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CONTRIBUTION OF EDUCATIONAL AND PREVENTIVE PROGRAM TO TRAFFIC SAFETY ON LEVEL CROSSINGS: THE CASE OF CROATIA

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Sažetak: Željezničko-cestovni prijelaz (ŽCP) mjesto je neposrednog sučeljavanja željezničkog i cestovnog prometa pa time je stajališta sigurnosti, predstavlja točku visokog rizika. Statistički podaci ukazuju na učestale izvanredne događaje na željezničko-cestovnim prijelazima čija su posljedica materijalna šteta i ljudske žrtve, a koje uzrokuju vozači cestovnih motornih vozila te pješaci što je pokazatelj niske razine poštivanja prometnih propisa korisnika željezničko-cestovnih prijelaza. Fakultet prometnih znanosti Sveučilišta u Zagrebu i HŽ Infrastruktura d.o.o. od 2016. godine provode projekt "Implementacija mjera za povećanje sigurnosti najranijijih sudionika u prometu na željezničko-cestovnim prijelazima" u okviru „Nacionalnog programa sigurnosti cestovnog prometa Republike Hrvatske 2011. – 2012.". U ovome radu prikazana je dinamika aktivnosti u okviru mjera projekta s posebnim naglaskom na edukaciju sudionika u prometu, koja predstavlja temelj za povećanje prometne kulture i smanjenje prometnih nesreća na željezničko-cestovnim prijelazima.

Ključne riječi: željezničko-cestovni prijelazi, sigurnost, preventivno-edukativni program

Abstract: As a place of direct conflict of the railway and road traffic, level crossing (LC) represents a point of potential high risk of traffic safety. According to statistics, the drivers of road vehicles, as well as pedestrians are most often those who cause such emergencies, indicating their extremely low level of complying with the traffic regulations, so the behavior of traffic participants represents the main cause of traffic accidents at LCs. Faculty of Transport and Traffic Sciences (University of Zagreb) and Croatian Railways launched in 2016 preventive and safety educational project "Implementation of measures to improve the safety of the most vulnerable traffic participants at level crossings". The paper presents methods and the dynamics of the activities within project measures with special focus on the education of traffic participants, as an essential element for increasing traffic culture and reducing the traffic accidents at LCs.

Key words: level crossings, safety, preventive-educational program
1 INTRODUCTION

Level crossings (LC) are places where roads cross railway lines or specifically, a place of crossing of the road pavement surface and the running surface of the rail [1]. As such they represent a significant safety challenge because interactions between many different types of road users (pedestrians, cyclists, motor vehicle drivers), railway operators (train drivers, signal operators) and infrastructure (protection systems) [2]. For that reason, LCs need to be properly marked and protected with appropriate protection systems. Basic classification of LCs protection systems is divided between passive and active [3]. With passive systems road user is solely responsible for observing traffic situation (approaching train). Road traffic signs used for passive level crossings ("Stop" and "St. Andrews Cross") stay unchanged and users have to understand what they mean, then search/listen for trains, and respond accordingly to observed traffic situation. On the other hand, active protection changes its state to warn road users of approaching train (flashing light and sound and/or full or half barriers) [3].

General perception in public is that the accidents at LCs are primarily a railway sector problem, but statistical analysis of accidents show that the main cause of all accidents is human factor of road users (motor vehicle drivers, cyclist and pedestrians). According to [3] fatalities at LCs represent almost 30% of all fatalities in railway traffic, but only about 1% of fatalities in road traffic. Due to this fact, accidents at LCs don’t represent a significant issue for road sector authorities, but they are major obstacles for both traffic efficiency as well as rail safety [4]. Apart from technical solutions regarding increase safety at LCs, education of drivers and pedestrians with the aim of raising their traffic discipline and culture are very important. For the prevention of emergencies, the educational and awareness programs and campaigns about traffic safety are of extreme importance and play a significant role. This paper present activities and innovations in educational program for LC users which are being carried out under the project Implementation of measures to improve the safety of the most vulnerable traffic participants at level crossings launched by Faculty of Transport and Traffic Sciences (University of Zagreb) and Croatian Railways under the National program of road traffic safety of the Republic of Croatia 2011 – 2020.

