information and requirement level of the contract also influence the number of tenders. Very difficult contracts attract the least number of tenders, because of the stricter requirements for the contractors' financial status and competence. In these contracts contractors carry bigger financial risks than in basic or difficult contracts.

In connection to developing the comprehensive risk assessment system in 2009, a more detailed study was made on the views of the client and contractor of the risks inherent in the different requirement categories of regional maintenance contracts. Several representatives of the client, contractors and consultants participated in the two seminars organised on the topic. The seminar and the analysis of the background materials brought to light a number of risks, which both the client and contractors of regional maintenance contracts had identified. The most significant risks in the regional maintenance contracts were connected with the uncertainties concerning costs, decrease of the road asset value, the market and competitive situation, quality, accuracy and interpretation of the tender documents, changes in the contract contents during the contract cycle, baseline information, communication, competence, resources and safety.[1,2]

The aforementioned risks can be cut by improved advanced planning, and risk assessment and description either in connection with maintenance planning or at the latest during the risk assessment of the tendering phase of maintenance contracting.

3. RISK MANAGEMENT AS PART OF MAINTENANCE PLANNING

Area and content planning of the regional maintenance contracts is part of the maintenance planning process. Principles of the maintenance planning process are presented in Figure 2.

The top part of the figure (phase 1) shows the factors guiding maintenance planning such as funding framework or road management policies and strategies. These factors combined with customer needs and the operational environment define the service level of the maintenance contract in the road network, that is which kinds of service level expectations will be taken into comparison (analysis of the phase 2).

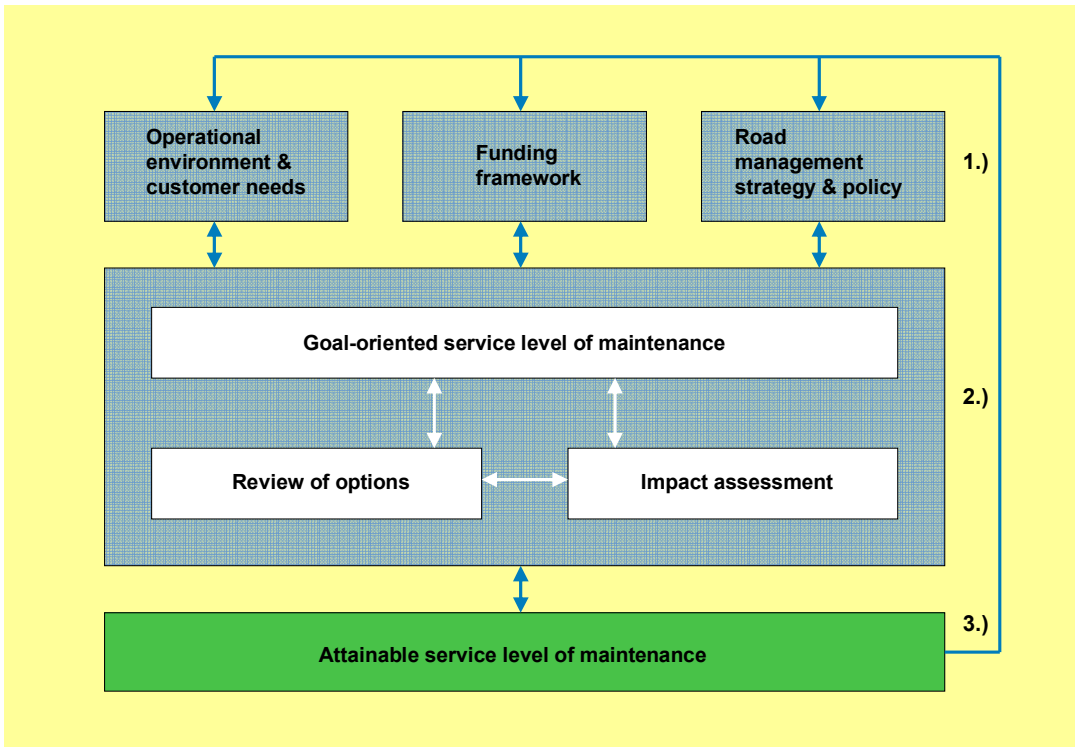


Figure 2: Principle of Maintenance Planning Process [3]

In phase three (3) such service level is determined as is considered to be attainable, when the contract is implemented as planned. In the maintenance planning process different alternatives are created, and the impacts and risks resulting from the targeted service level during the implementation phase of a regional maintenance contract are evaluated from the client's perspective.[3]

4. RISK MANAGEMENT IN REGIONAL MAINTENANCE CONTRACTS

4.1. Comprehensive Risk Management in Regional Maintenance Contracts

Comprehensive risk management means that risk management measures are integrated into the entire road management process. The main focus has to be on the operational and occupational safety risks during the planning and implementation phases of a regional maintenance contract. Risks to the road users from maintenance should not be overlooked either.

