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A General Model for Railway Systems Risk Assessment with the Use of Railway Accident Scenarios Analysis

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Abstract

The paper shows the developing process of the railway system risk assessment models and the indication of their applicability to the Slovakian railways. The risk assessment models are based on the accident scenarios. Various hazardous events, which have the potential to lead directly to casualties, were defined by gathering various accident reports and having workshops with railway safety experts. The developed models will be used to assess the accident risk of the Slovak railway system. The frequency of each hazardous event was evaluated from the historical accident data and structured expert judgments by using the FTA technique, ETA technique and other safety techniques were applied.

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1. Introduction

The Slovakian railway area has undergone rapid changes such as structural reform and interoperability conditions in common railway system in European Union. In order to manage increased hazard factors, *Directive (EU) 2016/798 on railway safety* [1] focused on the risk-based safety management. According to previous *Directive (EU)*

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2004/49/EC on safety on the Community's railways, railway operators and infrastructure managers should get the government's approval for their safety management plans, which are prepared by the risk assessment results.

In this reason, since 2007, Slovakian railway and national research institutions started to develop the common hazard analysis and risk assessment models for the railway systems in Slovakia. This paper introduces the developing process of these models and the description of their application possibilities to the Slovak railways conditions. The proposed risk assessment model is based on the accident scenarios. The accident scenarios were set up by gathering various accident reports and having several workshops with railway safety experts. According to the accident classification of national *Railway Accident Regulation* [3], the scenarios were divided into the five main areas: train collision, train derailment, train fire, level crossing and railway (traffic/safety) casualty accident. In each area, various hazardous events which have the potential to lead directly to casualties, were defined. Then, for each hazardous event, the railway accident appearance scenarios and railway accident progress scenarios were developed.

2. The theoretical background of developed risk assessment procedure

To develop the Slovak railway risk assessment models, various risk management procedures were reviewed such as ISO/IEC Guide 51 [4] and the risk management procedure applied to this study was developed. It is similar to the common approach risk management [5, 6] suggested in EU. The scheme on Fig. 1 shows three dimensions: a railway system, the life cycle of this system and the process of risk management.

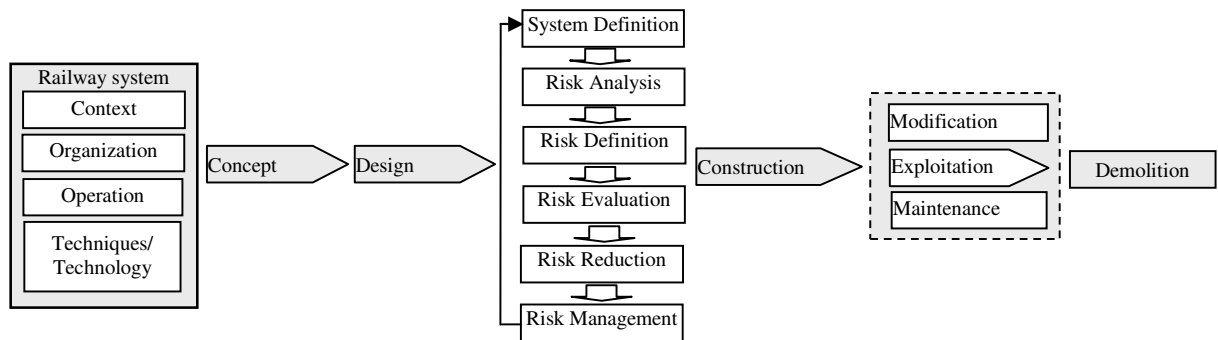


Fig. 1. Common Approach Risk Management.

Although unwanted events occur during the construction and exploitation phase, it is most helpful to take into account the whole lifecycle of a railway. Therefore, the risk management must start from the system design phase considering both – the normal mode and the degrade mode for this system [7]. Then, the results of the risk management in the system for design phase are transmitted to the involved organization of the construction phase and the similar approach is applied to the next stage as loop. The national railway risk management system architecture [8] will be utilized for the construction of a nation-wide railway risk management program and the execution of safety regulations [9, 10]. The hazard analysis and risk assessment procedure presents Fig. 2.

The hazard identification of railway accidents had been carried out by gathering various accident reports and information and having several workshops with railway safety experts. The railway accident scenarios are consisted of railway accident appearance scenarios and railway accident progress scenarios. Both scenario groups are divided by initiating hazardous events. Here, a hazardous event means one that has the potential to lead directly to death or injury. The railway accident appearance scenarios refer to the occurrence processes of accidents before hazardous events. These scenarios provide the base of FTA model structure for frequency evaluation on railway accidents. The railway accident progress scenarios mean the progress processes of accidents after hazardous events and they provide the base of ETA model for severity evaluation on railway accidents [11]. The railway accident appearance scenarios provide the base of accident causal analysis models for the frequency evaluation. The railway accident progress scenarios provide the base of accident consequence analysis models for the severity evaluation and developed models will be applied to assessing the accident risk of the Slovakian railway.

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