Exploring driving habits and safety critical behavioural intentions among road tunnel users: A questionnaire survey in Greece

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With a view to enhance the safety of the road transport system, it is crucial to focus primarily on its key elements, one of which is tunnels. The significance of tunnels is based on an endogenous problem, which is the severity of accidents that may occur. Several studies and aftermaths from disastrous accidents have shown that correct users' behaviour may smooth the adverse outcomes of a potential accident. Therefore, information campaigns are requested to be conducted. Before designing such a campaign, it is vital to have explored users' current state of knowledge on the issue. This paper presents an internet-mediated questionnaire survey conducted in Greece aiming to explore road tunnel users' awareness and to identify potential knowledge gaps that should be managed for the upcoming information campaigns. The results revealed that users have several misconceptions concerning the recommended behaviour both in normal and critical situations. Taking into account that users consist in the cornerstone of tunnel safety parameters, it is important to note that even a little improvement on their performance may greatly benefit the overall safety of the system. Hence, aspects highlighted in this paper could be taken into consideration by the upcoming information campaigns on the issue.

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1. Introduction

Road tunnels are regarded as a key element of the road transport system due to their significant role which is to create shortcuts in mountainous regions as well as traffic connections without changing the environment in the countryside and also to improve the environment in dense populated areas by relieving traffic congestion. Furthermore, the improvement of construction technology, over the last recent years, has rendered road tunnels as a cost-effective engineering solution in developing new road networks (Maidl et al., 2014). Therefore, their number has reasonably increased worldwide over the last two decades, increasing, in turn, the number of people using them (Zhuang et al., 2009; Meng and Qu, 2012).

On the contrary, the growth of road tunnels is a double-edged sword as it bears an endogenous problem, which is the severity of accidents that may occur. Although accident rates appear to be lower in tunnels than on the open roads, an accident in a tunnel may have much greater impact, owing to its enclosed nature. This becomes evident in Caliendo and De Guglielmo (2012) who present a report from Italy (the country with the highest number of road tunnels among EU Member States) that shows that severe accidents are more frequent in road tunnels. In particular, they report that between 2006 and 2009, road tunnels had a severe accident rate between 9.13 and 20.45 crashes/10⁸veh km, while on the associated motorways the rate was between 8.62 and 10.14 crashes/10⁸veh km. Still though, the overall accident rate on motorways was still higher than in tunnels. Another study including all the European States was conducted within Safe-T research project and presented similar results (Kraussmann and Mushtaq, 2005). Especially in accidents in which fire occurs, the limited space hinders the dissipation of smoke and poses difficulty in ensuring safe escape route of users leading to catastrophic consequences (Hansen and Inganson, 2011; Caliendo et al., 2012; Kircher and Ahlstrom, 2012; Sturm and Bacher, 2015).

In the past, the issue of safety in road tunnels has drawn public attention mainly after the disastrous accidents in trans-Alpine tunnels (e.g. the fires in the Mont Blanc tunnel, 1999; in the Tauern tunnel, 1999; in the Gotthard tunnel, 2001), which revealed that the safety level of such infrastructures depend not only on the technical installations of the system (e.g. ventilation and other electromechanical equipment) but also on the human factor, too.
(Voeltzel and Dix, 2004; PIARC, 2007). As a result, the European Commission issued the Directive 2004/54/EC that sets the minimum infrastructure and equipment requirements for all tunnels belonging to the trans-European road network. The Directive 2004/54/EC also includes a provision which suggests to every Member State to organise information campaigns, in regional level, in order to promote road tunnels safety (EC, 2004).

Greece, following the global trend, has significantly increased the number of road tunnels due to the rapid development of major highways during the last decade (GCTUP, 2015). Thus, Greece is ranked nowadays fourth behind Italy, Austria and Germany regarding the absolute number of road tunnels longer than 500 m which belong to the trans-European road network (PIARC, 2012b). Hence, the need for conducting information campaigns focused on users’ safety emerges. However, prior to implement an information campaign, capturing the current behavioural state of users is a necessary step for a successful outcome.

The aim of this research endeavour is to explore road tunnel users’ behavioural intentions towards safety and to identify misconceptions and knowledge gaps of users that must be dealt with by the forthcoming information campaigns. This aim is carried out through an internet-mediate questionnaire based on European and World Road Association’s (PIARC) best practices (PIARC, 2012b). Hence, the need for conducting information campaigns focused on users’ safety emerges. However, prior to implement an information campaign, capturing the current behavioural state of users is a necessary step for a successful outcome.

