RISK ASSESSMENT OF A RAILWAY INFRASTRUCTURE PROJECT

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ABSTRACT

The paper presents the methodology for risk assessment of a railway infrastructure project in the phase' of design and construction. The factors which impact over the level of risk are defined. The levels of risk are rated with one integrated indicator. For each variant of realization of the project the value of the integrated indicator for risk are calculated and the one with minimum value is chosen. After this, the measures for prevention and mitigation of the impacts of the risks are presented and finally the methodology is applied for a real project.

Key words:
Risk, risk management, risk assessment, project management, railway infrastructure.

1 INTRODUCTION

Risk analysis is made for the project "Modernization of the railway line Radomir - Kulata" [1]. The project provides eight different variants for construction. The main risks are identified, probability for their occurrence and their impact on the realization of the project variants are also identified. An integral criterion is defined for risk assessment, based on which all the proposed variants for development are compared and the one with minimal risk is selected.

2 METHODOLOGY FOR RISK ASSESSMENT

The risk assessment consists of two components, which are evaluated. One component is a quantitative assessment of the probability of occurrence of risk. The other component assesses the possible consequences of risk. Assessment of the occurrence (B), with which a negative event can actually occur is determined on a scale with numbers from 1 to 5, where 1 is estimated as an event, unlikely to occur,

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and 5 as an event likely to occur. These figures include a simplified and reported incidence of various adverse events.

Estimates of the possible consequences of risk are presented Table 1.

Table 1 Assessments of the possible consequences of the occurrence of certain risk

C – Possible consequences of risk	
Very low level of negative impact	0 ÷ 2
Low negative impact	3 ÷ 4
Average level of negative impact	5 ÷ 6
High level of negative impact	7 ÷ 8
Very high level of negative impact	9 ÷ 10

The ultimate cost of a risk (Table 2) is determined by multiplying the assessment of the occurrence of the negative event and the evaluation of the possible consequences of risk: P = B * C, where: P - final value of the risk assessment; B - probability of occurrence of risk and C - possible consequences of risk.

Table 2 Final risk values

P – Final value of risk		
P1	Very low level of risk	P <= 10
P2	Low level of risk	10 < P <= 20
P3	Moderate level of risk	20 < P <= 30
P4	High level of risk	30 < P <= 40
P5	Very high level pf risk	P > 40

The integral value of risk assessment is defined as follows:

$$P_{\text{var}iant} = \sum_{i=1}^{n} W_i.P_i, \quad \text{where:} \qquad (1)$$

n – Number of the reviewed and analyzed risks; W_i – Weight of each of the analyzed risks i, as a W_i is amended by 0 to 1; P_i – final value of the risk assessment i defined above.

3 IDENTIFICATION OF RISKS

The project is analyzed and the risks are identified, arranged and structured in the following groups: political; economic; related to meeting the requirements of the Contracting party and the quality of the final product; relating to the smooth interaction between the actors involved in the project implementation; related to the effective work of the consultant in the project management; related to coordination with the competent authorities and institutions; related to the financing of the project; regarding the duration of the project and other risks. The above are presented in the Table. 3.

Table 3 Type and structure of risks

№	**Type and structure of risks**
1	Political risk
2	Economic risks
	Risks related to meeting the requirements of the Employer and the quality of the final product
3	*Spatial planning legal restrictions and risks related with this - expropriation of lands*
4	*Spatial planning legal restrictions and risks related with this – further expropriation of lands*
5	*Limitations of the plans of the local authorities and associated risks*
6	*National and local development plans and the associated risks*
7	*Environmental constraints and the related risks*
8	*Technical construction constraints and related risks*
9	*Operating restrictions and associated risks*
10	*Restrictions related to achieving interoperability of the national rail system with the trans-European rail system and the associated risks*
	Risks associated with the effective work of the consultant in project management
11	*Disagreements in the work of the Consultant*
12	*Risks in working with subcontractors*
13	*Inadequate organization of work*
14	*Risk associated with the workforce*
	Risks associated with the smooth interaction between the participants in the project
15	*Unavailability of the necessary basic information needed for the design and implementation of the project*
	Risks related to coordination with the competent authorities and institutions
16	*Failure to comply with legal deadlines for the coordination and approval of projects by the authorities of the state administration*
17	*Cooperation with the railway infrastructure manager ("NRIC") in the implementation of the project*
18	*Risk of other interface sides*
19	Risks related to project financing
	Risks associated with the duration of the project
20	*Delay in implementation of the work program*
21	*Failure to comply the deadline*
	Other risks
22	*Risk of changes in legislation*
23	*Normative risks*
24	*Financial Risks*

In order to determine the probability of occurrence of risk and risk assessment of a particular category certain parameters of the project are of big importance. They are presented in Table 4.

