ICT AND ITS APPLICATIONS FOR IMPOVING SAFETY OF CYCLISTS

Mr. Zbyněk SPERAT
CDV Centrum dopravního výzkumu v.v.i. / Transport research center
Divize rozvoje dopravy / Division of transport development
Líšeňská 33a
636 00 Brno
Czech republic
zbynek.sperat@cdv.cz
tel.: 00420 602 372 486
www.cdv.cz

1) ABSTRACT

Bicycle fatalities make up 6.5% (2.600) of the total number of road accident fatalities (40.000, EU-23 countries, 2008). There are many traditional ways to reduce the risk of cycling accidents, but very little is known how Information and Communication Technologies (ICT) or Intelligent Transport Systems (ITS) can be used to increase the safety of cyclists. The SAFECYCLE project[1] integrating 3 transport topics - cycling, ICT/ITS and safety, was realised to focus more on this area. The objective of this paper is to present attitude of EU countries to this integrated theme in general and to the eleven applications which were selected before in scope of SAFECYCLE project. Ministries of Transport were asked to give their opinion to the list of different applications and to rate importance and contribution of these application in their country. The core question was to evaluate to what degree each of the eleven applications can lower the risk or impact of traffic accidents involving cyclists in each country - rating the applications (from 1 to 5 points) and by providing comments. The results were obtained from 11 ministries. Results showed that most promising application is the Lexguard (average score 4,1) which can prevent acccidents between cyclists and right-turning truck at junction by way of sensors on the track and sound and visual alarm in truck-drivers cabine. Comparison of the results showed differences between answers of Eastern and Western European countries. As Western European countries prefer information giving information and route planners, Eastern European countries expect more from applications

[1] For more information about selected applications, take a look at the SAFECYCLE website www.safecycle.eu

increasing the visibility and decreasing impact of the accident. The paper gives recommendations for the future development and usage of e-safety application.

Keywords: Cycling, safety, ITS, ICT
Research domain: Intelligent transport systems, ITS & Traffic

2) INTRODUCTION

ICT/ITS can be used in cycling to provide intelligent systems that assist the cyclist to avoid, prevent, or mitigate accidents. Although some ICT/ITS applications and services have been developed for cycling, there is no integrated approach to research activities in this domain at a national or international level. To fill in this gap, the SAFECYCLE project was done between 2011 and 2012.
The main objectives of the research were
(i) to identify e-safety applications that have the potential to enhance the safety of cyclists in Europe;
(ii) to create knowledge and raise awareness about e-safety applications applied to cycling (policy, industry, users);
(iii) to speed up the adoption of (new) e-safety applications in cycling.

E-safety in SAFECYCLE project was defined as an intelligent safety system that could improve road safety in terms of exposure, crash avoidance, injury reduction and post-crash phases. A variety of measures are being promoted widely as 'e-safety' measures, though the knowledge about e-safety is slowly evolving, including information on the costs and benefits of measures (EC 2012). This is also what the project team found out while working on the impact assessment of the selected applications.

In the first part of the project more than 120 applications for cyclists were found by the project team. Not all of the applications are in definition e-safety applications, but have the potential to increase safety in a smart manner. The search not only included Europe, but also other continents. At the end of this part the list of e-safety applications was reduced to 30 applications based on various criteria. These applications were entered into next part of the project, which was SWOT (strength, weakness, opportunity and threat) analysis. Cycling, ITS and road safety experts filled in many SWOTs, resulting in a list of applications from most to less promising in relation to increasing road safety for cyclists. The SAFECYCLE project team selected 11 applications out of the 30 applications based on the SWOT. In next step an impact assessment on traffic safety for cyclists was carried out for each of the eleven applications. Increasing the safety for cyclists can be reached in more ways, for instance by increasing the visibility of cyclists, by preventing blind-spot accidents, by preventing red light negation or by planning safer cycling routes.

This paper is focused on specific part of SAFECYCLE project which is evaluation of eleven selected applications by Ministries of transport of EU countries. It also gives recommendation for future development of e-safety application in general.

