HOW CAN WE ENHANCE THE SAFETY OF SCHOOL CHILDREN WITH USAGE OF HUMAN FACTOR KNOWLEDGE IN ROAD DESIGN?

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Abstract:

Todays' infrastructure is becoming in many ways obsolete and with that, in a way, in contradiction, with the concept of road safety. We cannot change the infrastructure promptly, for that, we need time and sufficient funding, so therefore, we need an affective short term solutions to engage on wider scale and improve road safety for all. Considering the needs and challenges, we can improve our roads (their design) with understanding and implementation of Human Factor knowledge in to the road design.

In this paper a pilot project is presented, how Human Factor knowledge was used for improved road safety for children within the vicinity of School and Kindergarten. So only with usage of urban equipment and traffic signage (low cost solution, without construction intervention) a safe way to school and proximity of school was introduced. Usage of knowledge of how drivers perceive, understand and therefore (re)act upon certain Road Design (Human Factor), is presented in actual project from the idea and design stage to its implementation.

The intention of this paper is to support a new way of thinking and help communities (road operators) to deal with the issues of children and their safety on everyday basis, on their way to/from Schools, as in the vicinity of Schools.

Key words: road safety, human factors, road design

1. SUSTAINABLE DEVELOPMENT GOAL

In the end of 2015 was in Brazil the Second Global High-level Conference on Road Safety: Time for Results. The target was also to provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons. Recommended actions to protect vulnerable road users was to promote, adapt and implement road safety policies for the protection of vulnerable people among road users, in particular children, youth, older persons and persons with disabilities, in line with relevant UN legal instruments, including the Convention on the Rights of the Child and the Convention on the Rights of Persons with Disabilities. (Brasilia Declaration on Road Safety, 2015)

1.1. A Decade of Action for Road Safety

Activities over the Decade takes place at local, national, regional and global levels, but the focus is primarily on national and local level actions. Within the legal constructs of national and local governments, countries are encouraged to implement activities according to five pillars below. (Global Plan for the Decade of Action for Road safety 2011-2020)

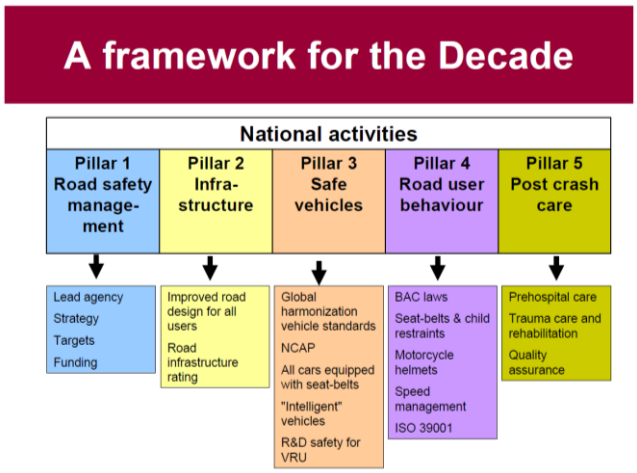


Figure 1: Five Pillars of Decade of Action for Road Safety

Safety of VRU is depending on all of us and therefore should be treated in all 5 pillars of UN Decade of Action for Road Safety. Especially in first 4 pillars, as 5th pillar is Post crash care, which means accident has already occurred, consecutively that means that we failed in first 4 pillars (Rod safety management, Infrastructure, Safe vehicles, Road user behaviour). In practice (real life), we often come to problems and barriers when dealing with road safety issues. Sometimes key stakeholders do not really understand the importance of 1st pillar and its influence on other pillars. That means, if we do not have proper (professional / sustainable) legislation and goals, than road safety engineers often cannot implement professional solutions on roads, no matter how they try. Safe System Approach (Vision zero, Sustainable Safety) should be considered and implemented from top down and have political support and will-power, linked-up thru all pillars of Road Safety and responsibility thru decision makers should be transparent and clearly defined (who is responsible and for what).

1.1.1. Vulnerable road users

As we know, all around the world 1,8 billon children go to schools every day and many of them do not make it to school and back. It is very sad and not acceptable that in fact over 500 children are killed every day on the world's roads! Considering this fact it is time for action and to find sustainable solutions in each Road Safety pillar. In this paper, there are some engineering solutions for Pillar 2 "Infrastructure", which lead to safer road environment for children.

