EARLY WARNING IN TRAFFIC: POSSIBILITIES AND USER PERCEPTION IN THE CZECH REPUBLIC

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Abstract: *This paper focuses on the situation in traffic. It describes currently used telematics systems in traffic and suggests possible extensions and improvements with using both already used technologies and concepts. Firstly it introduces Radio-HELP system that could help to decrease reaction time in case of traffic accident even during blackout and secondly there is a concept of incorporating a social GPS navigation WAZE into the warning system. Both advantages and disadvantages of this connection compared to the current system are discussed in the paper. Results of a targeted survey are presented in the last part of the paper. The survey is aimed to find out how potential users perceive the new approach and if they are afraid of a potential misuse of their data. The paper concludes that people do not consider eCall and other telematics systems as sufficiently safe from personal data leaks. There are some more detailed findings too.*

Keywords: *Traffic, Radio-HELP, eCall, WAZE, Road safety*

JEL Classification: D80, O33

Introduction

Traffic accidents and problems accompany us through our everyday life. Timely distribution of relevant information is a key factor for reducing economic and human losses in these situations.

This paper aims to assess the current situation of the information collection and distribution and to identify weaknesses and influence of planned or proposed solutions. The financial aspects will be a subject of further research. Furthermore, the paper describes possible system improvements. For instance, an extension based on the use of a social GPS application, which already works and helps drivers. But it works separately and independently on a NTIC (National Traffic Information Centre) (NTIC, 2012), and therefore this paper outlines how it could be implemented into the already described system.

When presenting our proposal of connecting currently used telematics systems we meet many opinions and we found out that this topic is quite controversial. Therefore we decided to undertake a survey consisting of a survey covering this area.

1 Methods

It is a comprehensive article with several new improvements. The methods of work applied in particular are analysis and comparison. The third chapter contains a comparative analysis of the work. It identifies the strengths and weaknesses of the existing transport telematics system solutions. The possible inter-connection of the existing concepts for better delivery of information to drivers is outlined at the end of the third chapter.

The fourth chapter describes the results of quantitative survey on perceptions of telematics applications by potential users. The main question asks whether the potential users are for any reason afraid of using the eCall. Related objective was to identify potential reasons of their concerns.

2 Background and literature review

Today the information about a traffic accident is reported verbally to the emergency operations centres via mobile phones, either by those involved in the accident or by the witnesses. However, this is associated with problems when the person calling is attempting to explain the given situation and determining adequate intervention (the exact position and direction of the vehicle, the scope of damage, elimination of repeated reports of the same accident, etc.). Speed of intervention is a key factor for its success, whereby any possible delays influence negatively the outcome of the entire rescue operation.

Currently, there are several projects in various stages of development aiming to solve the current traffic problems in order to reduce damage to property and to protect health and lives of road users.

2.1 Smart Road Restraint Systems

The project aims - in addition to addressing timely reporting of accidents – to eliminate a loss of life and property through timely preventive distribution of warning information. The system collects data about the current situation using existing visual and sensory infrastructures (highway camera systems, radar systems and weather condition monitors) and distributes the data to the drivers. It also seeks to find opportunities for new materials in order to decrease safety hazards (such as better energy absorption through deformation zones). This project is one of three priorities of the EU on the issue of transport in 2020 and is also co-financed from the EU funds. (SMART Road Restraint Systems, 2010)

2.2 Variable information boards

Information displayed on the boards is transmitted from the unified traffic information system, a joint project of the Ministry of Transport, Directorate of Roads and Highways and several other bodies and organisations.

Currently, there are about one hundred of these variable information boards installed along the motorways and expressways in the Czech Republic, representing coverage of approximately one board per 20 kilometres of highway (Ředitelství silnic a dálnic ČR, 2012), which is not sufficient.

