The Analysis of Available Open Data in the EU for Increasing the Safety of Railway Level Crossings

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INTRODUCTION

One of the main focuses in traffic technology and research area refers to increasing the safety in transport network. In this context, the highlight is on places where traffic flows and different modes of transport are integrated: intersections, pedestrian crossings, level crossings, etc. Although accidents at level crossings do not occur so often, their consequences are much more severe compared to other road accidents, on personal, social, and financial level. Due to the physical "conflict" between road users and railway infrastructure, trains and train operations, level crossings represent one of the most complex traffic safety systems. Accidents on railways mainly occur due to the irresponsible behaviour of drivers and pedestrians, whether it is illegal movements on the railway, or non-compliance with traffic regulations and signalling at level crossings, therefore it is necessary to devise a solution that will reliably influence their behaviour (Tey, Ferreira, & Wallace, 2011). The goal of this research is to analyse available open data from the traffic system that can be used to create a solution that will reliably warn all road users of an approaching train. Such a solution would be based on historical data on critical points, i.e., crossings that have a history of traffic accidents (and can be classified as "black spots"), as well as real-time data on the position of road vehicles and especially trains. A solution based on historical data is applicable to all registered level crossings for which there is available data, while, in addition, real-time data on train movement would increase reliability and could also be applied at unregistered level crossings and in case of illegal movement on the railway.

SAFETY AT LEVEL CROSSINGS

The safety solutions that are commonly used today at level crossings refer to infrastructural interventions that change the level of the road or pedestrian crossing, or to signal warnings at level crossings. There are two types of signalling: passive and active. Passive signalling includes road traffic signs (crossbucks) and crossing fences, while active signalling refers to light and sound signals and barriers that activate in the event of an oncoming train. Passive signalling is a simple and the least expensive solution, but it is far more susceptible to human disobedience than active signalling. On the other hand, even within active signalling, there is much room for improvement. The most widespread system of active signalling is based on a sensor device placed at a certain distance from the level crossing, which register the arrival of a train and sends information to signal-sound devices placed at the level crossing. In principle, this system is a valid solution, but considering the human factor, the possibility of technical failure, and the financial profitability of installing such a system at every level crossing, it is necessary to resort to simpler and more reliable solutions within the framework of Intelligent Transport Systems and widely available technologies of today.

LITERATURE REVIEW – CURRENT RESEARCH

Today, numerous studies are being conducted on increasing safety at railway and road crossings. Most of these authors deal with the improvement of existing technical solutions for train detection (Khoudour, Ghazel, Boukour, Heddebaut , & El-Koursi, 2009), a more effective way of broadcasting warnings that leads to a reduction in speed (Tey, Wallis, Cloete, & Ferreira, 2013), a more reliable transmission of information between the trains and the infrastructure (Cañete , et al., 2015), warnings to the train driver about obstacles on the track (Wisultschew, Mujica, Lanza-Gutierrez, & Portilla, 2021), etc. Although these studies produce quality solutions, they led to incremental system design changes that have only marginal effects on traffic safety. The impact of any system on increasing traffic safety primarily depends on the impact on the road user himself, i.e., the level of his obedience to the system. Recent research shows that warning systems inside vehicles or smartphones can have a significant impact on the drivers/pedestrian's behaviour if they can be considered credible and trustworthy. A study on the impact of different ITS applications on drivers (Larue, Rakotonirainy, Haworth, & Darvell, 2015) was conducted using the simulation of level crossing with three types of warnings: visual, audible, and on-road valet system. The results showed that respondents are more inclined to use ITS technologies at passive crossings than at active crossings, and they prefer the system that is the easiest to use. The authors of a similar study (Landry, Jeon, Lautala, & Nelson, 2019) concluded, among other things, that warning systems inside vehicles have a lasting effect on driver behaviour even after the warning system is no longer presented. In a study (Salmon, et al., 2016), using cognitive work analysis, the authors concluded that the level of safety at level crossings cannot be influenced only through changes at the level crossing itself, but the introduction of new ways of warning drivers and new data collection systems is necessary, or at least the integration of existing systems of different stakeholders. Through their research (Ryder, Gahr, Egolf, Dahlinger, & Wortmann, 2017) developed and tested (in real environment) a comprehensive in-vehicle decision support system which provides accident hotspot warnings based on location analytics applied to a national historical accident dataset. They demonstrated that in-vehicle warnings of historically dangerous locations have a significant improvement on driver behaviour over time while crossing these hotspots, they also raise awareness of the gradually reduced obedience of local drivers.

