International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 09
August 2017

Factors Of Road Accident: A Review Of Intelligent Transport System

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Abstract: *Road accidents comprise one of the main causes of death in western society and a new set of measures that are anticipated to improve road safety has evolved – namely, the intelligent transport systems. This paper presents a structured evaluation of intelligent transport systems. First, common causes of accidents are identified and specific systems that could remove those causes or reduce their effects are proposed. The systems are then assessed based on conclusions drawn from research studies and expert opinions. For each of the suggested systems the potential capabilities for improving driver behaviour and road safety but also the anticipated shortcomings of their implementation are discussed.*

Keywords: ITS, SWOT, Risk, Factors, BAC, DUI

Introduction: Road accidents comprise one of the major causes of death in western countries, and the primary cause of death for specific groups, such as young people. A great variety of measures aiming at the reduction of accident rates have been discussed and applied worldwide, and have indeed improved the safety of the road networks. With the new targets set for road safety levels in various countries, however, there is a demand for more dynamic solutions. Intelligent transport systems (ITS) could be a promising direction towards providing an efficient solution for the improvement of road safety, thus setting new standards.

Intelligent transport systems comprise a quite recent development in the field of transport and technology and as such it demonstrates rapid development. ITS are anticipated to contribute to several issues that have been a consequence of the mobility growth including improving road safety, and reducing traffic congestion and environmental pollution. Other elements at which ITS are anticipated to contribute are increase in mobility especially of the less 'mobile' groups (disabled, elderly drivers etc.) and increase in driving comfort. The majority of the research studies conducted on the impact of intelligent transport systems on road safety follows a 'system' methodology.

In particular, the intelligent transport systems that are foreseen to have been implemented in the near future are described and their general impact on road safety is discussed. The present study adopts a more 'humanistic' and 'safety-related' approach by defining first the risk factors that contribute to road accidents and then proposing targeted IT-solutions. The procedure of application and evaluation of intelligent transport systems seems to be a rather slow one. The quantification of the impact of such systems on accident rates can only be established after they have been implemented for a long period so that specific elements including technological features, penetration rates and driver behaviour when using the systems have been stabilised. Still, specific elements of their impact can be somewhat estimated indirectly with the use of surrogate measures. Hence, although the implementation cost of intelligent transport systems is definable and is quite high, their benefits are still abstract. After all this research, the question remains: "Can intelligent transport systems be an efficient answer to road accidents?"

Objective of the Study: This study is to determine the possibilities that intelligent transport systems can provide on the improvement of road safety by targeting specific risk factors. In addition, the shortcomings of these proposed solutions are also discussed to indicate the needs for future research and system development. The capabilities and shortcomings of ITS are extracted from three different types of analysis. The first is the collection of research studies on the impact of intelligent transport systems on the user and on road safety in general. The second type of analysis used involves applying a common evaluation procedure to the investigated systems – namely, SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis. Finally, the third type of analysis is the conduction of a Delphi study dealing with the impact of intelligent transport systems, from which experts' opinions were also extracted.

In the second section of the paper the risk factors contributing to accident occurrence are discussed, and in the third section possible IT-solutions that could reduce the defined risk are described. The fourth section deals with the impact of these systems on road safety both in terms of positive and negative impact. Last, in the fifth section a general overview of the potential impact of intelligent transport systems on road safety is provided.

Risk Factors: Traffic accidents are quite complex events and rarely have a single

cause. To illustrate this statement the following example is presented: A driver crosses a junction (following a sharp curve) and hits a vehicle coming from the junction leg that had 'right of way'. The result in this example is an accident. However, the cause cannot be extracted from the above description. This driver, who was a novice driver who was not familiar with this particular road network, was returning home after a night at the bar, having drunk several beers, was speeding, and was listening to his favourite song on the radio while talking on his mobile phone. The accident took place at night, and the pavement was quite slippery as it had been raining. Possible isolated explanations of what had caused the accident are:

- the driver was not aware of the 'STOP' sign and he was driving too fast to make a complete stop upstream of the junction approach, or
- although he was aware of its existence he did not see the sign because he was listening to music and talking on the mobile phone, or
- he did see the sign but the pavement was too slippery and he did not manage to stop, or
- he did see the sign on time but his reaction time was too slow because of being drunk, or
- He did stop at the junction approach but did not judge well the speed and distance of the other vehicle because of his inexperience and decided to cross.

Still, it would be difficult to identify a single cause for this accident. The cause of the accident could be one of the above described ones, or a combination of them. There are multiple sub-causes and procedures that contribute to an accident, the treatment of one, some or all of which may result in the avoidance of the accident or the mitigation of its consequences. These sub-causes will be referred to as risk factors. Risk factors can be classified into three main categories – namely the ones induced by the human, the road environment and the vehicle. Human factors involve the condition or the actions taken by the driver. Road environment factors involve the roadway design and roadside hazard and conditions. Last, vehicle factors involve vehicle-operation failures or vehicle design issues. Intelligent transport system solutions only target at reducing or eliminating human and road environment factors, hence only these two factors will be presented in this paper.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
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Human Factors: The most prevalent risk factors contributing to a road accident are human factors. In addition, there is a great variety of different human factors in relation to environmental factors and their treatment can be less costly and is more effective on road safety, if achieved. For the reasons mentioned above research on risk factors and countermeasures is more concentrated on the human factors category. Human factors can be divided in several different categories, which will be dealt with separately and are:

- Alcohol and illicit substances
- Speeding
- Violations of the highway-code
- Driver inattention
- Driver decision errors

- **Alcohol and illicit substances:** One of the most prevalent risk factors is driving under the influence (DUI) of alcohol, illicit substances or a combination of legal drugs and alcohol. The main effects of DUI are a reduction in driver perception, concentration and an increase in reaction times. There is a clear relationship between DUI and accident rates; increase in blood alcohol concentration (BAC) or other such substances results into higher accident risk. The relationship between DUI and severity rates has not been established yet although in some studies there has been evidence that alcohol has been the prevailing factor in most severe accidents. Driving under the influence of such substances (and especially alcohol) is encountered in many countries to a lesser or a greater degree. A survey that took place in 23 European countries showed that the proportion of checked drivers with higher BAC than the legal limit ranged from 4% to 64%, with the average being 16%. Road accidents involving DUI are related to driver characteristics such as age and gender. In particular, this type of accidents decreases with age, and young male drivers are of the highest risk drivers. Last, DUI is observed more frequently at the weekend nights as the majority of leisure trips take place during these periods.
- **Speeding:** Speeding is also one of the most significant factors contributing to road accidents. The relationship between speeding and accident rates has been established and is twofold. Higher speeds lead to greater risk

rates and higher speeds lead to higher severity rates. High speeds increase the probability of making a perception or a decision error as there is less time to react to observations. They also reduce manoeuvrability and time-to-collision (TTC), and increase the crash impact. A consequence of the latter is that speeding accidents involving vulnerable users such as pedestrians or cyclists have a greater probability of being fatal.

- **Violations of the highway-code:** Violations of the highway-code are actions involving the conscious ignorance of the traffic rules and can be considered as conscious risk-taking. However, the majority of drivers that violate the highway-code underestimate the risk and overestimate their driving abilities, as thoughts such as 'I am careful when crossing at the red signal indication' are usually in mind. Examples of violations of the highway-code are crossing a junction when the traffic signal indication is red, not yielding way at 'right-of-way' movements, not stopping at 'STOP' signs etc. It must be emphasised that this category deals with these actions when they are made consciously.
- **Driver inattention:** Driver inattention can be described as a lack of focus (visual or cognitive) on the required field of view, typically the forward and the peripheral, that leads to a loss of concentration on the driving task. It occurs when the driver performs a secondary task (tuning the radio, talking on the phone) while driving, and part of his attention is switched from driving, which is the primary task, to the secondary one. Driver inattention is a significant risk factor and has also been linked with severe accidents.

Environmental Factors: The most important environmental factors that may have an impact on road safety, and are discussed in the context of this study are the following:

- ✓ Geometrical characteristics
- ✓ Pavement conditions
- ✓ Weather conditions
- ✓ Street light conditions

Opportunities and Methodology: In this section the proposed intelligent transport solutions will be evaluated. Three tools contributing to this evaluation will be used. These are a literature review based on an extensive search of related studies, the conduction of a SWOT analysis and the results of a Delphi questionnaire. For the

literature review, several national, international and EU projects as well as research studies published in scientific journals and conferences were collected and their main findings were processed. The second tool, is the results from a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis , which was conducted by experts who were asked to identify the potential S, W, O, T's of specific ITS. SWOT has been previously employed to assess the role of intelligent transport systems in the transportation planning process. Strengths and weaknesses involve the technological possibilities and problems of the systems and comprise internal factors, whereas opportunities and threats are external factors including user behaviour, political, legislative and market issues. In this paper, only the external factors will be presented as the internal ones are temporary and can change rapidly with system technological development. Last, the results of a Delphi study will also be used in the assessment of the systems. Experts in the field were asked to fill-in a questionnaire discussing issues related to the impact of specific systems on road safety. The Delphi study tool has been previously employed in the field of intelligent transport systems.

Conclusion: This study discusses potential intelligent transport system solutions that can improve road safety by targeting specific risk factors. Hence, risk factors including both human and road environment factors that have been found to contribute to road accidents are identified. Prevalent human risk factors include intoxicated drivers, speeding, traffic rules violations, and driver inattention and decision errors. Whereas, the most important road environment risk factors are bad geometrical design of a road section or junction, and adverse surface, weather or road lighting conditions.

For most of the identifiable risk factors intelligent transport systems that have the potential to act as targeted countermeasures exist as fully developed systems that have been introduced into the market or in a less developed form. Example of the proposed systems include alco-lock, speed limiting systems, collision and lateral warning systems, driver monitoring, driver information and vision enhancement systems. Some of these systems prevent the driver from driving under hazardous conditions (alco-lock, driver monitoring system, intervening speed limiter), others assist drivers while driving by alerting the driver when detecting possible errors (collision avoidance, lateral warning) or by enhancing his perception/vision (vision enhancement

system) and other systems inform or warn the driver of risky driving or environment conditions (informative and warning speed limiters and driver information systems). The employment of the proposed intelligent transport systems provides the opportunity to reduce risk rates and hence improve road safety. Nevertheless, it also imposes specific threats that should not be neglected. These arise from a number of factors including driver frustration because of the frequent warnings, driver over-reliance on the systems and behavioural adaptation which may lead in an increase in risk rates. The adverse effects of the use of intelligent transport systems should be looked-at thoroughly and ways of overcoming them have to be proposed in order to allow for their successful implementation.

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