The risk management process in the regional maintenance contracts is presented in Figure 3. In the figure the most significant factors connected to the regional maintenance contracts have been grouped into larger categories, which have been divided into the planning, tendering and implementation phases.

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Figure 3: Risk management during the different phases of a regional maintenance service contract. [2]

In Figure 3, Phase 1 (planning) and Phase 2 (competitive bidding) play a central role in the risk management process of the tendering of regional maintenance contracts. During these phases, attention is paid to the specifications made in the maintenance planning process (see Figure 2), documents of the invitation to tender, tendering process, contract management, implementation, operating environment, quality, work methods, and environmental requirements. The objective is to make as comprehensive risk assessment as possible of the operational risks to be included in the tendering process of a regional maintenance contract.

Another important objective is to include the safety document based on the risk assessment in the tendering documentation. Safety risks are identified separately, see Figure 3.

4.2. Risk Assessment Method in Regional Maintenance Contracts

The project completed in 2009 aimed at creating a method, which could be used to assess risks of the regional maintenance contracts in a uniform manner in all maintenance regions. As a result, a risk assessment method was created based on a risk chart, risk matrix and risk management plan. [1]

4.2.1. Risk Chart

The risk chart lists key words, which help to identify risks in the regional maintenance contracts as part of the comprehensive risk management process. The risk chart covers extensively issues inherent in the maintenance of the road network and operations in order for the experts making risk assessments to take into account as extensively as possible all

risks connected to the regional maintenance contracts. The idea of the risk chart is not to give a direct answer to the question, which risks in a specific regional maintenance contract are the most significant. Its idea is to prompt thoughts on the risks of the regional maintenance contract being assessed, in other words to assist the person making the assessment to find the probable risks in the contract. [1]

The issues presented in the risk chart have been grouped into larger categories, which vary in the different phases of a regional contract (planning, tendering and implementation). The risk categories have been presented in the risk chart under sub-titles, which are further specified in the risk management plan.[2]

The following Table 1 presents the risk categories of the different phases.

Planning	Competitive bidding	Implementation
<ul style="list-style-type: none"> • cost control • operational policies • quality requirements and control • contract formulation • customer needs and subsequent changes in customer needs 	<ul style="list-style-type: none"> • preparation of tendering documents • sharing of risks and responsibilities • accuracy and relevance of baseline information • specific regulations concerning the contract • specifying quality • preparing a tender and procedures • eligibility of tenderers • acceptability of a tender 	<ul style="list-style-type: none"> • functionality of co-operation • quality control during implementation • responsibility during implementation • risks connected to employees • customer satisfaction • realisation of the safety plan • management of problems • environmental risks • risks connected to the end product

Table 1. Risk categories to be assessed in the different phases of a regional maintenance contract. [2]

The risk categories presented in the table are divided into sub-titles, which are always assessed according to the regional contract in question. A more detailed risk chart is in Appendix 1.

4.2.2. Risk Matrix

The risk matrix is used to describe the probability of the realisation of risks, their severity and measures to prevent or eliminate risks.

The likelihood of a risk materializing is classified into five stages (Table 2)

Frequency of Event	Incidence Rate
Very frequent	At least 10 times a year
Frequent	At least once a year
Occasional	At least once in 10 years, at least once during the implementation of a regional contract
Infrequent	At least once in 100 years, at least once during the implementation of a regional contract
Extremely infrequent	Less frequent than once in 100 years, and not at all during the implementation of a regional contract

Table 2. Classification of risk in accordance with probability of materialisation.[2]

The severity of risk consequences is also divided into five classes. In addition, the severity classes have been classified according to the type of damage, which is presented in Table 3.

