Establishing Methods to Understand Human Error at Intersections

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INTRODUCTION

Road deaths and injuries are preventable by understanding the causes of accidents and developing effective countermeasures to manage these issues. Research has suggested that at least 70 per cent, and possibly as many as 92 percent, of all traffic accidents are attributable to the human element in traffic (Sanders and McCormick, 1992). Other research by Hakkinnen and Luoma (1991) suggests that traffic accidents may be preceded, on average, by as many as 75,000 errors. Therefore, an understanding of the types or errors that occur, and the underlying contributory mechanisms, is critical for successful safety improvement.

When considering human error, a holistic approach needs to be taken that contemplates the way in which all of the elements in the system are designed, how they interact, and the consequences for errors. For example, the role of the driver and other road users (e.g. training, knowledge and behaviour), the vehicle (e.g. the extent to which it is maintained), and the road environment (e.g. the road layout) all need to be examined.

The occurrence of human-errors in complex systems such as traffic almost always involves multiple errors and contributory factors at various levels of system operation. This has been established in other complex systems including aviation and medicine. While human-error frameworks have been developed to guide the incident investigation process and to develop preventative programs in various other domains, their application in road-transport has been largely neglected. As a result, relatively little is currently known about the different errors that road users make and their associated contributory factors.

This research is a practical approach being conducted to gain a deeper understanding of the relationship between human error and safety critical events in the road traffic system. The broader aim of the work is to develop a taxonomic structure for classifying driver errors and their associated contributory factors, which has the potential to be used for guiding the collection of data as well as for classifying errors and their causes for subsequent analysis.

Accidents at metropolitan intersections are the focus of this work as they are specific examples of complex design that involve increasingly demanding interactions between a driver and their environment. Research has suggested that accidents at intersections account for over 50% of serious casualties in metropolitan Melbourne, and the trauma problem is generally resistant to common present-day solutions (Corben, 2006).

This paper describes the approach that is being taken to understand contributory factors in intersection accidents and to inform a human error taxonomy. A key objective of this paper is to review the existing data sources that are being examined to understand the contributory factors for intersection accidents. These are described and reviewed with respect to their relevance and usefulness, and the ways in which these data can feed into the human error taxonomy are identified. Finally, the potential uses of the taxonomy, based on this data collection approach, including how the data can be analysed to highlight associations between factors, are commented upon.

OVERVIEW OF THE APPROACH

Two approaches were adopted in this study to further our understanding of contributory factors in crashes: collection of data and consideration of existing data sources. Firstly, data were collected on road user interactions within Melbourne through the selection of two 'blackspot' intersections for in-depth examination. The historical accident data for these intersections were reviewed, and observations were conducted at the two intersections to identify potential design deficits and safety problems contributing to human error and safety. Focus groups were also conducted to further identify and classify the different types of road-user errors along with the many factors involved in their occurrence, and to identify and classify the consequences associated with these errors.

Secondly, a number of other data sources were examined for their potential to provide further information to achieve the project aims. To collect the accident-involved road users' perspective of the human error related contributing factors, driver interview data from the Australian National Crash In-Depth Study (ANCIS) and the Enhanced Crash Investigation (ECI) was examined. Additionally, expert opinion that is documented as an essential part of the ECI Project was also examined. Coronial records were also examined as a potentially viable data source.

These combined approaches yielded information on the individual data sources, detailed in the next section, and as a consequence, a detailed taxonomy for analysis of human errors at intersections is now in development.

EXAMINATION OF ERROR AT SELECTED INTERSECTIONS

Focus group data

Focus groups were conducted to collect qualitative information regarding types of human error and contributing factors to accidents at intersections. The data collected from the two focus groups provided a useful overview of road users' understanding of safety at intersections and the commonly perceived types of errors occurring. Interestingly, the focus of the discussion was on the design of intersection infrastructure, with the next level of emphasis on road users' contributions to accidents. A variety of error types were raised by the participants and this exercise assisted in raising the understanding of what drivers perceive as being the problems at intersections. As approximately one third of the participants had driven in other countries for extended periods, and had considerable understanding of intersections in other driving environments, a variety of perspectives were raised during the focus groups, including proposals for countermeasure development based on safety improvements internationally. The information collected can usefully feed into the continued development of the human error taxonomy

Historical accident data (police data)

Accident data for the two determined intersections were obtained from the VicRoads database (CrashStats). The statistics in the CrashStats database are compiled with data from the VicRoads Accident Database which is based on accident data collected by the Victoria Police. Up to 1 January 2006, the Victoria Police Collision Report (Form 510) was completed by police officers as the official reporting mechanism. Information was sourced from notes taken by police officers at the scene of a crash, and/or witness statements at a police station. Since 2006, a very similar set of information has been collected from the scene of an accident and fed into the electronic Traffic Information System. The protocol requests information on multiple variables, specifically: day, date and time the accident occurred; location; type of collision; individuals involved; vehicles involved; diagram of collision scene; brief description of collision (with no apportioning of blame); environmental conditions; traffic control involved; driver movement prior to impact; driver intentions prior to collision; initial point of impact; level of damage; and, whether the vehicles involved were towing a trailer of some sort.

It was clear from reviewing the accident data that many useful sets of information are gathered at the scene of an accident to describe the vehicles, the individuals involved, the road infrastructure, and the environmental conditions. However, it is also obvious that there is currently no clear way of recording more than a very basic level of human factors information or any specific contributing factors for road accidents attended by the police. The information contained in current accident reports therefore provides only limited support for analysis of the errors and latent conditions involved.

