LITERATURE SURVEY ON SMART SIGNS FOR BETTER ROAD SAFETY

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Abstract :

Driver inattention and distraction are recognised as two of the most critical factors for road safety worldwide. While roadside advertising is often identified as a potential source of distraction, it has received less attention compared to other types of distractions such as texting or calling while driving. Therefore, this study focused on the impact of roadside advertising signs on driver behaviour and road safety. To examine this, a theory-driven systematic literature review was undertaken. In total, 90 unique documents were identified and reviewed using the Task-Capability Interface (TCI) Model to explain the potential safety impact of roadside advertising. The findings confirmed that the TCI model is a useful tool for describing the relationship between roadside advertising and driver behaviour. From this perspective, roadside advertising signs can be considered environmental clutter, which adds additional demands to the driving task. In particular, roadside advertising signs impaired eye movement patterns of drivers. Additionally, it was demonstrated that the impact of roadside advertising on driving behaviour is greatly moderated by individual differences among drivers. Of great importance was that young drivers invest more attentional resources in interacting with roadside advertising, which suggests a lower capacity to discriminate between relevant and irrele- vant driving information. Based on the available evidence, however, it is not possible to definitively conclude that there is a direct relationship between the driving behaviour changes attributed to roadside advertising and road crashes. Nonetheless, while most studies remain inconclusive, there is an emerging trend in the literature suggesting that roadside advertising can increase crash risk, particularly for those signs that have the capacity to frequently change (often referred to as digital billboards). Lastly, it is important to mention that most of the empirical studies undertaken to date feature strong methodological limitations. Consequently, there is an urgent need for more research in this area, given that roadside technology and the transport system are changing rapidly.

INTRODUTION:

Driving as a transport behaviour delivers important social and economic benefits, but also poses significant risks to quality of life, including injury and death. Worldwide, over 1.2 million people die each year as a result of injuries sustained from road crashes (WHO, 2015). Economically, injuries and death that result from road crashes cost governments on average 3% of their gross domestic product (WHO, 2015). Notable improvements in technologies such as cooperative intelligent transport systems and driving automation are expected to benefit road safety in the future. However, recent estimates suggest that large benefits are only likely to be observed in

the long term—25 to 30 years—(Dia, 2015) due to numerous challenges related to infrastructure investment (Clark et al., 2016), public perception (Kyriakidis et al., 2015), and vehicle design policies (Smith, 2016). Until active safety technologies are completely accessible to all drivers, it will remain necessary to develop and implement effective road safety countermeasures to prevent road trauma.

Inappropriate or inadequate interactions between drivers and vehicles play a significant role in vehicle collisions. Driver per- formance is influenced by a wide range of factors, including fatigue (Filtness et al., 2012), distraction (Regan et al., 2011), mood (Rhodes et al., 2015), etc. Among these, distraction is recognised as one of the most critical factors for road safety worldwide (WHO, 2011). Conservative estimates suggest that distracted drivers are heavily overrepresented in road traffic crashes (Beanland et al., 2013). Distracted driving involves sharing attention between the primary task (driving) and a non-driving related secondary task. The non-driving related secondary task can be in-vehicle (e.g., mobile phones conversations, in-vehicle infotainment interactions, etc.) or external (e.g., reading roadside advertising signs, looking at non-related landscape elements, etc.).

Roadside advertising signs (often referred to in the literature as billboards) have become a common form of advertising around the world. As such, the impact of these signs on road safety is an area that needs a strong research focus to support policy decisions. Technology is evolving exponentially, and this extends to the technology utilised by road advertising companies. For example, an advertising company has recently created a sign that tailors its advertisements based on how heavy the traffic is (Adweek, 2018). This roadside advertising technology has been used to advertise restaurants, where simple images of food items are presented in fast- flowing traffic with the purpose of stimulating drivers' appetite. Meanwhile in heavy traffic, the advertisement changes to the words 'stuck in a jam? There's light at the end of the tunnel' with a picture of the restaurant logo. In addition, some advertising companies are considering creating personalised messages on roadside advertising signs for specific individuals via number plate recognition (Global Marketing Alliance, 2018) or new delivery modes such as turning other vehicles' windows into video billboards (Kumparak, 2018). These emerging technologies highlight the necessity of an up-to-date review of the literature in this area.

