

## RISKS ASSESSMENT IN FOREST ROADS DESIGN

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**Abstract:** *This paper presents the importance of risk management implementation for design process of the forest roads. The management of risks is a central issue in the planning and management of any venture. It involves processes, tools, and techniques that will help the project manager maximize the probability and consequences of positive events and minimize the probability and consequences of adverse events. The case study focuses on quantitative and qualitative risks assessment, starting from detailing the horizontal, vertical and transversal phases of design process of forest roads. After the implementation of corrective actions it can see a significant reduction of the risks from the major field to the acceptable risk zone.*

**Key words:** *risk management, forest roads design, risk assessment, implementation.*

### 1. Introduction

The risks represent uncertain events or situations that potentially can adversely affect a project as planned, usually in terms of cost, schedule, and/or product quality.

Risk is characterized by three important elements [1], [2]:

- event;
- likelihood of occurrence of the event;
- severity or event impact.

Risks are classified according to their probability of occurrence and degree of severity, thus being performed an assessment of acceptance of each risk:

- minor risks that can be accepted or ignored;
- medium (moderate) risks with a medium probability of occurrence and a

moderate impact on the project should be considered;

- major risks with a high probability of occurrence and a high impact, which will require significant levels of analysis.

Forest roads are necessary to provide access to the forest for general management, maintenance, timber extraction and recreation. Apart from initial establishment, roads represent the single greatest capital investment by the owner. There is a need not only to provide a cost efficient road design and layout suitable for extraction but also to ensure that the forest road is compatible with environmental values. Forest roads are not just for timber extraction. Their role is much more multifunctional than merely

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carrying loads of timber. When adequately designed and constructed, forest roads can enhance biodiversity, give access for better and timelier inspection and management, allow access for the fighting of forest fires and act as a fire break, and, subject to landowner approval, give access to the public to enjoy the many and varied recreational uses presented by forests [3].

Forest roads are a vital infrastructure for ongoing forest management. Most forest roads are primarily industrial roads but many are also a public benefit by providing access for recreation activities, to utilities and facilities (e.g., communications towers, weather stations, research and monitoring sites), and to remote communities or rural residences [6].

## 2. Risks Management in Forest Roads Design

Risk management in forest road design aims at providing an efficient and effective management regarding risks and opportunities associated with enabling planning, identification, assessment, quantification, response, monitoring and control of potential risks.

Risk management processes consist of the following stages:

- Risk management planning;
- Risks identification;
- Qualitative analysis of risks;
- Quantitative analysis of risks;
- Planning of risks response;
- Monitoring and control of risks.

This process is continuously performed throughout the duration of the project life cycle.

Risks classification in qualitative terms, relative to the likelihood and impact is usually in five classes.

The assessment process of the likelihood of the risk occurrence means to determine the risk probability index (table 1) [2].

Table 1  
*Qualitative assessment of risk likelihood*

Assessment	Probability index	Event probability
Very high	5	80% - 99%
High	4	60% - 79%
Moderate	3	40% - 59%
Low	2	20% - 39%
Very low	1	1% - 19%

The determination of risk score is based on the risk matrix presented in table 2 [5].

*Risks matrix* Table 2

Likelihood					
0.90	0.05	0.09	0.18	0.36	0.72
0.70	0.04	0.07	0.14	0.28	0.56
0.50	0.03	0.05	0.10	0.20	0.40
0.30	0.02	0.03	0.06	0.12	0.24
0.10	0.01	0.01	0.02	0.04	0.08
	0.05	0.10	0.20	0.40	0.80
Impact					

## 3. Risks Assessment for Design Process of Forest Roads - Case Study

In the design process of forest roads, there can be considered the following risk categories presented in figure 1 and figure 2, respectively associated activities.

There were identified the risk categories for the following stages of design process of forest roads:

- horizontal design;
- vertical design;
- transverse plane design;
- earthworks design
- design of protection / consolidation works;
- superstructure design.

The score of major risks associated to the design activities of forest roads are presented in table 3.

Vertical and horizontal alignment, sight distance and travel speeds may be constrained by terrain conditions [4].

