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Injury causation in the great outdoors: A systems analysis of led outdoor activity injury incidents

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ABSTRACT

Despite calls for a systems approach to assessing and preventing injurious incidents within the led outdoor activity domain, applications of systems analysis frameworks to the analysis of incident data have been sparse. This article presents an analysis of 1014 led outdoor activity injury and near miss incidents whereby a systems-based risk management framework was used to classify the contributing factors involved across six levels of the led outdoor activity 'system'. The analysis identified causal factors across all levels of the led outdoor activity system, demonstrating the framework's utility for accident analysis efforts in the led outdoor activity injury domain. In addition, issues associated with the current data collection framework that potentially limited the identification of contributing factors outside of the individuals, equipment, and environment involved were identified. In closing, the requirement for new and improved data systems to be underpinned by the systems philosophy and new models of led outdoor activity accident causation is discussed.

1. Introduction

There is an acknowledged risk of both severe and frequent injury associated with active pursuits, especially those participated in for sport, active recreation or leisure (e.g. Finch et al., 2007; Flores et al., 2008; Gabbe et al., 2005). One important educational form of active recreation is led outdoor activities, which are defined as facilitated or instructed activities within outdoor education and recreation settings that have a learning goal associated with them (Salmon et al., 2010). Examples include activities such as school and scout camping, hiking, harness sports, marine aquatic sports and wheel sports. Although the organised, structured, and led nature of such activities provides a degree of risk management, these very same features engender a level of complexity that inevitably leads to injury causing incidents in which multiple contributory factors play a role. This is exemplified by the findings from an exhaustive investigation into the recent Mangatepopo gorge walking incident which identified multiple contributory factors related to various different actors, equipment, processes, and organisations (Brookes et al., 2009). The incidence of such 'systems' accidents and incidents during led outdoor activities necessitates the adoption of a systems approach when attempting to understand and prevent led outdoor activity accidents and injury-causing incidents.

The systems approach to accident causation and analysis has a long history of applications in safety science efforts (Davis et al., 2013; Waterson, 2009). Although the notion that multiple causal factors from across work systems play a role in accidents is not a new one (e.g. Heinrich, 1931), the systems approach has yet to become the dominant approach to understanding and preventing accidents in some areas (Davis et al., 2013). This is the case in the led outdoor activity domain, where the approach typically has not been underpinned by contemporary systems theory-based models of accident causation the like of which are widely used in other safety critical domains such as aviation, process control, and mining (Salmon et al., 2010). Moreover, although recent incident investigations such as Brookes et al. (2009) suggest that catastrophic led outdoor activity incidents are the result of multiple failures across the overall led outdoor activity system, there is little data or analyses available to demonstrate that this is the case for the everyday injury incidents that occur (e.g. falls, sprains and strains). This has some significant implications. First, it inhibits communication and uptake of the systems approach philosophy since information on the role of systems factors in incident causation is not forthcoming. Second, it hinders the development and implementation of data collection systems and analysis methods underpinned by systems thinking, since there is no evidence clarifying the role of systems

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factors in injury incidents. Third and finally, it limits the utility of interventions designed to prevent future incidents since they are based on a limited understanding of incident causation.

As part of a wider program of research aiming to develop and implement a systems-based accident and incident reporting and learning system in the Australian led outdoor activity sector, the aim of the study described in this article was to utilise an in-depth led outdoor activity incident database in order to test a systems approach-based framework for its ability to classify the system wide contributory factors involved in led outdoor activity incidents. This incorporated the aim of investigating the nature of the contributory factors involved in led outdoor activity injury-causing incidents.

The study involved the use of a Rasmussen's risk management framework and associated accident analysis method, Accimap (Rasmussen, 1997), to classify the contributory factors reported for 1014 led outdoor activity incidents in the New Zealand Outdoor Education/Recreation National Incident Database. This paper makes a contribution to the accident literature, since it presents a systems analysis of the causal factors involved in led outdoor activity injury-causing incidents. Such analyses have not yet been produced for multiple accident cases in the led outdoor activity context. Moreover, a practical contribution is made through the examination of existing data systems for their ability to support systems analyses of led outdoor activity injury incidents and in the specification of potential interventions designed to prevent future incidents.