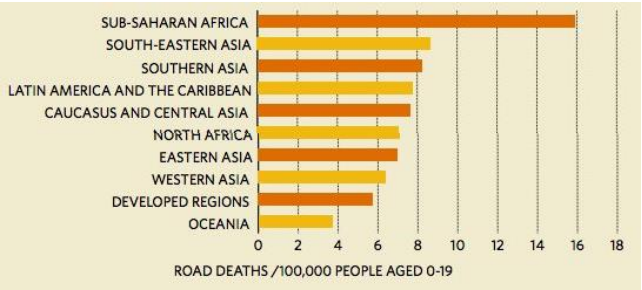


Figure 2: Child Road Deaths in World Regions (FIA Fundation analysis of IHME Global Burden of Disease data)

This paper approaches road safety, considering the UN Decade of Action, from Pillar 2 "Infrastructure", by improving road design for vulnerable road users, especially the school children. Within the engineering solution, we are considering the human factor in road design, which is the basic for implementing self-explaining road infrastructure, including its surrounding.

It is well known, that human factors have an enormous influence on the safe handling of technical systems. Human factors can be described as people's contributions to damaging events. It is the generic term for those psychological and physiological patterns, which are verified to contribute to operational errors in handling machines and vehicles. The human factors concept in relation to road safety, considers road features that influence right or wrong behaviour of the driver. It considers the

causes of driver's operational error as the first step in a chain of actions, which may proceed to an accident. Many of the often observed operational errors result from the direct interaction between road characteristics and the driver's reaction characteristics. Because the driver's reaction characteristics cannot be changed, the attention should be focused on a self-explanatory road design. (Human factors guidelines for safer road infrastructure, PIARC Technical Committee 3.1 Road Safety, 2008)

Alongside Human factor issues, we also have to consider other driver's issues involving automated driving (driving on well-known road, and as such, driver usually does not remember how he/she came / drove from point A to point B") and daydreaming, where drivers drive on subconscious mode and they are not aware of what is actually happening on or beside the road, they become less attentive. Considering this, we have to activate driver's attention approximately 7 seconds or more before the critical point (for example the school area). Re-activation time depends upon how de-activated driver actually is. (Driver distraction and fatigue, PIARC, Technical Committee 3.2, 2012-2015)

2. SAFE WAY TO SCHOOL PROJECT

In Slovenia, we do not yet have a strategy and with that directive or guidance how to deal with school paths and vicinity of schools alongside roads (consequence of poor spatial planning and land use / urbanism), so we decided to make a pilot project and to introduce low cost solution, without construction intervention (prompt measures), using good practice from other countries, and with that improve road safety from infrastructure pillar of UN Decade of Action for Road Safety. The aim of the project was to implement safe(er) School and Kindergarten area on municipality road by introducing Human Factors in to road design. The pilot project could be used to learn (find potential defectiveness and find improvements), for further "best practice" implementations on Slovenian roads and background for legislative part (1st pillar) and potential guidance how to deal with those kind of problems (linear settlements and schools alongside roads).

2.1. Finding location and identifying the problem

Location, suitable for pilot project, was defined together with municipality Žalec, taking into the consideration road safety issues around the schools and the location of schools. As majority of schools are situated in urban areas with traffic calming measures and reduced speed limit "Zone 30", we defined School and Kindergarten Trje, to be most appropriate for the project.

Figure 3: Location of School and Kindergarten alongside the road and direction of travel

After finding the location we took a look at the road and its appearance.

When driving on the road, driver does not get proper information that School and Kindergarten is nearby and with that also children, as vulnerable road users (VRU), are more likely to be present on the road. Drivers in transit does not expect that School and Kindergarten will be situated outside the town, while ones who are familiar with the location of School and Kindergarten (the locals) pay a little attention to it, as they drive by daily in automated driving mode (daydreaming etc.). So the existing road design is not very self-explaining nearby the School and Kindergarten and where children walk – School path.

Figure 4: Existing road design in the vicinity of School and Kindergarten (direction "A")

Figure 5: Existing road design in the vicinity of School and Kindergarten (direction "B")

We could say that road does not speak to the drivers and therefore they are not attentive to potential danger – children on the road.

2.2. Designing the solution

Considering the legislation, we could not drastically change the road design, as we did not want to make the solution legislative litigable, also some budged restrictions had to be considered as pilot project was supported by the companies who decided to do the work "pro-bono". So taking all this into account we first gathered information from school, where pupils actually walk. After receiving all the information, we decided to design the solution in a way, that road will talk to drivers by its design to be aware of children.
We designed new information signs, that are "in user friendly way" talking to drivers and stimulating them to be more attentive of children on the road and at the same time encourage them to drive with more caution.

Figure 6: Information signs (direction "A" – left picture; direction "B" – right picture)

At the same time new pavement markings are accompanying drivers and "telling them" that they are driving in area where children walk.