2.3 RDS – TMC

RDS-TMC (Radio Data System - Traffic Message Channel) is a service that provides the drivers with traffic and travel information before and during their journey. This service integrates all relevant information and gives the driver a possibility to optimise the journey. The aim of the RDS-TMC is to disseminate traffic information within the FM broadcast band using RDS technology. Information is encoded using an independent ALERT-C protocol and subsequently transmitted to the users as a silent part of the FM broadcasting and further processed by the navigation device. According to national and international studies, the main system benefits encompass significant improvement in traffic continuity and lower environmental impacts.

The disadvantage of this system is that a warning symbol appears in case a traffic problem occurs anywhere on the preselected route. For more information, the driver must operate the navigation device, which diverts his attention. In addition, further traffic incidents occurring later on the given route do not trigger any change of the warning icon, even though this newer incident may have occurred closer to the car position compared to the originally reported one.

2.4 FCD

Floating Car Data (also Floating Cellular Data) is one of the methods for obtaining data about traffic. It uses data networks (i.e. CDMA, GSM, UMTS, GPRS) and requires no special software or equipment. Each active telephone becomes an anonymous source of information. Location of a mobile device is determined by a triangulation in the cellular mobile network. Since the GSM localisation is less accurate than systems based on geographic coordinates, for ensuring data reliability it is necessary to monitor multiple devices and to use complex algorithms.

2.5 Cooperative systems

Cooperative systems were developed to transfer information among different elements of the traffic. Three basic types are used for dissemination of information of wireless communication (Pípa, 2015):

- Car - Car

Communication Car - Car (C2C) allows vehicles to communicate directly with each other. This type of communication is particularly suitable for safety applications when every second counts. Additionally, it can be applied in situations where there is no functional access point available (e.g. physically missing, inoperable or overloaded with information). C2C communication is decentralised; it does not depend on the backbone network. It is important to equip enough vehicles with the OBU (On Board Units) to make this type of communication effective and successful (i.e. sufficient market penetration). A minimum penetration rate of 10% is stated as an effective threshold.

- Car – Infrastructure

Communication Car - Infrastructure (C2I) connects cars with vehicle access nodes located along the roads and thus provides the connection to the backbone and to the internet network. This communication is primarily used for an efficient management of traffic flow, typically a warning about a traffic congestion or an accident ahead or weather on the route etc. The largest limitation of the C2I communication is the costly infrastructure along the road.

- Car – X

Communication Car - X (C2X), where X is a different type of communication device other than the vehicle or communication element of the infrastructure. It connects vehicle with e.g. mobile phones or tablets. There is a huge potential for security and entertainment sector. However, this kind of communication is not yet well tested and researched, compared to the two mentioned above.

Two types of messages are used for communication. The first is a single message. It informs the driver about the events resulting from dangerous situations, such as critical braking of the vehicle in front of the driver or warning of an obstacle on the road. The second message type is a repetitive message. This type of message informs the driver about the less dynamic events that unfold in front of him. A typical example can be generated by traffic jams or restrictions on the road due to road reconstruction. The spread of this type of reporting uses in most cases C2I communication.

Cooperative systems allow communication with the vehicles in close proximity, but there may be such a critical distance that has no C2C communication, but the driver still does not have time to receive information via the NTIC.

2.6 eCall

A project co-funded by the European Union aims to create a system that enables automated reporting on accidents to the European-wide emergency line 112, including accurate location information. When the eCall device installed in a car detects an accident by means of sensors, it automatically sends a message to the nearest emergency centre, indicating the exact geographical location of the accident as well as other data. This system can be activated either manually by pressing a button on the dashboard by the vehicle passengers or triggered automatically by the vehicle sensors during an accident. After the system is activated, a connection with the nearest emergency call centre is established transmitting both sound and data flows. At first, the data message (MSD – Minimal Set of Data) is transmitted. Then sound connection enables vehicle passengers to communicate with professionally trained emergency call operators. Each message contains details about the accident, such as time, exact location, car identification, eCall system status (whether the eCall was activated manually or automatically) and information about possible service providers. Based on this information, the operator will liaise with the integrated emergency services to direct them to the exact accident location as well as provide them with an exact description of the accident's severity and the number of injured. (Vávra, J., 2010)

A manual use of the system can be useful when a traffic accident is witnessed (European Commission, 2010). The eCall system should be installed in all new cars sold after January 2018 and possibly also installed in older cars.