3) BACKGROUND

For better understanding the context of this paper short introduction is given to describe the background of responses and show that traffic safety and modal share of bicycle are aspects necessary to consider while evaluating the traffic safety data.

Figure 1 below shows modal split of bicycle in Western European countries (Ministerie van Verkeer en Waterstaat & Fietsberaad, 2009). Relevant data for Eastern Europe are not available except the Czech Republic with 3% (Ministerie van Verkeer en Waterstaat & Fietsberaad, 2009). Other Eastern countries may have similar bicycle share; Hungary and Baltic countries are more cycle friendly and scores higher than the others.

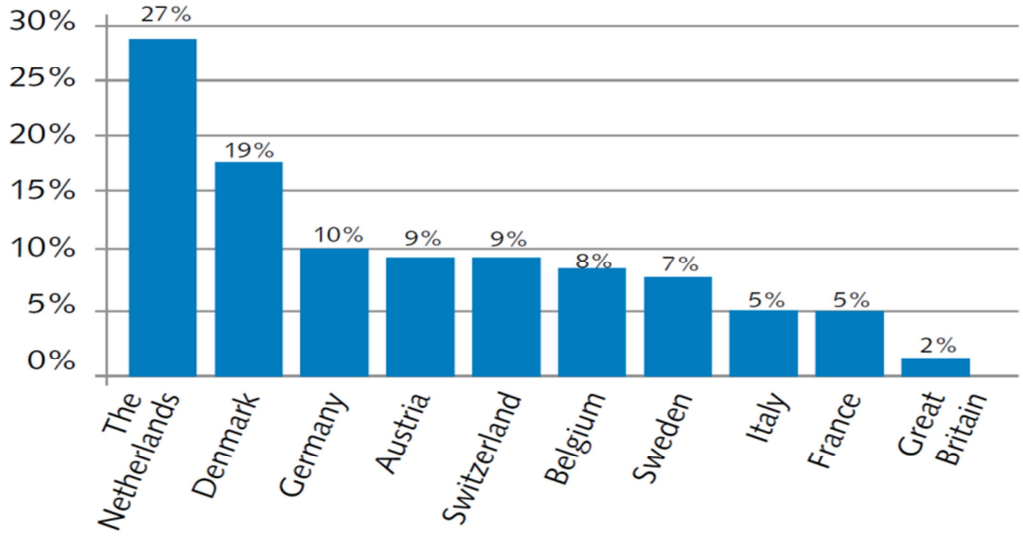

Figure 1. Bicycle share in some European countries (Ministerie van Verkeer en Waterstaat & Fietsberaad, 2009).

Considering the fact that the biggest volume of cycle traffic is concentrated within the cities, the bicycle share as the national average number does not explain much. The modal share of the cities varies a lot in all countries. Even in Great Britain some cities like Oxford and Cambridge reach nearly 20% (Ministerie van Verkeer en Waterstaat & Fietsberaad, 2009). But direct relationship between general conditions for cycling and ´national´ modal bicycle share can be considered. E.g. the better legislative conditions or more attention to cyclists, the higher modal share.

In some Eastern countries the priorities of transport modes differs in comparison to the Western European countries and cyclists do not have as strong position as they should have. Since 1990s cyclist have not been considered to be an obstacle in traffic flow yet. The situation is getting better but the process of getting equal position among other traffic modes is very slow.

Safety of cyclists relates to the position of bicycle traffic too. Statistics show indirect relation between the number of fatalities and kilometres cycled (see Figure 2). In the light of this relationship the total number of fatalities per number of inhabitants does not say much about safety of cycling in the country. Despite the fact that the Netherlands has the third highest number of cyclists victims in EU (EU-23 countries, 2008), related to kilometres cycled it is the safest country.