Figure 7: Pavement markings (blue and yellow circles)

In vicinity of School and Kindergarten junction, where there are also bus-stops and a pedestrian crossing, we re-activated driver's attention and stimulated them to be more attentive of potential danger – children on the road, by setting up totems and colorful bollards alongside the road. At the same time we enhanced the conspicuousness of pedestrian crossing with blue background and at the stopping site distance, we warn drivers that they are approaching the School and Kindergarten junction, by marking red surfaces (fields) on the road. We also set up new (more conspicuous) legislative traffic signage, to be in accordance with the law.

Figure 8: Improved road design in the vicinity of School and Kindergarten (direction "A")

Figure 9: Improved road design in the vicinity of School and Kindergarten (direction "B")

Traffic signage, urban equipment and markings were carefully designed and put into place considering the road alignment and roadside environment (Human Factors knowledge). During the design stage we had to change the bollards color and totem design, as they would not be visible enough during the day, because of natural environment behind them, considering overall driver's field of view.

Figure 10: Comparison of proposed design solutions (direction "A" – upper pictures; direction "B" – lower pictures)

Bollards and totems have to stand out and be visible, during day and dusk conditions. Especially totems had to be conspicuous to "wake up" drivers from automated driving mode (daydreaming etc.) and to re-activated their attention on what is really important – children on the road.

Figure 11: Comparison of day and night driving conditions (direction "A")

All equipment (especially bollards) was carefully chosen, so that in the case of impact they do not pose additional threat to road users. Passive safety is also important when designing this kind of safety solutions.

3. PROJECT EVALUATION

The design was very well accepted among children, parents, teachers, local community and drivers. The idea behind the design and its purpose was to alert drivers, to properly stimulate them to be more attentive for children presence and to reduce speed. Speed monitoring (before/after) was also carried out, with Traffic data collection of traffic volume and speeds (ViaCount II). We monitored speed before the project:

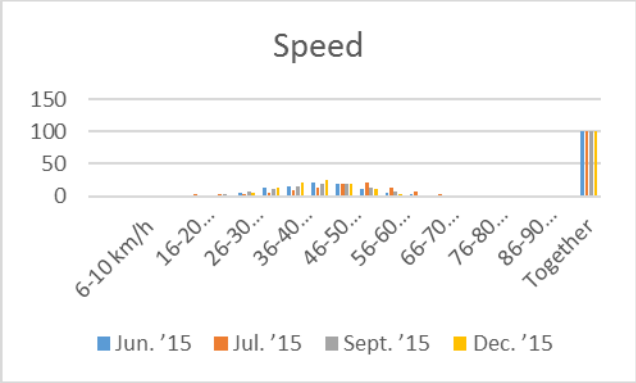
- *June '15 (during School),*
- *July '15 (School-brake),*
- *September '15 (beginning of School),*

and after the project implementation:

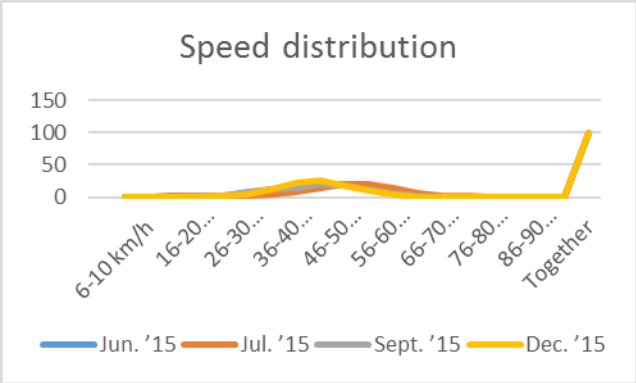
- *December '15 (during School).*

Monitoring was done in similar weather and road conditions, so the weather and the road surface did affect the driving speed.

Graph I: Speed monitoring



Graph II: Speed distribution



When analyzing the speeds, we came to the conclusion that after the project implementation, speeds were lower and also extremes, those who were driving way over the speed limit, has been reduced. Also those who were driving before within the speed limit (50 km/h), they drove between 46 km/h and 50 km/h and now, after the project implementation, there speeds come down between 40 km/h and 45 km/h. We can also see that the curve of the normal distribution (Gaussian distribution), in graph II, has moved to the left in December '15 (after the project design was implemented).