1.1 The interaction between driving and roadside advertising signs

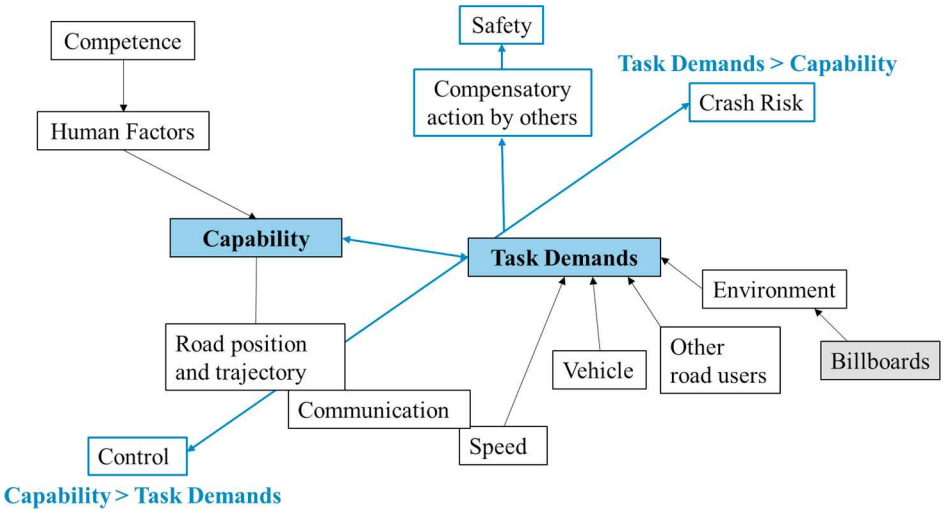
Driving is a complex task that involves extensive interactions between road users and the other components of the transport system such as the driver, the vehicle, and the road traffic environment. Additionally, each component of the transport system includes various elements which can have an impact on driving performance (Rothengatter, 1997). For example, a person with 10 years' driving experience travelling at the speed limit on a clear highway is likely going to demonstrate a different level of perfor- mance than someone who has less experience and is driving on the same highway with multiple noisy passengers. Drivers' individual differences and the wide range of elements in the road traffic environment necessitate the implementation of systemic frameworks to analyse driving and manage safety risks (Scott-Parker et al., 2015; Oviedo-Trespalacios et al., 2018).

Various theoretical frameworks have been developed to conceptualise the driving task and explain safety risks. A notable fra- mework that has the ultimate goal of explaining crash risk is the Task-Capability Interface (TCI) model developed by Fuller (2000). Using a driver-centred approach, the TCI model focuses on two key elements relating to the driving task: (i) the task demands experienced by drivers, and (ii) the driver's capability. The driving task requires the driver to successfully travel from one location and arrive at another while also avoiding safety-threatening events (Oviedo-Trespalacios et al., 2016). The difficulty of completing this task is affected by a number of factors including the environment, control characteristics of the vehicle such as speed or tra- jectory, the driving behaviour of others, and the communication between drivers on the road. The resulting difficulty of the task is what is referred to as task demands (Fuller, 2000). The ability