Type of damage	Severity of Consequences				
	No consequences	Mild/minor	Severe/notable	Great	Extremely great
Personal injury	no consequences	minor injuries, sick leave less than 14 days	severe injuries, sick leave over 14 days	fatalities	several fatalities
Property damage or loss of business	no consequences	minor	notable	great	extremely great
Operational obstacle	no impact on schedules	hampers implementation, small claims	hampers implementation, large claims	delays implementation, large claims	several months' delay, extremely large claims
Environmental damage	no consequences	minor, easy to repair	notable damage, minor harm, can be repaired	great damage, notable and extensive harm, can be repaired	extremely great damage, long-lasting effects, difficult to repair
Financial loss	€ 0	€ 10 000	€ 100 000	€ 1 000 000	€ 10 000 000

Table3. Classification of risk severity according to type of damage. [2]

Actions to be taken to prevent or eliminate risks have been divided into four classes, which have been given a colour code to describe how important it is. The classes for actions are: immediate action (red), take action (yellow), monitoring required (dark green) and no action required (light green).

In combining the components of the probability of risk materialisation, risk severity and actions to be taken, it is possible to create a visual representation of the risks (Appendix 3). The combination of the probability of risk materialization and its severity can be used to describe a risk for example as follows: occurrence frequent and consequences from materialization significant. In such a case it would be classified as a moderate risk (Appendix 2).

4.2.3. *Risk Management Plan*

The risk management plan is a written document, which describes for example a risk, its consequence, classification, actions to be taken and responsible persons. The risk management plan can be a form, which is used to manage and monitor risks.

Risk assessment of a regional maintenance contract starts with the identification of safety risks (see Figure 3), which is made in co-operation with maintenance experts. With the help of the prepared risk charts, the adverse factors, i.e. dangers and damages, inherent in regional maintenance contracts are identified. The identified risks are presented in the management plan of safety risks (Appendix 3).

Risk assessment continues with the assessment of operational risks.

4.2.4. *Assessment of Operational Risks in the Planning Phase of Regional Contracts*

The risk assessment of the planning phase is primarily the task of the organisation's executive management, because the risks concerning regional maintenance contracts concern mainly the entire road management region.[1,2]

In some cases the risks concern all regional maintenance contracts in Finland, and then it is the Finnish Transport Agency which carries the responsibility for risks. Such risks can come up for example in connection to changes in operational policies.

These kinds of risks have to be already identified during the maintenance planning process, see Figure 2.

4.2.5. *Assessment of Operational Risks in the Tendering and Implementation Phases of Regional Contracts*

In the tendering and implementation phases (phases 2 and 3 in Figure 3) risk assessment is further specified to target a separate maintenance contract in the road network. At this point both operational and occupational safety risks of the regional contract are identified (Table 1). The objective is to include all identified risks in the appendices of the tendering documents of the regional maintenance contract, in other words inform the contractors of the risks already in the invitation to tender. [1]

Before the contract is signed, the winning contractor complements the risk management plan concerning occupational safety that the client has prepared.

In the regional contract of Nilsia opened to tender by the Centre for Economic Development, Transport and the Environment for North Savo the contractor is also informed of the so called operational risks, which the winning contractor will complement before the contract is signed. All risks (operational and occupational safety ones) will be monitored throughout the contract cycle (7 years).

5. EXPERIENCE FROM THE RISK ASSESSMENT METHOD

The area of responsibility of the Centre for Economic Development, Transport and the Environment for North Savo covers three regions: North Savo, South Savo and Northern IAZJOQKBSLQT

Karelia. The total length of the public road network of the area is 16 000 km, which constitutes 20 % of the national public road network. The amount of paved roads is 7 600 km and the remaining 7 400 km are unpaved gravel roads.

The road network is divided into 15 regional maintenance contracts, where the average length of road network to be maintained is 1 100 km. From 2 to 4 regional contracts are opened yearly for competitive bidding and their annual expenditure is € 1-2 million. The regional contracts are currently divided between three contractors so that the first contractor has 12 regional contracts, the second has two and the third has one.

In 2011 the Centre for Economic Development, Transport and the Environment for North Savo will open three regional maintenance contracts for competitive bidding. An occupational risk assessment, a risk management plan and a safety document, which is statutory in Finland, were prepared for each regional contract. [4,5]

The comprehensive risk assessment process (assessment of safety risks and occupational risks) was tested in only one regional contract, namely in the Nilsiä regional contract, whose duration is seven years (2010-2017). The total expenditure of the contract is estimated at € 15 million. The length of the contract road network is 1 100 km. The contractor is already informed of the identified risks at the tendering phase, and the contractor takes them into consideration when preparing the tender.

