Accident Analysis and Prevention 76 (2015) 141–151

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Do not blame the driver: A systems analysis of the causes of road freight crashes

Sharon Newnam [a,*], Natassia Goode [b]

[a] Monash University Accident Research Centre, Monash Injury Research Institute, Building 70, Monash University, VIC 3800, Australia
[b] University of the Sunshine Coast Accident Research, University of the Sunshine Coast, Locked Bag 4, Maroochydore DC, QLD 4558, Australia

ARTICLE INFO

Article history:
Received 14 November 2014
Received in revised form 14 January 2015
Accepted 18 January 2015
Available online 30 January 2015

Keywords:
Road freight transportation
Systems theory
Safety
Heavy vehicles

ABSTRACT

Although many have advocated a systems approach in road transportation, this view has not meaningfully penetrated road safety research, practice or policy. In this study, a systems theory-based approach, Rasmussens's (1997) risk management framework and associated Accimap technique, is applied to the analysis of road freight transportation crashes. Twenty-seven highway crash investigation reports were downloaded from the National Transport Safety Bureau website. Thematic analysis was used to identify the complex system of contributory factors, and relationships, identified within the reports. The Accimap technique was then used to represent the linkages and dependencies within and across system levels in the road freight transportation industry and to identify common factors and interactions across multiple crashes. The results demonstrate how a systems approach can increase knowledge in this safety critical domain, while the findings can be used to guide prevention efforts and the development of system-based investigation processes for the heavy vehicle industry. A research agenda for developing an investigation technique to better support the application of the Accimap technique by practitioners in road freight transportation industry is proposed.

1. Introduction

Safety in road freight transportation represents a long standing public health problem (e.g., Friswell and Williamson, 2010; Smith and Williams, 2014; Torregroza-Vargas et al., 2014). For example, in the United Stated, 8% of all road deaths have been attributed to heavy vehicle crashes (Kanazawa et al., 2006), whereas in Australia, heavy vehicle driving is considered to be one of the most dangerous occupations (SafeWork Australia, 2011; Transport Workers' Union of Australia, 2011), representing 16% of total road fatalities (BITRE, 2013). These figures are not surprising given that the work environment predisposes professional heavy-vehicle drivers to a number of unsafe working conditions, including a high level of exposure to the road environment and tight delivery schedules (Thompson and Stevenson, 2014).

Despite acknowledgement of the challenging working conditions, investigations of heavy vehicle crashes have primarily adopted a reductionist approach focused on identifying unsafe driver behaviours, such as inappropriate speed (e.g., Brodie et al., 2009; Chang and Mannering, 1999), fatigue (e.g., Arnold et al., 1997; Feyer et al., 1997; Häkkänen and Summala, 2001; Stevenson et al., 2013) and drug use (e.g., Brodie et al., 2009; Brooks, 2002; Duke et al., 2010; Häkkänen and Summala, 2001; Raftery et al., 2011; Williamson, 2007). While this research has informed the development of targeted preventive strategies, this approach implies that drivers are to "blame" for road freight transportation crashes. The complex system of factors that interact to generate hazardous situations and unsafe driver behaviours has largely been ignored (Salmon and Lenné, 2015 in press; Thompson and Stevenson, 2014; Williamson et al., 1996). This reductionist, driver focused approach to road safety has been criticized as one of the barriers preventing the achievement of further reductions in road trauma (e.g., Salmon and Lenné, 2015 in press; Salmon et al., 2012a,b,b).

Road freight transportation is no different to any other transport system in that it has the characteristics of a complex sociotechnical system. To illustrate this system, a crash caused by fatigue might not only reflect the individual driver's disregard of fatigue management policies and procedures (e.g., inadequate rest breaks), but also the supervisor's lack of involvement in journey management (i.e., lack of involvement/approval of trip plan), or the type of compensation method used by the organization to align performance objectives (i.e., deliveries made, tonnage hauled, or km driven) to driver payments. Moreover, the supervisor may be

* Corresponding author. Tel.: +61 3 9905 4370.
E-mail address: sharon.newnam@monash.edu (S. Newnam).

http://dx.doi.org/10.1016/j.aap.2015.01.016
0001-4575/

restricted in their level of involvement through their own workload, company policies, and pressures from higher up in the organization and so on. Finally, the company themselves will be influenced by financial and production pressures along with regulatory frameworks. In this sense, the road freight transportation system is representative of a complex sociotechnical system (Rasmussen, 1997; Reason et al., 1990).

According to Salmon et al. (2012a,b); Salmon et al. (2012a,b) a paradigm shift toward complexity and system thinking is required in road transportation more generally. Road transportation can be classified as a complex sociotechnical system given that: (i) it comprises technical, psychological and social elements, which when combined inform goal directed behaviour (i.e., involves delivery of goods, people etc) and (ii) the system is influenced by a high degree of uncertainty and independence, forever evolving in an unpredictable manner, challenging the boundaries of safety. Although many have advocated a systems approach in road transportation, this view has not meaningfully penetrated road safety research, practice or policy (Salmon and Lenné, 2015 in press). Salmon and Lenne (2015) (in press) identified the lack of appropriate systems thinking based crash analysis systems as one of the key barrier preventing systems thinking applications in road safety.

To address this issue, research is needed to capture the complex system of factors influencing road transport crashes, and specifically in the road freight transportation industry. In this study, we present an application of a systems theory-based approach, Rasmussens's (1997) risk management framework and associated Accimap technique, to the analysis of road freight transportation crashes.