1.1. The systems approach

The systems approach to accident causation and analysis is a long and established philosophy that first emerged in part in the early 1900s (e.g. Heinrich, 1931) and has since evolved through a number of accident causation models and analysis methods (e.g. Leveson, 2004; Perrow, 1984; Rasmussen, 1997; Reason, 1990). The systems approach centres on the notion that safety, and indeed accidents, are emergent properties arising from non-linear interactions between multiple components across complex sociotechnical systems (e.g. Leveson, 2004). Based on a review and comparison of models, Salmon et al. (2010) concluded that Rasmussen's (1997) risk management framework and accompanying Accimap accident analysis framework are suited for application in the led outdoor activity context. Rasmussen's risk management framework (see Fig. 1) argues that work systems comprise various levels (e.g. government, regulators, company, company management, staff, and work), each of which are co-responsible for production and safety. With regard to accident causation, the framework argues that decisions and actions at all levels of the system interact with one another to shape system performance: safety and accidents are thus shaped by the decisions of all actors, not just the front line workers in isolation, and accidents are caused by multiple contributing factors, not just one bad decision or action.

To support use of the framework in accident analysis studies, Rasmussen (1997) outlined the Accimap framework for analysing accidents. Accimap is used to graphically depict the decisions, actions, and conditions that interacted with each another to produce the accident in question. Accimap typically structures these contributing factors across six organisational levels: government policy and budgeting; regulatory bodies and associations; local area government planning & budgeting; technical and operational management; physical processes and actor activities; and equipment and surroundings. Factors at each of the levels are identified and linked between and across levels based on cause–effect relations. Based on a comparison of three popular accident analysis methods, Salmon et al. (2012) concluded that the Accimap framework was

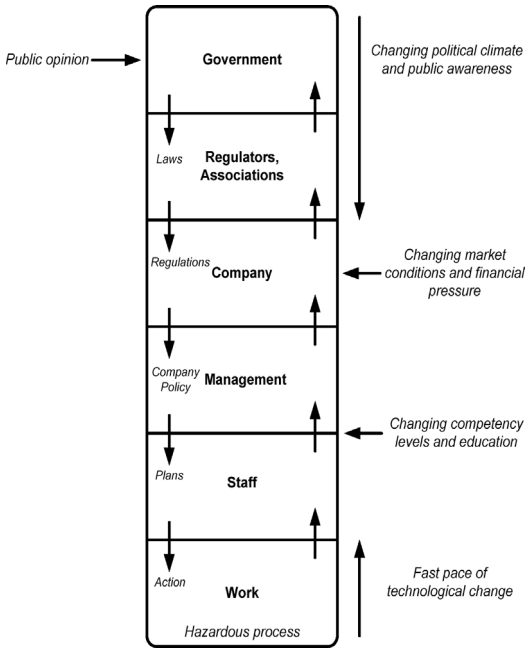

Fig. 1. Rasmussen's risk management framework. Adapted from Rasmussen (1997).

the most suitable for analysing multiple led outdoor activity injury and near miss incidents.

In testing Rasmussen's risk management framework in the led outdoor activity context, the authors wished to examine whether the framework could be used to classify the data in accordance with the key tenets of the systems approach. This involved testing whether the framework could be used to classify the contributory factors involved and identify where in the led outdoor activity system they reside (i.e. place the contributory factors across the different levels of the led outdoor activity system).

1.2. The systems approach in the great outdoors

To enable the Accimap framework to be used in the analysis of led outdoor activity incidents, the six systems levels typically used in Accimap analyses were adapted to reflect the led outdoor activity domain. This led to the definition of the following six led outdoor activity system levels:

1. *Equipment and surroundings:* factors associated with the equipment used in support of the activity, the physical environment in which the activity was undertaken, and the ambient and meteorological conditions prior to or during the incident;
2. *Physical processes and instructor/participant:* activities undertaken 'at the sharp end' prior to, and during, the incident. It therefore describes the flow of events leading up to and during the incident in question. This includes decisions and actions made by instructors, participants, etc., but may also include decisions and actions made by other actors, such as supervisors, emergency responders, members of the public, etc.;
3. *Technical and operational management:* activities, decisions, actions, etc. made by personnel at the supervisory and managerial levels of the organisation providing the activity involved in the incident. These factors typically occur prior to the incident itself but can also include decisions and actions made during, or in response to, the incident.
4. *Local area government, activity centre management planning and budgeting:* activities, decisions, actions, etc. made by personnel working in local government and at the senior managerial levels