to successfully meet these task demands and complete a successful trip is dependent on the driver's capability. Within the TCI model, a driver's level of competence (skills and knowledge) interacts with human factors (fatigue, emotions, substances, distraction, etc.) to determine the driver's capability. The model explains how human factors can influence a driver's capability but do not influence the task demands. Using these definitions, the TCI model provides a simple conceptualisation of how task demands and driver capability can explain the interactions between the driver, the vehicle, and the environment, which will lead to either positive or negative driving outcomes. Roadside advertising signs are part of the road traffic environment and, therefore, serve to modify the driving task demands (see Fig. 1). This could be problematic because drivers' attentional resources (drivers' capability) might not be sufficient to both safely drive and interact with the roadside advertising sign. More specifically, the balance of capability and task demands impacts on the perceived difficulty of the task and the task outcome. In other words, in any given situation a matrix of competence and task demands will exist such that if the task demands are low, then the task is perceived as not difficult for drivers with low and high capability. However, if the task demands are high, then those with low capability will find the task more difficult than those with high capability. Similarly, if a driver's capability is impaired, a task can quickly become more difficult than it was previously perceived. In the same way that the balance of capability and task demands impacts perception, it also relates directly to the driving outcomes. As shown in Fig. 1, when the capability is higher than task demands, the driver can maintain control. However, if the task demands exceed the driver's current capabilities, the driver would potentially lose control. This loss of control will likely lead to a crash unless action is taken to ensure safety. Applications of the TCI model have demonstrated its usefulness in explaining speed selection (Fuller, 2011), mobile phone use while driving (Oviedo-Trespalacios et al., 2017a,b), and other driving behaviours.

1.2 Current Study

Despite the relatively widespread use of roadside advertising, scientific understanding about its impact on task demands is limited. Firstly, the available literature is disorganised and limited compared to other road safety concerns such as mobile phone distracted driving, fatigue, speeding, etc. Secondly, roadside advertising signs are continuing to evolve technologically, creating the need for ongoing research to address recent technological advancements. For example, over the last 50 years, roadside advertising signs have evolved from static images to incorporate digital displays and changing pictures/videos designed to capture drivers' attention. Therefore, these technological differences are likely to influence driving task demands in different ways. To close this gap, we conducted a comprehensive systematic literature review informed by the TCI model.



2. METHOD:

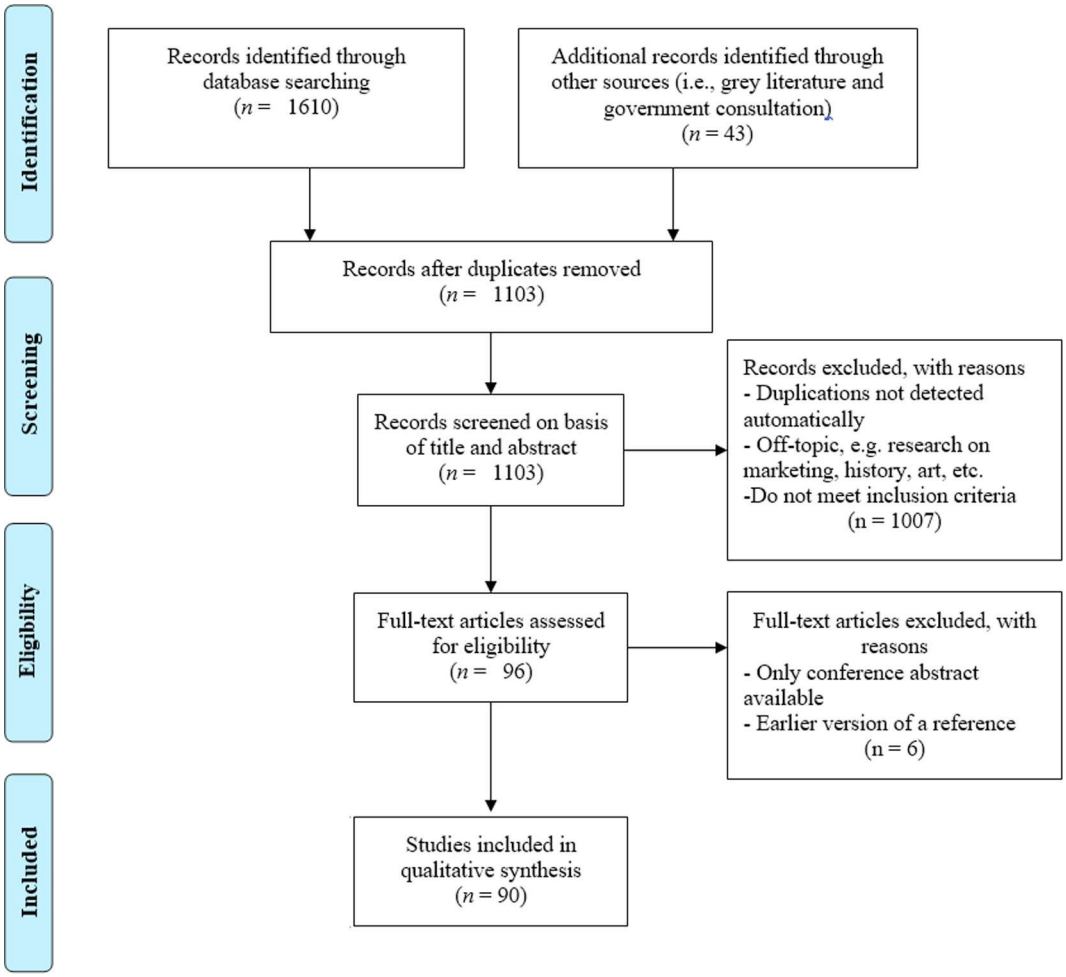
A literature review was selected as the most appropriate method of research to address the question of whether roadside ad- vertising signs impact on driver behaviour and crash risk. Given the number of components and causal mechanisms theoretically described in the TCI model, a systematic classification scheme (SCS) was developed to guide and assist in synthesising the available literature. As described in the introduction, the TCI model proposes that crashes are a result of impaired driver behaviour (i.e., longitudinal and lateral vehicle control including eye movements) which is a function of driving demands exceeding driver cap- ability.