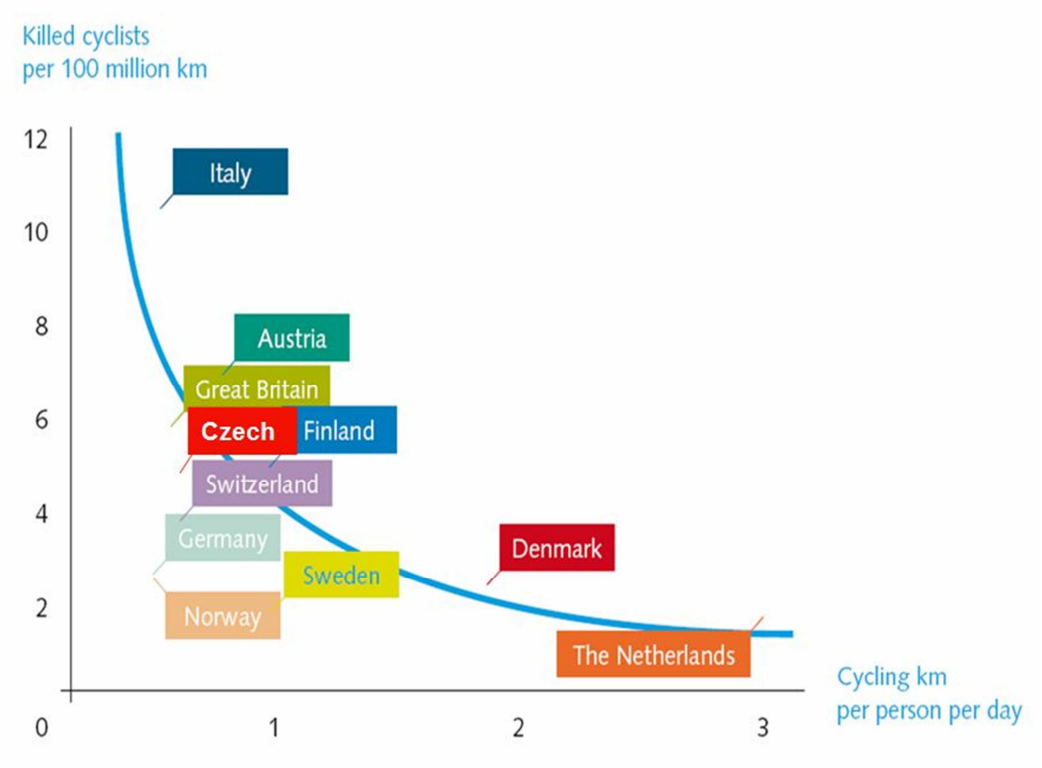

Figure 2. Relation between accidents and bicycle usage (Ministerie van Verkeer en Waterstaat & Fietsberaad, 2009).

To conclude, research described below has to be related to these facts:

- different bicycle share in the countries
- historical background and priorities in Eastern Europe
- cycling and road traffic in general is more danger in Eastern countries
- cyclists in Eastern Europe usually do not have the same priority as in Western Europe

4) OBJECTIVES

The main objective of this paper is to find out the state of the art of eleven e-safety applications for cyclists and their expected benefits to improvement of cyclists safety in various European countries.

The objective is also to give several recommendations for future development, deployment and research for improving safety of cycling based on information collected.

5) METHODOLOGY

Participants

The aim was to get evaluation of eleven applications described below, national research and recommendations for deployment e-safety applications from official institutions of European countries. National offices for standards were thought to be the right source of the data but regarding the findings that these bodies are not able to present transport data, appropriate Ministries were chosen as the complex source of information and official opinion of the country. Finally 29 countries were selected and appropriate ministries, which are most relevant for the project.

Content of the survey

Ministries were contacted by email through mailroom by an official request with the purpose to get the following data or answer these questions:

(i) To what degree can each from the eleven applications lower the risk or impact of traffic accident involving cyclists in each country - rating the applications (from 1 to 5 points) and comments

(ii) List of eleven applications:

Lexguard
Bicycle Braking Light
LEDmark
SaveCap
Routeplanner Gent
Citizens Connect
Individual Speed Adaptation
Traffic Eye Zürich
Countdown Traffic Light
Hind Sight
Light Lane Bike

(iii) Identification of the possibilities and conditions of deployment of each application in each country (legislative regulations for using some applications, necessity of permissions, approvals).