Although this system brings a clear improvement of the current situation by facilitating rapid and potentially life-saving emergency service, it does not address the distribution of information about the accident to the drivers approaching the place of accident, i.e. who are potentially in danger. When using existing information channels, the acquired accident data could be made available in about 5-10 minutes via variable information boards, RDS-TMC messaging and radio travel news. However, each of these distribution channels has specific limitations and based on current traffic density the above-mentioned reporting times are clearly insufficient.

Given the extent of collected data, personal data safety may be a concern, even though the official stand claims there is no way how the eCall can spy on its users. An official document called „SfC" advises the responsible officials on how to introduce the eCall to the citizens. In this document there is clearly stated that other advantages of the system are following:

- Less traffic jams caused by traffic accidents.

- More effective control of traffic after traffic accidents.
- The system could be used for other purposes – electronic road-toll, monitoring of dangerous wares, more modern models of insurance etc.
- Via this system automotive industry and telecommunication companies could provide new services.

This view tries to prove that implementing the eCall is going to be to have next stages and their assertion may result in the real possibility of online tracking of our vehicles. The eCall system on its own cannot serve for the people tracking. But its components possibly can.

Unfortunately, the document was withdrawn in the course of working on this paper so the link is not valid. The original document may be requested by email from the authors of the paper.

2.7 Radio HELP

For better and particularly early distribution of warning information, a system called System for Automated Forewarning of Vehicle Crashes (the System) could help. The system has a data connection to the receiver systems-vehicle emergency call (e.g. the eCall). The principle consists of full automation of generation and transmission of all relevant information about an accident to vehicles moving in its vicinity.

The process of warning is initiated by the crashed vehicle, which sends the information about the accident using eCall immediately after the collision happens together with the exact location of the accident. Information is received by the central office of the System which immediately generates data and/or voice information about the accident, including a positional code of the accident. Data will be sent via radio session and to car receivers as well. (Brunclík & Skrbek, 2010)

System receivers (mobile phones, navigation devices) must be equipped with the positional code comparator. If the comparator evaluates that the position code of an accident coincides with position code of the receiver and vehicle movement is evaluated as being directed to the scene of the accident, it is forced to activate the data reception and/or voice session. In practice, we may be able to automatically inform road users according to their current position and direction of the danger which is coming, almost immediately.

This principle implies that it is possible to simultaneously transmit separate sessions to more areas. In this case, it would suffice to cover the whole ČR by only one central longwave transmitter.

Due to the development of technologies, whereby most of the new mobile phones are now equipped with the circuits for terrestrial broadcasting and GPS positioning, it should not be technically demanding to use it for these purposes. Also, upgrading domestic appliances (radio, TV ...) with the reception of Radio-HELP would not be a major technological problem.

This solution also has a distinct advantage in case of a complete power outage, a risk which we are often confronted with. Using this technology offers the possibility of permanent information sharing with the population about the current situation.