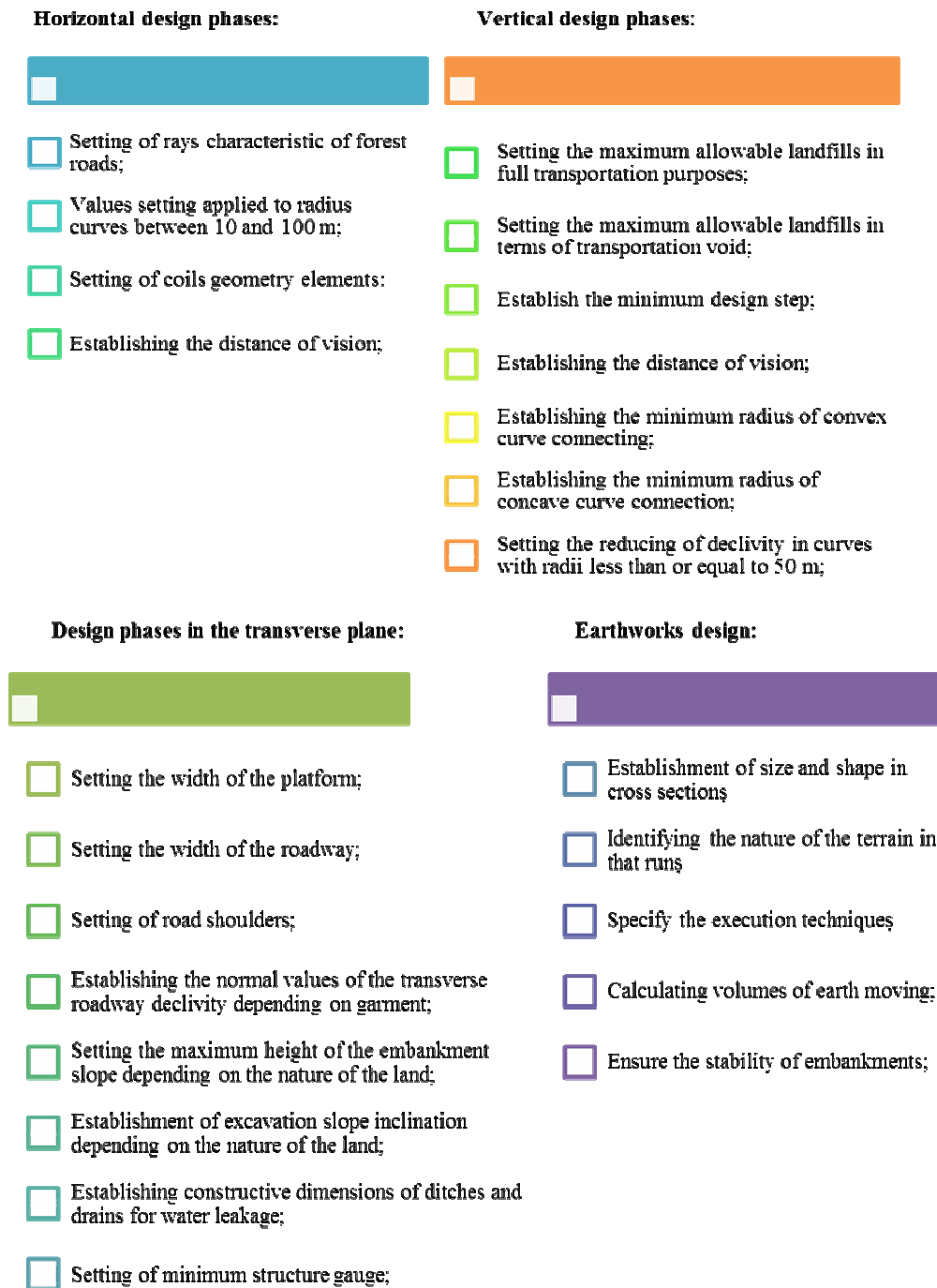


Fig. 1. *The horizontal, vertical and transverse design of forest roads*

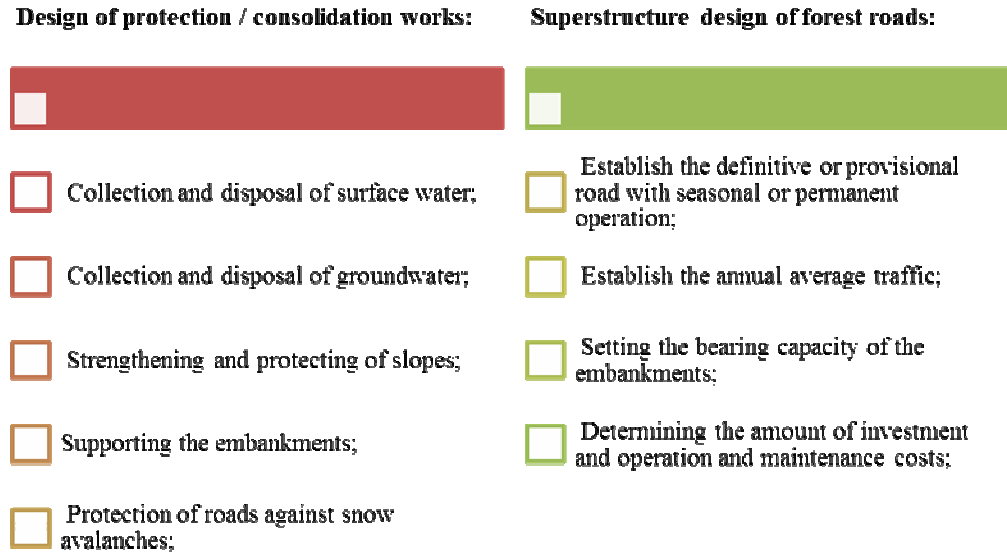
Fig. 2. *The design process steps of forest roads**The score of identified major risks*