(iv) Recommendations of other application(s), which could decrease the risk or impact of accidents involving cyclists.

(v) Description of national research programmes focused on ITS related to bicycle traffic.

The applications were divided into four categories, according to their main objective:

a. Bicycles
b. Other vehicles
c. Infrastructure
d. Web applications (internet and nomadic devices)

For the category 'cyclist' no application was selected as a result of the SWOT analysis. Table 1 below gives an overview and short description of the applications:

Table 1. Overview and description of applications analysed by the Ministries

Category	Application	Description
Bicycles	Light Lane Bike	A green laser projects a cycle lane behind the bicycle, which increases the visibility of the cyclist and makes it easier for other road users (car drivers) to react appropriately to the cyclist's presence.
	Hind Sight	A rear camera records the movements around the bicycle and the images are shown on a display on the handlebars. The cyclist knows what is going on behind the bicycle without having to make extra manoeuvres. This allows the cyclist to focus on the road ahead and to avoid instability.
	Bicycle Braking Light	The rear light of the bicycle becomes brighter when the cyclist starts to brake.
Other vehicle	Lexguard	Detection strips on the truck detect objects around the truck and trigger warning signs inside the truck.
	Individual Speed Adaptation	By adapting the speed of individual cars, based on their position on the road network and specific characteristics of the vehicle, safety of specific road user groups can be increased.
	SaveCap	Decrease of severity of injuries of cyclists in case of a collision with a car bonnet.
Infrastructure	LEDmark	Increased visibility of cycle infrastructure by LEDs integrated in the cycle lane.

Category	Application	Description
	Traffic Eye Zürich	To prevent conflicts between trams, buses and other traffic at intersections, bicycles get green before the public transport to increase the safety and comfort of the cyclist. Extra green is only given when cyclists are detected to ensure optimal use of the intersection.
	Countdown Traffic Light	Traffic light gives information about the expected waiting time during red light.
Web apps	Citizens Connect	App for nomadic devices aimed at involving citizens in keeping the public environment liveable and safe.
	Routeplanner Gent	Route planner enabling cyclists to plan a safe route, avoiding (perceived) dangerous situations for cyclists.

Provided background information

Each application was described in detail on Factsheet which was enclosed to the request, so that Ministries had good idea about its specifications, potential effects and other benefits (see Picture 1).

HindSight	www.cerevellum.com		
Information			
Idea in short:	A rear-view camera records movements around the bicycle and the images are shown on a display mounted on the handlebars. The cyclist knows what is going on behind him without having to make extra manoeuvres, which allows him to focus on the road ahead and avoid instability.		
App number:	B09	**Developed by:**	Evan Solida from Cervellum
Type of app:	Bicycle	**Sub category:**	Physical problems
Focus of the app:	Bicycle	**Action by:**	Cyclist
Area:	All	**Time / day:**	Always
Geography:	Everywhere	**Weather:**	Not related
Status:	Existing (copyright)	**Spread:**	USA, UK
Availability:	Unknown	**Costs:**	Unknown
Reason for development: To have better sight and to avoid turning around on the bicycle to know what is going on behind you.			
Hindsight 35  ctrl+click for high-res images **Price:** to be announced **Availability:** Following Interbike 2011		**Technology** 	
Specifications			
• 7 function wireless cyclometer • ANT+ • 10-minute video recording • Accident recording		• 3.5"transflective LCD • LED taillight • 227 grams	
Additional information:			
• From spring 2012: additional heart-rate, cadence and power upgrades available			
Potential effects			
Safety effects: • Decrease of blind spot of the bicycle • Better idea of what is going on behind the bicycle which allows to anticipate • Less movements with the body so less problems with stability			
Other benefits:			
Stats about cycling like speed, distance, time, ... Prove in case of accident because of the footage			

Picture 1. Factsheet of HindSight application.