2 SAFETY AT LCs

Level crossings safety varies depending on the country, so for example, there are 211,893 LC’s in USA on 228,218 km of railway tracks [5]. There were 2,611 fatalities between 2007 and 2016 on 21,766 LC’s accidents which represents 35% of all railway related fatalities (7,460) in the USA [6]. In Australia there are 23,532 LC’s with yearly average of 7 accidents and 38 fatalities which is largest cause of Australian rail-related fatalities. Only 33% of LC’s in Australia have active protection systems [7].

In the European Union (EU) there are 114,120 level crossings on 213,910 km of railway tracks, out of which 51% have passive and remaining 49% have active protection systems. There were total of 24,670 railway related accidents in the EU between 2006 and 2015 of which 7,067 were LC accidents. Overall railway traffic saw 11,441 fatalities in the same time span out of which 3,377 were fatalities on level crossings [8]. This is a significant safety challenge for EU railway traffic because fatalities at LC’s represent almost 1/3 of all railway related fatalities.

Railway safety in the Republic of Croatia in the 10-year period (2007 – 2016) is lower than the EU average. There are total of 1,519 LC’s (63% passively, 37% actively) on 2,604 km of railway tracks (Table 1.).

In the observed period there were total of 438 LC’s accidents which is 56% of all railway related accidents [9][10]. In those accidents 58 persons lost their lives between 2007 and 2016. It can be observed from Figure 1. That number of fatalities is decreasing in the observed time span.

Unfortunately, almost 50% of all fatalities happened on actively protected level crossings, which is a sad testament for poor traffic culture in the republic of Croatia (Figure 2).

Another safety challenge in the Republic of Croatia is yearly number of broken or damaged barriers and half-barriers. This present significant problem because these incidents happen just before approaching train which can lead to catastrophic consequences. Figure 3. shows number of broken or damaged barriers between 2007 and 2016.
Table 1: Classification and number of level crossings in the Republic of Croatia [9]

<table>
<thead>
<tr>
<th>Passive LC</th>
<th>Active LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic signs + visibility triangle</td>
<td>Sound and flashing lights with half-barrier</td>
</tr>
<tr>
<td>Pedestrian crossings with sound and flashing lights warning</td>
<td>Manual full barriers</td>
</tr>
<tr>
<td>Total</td>
<td>Sound and flashing lights</td>
</tr>
<tr>
<td>895</td>
<td>65</td>
</tr>
<tr>
<td>56.88%</td>
<td>4.27%</td>
</tr>
<tr>
<td>59</td>
<td>348</td>
</tr>
<tr>
<td>3.88%</td>
<td>22.97%</td>
</tr>
<tr>
<td>11</td>
<td>141</td>
</tr>
<tr>
<td>0.72%</td>
<td>9.28%</td>
</tr>
<tr>
<td>1,519</td>
<td>100%</td>
</tr>
</tbody>
</table>

Even though the number of broken barriers is declining, it is still considerably high because there are currently only 413 level crossings with full or half-barriers in the Republic of Croatia.

Figure 1: Fatalities on LC’s accidents between 2017 and 2016 [8][9]

Figure 2: Fatalities on LC’s according to protection systems [8][9]

Figure 3: Broken barriers on railway network in Croatia (2007 – 2016) [10].

3 Educational and Preventive Program to Traffic Safety on Level Crossings: The Case of Croatia

3.1 Awareness campaigns and programs on safety at level-crossings

Awareness campaigns and preventive programs conducted at national or international level against safety on railroad crossings aim to increase awareness of risks for railroad crossings users and people living close to the stations or tracks, regarding careless behaviour such as crossing or walking along the tracks. They consist of posters, communication in...
the press (TV, radio, paper), web sites, social networks and different events (workshops, safety training) aimed at the general public and describing the dangers related to the being on the tracks, and the consequences of an accident. National safety campaigns with the aim of improving safety at railroad crossings are especially present in USA, Canada, Australia, some European countries as well as in other countries all over the world [11].