2. Rasmussen's (1997) risk management framework and Accimap technique

Rasmussen's (1997) risk management framework (Fig. 1) is underpinned by the idea that accidents are caused by: the decisions and actions of all actors within the system (e.g., government departments, regulators, CEOs, managers, supervisors), not just front line workers alone; and multiple contributing factors, not just one bad decision or action. Safety is maintained through a process referred to as 'vertical integration', where decisions at higher levels of the system (i.e., government, regulators, company) are reflected in practices occurring at lower levels of the system, while information at lower levels (i.e., work, staff) informs decisions and actions at the higher levels of the hierarchy (Cassano-Piche et al., 2009; Svedung and Rasmussen, 2002).

To support the use of the framework for incident analysis, Rasmussen developed the Accimap technique (Rasmussen, 1997; Svedung and Rasmussen, 2002). An Accimap is typically used to graphically represent how the conditions, and decisions and actions of various actors within the system interact with one another to create the incident under analysis. In other words, an Accimap is used to represent the systemic factors leading up to an incident. The Accimap describes the system in question as comprising of six levels (government policy and budgeting; regulatory bodies and associations; local area government planning and budgeting; technical and operational management; physical processes and actor activities; and equipment and surroundings). These levels can be adapted to reflect different situations and domains of interest (Waterson and Jenkins 2010). Factors at each of the levels are identified and linked together based on cause-effect relationships. The Accimap technique has been applied to represent large-scale organisational accidents in multiple domains (e.g., Branford, 2011; Cassano-Piche et al., 2009; Jenkins et al., 2010; Johnson and de Almeida, 2008; Salmon et al., 2014, 2013; Vicente and Christoffersen, 2006), including freight transport (Salmon et al., 2013) and to multiple incident analyses (Goode et al., 2014; Salmon et al., 2014). Applying the Accimap technique to the analysis of road freight transportation accidents would allow for the identification of causal factors beyond the heavy vehicle driver. As stated by Salmon et al. (2012a,b); Salmon et al. (2012a,b), applying systems-based accident analysis methods to road transportation "moves road traffic crash analysis from a 'hunt for the broken component' to a 'hunt for the interacting system components' mentality" (p. 1834). This hunt for the broken component mentality has previously been identified as a key barrier that prevents safety enhancements within complex socio-technical systems (Dekker, 2011).

Rasmussen's framework makes a series of predictions (i.e., described in the discussion section of the paper; Table 1) regarding performance and safety in complex sociotechnical systems. These predictions describe the characteristics of complex sociotechnical systems and have previously been used to evaluate the applicability of the framework and the Accimap technique in new domains (e.g., Cassano-Piche et al., 2009; Jenkins et al., 2010; Salmon et al., 2014). There is some evidence that supports the conclusion that the road transportation is a complex socio-technical system (Salmon et al., 2012a,b,b); thus, Rasmussen's framework and Accimap technique are appropriate for analyzing road freight transportation crashes. In the current study, Rasmussen's predictions will be used to evaluate whether the most detailed publicly available data on road freight transportation crashes [investigation reports from the National Transport Safety Bureau (NTSB) in the United States], adequately describes all aspects of road freight transportation system performance. That is, whether the current investigation process supports the application of systems accident analysis methods in this domain.

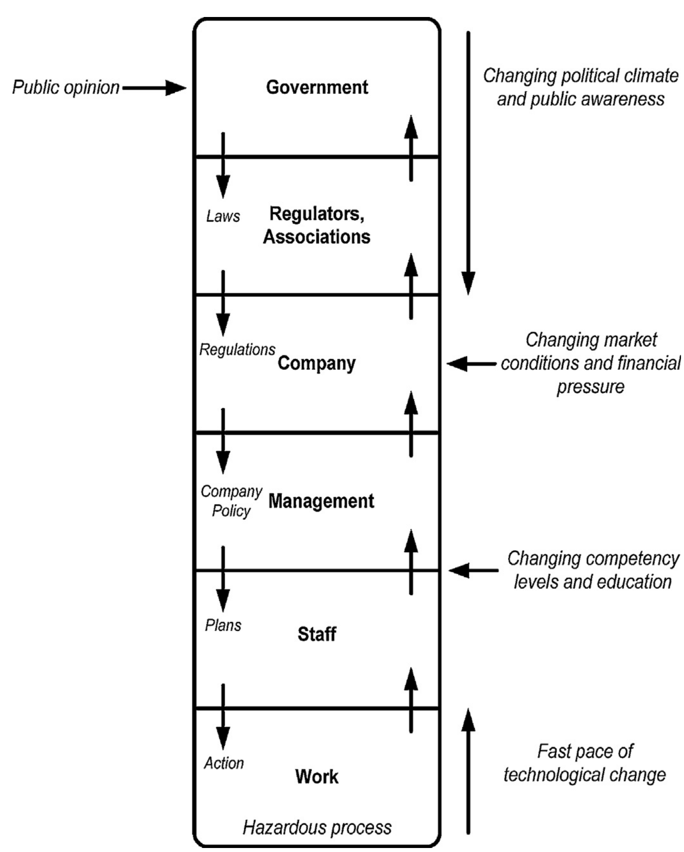

Fig. 1. Rasmussen's risk management framework (adapted from Rasmussen, 1997).