Table 4 Project parameters which are of importance in determining the risk assessment

Variants	Funds for the expropriation of land (€)	Corrective measures for environment (€)	Complexity of construction-facilities: bridges, tunnels (€)	Investments (years)	Reinvestments (years)	Costs for construction of railway infrastructure (€)	Total cost of the project (€)
Variant A	15 011 026	30 716 823	372 400 137	8	3	231 380 732	886 093 680
Variant B	8 362 070	35 420 719	429 205 131	8	3	207 675 963	926 920 148
Variant C	19 242 449	21 715 548	335 465 419	8	3	223 603 574	826 928 012
Variant D	14 856 016	21 288 192	357 195 985	8	3	215 010 830	844 872 093
Variant E	14 630 632	29 551 113	358 943 186	8	3	220 204 282	849 549 484
Variant F	8 287 650	25 006 058	384 979 206	8	3	207 810 719	864 673 715

4 RISK ASSESSMENT BY CATEGORY AND VARIANTS

Political risk. The political situation is stable. There is political willingness for implementation of infrastructure projects. These risks are low.

Economic risks. The effects of the economic crisis are still felt and it is likely that the economic activity is still low. There is a risk that the latter can have a negative impact on the project by late payments and extend the deadline.

Expropriation of lands and further expropriation of lands.

The issue of expropriation of land and further expropriation of lands for the realization of future construction is extremely important and its incorrect solution can lead to bet on unrealistic deadlines for implementation of future construction prepared by the Consultant in the tender documents. Expropriation of land and additional land expropriation matter the extent of building a new track in each of the variants. This can be judged by the financing for that purpose.

Measures to reduce the risk are related to the government of the Republic of Bulgaria to determine the project as a "National infrastructure projects". This will ease the procedure of expropriation of land.

Limitations of the plans of the local authorities and associated risks. These are the plans of the local authorities in the area of the project that are in progress or are being developed.

Measures to reduce the risk. The realization of the railway line Radomir - Kulata must comply with the plans for urban development of Radomir, Dupnitsa, Blagoevgrad, Sandanski, General Todorov and Kulata.

Environmental constraints and related risks. The environmental constraints are some of the most serious for large infrastructure projects. For the level of risk it is essential that the degree of construction of a new track in each of the variants is considered and the corrective measures for the environment are provided. The latter caan be judged by the resources for this purpose and means of expropriation of land.

Measures to reduce the risk. The main measures to reduce this risk are related to compliance with the Law on Environmental Protection, Biodiversity Act, the Protected Areas Act, the Clean Air Act, the Water Act, the Waste Management Act and the Protection of noise.

Technical construction constraints and risks related with this. The technical construction constraints are most important for large infrastructure projects. For this risk can be judged by the complexity of the construction, which is assessed by estimated costs for the facilities on the railway line: bridges and tunnels. The increase in the complexity of the construction leads to increased project costs, extension of time for completion, and the lack of skilled labor and road machinery.

Measures to reduce these risks. Compliance with the conditions and procedures for the design and construction of railway lines, railway stations and other sites and facilities of railway infrastructure that guarantees compatibility with the infrastructure of the trans-European rail system, the requirements of the technical specifications for interoperability (TSI) and AGC standards and AGTC international corridors.

Operating restrictions and risks associated with this. Operational restrictions are important in defining the requirements for the contractor in the tender documents for the selection of the contractor. The risks are associated with the violation of operational activity of the railway line during construction. The consequences of the occurrence of this type of risk will negatively impact the rail carriers and will offer a poor transport service. Relevant to the assessment of these risks are the periods of the investments and the reinvestments.

Measures to reduce the risk. The design must take into account that in the tender documents for the selection of contractor the requirements related to ensuring the proper operation of the railway line under construction should be included.

Restrictions related to achieving interoperability of the national rail system with the trans-European rail system and the risks associated with this.

Restrictions related to achieving interoperability are very important and represent a very high risk.

Measures to reduce the risk. In developing the proposals for preparation of a tender strategy for further design and award of future works, the legal regulations of the EU, national legislation, the TSI and national technical rules adopted when no TSI must be taken into account.

Disagreements in the work of the Consultant, risks in working with subcontractors, inadequate organization of work and risk in the workforce.

Measures to reduce the risk. Peaceful settlement of disputes through communication on a professional level. Ensuring better coordination between the subcontractors and the main contractor. Improving the organization and control of work, especially among the executives responsible for the working stages. The risk in hiring and use of labor can be eliminated by selection of qualified, responsible enough and disciplined employees.

Unavailability of the necessary basic information needed for the design and implementation of the project.

Measures to reduce the risk. Parties responsible for providing and submitting the required information have to be called promptly to provide it.

Failure to comply with legal deadlines for the coordination and approval of projects by the authorities of the state administration.

Measures to reduce the risk. The management Consultant of the project should make the necessary legal coordination procedures with the external institutions and organizations on the Contracting authority.

Cooperation with the railway infrastructure manager ("NRIC") in the implementation of the project and the with the other interface sides (state institutions, local authorities, ministries and others**) in the development of the conceptual design.**

Risks related to project financing. The risks related to the financing of the project depends primarily on the total project cost. The total project cost of each variant is different.

Measures to reduce the risk. Proper development of the project budget and providing of own funds for unforeseen financing.