3.2. Awareness campaign and program on safety on level-crossings in Croatia

Croatian Railways (HZ Infrastruktura) launched in the 2000th safety preventive campaign “Train is always faster”, which was initially intended for children with main goal to warn children how to behave on the track and about risk of game on the railway crossing. The action is today focused on the drivers as well, especially after join project of Faculty of Transport and Traffic Sciences and Croatian Railways launched in 2016 (Implementation of measures to improve the safety of the most vulnerable traffic participants at level crossings performed as part of the National program of road traffic safety of the Republic of Croatia 2011 – 2020) [12].

3.3. Measures and activities under the project “Implementation of measures to improve the safety of the most vulnerable traffic participants at level crossings”

Every measure of the project Implementation of measures to improve the safety of the most vulnerable traffic participants at level crossings is named: “Safety begins with you”, “Your opinion is important”, “Book Month”, “Traveling exhibition - Safety and design”, “Conscientious driver”, “Social Networks”, “Media” and „LC-locator”. Under every measure there is a few activities. Some of the most important activities are:

- Developing methodology for collecting data on safety on LCs
- Education at Level Crossings
- Workshops in Schools
- Safety Games
- Traffic safety bonton
- Traveling exhibition
- Competition “Write a safety story or a poem!”
- Safety & Virtual reality – VR application “Driving across the railroad crossing”
- Creating safety brochures
- Creating safety video
- Social networks
- ILCAD Day
- Etc. [12][14]

3.3.1. Developing methodology for collecting data on safety on LCs

A good database needs to develop for a purpose of a quality analysis. To found out what is current situation on each LC, and how LC users behave it is necessary to have a good database. Within the project, a unique methodology for collecting and archiving data in the GIS database was developed (Figure 4).

![Figure 4: Close-up GIS map [13]](image)

Surveys and video surveillance were used to evaluate pedestrian and cyclist behavior at an LCs. Study is based on continuous observation of pedestrian and cyclist behavior at LC with the goal of determining the frequency of risky behavior and identifying potential causes (Figure 5). In addition, the study aimed to examine whether risky behavior was affected by the presence of video cameras, HZ personnel and a uniformed police officer empowered to issue fines [13].

![Figure 5: Positioning of video cameras and educational/warning posters at the LC R. Austrije in Zagreb [13]](image)
According to methodology for collecting data about behaviour of LC users, field observations and video-recorded user behavior at the LC is conducted during five days from Monday to Friday. Video footage is collected using two cameras. Field observations is carried out under various conditions in order to assess and compare pedestrian and cyclist behavior:

- Day 1 and 2: hidden recording cameras
- Day 3: cameras are clearly visible to all participants
- Day 4: clearly visible camera and placed educational posters in the presence of police officer and employees of Croatian Railways Infrastructure, conducting surveys by Faculty members
- Day 5: hidden recording, placed posters [13].

### 3.3.2. Education at Level Crossing

During the education day on LC, educational posters were positioned immediately in front of the half barriers or mechanical barriers on either side of the LC. The posters warned about the dangers of LCs and the amount of a fine for illegal crossing. Uniformed police officer (MUP) is also present at the LC. As part of the preventive safety campaign, safety team with law enforcement partners warns all road users, car drivers, motorists, bicyclists and pedestrians at LCs for extra caution when crossing LC (Figure 6). Main activities at LCs during education program is pedestrian and driver's behavior on level crossings, conduct survey about they behaviour in traffic in general and LCs [12].

![Figure 7: Workshops at primary school](image)

Preventive-educational actions in high schools take place in the 3rd and 4th grade, as these students are future young drivers (Figure 8).

![Figure 8: Workshops at high school](image)

### 3.3.3. Workshops in School

Preventive-educational actions in elementary schools take place in the lower and upper classes and, given the age of the children, two types of lectures were prepared. Presentations in primary school are intended for children in 3rd and 4th grade and 7th and 8th grade. They learn about the concepts of traffic, the general concepts of rail and road traffic, such as train, railway, railway-road crossing, train types, railway profession types, traffic signs, dangers along the lines, and how important it is to respect traffic rules. Lectures to high school students, additionally contain a part related to vandalism in traffic. To children in schools is during the action given promotional material and flyers that warn of the dangers along the railway line and during the crossing of the railroad (Figure 7). In addition, the children receive a brochure that warns of the danger from electric shock while climbing on the wagon, the contact network and other forms of unwanted and dangerous behavior by the railway. At the workshop, the children draw and write essays on the topic of level crossings and fill out a questionnaire [12].

