The war on accidents: knowns, known unknowns, and unknown unknowns

Paul M. Salmon[1], Adam Hulme[1], Guy H. Walker[2], Neville A. Stanton[3] and Patrick Waterson[4]

[1]Centre for Human Factors and Sociotechnical Systems, University of the Sunshine Coast, Australia; [2]School of the Built Environment, Heriot-Watt University, UK; [3]Transportation Research Group, University of Southampton, UK; [4]Human Factors and Complex Systems Group, Design School, Loughborough University, UK

THE WORK IN CONTEXT

Regardless of domain, accidents continue to create an unacceptable personal, social and economic burden. Worryingly, despite many years of research, reductions in accidents, injuries and fatalities in many areas are plateauing. In this presentation we argue that this failure to control safety is driven, in part, by significant gaps in contemporary accident causation models and analysis methods which leave practitioners ill-equipped to fully understand, forecast, and prevent accidents. We present the findings from the first phase of a program of research designed to develop and test a new model of accident causation and practical methods for accident analysis and proactive risk assessment. A synthesis of previous accident investigations and an analysis of eleven recent major catastrophes revealed that there may be a common causal network of contributory factors involved in accidents regardless of domain, and further that there are a set of systemic conditions that are present when major catastrophes occur. Unfortunately, the research also found that state-of-the-art accident analysis methods such as AcciMap are being applied in a manner that is inconsistent with the systems thinking perspective on accident causation. Further, aspects of the causal texture of accidents remain poorly understood, and current models and methods are ill-equipped to elucidate them. These include the role of normal performance in accidents, migration of work practices, feedback loops, and emergent behaviours. It is concluded that, despite the significant advances that have been made to date, further work is required to develop more comprehensive models and methods to support more effective accident analysis and prevention practices.

KEYWORDS

Accidents, accident causation, accident analysis

A brief outline of the work carried out

Almost a hundred years of research effort has been expended in attempts to understand and explain accident causation. As a result, there are now a subset of accident causation models and accident analysis methods that are state-of-the-art. For example, Rasmussen's Risk Management Framework and accompanying Accident Mapping (AcciMap) method and Leveson's System Theoretic Accident Model and Processes (STAMP) and associated Causal Analysis based on STAMP (CAST) method have been used extensively over the past decade and currently dominate accident prevention research and practice. Whist many have noted the strengths of these models and methods, there are also limitations. Indeed, despite a diverse set of applications, it is questionable whether we fully understand accident causation in a manner that is sufficient to support effective prevention activities.

In this work we explore this by discussing the findings from the first phase of a major research program which was designed to develop and test a new model of accident causation and practical methods for accident analysis and risk assessment. To date, the research has included a systematic review of systems thinking-based accident analysis applications, an analysis of twelve major catastrophes, and a subject matter expert delphi study designed to gain expert consensus on the key tenets of accident causation.

Findings/solutions (the outcome)

The research program has produced four key findings regarding accident causation and accident analysis.

First, state-of-the-art accident analysis methods such as AcciMap are being applied in a manner that is not consistent with the systems thinking perspective on accident causation. For example, the systematic review of AcciMap applications found that over 80% of the contributory factors identified reside at the sharp-end of work systems. As a corollary, it is argued that we do not fully understand the systemic nature of accident causation in many areas.

Second, it is apparent that there may be a common causal network of contributory factors that play a role in accident causation, regardless of domain. This network spans all levels of work systems, with example factors including government planning, political structures and services, legislation and regulatory systems, company policies and procedures, risk assessment and management, worker training, experience and competence, inter and intra organisation communication and coordination, personnel recruitment and management and judgement and decision making.

Third, there are a core set of conditions and characteristics that are present when systems fail. These so-called accident causation tenets were developed based on a synthesis of state-of-the-art accident causation models and were found to be present in eleven catastrophes. It is important to note, however, that it is unclear whether different combinations of the tenets are present in different accidents, or whether certain tenets are more prominent than others.

Fourth, although significant progress has been made, key aspects of accident causation remain ill understood, and current models and methods are ill-equipped to elucidate them. These include the role of normal performance in accidents, migration of both safe and unsafe work practices, feedback loops, and emergent behaviours.

It is concluded that, although state-of-the-art models and methods have allowed us to expand our knowledge on accident causation, further work is required to address key limitations. Whilst our understanding of accident causation is undoubtedly the most advanced it has ever been, it is by no means complete. In closing we provide an overview of the next phase of the research program. This includes developing and testing a new model of accident causation and a new accident analysis method.

Impact

This presentation gives an overview of the findings from an exhaustive review of accident causation models, previous applications of state-of-the-art accident analysis methods, and an analysis of eleven major catastrophes. As a result, an understanding is gained of the key contributory factors and conditions that play a role in accidents and insight is given into the limitations of accident analysis methods. This will help improve practice during accident analysis and prevention activities.