2.8 WAZE method

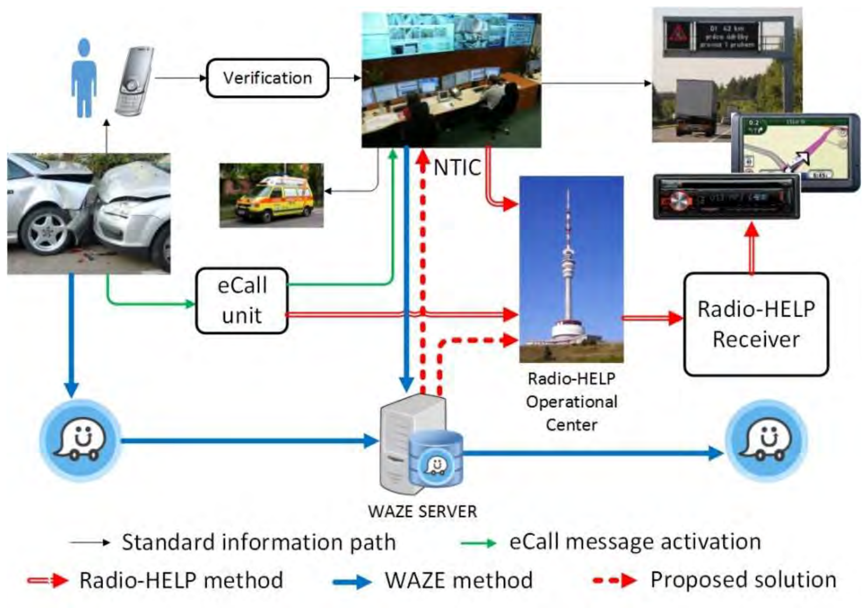
2.8.1 Generally about WAZE

WAZE is a free social GPS application featuring turn-by-turn navigation. WAZE is supported by Android, iOS, Symbian, Windows Mobile. WAZE differs from traditional GPS navigation software as it is a community-driven application and learns from users' driving times to provide routeing and real-time traffic updates. It gathers map data and other information from users who use the service. Additionally, people can report accidents, traffic jams, speed traps and police patrols.

For the purpose of early warning, we are going to deal only with the alerts. The routeing and navigating is not important for this paper. WAZE can be used for warning in both cases – car accidents and traffic problems. It will inform other users the fastest way (compared to previously described methods). On the other hand, it has some disadvantages. A sufficient penetration is required. A smartphone is necessary (Operating systems: iOS, Android, Windows Mobile) and a data plan is needed (to eliminate expenses for mobile data). But even with a data plan, there are areas with no signal. In case of an accident, there is a delay described in the next chapter.

WAZE does not get information only from its users but from the NTIC as well. The reverse flow of information is not possible at the moment. Reports from drivers are verified by other drivers but WAZE is still not a reliable information source for the NTIC. Of course, even a WAZE user has a duty to report an accident on line 112. In which case the other WAZE users are informed twice.

Fig. 1: Transmission and acquisition of information in the event of an accident with the use of the eCall, Radio HELP and WAZE)



Source: author

2.8.2 Implementing WAZE

The idea was to allow information from WAZE report flow into the National Traffic Information Centre (NTIC) that would then deal with it like with information from any other source (Kubát, 2013). The data format of the information would have to be standardised. After the standardisation the information could be processed flawlessly. It would ensure better awareness on the input. If the information is properly verified it could be processed by the Radio HELP system immediately without causing delay in the NTIC. WAZE implementation would take effect in case of traffic problems that are not life-threatening. In those cases, the eCall is not activated and drivers are not obliged to inform NTIC about the problem.Comparing separate segments of each method.

We could divide the entire process into three parts: input, processing data and output. We can group them together and compare their advantages and disadvantages. In the following summary, good data coverage for WAZE is assumed.

The situations on **input** can be the following:

- A participant or a witness will call an emergency line (112) and announces the accident/traffic problem. Then NTIC will have to verify the message by sending police unit or fire department unit to check coordinates of the accident. A disadvantage of this method is an inevitable delay caused by the necessity of physical verification. The calls could also be compared to other calls. It would request waiting for further people to call the NTIC.
- The eCall unit will automatically open a communication canal with an operator in the emergency centre (only in case of an accident). This method is the quickest one but it is switched on only in case of an accident and its implementation is not finished yet.
- WAZE user inputs information about an accident or a problem to the application. After the accident is reported the information is promptly forwarded to other users. Besides disadvantages mentioned earlier, there is a delay in special cases, such as a chain crash. There is no time to input the event so approaching drivers have no chance to be informed. Even in usual (not chain) car accident the third driver will be warned (first driver crashes, second driver reports the accident and third driver get a notice).

There is no absolute winner. The best choice consists of combination of all three methods.