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2. Users’ role in tunnel safety

A review on users’ role in the current framework of the road tunnel safety is a preliminary stage in the way of forming the research questionnaire. Existing safety provisions is the first aspect that should be considered. Directive 2004/54/EC is the main regulatory provision and has been part of the Greek legislation since 2008. The Directive brought a new notion towards safety in tunnels and this was the holistic approach of tunnel safety encompassing all the crucial elements of the tunnel system, namely: (a) the infrastructure, (b) the users, (c) the vehicles and (d) the facilities, as depicted in Fig. 1 (PIARC, 2008, 2012a). It should be stated here that traffic, although now laying under vehicles can be a new element of the system due to its significant importance. According to the holistic approach, each element has to adopt the necessary safety requirements not only considering it as a unit but also taking into account the interaction with the other elements. Thus, users’ role for the system safety has been upgraded.

Considering users’ role in the new framework, the need for assessing users’ driving habits and safety critical behavioural intentions emerges. Results from the post-accident reports regarding the trans-Alpine disasters indicate that many users did not behave correctly during the evacuation process (e.g. stayed in their cars, were trapped in the shelters, etc.) (Voeltzel and Dix, 2004). These accidents gave rise to various projects afterwards in which an extensive research of human behaviour in the road tunnels safety domain was included. For instance, the UPTUN project exhibited the significance of information campaigns for a successful self-evacuation process of the users (Papaioannou and Georgiou, 2003). In parallel, the ACTEURS project names users as basic players of the system, and comments on the difficulty to communicate to them the right behaviour (Noizet et al., 2003).

Furthermore, various research studies were conducted focusing on exploring users’ habits and behaviours. A study performed in Norway exploring driving habits of drivers in road tunnels showed the gaps of knowledge of drivers towards tunnel safety (Amundsen, 1994). Another questionnaire study from Singapore showed that drivers’ perspectives for open roads and tunnels are indeed different to some extent (Yeung et al., 2013). A study performed in the Rhone-Alpes Region of France indicated several key points towards users’ behavioural intentions like the relationship between fire – awareness of rescue and safety devices as well as road tunnel experience. The outcome showed that evacuation behaviours and coping strategies reported by the participants were far away from reflecting the expected ones (Gandit et al., 2009). Similar results were reached from a Benelux tunnel study where it became evident that many drivers did not have any information about safety facilities and some others, mainly motorists, did not even assess the criticality of the situation (Boer and Veldhuijzen van Zanten, 2007). An evacuation experiment conducted in Sweden, explored how parameters like social influence and information signs are important for the success of the self-evacuation process (Nilsson et al., 2009). The same subject was investigated through an experimental evacuation in the tunnel harbour of Sydney (Burns et al., 2013).

Kinateder et al. (2013) research focuses on the effect of the information on users’ behaviour as well as training, which are crucial factors during an evacuation process. Additionally, evacuation behaviours were shown in the experiments for calculating, one of the most important factor when assessing safety, the evacuation speed in a smoke-filled tunnel in Japan (Seike et al., 2016). Lastly, in Ronchi et al. (2016a,b), the parameters which define the choice of evacuation paths were examined in a virtual reality experiment that took into account distance and social influence. All the aforementioned indicative experiments showcase the importance of the human factor in the evolution of a tunnel accident.

Another essential element for better understanding the human behaviour in fire accidents is the existing theoretical framework. Fridolf et al. (2011) mention four commonly used and accepted theories on this issue namely, (a) the behaviour sequence model, which separates the human behaviour in four distinct areas (receive; interpret; prepare; act), (b) the role – rule model, which considers that every person will behave according to the set of rules of his position, (c) the affiliation model, which assumes that a person will head to places or follow people that are familiar to him and (d) the social influence, which considers that a presence of other people can affect one’s evacuation process. Each one of the above theoretical models can be used to interpret the evacuation process that is going to be followed by the users. These models have been used in many research and experimental endeavours. For instance, UPTUN project refers to the behaviour sequence mixed with role-rule model (Papaioannou and Georgiou, 2003).

Fig. 1. Safety framework (adapted from PIARC, 2008, 2012a).
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