6) RESULTS

From 29 sent requests for information 11 answers (38%) were received from the countries with different level of completeness of the answers (Belgium - Flanders, Czech rep., Estonia, Finland, France, Ireland, Latvia, Lithuania, Norway, Spain, Sweden).

General overview of ranking from these countries is described in Figure 3. The higher green column the better score.

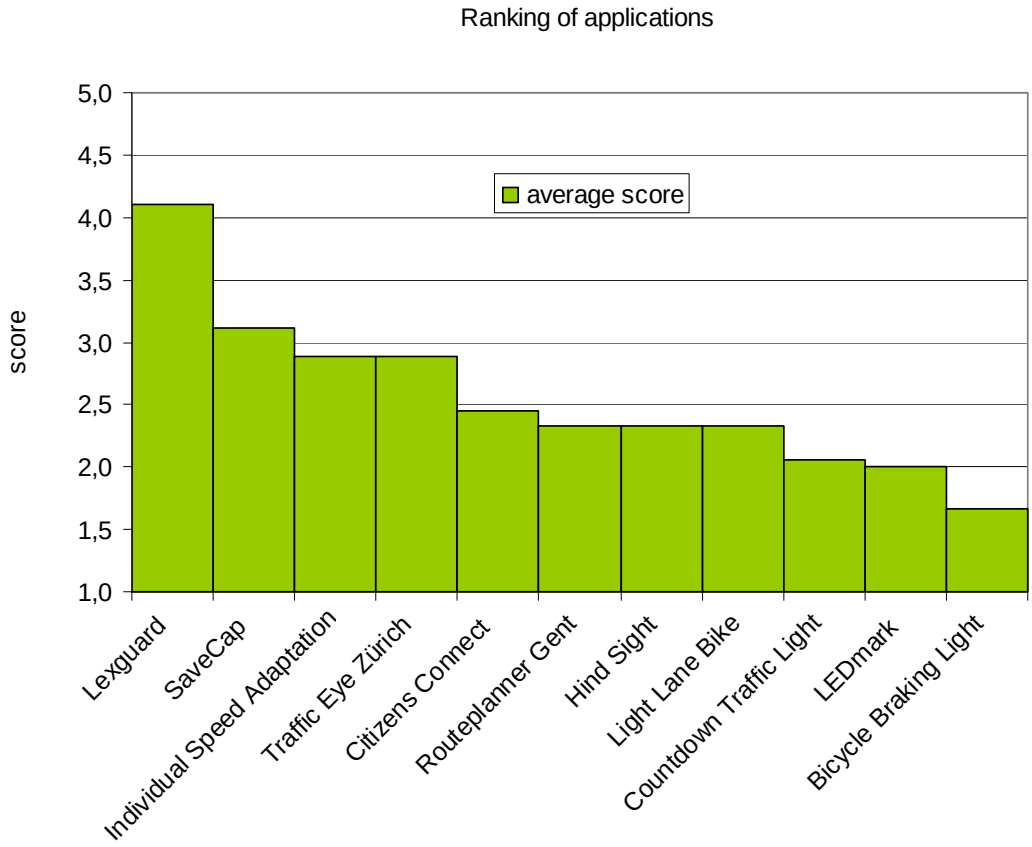

Figure 3. Average ranking of applications; 9 countries

Lexguard is a winner and scores very high (4,1). In most countries it seems to be the most progressive application in terms of safety of cyclists. Savecap (3,1) is in second place, but far behind Lexguard, also ISA – Individual Speed Adaptation and Traffic Eye Zürich score above the average and are in "positive" interval of ranking (2,9 both). Bicycle braking light got the worse ranking (1,7) followed by LEDmark (2,0) and Countdown traffic light (2,1).

Interesting is the comparison of the average scores when we consider Eastern European countries (Czech Rep., Estonia, Latvia, Lithuania) and Western European countries (Belgium

– Flanders, Finland, Ireland, Spain, Sweden) separately which is shown in Figure 4.