2.1 Search strategy

All searches included the words “driving” as mandatory, followed by the terms “advertising” or “billboard” and were conducted in February 2018. These terms were sought in the full text of the references. The search of academic references and grey literature was conducted in Google scholar and academic databases, i.e., PROQUEST, SCOPUS, TRID, EBSCO, and Web of Science. No time frame was specified in the searches. Besides, a request was sent to the Department of Transport and Main Roads (Queensland, Australia) to obtain access to the literature utilised in their policymaking. With regards to exclusion criteria, studies explaining roadside char- acteristics without considering road users' behaviour were excluded as well as road authorities communicating driving-related in- formation (e.g., directions or work zones) to drivers.

3.RESULT

A total of 90 unique documents were identified and reviewed using the SCS. The process to identify the articles followed a PRISMA methodology (Moher et al., 2009) as described in Fig. 2. These studies were divided in two groups: (i) documents including original research data (n = 60) and (ii) documents including reviews or position papers (n = 31). The number of references in this list is 91 because the conference paper by Herrstedt et al. (2013) was counted twice as it included original research and a literature review. The final studies included in the synthesis consisted of 28 journal articles, 24 literature reviews (published in the form of journal articles, reports, conference papers, and book chapters), 15 conference papers, 12 reports, 4 theses, 1 handbook chapter, 2 letters to the editor, 3 opinion/position papers and 2 paper critiques. The literature review findings are presented in the Appendix.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 1610)
Additional records identified through other sources (i.e., grey literature and government consultation) (n = 43)
Records after duplicates removed (n = 1103)
Records screened on basis of title and abstract (n = 1103)
Records excluded, with reasons
- Duplications not detected automatically
- Off-topic, e.g. research on marketing, history, art, etc.
-Do not meet inclusion criteria
(n = 1007)
Full-text articles assessed for eligibility (n = 96)
Full-text articles excluded, with reasons
- Only conference abstract available
- Earlier version of a reference
(n = 6)
Studies included in qualitative synthesis (n = 90)