Delay in implementation of the work program and violation of the deadline. Failure to meet deadlines can lead to additional costs and extension of the period for the implementing the project

Measures to reduce the risk. Speeding up the work to catch up eith the deadlines, maintaining quality, and the exercising permanent control over the progress of tasks and meet the deadlines.

Risk of changes in legislation. More in the preparation of tender documents is enshrined rule that during the entire period of construction is valid legislation in force at the time of signing the contract.

Normative risks. There is a risk that during the project implementation can be adopted legislation that will lead to design changes.

Measures to reduce the risk. Timely acquaintance with new legislation and the establishing of his impact on the project.

Financial Risks. The financial risks are associated with non-compliance with payment deadlines in contracts related to the project. This can lead to the insolvency of the contractors and the delay in terms of implementation.

Measures to reduce the risk. The parties concerned to resolve the problems that have financial nature through mutual cooperation.

5 IDENTIFICATION OF RISK FOR EACH VARIANTS

To determine the integral indicator of risk each of the analyzed risks has weight. The weights are represented in Figure 1. They are presented on each radial axis, numbered in accordance with the risks of Table 3, proportionally are presented their respective weights.

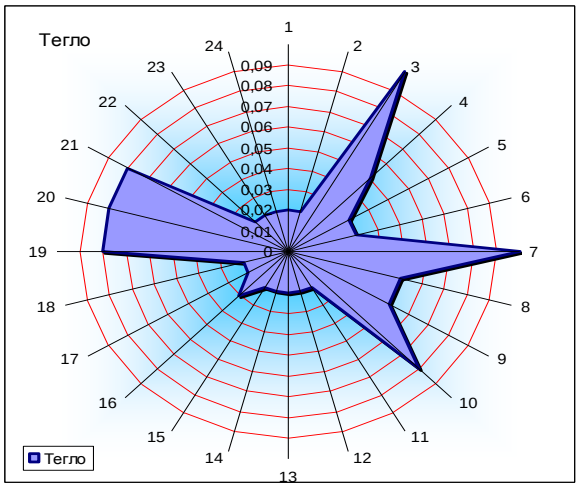

Figure 1 Weights of the analyzed risks

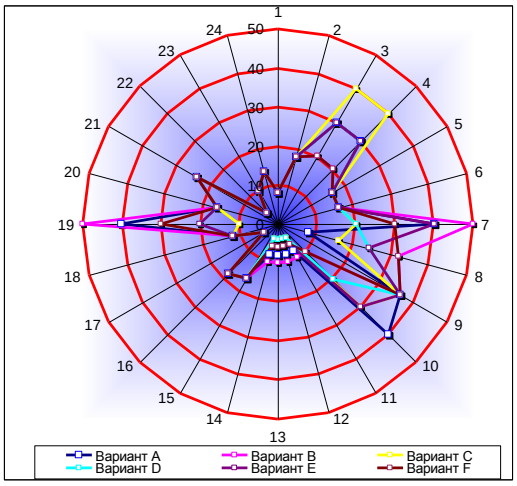

Figure 2 Values of the analyzed risks for all variants

In Figure 2 the values calculated for each of the analyzed risks for all variants are shown. Concentric circles determine relevant levels of risk. From the center of the diagram to the first concentric circle the level of risk is P1 (very low risk), from the first to the second concentric circle the values of the risks that meet the level P2 are presented (low risk), etc.The numbers of radial axes correspond to the risks described in Table 3.

The values of the integral indicator of risk for each option, calculated according to the methodology presented in section 2, is shown in Table 5. The greater integral indicator means greater value risk in the implementation of the version of the project.

Table 5 Values of the integral indicator of risk

	Variant A	**Variant B**	**Variant C**	**Variant D**	**Variant E**	**Variant F**
Political risk	0,160	0,160	0,160	0,160	0,160	0,160
Economic risks	0,360	0,360	0,360	0,360	0,360	0,360
Risks related to meeting the requirements of the Employer and the quality of the final product	14,860	13,160	13,960	12,060	14,860	11,160
Risks associated with the effective work of the consultant in project management	0,640	0,800	0,320	0,320	0,480	0,480
Risks associated with the smooth interaction between the participants in the project	0,320	0,320	0,320	0,320	0,320	0,320
Risks related to coordination with the competent authorities and institutions	0,860	0,860	0,860	0,860	0,860	0,860
Risks related to project financing	3,200	4,000	0,800	1,600	1,600	2,400
Risks associated with the duration of the project	3,200	3,200	3,200	3,200	3,200	3,200
Other risks	0,560	0,560	0,560	0,560	0,560	0,560
Total integral indicator of risk	**24,160**	**23,420**	**20,540**	**19,440**	**22,400**	**19,500**

CONCLUSION

The variant with the lowest risk is Variant D. The next option with the lowest risk is Variant F. In terms of risk most suitable for implementation are Variants D and F (Table 5 and Figure 3).

REFERENCES

[1] Project: "Technical assistance for modernization of railways RADOMIR – KULATA", TEN–T.

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Článok recenzovali dvaja nezávislí recenzenti.