

RISK PRIORITIZATION AND TECHNICAL-ECONOMIC JUSTIFICATION FOR THE MODERNIZATION OF UNGUARDED RAILWAY LEVEL CROSSINGS IN ANDIJAN REGION

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Abstract: The paper addresses traffic safety at unguarded railway level crossings in Andijan region in view of the launch of the China-Kyrgyzstan-Uzbekistan railway. A risk exposure index was calculated for six railway sections based on traffic flow and accident statistics for 2024-2026, and the sections were ranked by priority. Automatic barrier, UZP (crossing barrier device) and bollard system options were compared under three scenarios in terms of capital cost, payback period and 10-year net result. The Andijan 1-Jalal-Abad section was found to account for 45% of total exposure; in the base scenario, UZP pays back in 2.4 years, the automatic barrier in 2.9 years and the bollard system in 5.7 years. A three-stage modernization programme for the 21 unguarded crossings is proposed.

Keywords: railway level crossing, unguarded crossing, traffic safety, risk exposure, automatic barrier, UZP, payback period, China-Kyrgyzstan-Uzbekistan railway

Introduction. The China-Kyrgyzstan-Uzbekistan railway enters the country through Andijan region; freight volumes are expected to reach 5-8 million tonnes per year at the initial stage and 13-15 million tonnes in the long term (up to 20 million tonnes in the double-track option) [1, 2]. This increases the load on at-grade railway level crossings. Of the 51 crossings in the region, 21 are unguarded; of the 16 accidents recorded between 2024 and 1 May 2026, 5 were fatal, and 72% occurred at such crossings [3]. The aim of the study is to prioritize railway sections by risk exposure and to assess the economic efficiency of alternative protection devices.

Materials and methods. Daily traffic flow, crossing types and accident statistics (Kokand Regional Railway Junction, Ministry of Internal Affairs) were analysed for 6 railway sections [3]. The exposure index $I_j = U_j \cdot (F_j / N_j)$ was calculated (U - number of unguarded crossings, F - section traffic flow, N - number of crossings; traffic flow was assumed to be evenly distributed among crossings). The corridor load was estimated for a conventional freight train mass of 3 500 t. For the automatic barrier, UZP (crossing barrier device) and bollard system, the capital cost K, annual operating cost and payback period $PP = K / (B - E)$ were calculated under three scenarios, assuming an accident reduction of 70-83% [4] and a loss per accident of UZS 300 million (range 150-450). As the crossings are unattended, savings on staff wages were not included in the benefits.

Results. The Andijan 1-Jalal-Abad section has the highest priority: its index accounts for 45% of total exposure (Table 1). On the Andijan 2-Pakhtaabad section, freight traffic accounts for 40.1% of the flow. If the corridor carries 5-20 million tonnes per year, an additional 8-31 train movements per day are expected. The capital cost of equipping the 21 crossings is UZS 2 016 million for automatic barriers, 1 743 million for UZP and 3 591 million for bollards. In the base scenario ($r = 83\%$), the payback periods are 2.9, 2.4 and 5.7 years respectively, and the 10-year net result is UZS 4 996, 5 395 and 2 760 million. With a loss estimate of UZS 150 million, none of the options pays back within 10 years.

Table 1.

Risk exposure index by railway section

Section	Unguarded crossings	Index I
Andijan 1-Jalal-Abad	6	66 972
Andijan 2-Pakhtaabad	3	20 265
Margilan-Andijan 1	1	19 991
Uchkurgan-Post 331 km	3	18 572
Asaka-Shakhrikhan	7	16 144
Savay-Khanabad	1	6 939

Discussion and conclusion. Risk is distributed very unevenly across the sections; it is therefore recommended to carry out modernization in stages, with seven crossings per stage: Stage 1 (1-2 years) - Andijan 1-Jalal-Abad and Margilan-Andijan 1; Stage 2 (3-5 years) - Andijan 2-Pakhtaabad, Uchkurgan-Post 331 km and Savay-Khanabad; Stage 3 (5-10 years) - Asaka-Shakhrikhan and connection of all crossings to a unified monitoring system. Since UZP and bollards complement rather than replace automatic barriers, further research should compare the “barrier + UZP” and “barrier + bollard” combinations. The results are sensitive to the small accident sample (16 cases), to section-level traffic flow and to the loss estimate; they should be refined using crossing-level traffic counts and train movement data.

References

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