Data processing:

- NTIC – quick response due to the number of reports. But there is a human factor leading to delays.
- Radio-HELP – automated processing, but it requests standard data format on input, which is possible only in case of the eCall or WAZE input (or other automated solution).
- WAZE server – no delay, a verification is done by other drivers (WAZE units).

After comparing the fastest input (eCall) and fastest data processing (Radio-HELP and WAZE), it was concluded that a combination of those two methods is not possible. The eCall is automatic, but in current circumstances, it needs a human worker to process information about an accident. On the contrary, Radio-Help and WAZE methods are processed automatically, but they need a human user to input the event.

Output – message for drivers:

- Output via standard methods (Variable information boards, RDS-TMC...) strongly depends on the quality and speed of the previous two segments (input and data processing). There are exceptions (i.e. variable information boards in strong snowfall) but in general, this claim is correct.
- Radio-HELP receiver provides immediate information about the traffic problem. But at the moment it is only in a conceptual stage, and further work has to be done.
- WAZE interface (smartphone) provides voice alert and it is quick as well, especially for traffic problems without the eCall activation.

Security issues of the application are equal to security issues of any other application that can send positional data. And using the application is a personal choice as opposed to the obligatory eCall. When asking people about their opinions and feelings regarding the eCall, there were some comments about personal security and information leaks. Therefore, we decided to make a survey covering this area (Kubát, Weinlich & Semerádová, 2014). The survey is described in the fourth chapter.

2.9 Google Traffic

Google Traffic is a feature of Google Maps that shows the traffic situation in real time in more than 50 countries. Google Traffic can view the Google Maps website, or using Google Maps on a mobile device. Google Traffic works on the analysis of GPS - determines placement based on information transmitted to Google's servers for a large number of mobile phone users. Google handles incoming raw data on the location of mobile devices and eventually excludes anomalies, such as postal vehicles frequently stopping. If a threshold is reached in a certain area the overlap layer on the Google Maps changes colour.

3 Survey

When presenting the idea of connection of WAZE with the NTIC, many doubts about user data security and other personal data issues were encountered. It was therefore decided to conduct a survey about this topic and to find out how people perceive the data security concerns and how they feel about possible data misuse. This part of the paper introduces results of the survey.

The questionnaire was created with emphasis on the fact that each respondent is different. Therefore the questionnaire was branched so that we can get useful information even from a respondent who does not own a car or a mobile device. For example, if he or she does not use a mobile device for navigation, there was a question: "*Why do you think other people find using mobile devices for navigation useful?*"

For the best variety of respondents, the questionnaire was disseminated in many different ways. Via e-mail (friends and family members), Facebook, iDNES.cz blog, car section on news server (garaz.autorevue.cz) and 1.9% of questionnaires was filled in directly on the server where the questionnaire was created. We avoided asking students because it would influence a diversity of results.

3.1 Composition of respondents

Total number of returned valid questionnaires was 210 out of 250, 62.9% were men and 37.1% women. Most respondents were from three age groups - 18 – 25 years old

(25.2%), 26 – 30 years old (20%) and 31 – 35 years old (19%). The education of respondents was mainly *high school* (43.8%) and *university* (46.7%). A response rate cannot be established because this questionnaire was online. Therefore when a potential respondent decided not to attend the research, authors would not know it. All respondents were from the Czech Republic.

3.2 Evaluation

3.2.1 Groups of users

In the first step, basic groups of users were identified. Almost three-quarters of the respondents (74.3%) respondents own a car, 73.1% car owners use a smartphone and 68.4%, e.g. 73 both respondents and smartphone owners use it for navigation. People who do not use it for navigation have following reasons: 58.3% users have dedicated navigation, 13.9% use paper maps, 25.0% do not need a navigation and 2.8% have other reasons.

The question „*Would you like to have the eCall installed in your older car?*“ showed also interesting responses. 40.6% respondents would agree if it cost less than 150 €. 10.1% would install it if it cost less than 300 € and 52.2% respondents would not install it at all.

