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The Role of Herding Behaviour in Exit Choice during Evacuation

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Abstract

Modelling of human behaviour during emergencies is an important issue to be investigated to improve the safety of transportation infrastructures. This behaviour can be influenced by both the environment (i.e. social influences) and characteristics of the users of infrastructures. The main aim of this paper is to investigate the social influences that push a user to manifest a herding behaviour during evacuations. A behavioural model based on discrete choice models is proposed by using data collected through an on-line survey. This approach is able to highlight the heterogenic tastes of decision makers that may influence this choice in exit behaviour. The results show that decision makers are influenced by both people close to the exit and their socio-economic characteristic.

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Keywords: Evacuation Modelling, Exit Choice, Herding Behaviour

1. Introduction

Recent terroristic attacks (i.e. Madrid 2004 and London 2005) and accidents in tunnels and undergrounds, (i.e. Burnley, 2007, Mont Blanc tunnel 1999, King's Cross, 1987; Zurich, 1991) have shown that existing transportation infrastructure is not always able to provide adequate safety conditions during evacuations (Fridolf et al., 2013). Increasing the safety level of infrastructure in case of emergency requires knowledge about human behaviour (Low, 2000).

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Performance Based Design (PBD) is an available approach to predict the safety level of transportation infrastructures. It is based on the comparison of the Available Safe Egress Time (ASET) and Required Safe Egress Time (RSET) (Nelson and Mowrer, 2002; Purser, 2003). In order to estimate RSET, different macroscopic and microscopic evacuation models and simulation tools are available to test the performance of an infrastructure during emergencies (Gwynne et al., 1999; Hensher et al., 2005; Johnson, 2005; Kuligowski et al., 2010; Zheng et al., 2009). These tools are largely used to evaluate the safety level of both new and existing transportation terminals and tunnels (Weidmann et al. 2014). Among the most recent applications, Le Glatin et al. (2014) implented one of these tools to evaluate the process of evacuation from London Bridge station (London Underground) after the redevelopment of the station realised as part of the Thameslink Programme. Liu et al. (2014) studied the performance of different cross-passageways for new rail tunnel during emergencies. The accuracy of these models, however, is limited by the lack of knowledge regarding human behaviour during these types of events (Lovreglio et al., 2014b). Thus, new studies on human behaviour are required in order to improve the validity of these models (Lovreglio et al., 2014b).

Different behaviours have been observed during evacuations including: herding behaviour (Helbing et al., 2000; Low, 2000; Pan, 2006), cooperative behaviour and competitive/selfish behaviours (Cirillo and Muntean, 2013; Heliövaara et al., 2012; McLean et al., 1996; Muir and Cobbett, 1995). Several theories have been proposed in order to explain the social interactions at the base of these behaviours, including: the role-rule theory (Canter et al., 1980; Tong and Canter, 1985), the affiliative theory (Sime, 1985) and the social influence theory (Deutsch and Gerard, 1955; Nilsson and Johansson, 2009) (Fridolf et al., 2013). Another more general theory that could be integrated to explain social interactions is Caldini's social proof theory (Cialdini, 1993).

This work focuses on herding behaviour in exit choice, which is one of the most important decisions during evacuations (Lovreglio et al., 2014a). Herding behaviour occurs whenever people behave as a group by putting aside their ability to act as individuals (Saloma and Perez, 2005). In the exit choice context, herding behaviour means that the decision-maker chooses the most congested exit only because that is the most popular choice, rather than an exit with less people which may ensure a lower evacuation time. This behaviour is directly influenced by social influences that occur during evacuations (Pan, 2006).

This work focuses on the possibility of explaining herding behaviour through the theories of social influence and social proof. Firstly, this paper gives an organic vision of this behaviour according the existing literature. An approach based on Random Utility Models is used to model herding behavior in exit choice. This approach is applied to the data collected by Lovreglio et al. (2014a) according to methodology that is based on "a priori" face-to-face interviews.

This work starts with a review of the social influence theory and the social proof theory and how these can be correlated with and lead to herding behaviour. A summary on the approaches used until now to model herding behaviour is presented and a case study based on data collected by Lovreglio et al. (2014a) is described. The model estimated is described and a behavioural analysis is presented. Finally, some suggestions are provided to overcome the limitations presented in this work.

2. Social Interactions and Herding Behaviour

Social Influence theory splits the social interaction among users of an infrastructure into normative and informative social influences (Nilsson and Johansson, 2009). Normative social influences concern the "influence to conform to the positive expectations of another" (Deutsch and Gerard, 1955). This means that people in general are afraid of standing out or making fools of themselves by not complying with prevalent social norms (Nilsson and Johansson, 2009). Informative social influences deal with the "influence to accept information obtained from another as evidence about reality" (Deutsch and Gerard, 1955). In regard to this aspect of social influence, people may be seen as sources of information about how to react during situations characterized by uncertainty (Kinateder, 2012).

Literature argues that these social influences (i.e. informative and normative) may be an important environmental factor during evacuations as a way to deal with the perceived uncertainty associated with these situations (Kinateder, 2012; Lovreglio et al., 2014a; Nilsson, 2009). Thus, during evacuations other people may be seen as both a source to understand what is happening and an example of how to behave (Informative Social Influence). On the other hand, the social norms that emerge during emergencies may also force people to behave differently in order to avoid embarrassment (Normative Social Influence).