For children of lower age, two educational games have been created, „Puzzles“ and „Memo“ which are also published on the project website, in the “Children’s corner” section and are therefore publicly available (Figure 9) [12].
3.3.5. Traveling exhibition

The exhibition "Traveling Exhibition - Safety through Design" presented works on safety on railway-road crossings and the environment (Figure 10). By using their default elements and associations, authors have interpreted selected themes with their style and sensibility and offered graphic solutions tailored to the contemporary tendencies of visual communication that is understandable to everyone. Along with superheroes and entertaining characters, educational content becomes close to users and has been transformed into an easily memorable message. The idea of "Traveling Exhibition" is to visit Croatia at locations circulated by many people, all categories of traffic participants. Traveling Exhibition has so far been set up at the numerous locations (primary schools, secondary schools, faculty, HAKOM, MMPI, MUP, HNK, Lisinski, etc) [12].

![Figure 9: Safety games „Puzzles“ and „Memo“ [17]](image)

![Figure 10: Traveling Exhibition - Safety through Design [18]](image)

3.3.6. Traffic bonton

The Traffic bonton in the form of an illustration was created with two themes "Safety Begins with You" and "Game Dangerous to Life". At the beginning the idea of Trafic bonton was to create only a bonton-book but as the safety illustration were very good accepted by Facebook followers, they are printed and set up first at the railway station in Vinkovci in the so-called city-light cabinets and then in Slavonski Brod and Zagreb as well (Figure 11, Figure 12) [12].

![Figure 11: Traffic bonton "Safety Begins with You" at the railway station in Vinkovci [19]](image)

![Figure 12: Traffic bonton "Game Dangerous to Life" at the railway station Zagreb Glavni kolodvor [19]](image)

3.3.7. Competition “Write a safety story or a poem!”

In addition to the numerous measures implemented under this project, with the aim of educating the youngest traffic participants about traffic safety on
LCs and consequences of non-compliance with traffic regulations the competition "Write a safety story or a poem!" was created. The main idea was to include elementary school students that through their literary work actively participating in this project. Therefore, children in primary schools are invited to write a short story or poem on the topic "Safe on the level crossing". Children were very creative so the all received children's literary work are integrated into the Proceedings which are sent to all schools in Croatia and the best works are rewarded (Figure 13).

![Image](image1.png)

**Figure 13:** Proceedings [20]

### 3.3.8. Safety & Virtual reality – VR application “Driving across the railroad crossing”

The video in application is filmed on the railroad crossing "Trnava" which is located at the intersection of the Zagreb Main Railway Station – Dugo Selo (M102) railway line in KM 430+112 and non-classified road in Zagreb. The video is filmed in 360° version, on real railroad crossing and the only simulation is made for train in version of risky driving. So, two possibilities for drivers are made, first one is safely driving and second one is risky driving across the railroad crossing. Main purpose of this application is to give young drivers opportunity to experience in virtual reality what are consequences of safely and risky driving across railroad crossing (Figure 14).

![Image](image2.png)

**Figure 14:** Screenshot of the application: Safely driving across the railroad crossing (VR 360°)

Testing the VR application “Driving across the railroad crossing” is initially made for driving schools (Figure 16) but during the pilot testing period application was testing at high schools and faculties (Figure 17) and safety centers (Figure 15).

![Image](image3.png)

**Figure 15:** Testing the VR 360° application at the Safety preventive center of PU Osječko-baranjska in Osijek (Ministry of interior) [21]

![Image](image4.png)

**Figure 16:** Testing the VR 360° application at the Driving school [21]

![Image](image5.png)

**Figure 17:** Testing the VR 360° application at the Faculty of Transport and Traffic Sciences [21]
3.3.9. Safety brochures

For preventive-educational actions in schools and at LCs educational materials have been produced in several forms such as flyers, jumbo posters, safety tips for children, pedestrians, young drivers, professional drivers, etc (Figure 18). In cooperation with UIC (International union of railways), Operation lifesaver and IRU (International Road Transport Union) flyers for professional drivers are translate in Croatian language as well as in many world languages [13].