5.1. Carrying out Risk Assessment

5.1.1. *Assessment Team*

A team of six experts carried out the comprehensive risk assessment process of the Nilsiä regional contract. The group consisted of five maintenance experts of the Centre for Economic Development, Transport and the Environment for North Savo and one consultant, who was experienced in the risk assessment method and use.

Four of the maintenance experts are working as supervisors for the regional maintenance contracts and one of them will monitor the Nilsiä regional contract as the client's representative. One of the experts acts as the contact person for occupational safety, in other words she/he is specialized in occupational safety. One member of the group is responsible for all maintenance in the operational area of the Centre for Economic Development, Transport and the Environment for North Savo, in other words she/he represents the executive management and acts as the chief of the maintenance experts.

All members of the assessment team had previous experience of risk assessment, for example from occupational safety risks.

5.1.2. *Carrying out Assessment*

The comprehensive risk assessment process was kicked off in a meeting of the assessment team, where the operational method and number of meetings (4 pcs) were decided. A proposal for action for each identified risk was made, incidence rate and severity of the risk was determined, and a suggestion made on who is responsible for taking action (client or contractor).

The risk assessment was made with the help of risk charts. The risk charts have different assessment targets and assessment is made separately for each so called main level. In the assessment attention is paid on matters that have, or may have, impacts on the

contract in its planning, tendering or implementation phases. All members of the assessment team make an individual assessment of the probable risks, which are then combined into a joint assessment in the risk management plan.

The actual assessment work commenced by assessing occupational safety risks. Occupational safety risks have been assessed already in the previous years and consequently the method was familiar to all team members. The risk chart for occupational safety is different from that of operational risks, but the forms used for the risk matrix and risk management plan are the same (Appendices 2 and 3).

The following sub-areas with inherent risks are assessed from the occupational safety perspective [5]:

- operational environment (characteristics, nature and conditions of the regional contract)
- traffic (road, rail and waterways)
- dangerous works and working phases (for example fast and slowly moving works, excavations, working with heights, jobs with drowning risk, lifting loads)
- occupational health (harmful effects).

After the assessment of occupational safety risks, the team moved on to assess operational risks. The assessment work began by assessing *risks in the planning phase* (Figure 3, Phase 1) advancing from there to the risks in the tendering phase. The risk assessment of the tendering phase also started from the main level issues getting more specific at the lower levels. When making the assessment it became evident that at this point more attention than anticipated needs to be paid also on the risks of the implementation phase (Figure 3, Phase 3 *Implementation*).

5.1.3. Identified Risks

In the contract area 58 risks connected to **occupational safety** and 21 risks from the operational environment were identified. Risks connected to traffic were 10 pcs, seven of which were from roads, one from waterborne traffic, one from rail traffic and one from data communication. In dangerous works and working phases there were 27 identified risks, most of which (11 pcs) from moving works. Other works with inherent risks were excavations, working with heights, electrical installations, tasks with drowning risks and lifting works. Of these risks, the second biggest group was risks to the health of employees totalling 8 pcs.

In the operational environment of a regional contract, risks to road users come from working near schools and day-care centres. At these locations, machines cause danger to children and other people going to school. As a preventive measure, it was suggested that the regional contractor schedules carefully the start of works near schools and day-care centres, and increases training of the maintenance equipment drivers.

A total of 35 **operational risks** were identified (during the planning, tendering and implementation phase). The share of so called regional risks was 29, which need to be taken into account in the whole region and in all regional contracts. The remaining six risks concerned directly the Nilsjä regional contract, which was the specific assessment target.

There were five risks in the *planning phase*, of which three were considered to concern directly the regional contract in question. These risks were connected to customer (road

user) needs and the operational environment of the regional contract. There is a tourist centre in the area, and increasing traffic due to the expansion of its activities was considered as an example of a risk from the operational environment.

There were also five risks in the *tendering phase*, of which one concerned directly the regional contract in question. Contract negotiations before signing the contract were considered as a moderate risk. This risk results from ending the ongoing contract and changing the contractor, and to the condition and possible defects of the road network at the moment when it is taken over by the new contractor. If these risks materialize, they may cause extra costs to the client.