Table 3

<b>Codification</b>	<b>Identified risks</b>	<b>Risk score</b>
R 2.1	• Compliance with topographic configuration of the land; • For the plain land route works it will follow the guide line; • For rough terrain it will follow the development of slopes not exceeding the maximum permissible value.	<b>0.16</b>
R 2.2		<b>0.225</b>
R 2.3		<b>0.18</b>
R 6.2	• Enlargement value depending on design speed.	<b>0.17</b>
R 7.1	• Minimum radius of principal curve; • Minimum radius of auxiliary curve.	<b>0.16</b>
R 7.3		<b>0.16</b>
R 10.1	• Radius of curves; • The number of percentage points that reduce the maximum allowable slope.	<b>0.16</b>
R 10.2		<b>0.15</b>
R 17.1	• Inappropriate choice of profile grooves according to established flow calculation; • Compliance with discharge coefficient c.	<b>0.24</b>
R 17.2		<b>0.18</b>
R 20.1	• Collection and disposal of surface water; • Collection and disposal of groundwater.	<b>0.16</b>
R 20.2		<b>0.16</b>
R 21.3	• Establishing the bearing capacity of embankments;	<b>0.2</b>
R 22.1	• The adequate advice for design process of forest road is not obtained .	<b>0.475</b>

Where alignment, road width or sight distance are reduced from the intended design standard, additional safety measures may be needed.

#### 4. Conclusions

Design criteria should be selected that will result in acceptable performance for the intended use. It is often necessary to balance objectives. The design documents should clearly describe the expected performance of the various road sections, as part of risk management objectives, and should describe any measures needed to address worker or user safety in consideration of the expected performance, for example, raveling cut-slopes [4].

The presented case study illustrates how the methodology was used as a tool for management of the risks.

The result of the qualitative risk analysis specific to design process of forest road consists of a general classification of risks:

high risk, moderate risk and low risk. This classification is done for each objective: time, cost, scope.

First, there needs to be considered the risks with high impact or high probability and for each risk to reduce the likelihood of occurrence or impact, or both.

For each risk, there can be identified the countermeasures that can be used and their costs. They must be specified precisely and in detail, depending on their complexity.

Analyzing the risk management plan will act on major risks (risks that have scores greater than 0.14), identifying improvement measures to minimize or eliminate them.

After the implementation of corrective actions the distribution of risks is presented in figure 3.

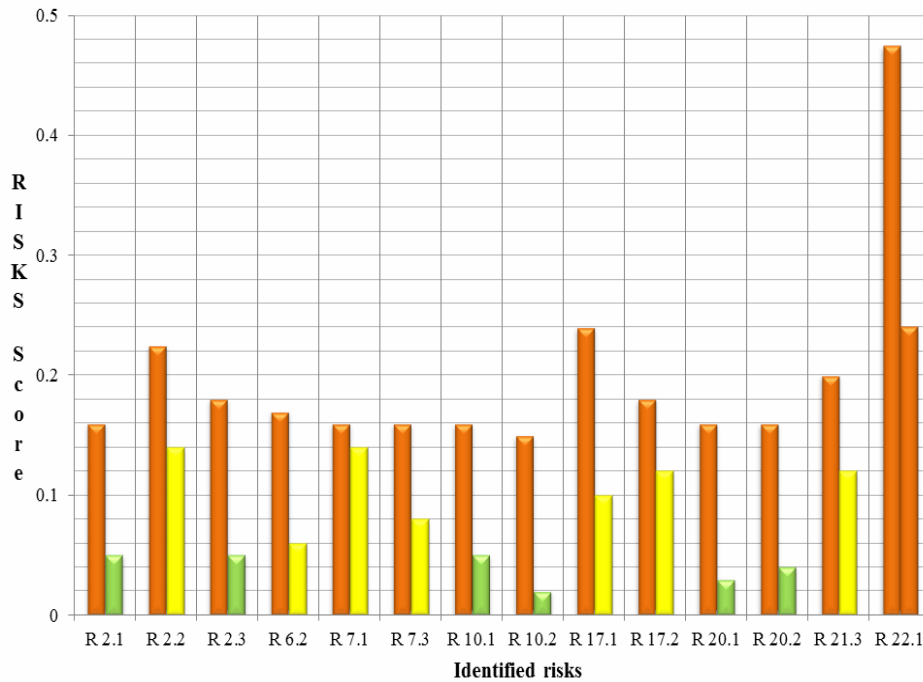


Fig. 3. *Distribution of risks*

Also, all identified risks are monitored throughout the design process of forest

roads, achieving a checklist so that their monitoring is optimal. After application of

measures for improvement (corrective / preventive actions), the risks should lie in the low zone. Thus, there has resulted one high risk, seven medium risks and six low risks. There can be noticed a significant reduction of the risks from the major field to the acceptable risk zone.

Survey information is an essential input to road design, whether the road design is done manually or assisted by computer applications. Examples of design parameters include [4]:

- cut and fill slope angles or material properties and depths from which the software selects pre-programmed design parameters;
- maximum vertical and horizontal curvature;
- maximum grade;
- road width;
- turnout spacing.

New and upgraded roads should be designed to [4]:

- comply with the standards set out later in this chapter;
- accommodate the anticipated frequency, type and speed of traffic;
- considering awareness of soil and sub-grade conditions;
- provide for road drainage and water quality requirements; and
- incorporate landscape and environmental values.

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