International Co-operation on Theories and Concepts in Traffic Safety

Comparison of level railway crossings and road junctions based on the risks perceived by road users

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Introduction

Level crossings and road junctions are both conflict points for road users. Although the length of the danger zone in a level crossing is generally shorter (about 6-8 metres) than that of a three- or four-way road crossing, it is still more dangerous. Level crossings have fewer accidents overall compared to road junctions, but the outcome of accidents is more severe, and the probability of fatalities is approximately ten times higher than in normal accidents. At the same time, accidents at road junctions are a major focus of attention alongside level crossings. The simplistic message that 70% of accidents are caused by three factors is often heard: speeding, failure to give way and breaking the rules on turning and changing direction. However, these are not causes of accidents, but consequences. In total, 13 real causes were found, of which only the most important are mentioned: tiredness, talking on the phone, drunkenness, children in (and outside) the car, pedestrians and cyclists, weather, inattention to other road users. These reasons may also be present at level crossings and may reduce their timely detection and, at the same time, increase the risk of accidents. It is therefore important to compare accident data at level crossings and road junctions and to analyse the perceived risk by road users.
In 2024, 39 accidents were recorded on Hungarian State Railways (HSR) lines. This is fewer than in previous years, but in January of that year there were twice as many accidents as in the same period in 2023. The number of fatalities is significant, with 34 fatalities in 2022. In that year, there were 90 accidents at level crossings. Several studies have addressed the level of risk perceived by road users at level crossings and proposed different solutions to increase safety and reduce risk at level crossings, but the perceived risks by road users have not been compared with actual accident rates and the level of risk perceived in other (e.g. road) infrastructure.

Aims

The aim of the research is to assess the level of danger perceived by road users at railway crossings and to answer the question how the perceived risk compares to the actual safety of the crossings. Further goal of the project is to compare railway crossings with road intersections in terms of the perceived risk and actual crash rates. The authors of the present abstract also conducted an anonymous questionnaire survey in which road users were asked to rate the dangerousness of different types of railway crossings and road junctions with different types of insurance. This is discussed in more detail in the section on "Research Methodology".

Research Methodology

In a previous article of the authors of this paper, a database of 266 level crossings in Hungary was presented, showing the number of railway lines and the number of roads involved, in addition to the level crossings; the authors determined the relative accident rates, relative injury rates and the summed relative accident rates of the 266 level crossings in Hungary, which were compared with the accident rates of the 3 and 4-legs intersections. This is presented in the table below.

Number of intersection legs	Traffic management mode	Summarized crash rate (injured / 10^7 vehicle))
4	Give way	4,6
	Signal lights	2,9
	Roundabout	1,1
3	Give way	2,7
	Signal lights	1,3
	Roundabout	0,8
Level road-railway crossing		0,25

In this study, it was found that, in addition to being a good starting point, there are many similarities between the relative accident rates and the aggregate relative accident rates, and that the aggregate accident rates at level crossings are lower than at road junctions. The study also concludes that although fewer accidents occur at level crossings, the outcome of these accidents is much more severe than at road junctions. In the present study, the road junctions closest to 266 level crossings in Hungary were identified using the Transport Information System and Database (TISD) and assigned the coordinates of the junctions and their average daily traffic. The WEB-BAL accident database was then used to collect the accidents that occurred at the intersections, branch by branch for each intersection. The lateral distance was set in 100 m. Using the accident rates and average daily traffic data, relative accident rates were determined. It was important to note that where two-way roads intersect, half of the average daily traffic entering the intersection was considered. And where one-way roads were present, the whole of the average daily traffic was considered. These were added together in the denominator of the formula.

In addition to comparing relative accident rates, the authors of this paper also conducted an anonymous questionnaire survey on how dangerous road users perceive at-grade level crossings and road junctions. In addition to the usual questions (gender, residence, age, education, employment), the questionnaire asked about the use of transport equipment, the different ways of securing level crossings ("Start of level crossing" signs, light barriers, half barriers). Respondents were asked to rank the types of road crossing (level crossing, signal, traffic lights, etc.) according to their perception of danger. Both types of intersections were then ranked. Respondents answered how often they crossed level crossings and how many times they did so irregularly, what irregularities they committed, whether they looked around during level crossing prohibition signs and what factors motivated them to use level crossings irregularly. The same questions were asked at road junctions. The questions included whether they had been involved in conflicts at level crossings and road junctions in the last 10 years, whether they had ever seen or been involved in an accident at the same locations and, finally, which level crossing and road junction they considered to be the most dangerous within a 10 km radius. The questionnaire is a good feedback tool to better understand the safety issues at level crossings and can also help, for example, to carry out cluster analysis.

Expected Results

Of the six types of road intersections, respondents to the questionnaire consider level crossings to be the most dangerous. This is followed, in order of danger, by signalised intersections, then turbo roundabouts, roundabouts with traffic lights, signalised junctions and finally single-lane roundabouts. The latter are not considered dangerous. In descending order, this is followed by signalised junctions and signalised roundabouts. The following diagrams show the ranking of level crossings and road junctions. Finally, the questionnaire respondents were asked to rank all nine types of facilities. The table below illustrates this.

Ranking	Type of facility	Total score
1.	Level crossings with "Start of level crossing" sign	810
2.	Level road junctions	1104
3.	Intersections with mandatory or STOP signs	1308
4.	Level crossings with light barriers	1456
5.	Turbo roundabouts	1512
6.	Roundabouts with traffic lights	1762
7.	Signalised intersections	1831
8.	Roundabouts	1843
9.	Level crossings with light and half barriers	1887

The table shows that the most dangerous type of facility is the one with the lowest score, i.e. mostly 1s and 2s on a scale of 1 to 9. Respondents to the questionnaire considered level crossings with a "Start of level crossing" sign to be the most important, while level road junctions, "Right of way is mandatory" or "Stop! Give way is mandatory", followed by level crossings with a light barrier. The turbo roundabout is in the middle of the ranking, and from there, roundabouts and junctions with traffic lights, roundabouts and finally level crossings with light and half barriers are the least dangerous. The results of the table above show that the better equipped a road crossing is with traffic lights and the more it is converted into a roundabout junction, the safer road users consider it to be. In terms of safety at level crossings, the level crossing with light and half barrier is the safest, as there is already a physical barrier for road users. The scores in the table show that level crossings are less dangerous than road junctions, but this may not be the perception of road users. Road users perceive level crossings to be more dangerous, since it was noted above that the probability of fatality is ten times higher than for an average accident. However, the same fear and caution is not present at road junctions. For this reason, the questionnaire also asked them to indicate the number of times they had committed an offence at level crossings and road junctions.

Discussion and conclusions

The accident rate at level crossings is lower than at road junctions, but the probability of fatalities is much higher at the former. The road user questionnaire suggests that road users have a different attitude towards road junctions and level crossings: they are more cautious at level crossings, where accidents are in the national press and where pictures of accidents remind them to be careful and cautious. Accidents at road junctions also encourage drivers to be careful, but not as much as accidents at level crossings. In such accidents, the probability of survival is slightly higher, whereas the chance of survival is low in the case of a collision between a vehicle and a railway train: accidents involving minor injuries and damage to property are less frequent. It is therefore worthwhile to try to learn from accidents at road junctions and to approach them with increased caution, as well as level crossings. Intersections with higher traffic volumes should also be approached as a road crossing with a signal of equal or priority importance.