The risks in the *implementation phase* totalled 28 pcs, of which three concerned viability of co-operation during the contract cycle, five concerned quality assurance during the implementation phase, seven were related to responsibilities during work, two concerned contract employees, three customer satisfaction, three concerned different kinds of incidents during the project cycle and two risks concerned the environment. Two of the risks were considered to result from the regional contract in question. Although the remaining 26 risks were considered to have an impact on all regional contracts, they have to be taken into account also in the implementation of the contract in question.

5.2. Experience from Comprehensive Risk Management Method

The assessment team thought that the comprehensive risk management method is an interesting approach to regional maintenance contracts and the problems inherent in them. The method is considered to bring about advantages, but the risk chart, matrix and management plan now in use need to be further developed to be more compatible with the risk assessment of the regional maintenance contracts.

The currently tested method has been developed from the risk assessment of a construction project, and therefore the terminology is not fully applicable to regional maintenance contracts.

In regards to operational risks, the comprehensive risk assessment was regarded as challenging, because assessment is made from the perspective of different phases (planning, tendering and implementation). In the testing project it was noted that the risk assessment of the planning phase has to be made during the maintenance planning process (Figure 2). Then it is possible to deal with all the risks in the region and get closer to the actual regional contract in assessing the planning phase risks.

Assessment of safety risks was considered easier, because it is better known from earlier experience. Safety risk assessment has already been in use in the competitive bidding process for the 2009 regional contracts.

CONCLUSIONS

In Finland the public road network is 78 000 km and the Finnish Transport Agency is responsible for providing guidelines for its maintenance and construction. The annual expenditure for road maintenance is approximately € 450 million. Road network maintenance is implemented through regional contracts. Currently there are 82 regional contracts in Finland.

Since 2010 the Centres for Economic Development, Transport and the Environment have been responsible for road management planning and implementation. These regional authorities procure road maintenance services through opening 9-12 regional maintenance contracts annually to competitive bidding.

In 2009 the Finnish Transport Agency carried out a pilot project to develop a comprehensive risk assessment method for assessing the safety and operational risks in regional maintenance contracts. The method comprises a risk chart, a risk matrix and a risk management plan. Assessment of safety risks had been made already since 2009, when it became a statutory procedure in Finland.

In 2010 the Centre for Economic Development, Transport and the Environment for North Savo launched a continuing project, in which the developed method was tested in one Nilsjä regional contract opened for tendering in 2011. The duration of the regional contract being assessed is 7 years and it will start on October 1st 2011. The risks identified in testing the method are made available as baseline information in the tendering process, and contractors have to take them into account in their tenders.

The risk assessment in accordance with the developed method was made by a team of six experts, who all have extensive experience in road maintenance. The expert assessment of the method was positive, and a uniform risk assessment method was considered useful.

It was concluded that the risk charts (occupational safety and operational risks), risk matrix and risk management plan require further development. Improving the terminology of the assessment tools (tables) to better suit maintenance was considered the most important development target. Another development target is integrating the risk assessment of the planning phase into the maintenance planning process, which is presented in Figure 2.

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Appendix 1. Risk chart for operational risks.