RELEVANT TRAFFIC DATA AND AVAILABLE DATA SETS

Traffic is an overly complex system composed of many interdependent elements. Most of these elements, or subsystems, use a particular form of information system and collection of relevant data. Today, many solutions in the field of transport depend on reliable and consistent spatial data. This research aims to detect available open data from the traffic system that can be used to create a solution for reliable warning to drivers and pedestrian about approaching train at a level crossing. For a quality result of such a system, it is necessary to connect data available from multiple sources or, in general, to connect certain safety features of the level crossing with their spatial component. Thus, the first step requires data on the locations of all registered level crossings. Furthermore, to classify level crossings according to the danger criteria, data on the technical equipment of crossings and detailed historical data on accidents for each crossing are required, with an emphasis on the severity of the consequences of the accident. In the last step, for the detection of an oncoming train, real-time data on the location of the train is needed. To connect these data in a quality way, data must be available in an open and machine-readable form.

In the field of transport, there are data available at national and at the EU level, but they are quite limited. For example, according to the Official portal for European Data, of the total number of available data sets, the field of transport occupies only 3.75% (including all modes of transport), and their quality and quantity differ depending on the source. This is primarily because traffic, as a complex system, and especially the railways which are most often managed by the state, uses the collected data mostly for its own purposes and within a closed system, therefore the data is closed and owned by them, and part of the published data is in a form and quantity adapted to their needs, that is, of each subsystem separately. Thus, data sources differ in terms of functionality, characteristics, and service quality. The same conclusion made (Pappaterra, Flammini, Vittorini, & Bešinović, 2021) in their systematic review, where authors analysed 62 publicly available datasets from whole railway domain addressed to Artificial Intelligence application. The main challenge they recognised for their review was the lack of publicly available datasets and its uneven distribution over subdomains.

Another obstacle in finding relevant data for this research is that published papers mostly address their specific studies or application, with little or no focus on the used data. Also, the authors rarely publish the relevant data. Analysing general available and well-known databases as Google Dataset Search, Kaggle and UCI Machine Learning, this research reveals that the number of open data sets regarding railway is very limited. Countries such USA, Australia and New Zealand have the most amount of the published data sets on mentioned repositories, while datasets from EU area are mostly published on European Data Portal. The table below lists some datasets found from railway domain, that can be used in future research.

Figure 1. List of reviewed datasets

Dataset	**Description**	**Type**	**Repository**
Railways Accidents in Europe	Annual number of railways accident by type of accident (2004-2015)	Numerical data	Kaggle

Cross-Accidents (Italy)	No description	Spatial data	European Data Portal
Type of Rail Accident (Slovakia)	No description	Spatial data	European Data Portal
Rail accidents by type of accident	No description	Statistical data	European Data Portal
Jvgdata Rail (Sweden)	The data product Räl is a visualisation of the physical rails in the railway network.	Spatial data	European Data Portal
Rail network level crossings (Spain)	Railway network. Rail network level crossings. They distinguish between steps with acoustic and light signals, with semi-barriers and without protection.	Spatial data	European Data Portal
GIP railway crossing (Austria)	Contains the current railway crossings including the security method of the respective transition.	Unknown	European Data Portal

As the table shows, the published data sets are not standardized, often there is no published description of the data, or they are published in different forms and different languages depending on the source.

CONCLUSION

The solution proposed in this paper must be seen as an upgrade of existing traffic systems, and acceptance by drivers/pedestrians is necessary for a successful system. To influence the driver's/pedestrian behaviour, the data presented must be reliable. Furthermore, all level crossings need to be classified according to the level of safety, then subsequently according to the history of accidents for each one separately, then based on the above, the level crossing should be defined as a place of traffic flows interference with high or low risk. To achieve this goal, it is necessary to combine data sets on the location of the level crossing, the technical equipment level, and the number and severity of traffic accidents at each individual level crossing. To combine all this data, a cooperation, and data sharing between stakeholders from different subsystems is necessary. Unfortunately, most datasets are still private or not declared as open data, which makes it difficult to search. Also, it is necessary to point out the need to standardize such data sets and to open their availability to all interested groups (government, scientific community, industry, and the public), because existing data sets are incomplete, missing, not in formats available for download, or generally, not of the sufficient quality and quantity.

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