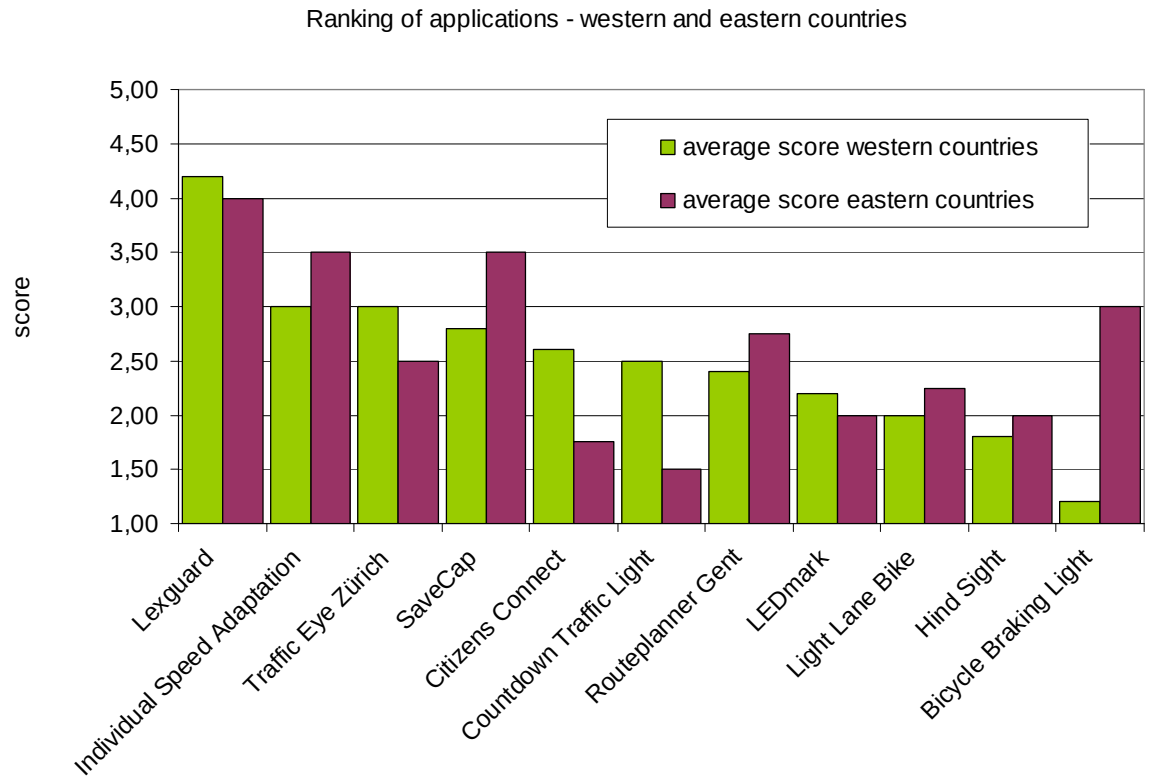

Figure 4. Ranking of applications – comparison of Western and Eastern Europe.

Great differences between the ranking in Eastern and Western Europe can be found for Bicycle Braking Light (average score 1,2 for Western Europe and 2,25 for Eastern Europe; total difference 1,05), Safecap (2,8; 3,5; 0,7), Hind Sight (1,8; 3,0;1,2) and Light Lane Bike (2,0; 2,75; 0,75). Those applications are assessed higher in Eastern Europe. Oppositely Countdown Traffic Light scores remarkably better in Western Europe (2,5; 1,5; 1,0).

Regarding the answers to the question*"What are the possibilities and conditions of deployment of each application in your country? (legislative regulations for using some applications, necessity of permissions, approvals)."*, two main views on the responses are available:

- necessity of permissions, approvals
- legislative regulation for usage of the applications

Some interesting facts related to specific applications were collected. For example Spanish national legislation do not allow to have Bicycle Braking Light or Light Lane bike on bike. Light Lane Bike can not either be implemented in Finland as colour and use of bike symbol this way is against the Finnish legislation.

7) DISCUSSIOIN AND CONCLUSION

The main objective of this paper was to find out the state of the art of eleven e-safety applications for cyclists and their expected benefits to improvement of cyclists safety in various European countries. The objective was also to give several recommendations for future development, deployment and research for improving safety of cycling based on information collected.