3.2.2 Concerns about eCall data misusing

In the next step, the fear of data misuse when using the eCall was evaluated. From the total of 210 valid respondents, 25.7% was anxious about a data misuse. One of the aims of this paper was to find out what affects such privacy concerns. If it is gender, income of the family, age or education. Respondents were not told about any misuse possibilities in advance but an open question was used to gather opinions (no options were suggested).

Hypothesis claimed that there is no dependency of concerns on observed property (age, income etc.). For finding out the dependency a Pearson contingency coefficient was used. The coefficient can reach values $0 \leq P < 1$, whereas value 1 cannot be reached. Calculations showed that the dependency in all investigated characteristics is very low. The strongest dependency is on age and the weakest on gender. Hypothesis was rejected.

$$P_{age}\,(0{,}254) > P_{education}\,(0{,}19) > P_{income}\,(0{,}125) > P_{gender}\,(0{,}039)$$

3.2.3 Privacy concerns of social network users

After comparing answers to questions: "*Are you afraid of misusing your personal data while using smartphone for navigation?*" and "*Do you use social networks?*" it was found out that from 35 respondents who are afraid of misusing their personal data 26 use social networks. This brings another question: How justified are these concerns? People may think that Facebook or Google+ are safe because these social networks are widespread. But they are suspicious about the eCall and the social navigation software. This contradiction is very interesting.

3.2.4 Categorising concerns

In the questionnaire, there were included some open questions For more detailed overview of respondents' concerns. Among them was the question: "*How could be the data misused?*" This question was answered by smartphone users and their replies are in the table 1.

Tab. 1: Categorising concerns – smartphone users

concern	% of phone users
Position tracking	26.5%
Marketing issues	23.5%
Stealing money, property	17.6%
Various ways	14.7%
Voice monitoring	5.9%
Identity theft	5.9%
I don't know	2.9%
Speeding tickets	2.9%

Source: author

From users' replies is easily readable that the position tracking is not the only issue. Misuse for marketing purposes or stealing money is a privacy concern of many users as well. Unfortunately, there were not more respondents so the results are not very indicative.

Next important question was: "Why are you afraid of implementing the eCall since 2015?" There are two main groups of respondent that have similar replies. Most respondents were worried of *Misusing with no detailed description* (34.6%) and *Permanent position tracking* (32.1%). Some replies correspond with facts discussed above, e.g. electronic road-toll is not only pointless fear but taking into account the official document it has some real foundations.

4 Discussion

The method combining WAZE and Radio-HELP system could work but there are non-technical problems that prevent the system from application. There would be a need for a strategic decision to support implementing the system on national basis. But the support is very uncertain.

Thus there are efforts to develop a concept of warning based on the same principle – non-addressed warning. But the means would be different. Instead of using Radio-HELP based on radio waves the more common methods will be used. The change consists of using SMS messages and Internet of Things (IoT). Those already used technologies could be incorporated into the original design of the system instead of using radio waves. IoT technology has its risks that need to be taken into account. But it is also increasingly widespread, more used and offers many benefits to its users. Risks are mainly security. In contrast, the inclusion of SMS messages to the proposed system should be risk-free, as current phones already have with these reports trouble-free long-term work. This solution is possible even after the transition to digital broadcasting.

The concept of using the Internet of Things would work with the already used sensors in vehicles for sharing data about road and weather conditions, etc. Those data would be stored in a cloud, where they can be accessed by vehicles possessing internet access and adapt the ride according to newly acquired information. These two methods should complement each other.

Conclusion

Warnings and information methods given in the previous chapters are not, of course, an exhaustive list. Almost every carmaker develops its means of warning more or less compatible with each other. Nevertheless, the proposed improvements are not dependent on the make or type of vehicle, and therefore should be universal.

There is no doubt that implementing new technologies can improve reaction time in case of an emergency situation. But in the contrary, there are facts that are not officially communicated to the public. And after evaluating the questionnaire it can be concluded that citizens are not unconcerned about their privacy. There are some ideas how to improve the safety. For example to make the eCall firmware open-source code. But the question is, if this would be acceptable by the authorities.

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