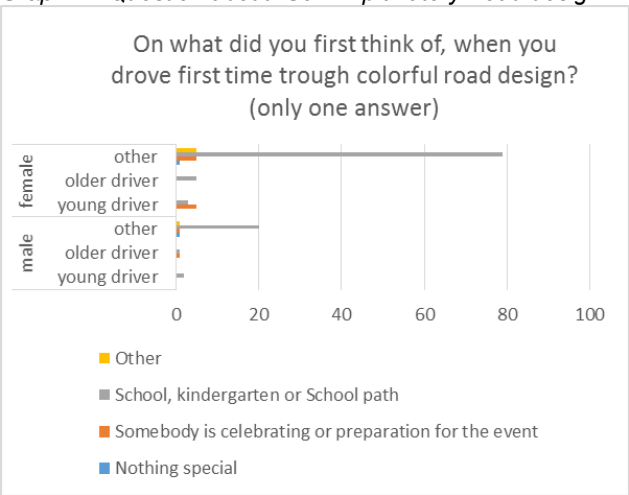
Alongside the speed monitoring we carried out the survey, trying to get answers if drivers understood the colorful road design, its purpose, and how do they re-act upon that. We wanted to know if design is enough "Self-explaining", do drivers know, that the School is near and therefore presence of children, and do drivers become more attentive, more alert, for children presence.
The survey were carried out in the local community and 131 replies came back.
Respondents were divided by gender (male – M and female – F) and each of those by age (driving experiences).

Table I: Respondents data

Que. / Ans.	driver M	driver F	% M	% F	% M+F
Beginner	2	8	7,41	7,69	7,63
Older	2	5	7,41	4,81	5,34
Other	23	91	85,18	87,5	87,03
Together	**27**	**104**	**100**	**100**	**100**

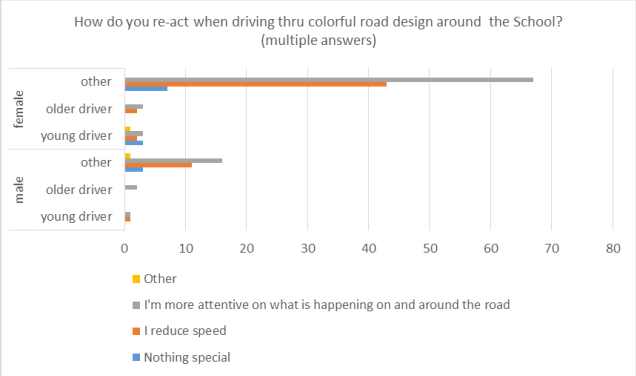
According to Slovenian regulations, the driver beginner (young driver) is driver until the age of 21 years or driver who has driving license up to 2 years, for older drivers are considered those of age more than 64 years, and in between those two categories are "other" drivers.

Graph III: Question about "Self-Explanatory" road design



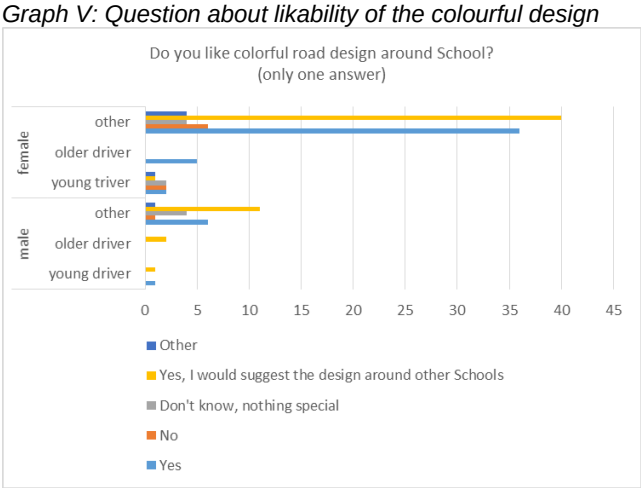
According to answers from graph III, the colorful road design in understandable, drivers did understand the meaning of the design and that is about School, Kindergarten and School path – presence of children. So, self-explanatory of the design was confirmed.

Graph IV: Question regarding drivers' re-action



From graph IV answers, we can see that self-explanatory road design has a positive effect on drivers' behaviour. They tend to be more attentive, more alert, of what is happening on or beside the road – more watchful for children and they slow down, as was also confirmed by speed monitoring.

Graph V: Question about likability of the colourful design



Again, answers about the likability, acceptance, of the colourful road design, in graph V, are positive. Drivers do like and accept it, and they recommend it, for further usage around vicinity of other Schools and Kindergartens.

For conclusion, we can fairly say that the project is a success and has beneficial results on driver behaviour – speed and attention.

By thoughtful incorporation of Human Factors knowledge in to the road design, we can enhance Road Safety, and at the same time tackle nowadays ever-growing problem on drivers' Distraction and Fatigue.

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