![Figure 18: Safety tips on flyer for young drivers [22]](image1)

3.3.10. Safety video

Safety tips were created as a video material as well. Some of them are dedicated to children, some of them to young drivers. The most important safety video materials are:

- Film „Safe with Andrew on the way to School”
- Film „Railway tracks are not a playground! Traffic safety starts with you!”
- Film „Problem?”
- Film „Safety tips for young drivers”

Film „Safe with Andrew on the way to School” is three-minute video clip with safety tips for children in primary schools. The main idea was to make video as a guide for 1st grade children who just started to go to school and help them to behave in traffic environment. This video was rewarded on the Global Road Safety Film Festival in Geneva this year, as the best educational video from European Union (Figure 19) [23].

Film „Railway tracks are not a playground! Traffic safety starts with you!” is 45 sec video-clips, with the purpose to show it on TV and during our educative lessons in schools. The main character in video is Croatian Paralympian Mladen Tomic. As a 2-year-old kid, he and his cousin played near track and on the track. When the train came, his uncle try to save two kids but unfortunately, only Mladen survived but lost a leg and his cousin and uncle died. Today, Mladen is pretty much involved in safety campaign but mostly is dedicating to help kids to choose sport. The message in this video is „Railway tracks are not a playground! Traffic safety starts with you!”. This video is made by high school students (16 and 17 years old) [24]. This video-clips is extended with adds of Tomic life story and in a 10-minute documentary film „Problem?”.

![Figure 19: Screenshot of the awarded film Safe with Andrew on the way to School [23]](image2)

3.3.11. Social networks

Among the most popular modern systems for communication and advertising via Internet are the social networks. The development of social networks contributes as well to greater safety in traffic. There is no doubt that social networks, as a relatively new way of communication, provide huge possibilities of spreading the message which is of extreme importance.

With the aim of promoting the safety on LC within the project, various social networks are constantly being developed. This measure is primarily intended for the younger population regarding current social trends. However, during the implementation of the project it has been noted that older age groups also use social networks as intensively. So, under the project a) new social networks are created: Project site network (Figure 20) and YouTube channel project; and b) continuously developed existing social networks:
3.3.12. ILCAD Day

The International Level Crossing Awareness Day (ILCAD) is a joint commitment continuing from the success of the first European Level Crossing Awareness Day held on 25th June 2009 in 28 countries raising public awareness on the dangers of behaviour at level crossings. Every year number of members are growing and on the 9th edition of the ILCAD more than 40 countries participated worldwide and messages of prevention were disseminated around the world all day on 2 June. HŽ Infrastructure participate every year in ILCAD and in last two-year Faculty of Transport and Traffic Sciences join as well (Figure 21) [12].

Figure 21: Legendary football coach Miroslav Ćiro Blažević supported ILCAD 2016 campaign in Zagreb

4 CONCLUSION

Only proper precautions can save lives! Human behaviour is very difficult to predict, monitor and track. Raising of awareness about the behaviour of traffic participants is significant for the reduction of emergencies.

There is no unique measure of preventing emergencies at level crossings. In spite of constant investments in the protection devices at level crossings, accidents continue to occur and it is necessary to constantly warn the traffic participants of the dangers when crossing the railway lines. Apart from technical and technological design solving of the crossings, the systemic activities in terms of education of road motor vehicle drivers, cyclists and pedestrians is of extreme importance, with the aim of upgrading the level of their traffic discipline, culture and awareness about the causes and consequences of risk behaviour at level crossings.

For the prevention of emergencies, the educational programs and campaigns about traffic safety are of extreme importance. The development of social networks, as a relatively new way of communication, provide huge possibilities of spreading the message which is of extreme importance and contributes as well to greater safety in traffic. There should be a continuous national campaign throughout workshops, media and social networks with ads and posters explaining the dangers and consequences of illegal behavior on level crossings. Project presented in this paper show few innovative measures acceptable and interested to level crossing users, especially children and young drivers. It can be assumed that in future the improvement regarding human behaviour on LCs could be made with more frequent educational campaigns, innovative way of education more acceptable to young people than traditional one.

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http://www.fpz.unizg.hr/projekt-sigurnost-na-zcp/

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