PLANNING	COMPETITIVE BIDDING	IMPLEMENTATION
<p>Cost control</p> <ul style="list-style-type: none"> capital value of roads funding level cost estimate of contracts market situation seasonal variation and economic situation <p>Operational policies</p> <ul style="list-style-type: none"> feasibility of policies concreteness how well the policies are understood changes in policies whilst under contract standard of service i.e. winter maintenance level. <p>Quality requirements and control</p> <ul style="list-style-type: none"> quality demands definition feasibility of quality demands quality assurance road condition at end of contract (quality level) <p>Contract formulation</p> <ul style="list-style-type: none"> content of the contract form of the contract construction period contracts and scope of the contract contract documents (consistency, accuracy, and clarity) changes of the contract period pilot project under contract <p>Customer needs and subsequent changes in customer needs</p> <ul style="list-style-type: none"> special requirements of customers needs of local customers 	<p>Preparation of tendering documents</p> <ul style="list-style-type: none"> tender documents terms of agreement changes during construction period demands of quality plan special conditions of contract premium rating criteria sanction and bonus criteria agreements with third parties border areas with other contracts safety document <p>Sharing of risks and responsibilities</p> <ul style="list-style-type: none"> sharing and bearing risks price of risks legal responsibilities <p>Accuracy and relevance of baseline information</p> <ul style="list-style-type: none"> volume information road condition information special subjects in the contract equipment and devices works in contract area <p>Specific regulations concerning the contract</p> <ul style="list-style-type: none"> limited working methods subcontractors safety demands special works with public authority <p>Specifying quality</p> <ul style="list-style-type: none"> final product demands quality control, quality assessment and quality control quality reporting (summer and winter time etc.) <p>Preparing a tender and procedures</p> <ul style="list-style-type: none"> timetable for competitive bidding decision-making data systems cooperation in accounting period complaints procedure <p>Eligibility of tender</p> <ul style="list-style-type: none"> value of collateral financial position of contractor references of maintenance works <p>Acceptability of a tender</p> <ul style="list-style-type: none"> draft of quality plan (resources etc.) price of tender 	<p>Functionality of co-operation</p> <ul style="list-style-type: none"> differences between client's and contractor's understanding flow of information partnership confidence between client and contractor <p>Quality control during implementation</p> <ul style="list-style-type: none"> neglecting quality demands quality control quality reporting <p>Responsibility during implementation</p> <ul style="list-style-type: none"> neglecting of duties operation times quality control and self supervision of contractor damages of road capital values compensation for damages and damaging occurrences subcontractors and suppliers <p>Risks connected to employees</p> <ul style="list-style-type: none"> the loyalty of key people employees' resources employees' absences employees' competence <p>Customer satisfaction</p> <ul style="list-style-type: none"> customer guidance and communication special requirements of customers maintaining good image <p>Realisation of the safety plan</p> <ul style="list-style-type: none"> risks of work risks of traffic damages for third parties safety legislation and responsibilities follow-up of security and safety <p>Management of problems</p> <ul style="list-style-type: none"> preparation for emergency situations cooperation between client and contractor reporting of dangerous situations <p>Environmental risks</p> <ul style="list-style-type: none"> methods of work groundwater and surface water air quality chemicals and pollution waste (problematic waste) exceptional weather conditions <p>Risks connected to the end product</p> <ul style="list-style-type: none"> technical solutions new products and methods

Appendix 2.Risk matrix

X

Frequency of event	No consequences	Mild/minor	Severe/notable	Great	Extremely great
Very frequent	Minor	Moderate	Major	Intolerable	Intolerable
Frequent	Insignificant	Minor	Moderate	Major	Intolerable
Occasional	Insignificant	Minor	Moderate	Moderate	Major
Infrequent	Insignificant	Insignificant	Minor	Minor	Moderate
Extremely infrequent	Insignificant	Insignificant	Insignificant	Minor	Minor

Type of damage	Severity of Consequences				
	No consequences	Mild/minor	Severe/notable	Great	Extremely great
Personal injury	no consequences	minor injuries, sick leave less than 14 days	severe injuries, sick leave over 14 days	fatalities	several fatalities
Property damage or loss of business	no consequences	minor	notable	great	extremely great
Operational obstacle	no impact on schedules	hampers implementation, small claims	hampers implementation, large claims	delays implementation, large claims	several months' delay, extremely large claims
Environmental damage	no consequences	minor, easy to repair	notable damage, minor harm, can be repaired	great damage, notable and extensive harm, can be repaired	extremely great damage, long-lasting effects, difficult to repair
Financial loss	€ 0	€ 10 000	€ 100 000	€ 1 000 000	€ 10 000 000

Appendix 3. Risk Management Plan

RISK MANAGEMENT PLAN, SAFETY

PROJECT:
 PARTICIPANTS:
 DATE:



> Requires immediate action

N:o	HAZARD/PROBLEM/ DISTURBANCE	DICTION OF HAZARDOUS SITUATION	Prob-ability	Severity	Procedure class	PREPATATION / SUGGESTED PROCEDURE/FOLLOW-UP	Person in charge	Date
1.1.	Properties of construction project							
1.2.	Nature of construction project							
1.3.	Circumstances of construction project							
2.1.	Road traffic							
2.2.	Rail Traffic							
2.3.	Waterborne traffic							
2.4.	Air traffic							
2.5.	Telecommunications							