Five top rated applications

Lexguard
Peripheral detection on buses and trucks is required urgently, that is the reason why Lexguard (or similar type of blind spot systems) is the best rated application.
Legislative obligation could speed up the use of it, all new vehicles should be equipped with such a detection and warning application if deeper cost benefit analysis proves its rationalization.

SaveCap
Further research is needed to define types of accidents for which SaveCap provides a solution. Based on its results SaveCap can be made mandatory for all vehicles or could become part of the EuroNCAP system.

Individual Speed Adaptation
Impact analysis to drivers attention is needed. It is convenient to connect development of this application to development of navigation systems.

Traffic Eye Zürich
The traffic volume of both modes is one of the key parameters when assessing the convenience of usage this application. More research is needed to determine the circumstances of usage and the impact on safety.

Citizens Connect
Application can be used for more purposes, not only for cyclists. Improving traffic safety is not the main purpose of the application. Citizens Connect can be interconnected to route planners or other application where integration of citizens and their contribution to coty monitioring is needed (out of transport sector).

Looking at the result of the project, it is surprising that some applications score very differently in some countries. Some score considerably lower in Eastern Europe because they are not in practice there and good experiences from Western Europe are not known yet in the

Eastern European countries. The good examples of these kinds of solutions are the Countdown Traffic Light and Traffic Eye Zürich. Applications which are based on smart information provision to the user are rated higher in Western Europe, for example Countdown Traffic Light, ISA, Routeplanner Gent and Citizens Connect. To conclude, in Eastern Europe applications based on warning (driver or cyclists) score higher than in Western Europe, reversely in Western Europe applications providing smart information to cyclist are rated better.

The assumed reason for these differences is that in Eastern Europe every application which can contribute to better visibility is rated quite high even if there are obvious limits in use or side effect which can lower attention of the user. In this respect Bicycle Braking Light and Hind Sight are good cases.

Regarding warning applications opinion of European countries is that Lexguard is most useful and safety contributing application. Maybe the view at its purpose can show the way ahead. Lexguard prevents very concrete types of accidents where both vehicles (bike and truck), location (junction) and position and driving manoeuvre (right turning of truck cross the way of cyclist) are clearly defined. In this aspect the assumption is whether these types of ´monofunctional´ application focused on unique traffic situation are the way for future interest instead of wide-range universal applications.

In general this research displayed the lack of detailed data or evaluation the impact of the application. To assess the contribution of each application to improvement the safety of cyclists, detail circumstances of accidents and their causes are needed. These data were not available. Therefore it is essential to recommend more research in the causes of bicycle accidents. More knowledge is also required on the impact of e-safety applications for cyclists. The reason why some application are not allowed to use in some countries (e.g. Bicycle Braking Light in Spain and the Netherlands) is that using it brings disadvantage in terms of worse visibility of cyclists who are not equipped with it. So the impact of the application to other cyclists had to be considered as well.

8) REFERENCES

CEN ITS standards, available from: http://www.itsstandards.eu/
CENELEC - European Committee for Electrotechnical Standardization http://www.cenelec.eu
ETSI TC ITS standards, available from:
http://www.etsi.org/website/technologies/intelligenttransportsystems.aspx
Ministerie van Verkeer en Waterstaat & Fietsberaad (2009). Cycling in the Netherlands *Den Haag: Ministerie van Verkeer en Waterstaat*
Tripodi A., Persia L., Zoer H.J., van der Kloof A., Jorna R., de Jong M., Sperat Z., Jordova R. (2012). SWOT analysis results and best potential ICT applications. *Deliverable 3.1 of SafeCycle project*. Available from: www.safecycle.eu
Zoer H.J., van der Kloof A., Jorna R., Tripodi A., Persia L., de Jong M., Sperat Z., Jordova R. (2012) Impact assessment safety effect of ICT-applications for cycling. *Deliverable 4.1 of SafeCycle project*. Available from: www.safecycle.eu