Observational data

Observation represents a valuable method for collecting traffic safety data that complements the historical accident data for a chosen site. On-site observation allows the dynamic interactions between road-users, vehicles and the traffic environment to be studied, revealing various types of problems or inadequacies in the traffic system. This type of study also creates a better understanding of the roadway design and form of traffic regulation used in relation to the traffic demand and need for safety. The data from an observation study often provides a more up-to-date picture of the prevailing safety situation than historical data, where the latter is often influenced by a number of changes to the intersection design and traffic regulation (e.g. revised signal timings), or influences in the surrounding road network over the years that have increased or decreased traffic demand levels.

REVIEW OF ADDITIONAL DATASETS TO INFORM TAXONOMY DEVELOPMENT

There have been only limited attempts to use mass crash data to determine the different types of errors made by road users and their associated causes, and no recent research in Australia. In this section, the existing data sources that are being examined to understand contributory factors for intersection accidents are described and reviewed with respect to their relevance and usefulness.

ANCIS data

The overall objective of this study is to determine the patterns and severity of modern passenger vehicle crashes and the extent and severity of occupant injuries by means of a multi-centre research study. This objective is pursued with the use of accident investigation and reconstruction methodologies, including: examination of the occupant injuries, vehicle, and accident circumstances, which requires a semi-structured interview with the driver of the case vehicle. Inclusion criteria include individuals who have been occupants of motor vehicles involved in crashes, as a result of which they were hospitalised or fatally injured. The types of vehicles involved in crashes included in the study are sedan, utility, passenger van and off road vehicles no older than 15 years. No age limits apply to occupants of the case vehicle who wish to participate. ANCIS commenced in 2000, therefore the project several hundred accident cases stored in its relational database. Although the information amassed for ANCIS has a strong bias towards passive safety, there are several variables collected which enable an understanding of the contributory factors in accidents to be examined. This information is predominantly collected during the semi-structured interview conducted with the driver.

ECI data

In 2001 the Victorian government released arrive-alive! Victoria's Road Safety Strategy 2002-2007 that targets a twenty percent reduction in deaths and serious injuries by 2007. One of the seventeen challenges outlined in the strategy was the need to collect more detailed crash data, better understand the causes of crashes, increase knowledge of crash factors and dissemination of the findings to key road safety practitioners to facilitate the implementation of a range of road safety actions. The initiative led to the Enhanced Crash Investigation (ECI) project. The project serves several objectives: as a means of collecting more detailed information on critical crash types (run off road and side impact crashes); as an educational tool for regional practitioners; and as a mechanism for increasing both the amount and effectiveness of the co-operation among the diverse range of key stakeholders. The project involves the in-depth investigation of serious injury crashes in Victoria (using a very similar data collection strategy to ANCIS) and presentation of the findings (in a de-identified format) to multi-stakeholder Regional Case Review Panels. The function of the panels is to review the factors which led to the crashes occurring and which influenced their severity, to develop local action plans and to identify any central actions which needed to be considered at the whole-of-state level. Outcomes of this research provide a valuable resource for policy makers and designers.

Coronial data

Coronial reports represent a rich source of fatal road crash data and may represent the best opportunity to assess the role of human error in fatal road accidents. Coroners' reports typically include four different reports including: a findings report, a toxicology report, a police report and a medical report (plus the report of an inquest if held). As noted in another recent MUARC study, there are a number of contributory factors noted by the Coroner that include behavioural factors and to a lesser extent vehicle and environmental factors, although there may be variability in case reporting (Fitzharris, Lenné, & Fotheringham, 2007). It is important to note however that the primary role of NCIS is to assist coroners in their role and to enhance their ability to identify and address systematic hazards within the community.

RELEVANCE TO TAXONOMY

The data sources cover a range of accident outcome scenarios, Table 1, giving a valuable collection of information for use in the development of the taxonomy.

Table 1. Data source reliance on accident outcome (injury severity).

Outcome / Data Source	Focus groups	Police data	Observations	ANCIS	ECI	Coroner
Fatal		✓	✓	✓	✓	✓
Serious Injury	✓	✓	✓	✓	✓	
Slight Injury	✓	✓	✓	✓	✓	
Non-Injury	✓	✓	✓			
Near Miss	✓		✓			

Key: ✓ = Strong probability of data being available from source;
✓ = Some probability of data being available from source.

Data collected via these varied methods can feed into the different components of the taxonomy (see example in Table 2). Not surprisingly, the majority of the sources offer details on the environment related contributing factors to accidents, but information is least available for the road user related contributing factors.

Table 2. Example content of each data source (for road user related contributing factors only).

Content	Data Source	Focus groups	Police data	Observations	ANCIS	ECI	Coroner
Road user related contributing factors							
Functional state	Physical and/or cognitive fatigue	✓			✓	✓	✓
	Under the influence of substances	✓	✓		✓	✓	✓
	Physiological state	✓			✓	✓	
	Observation	✓			✓	✓	
	Psychological state	✓			✓	✓	✓
	Inadequate mental planning/reasoning	✓			✓	✓	
	Memory failure	✓			✓	✓	
	Distracted	✓	✓		✓	✓	✓
Experience	Insufficient experience	✓	✓		✓	✓	✓
	Expectation	✓			✓	✓	
Skill	Insufficient skills/ability	✓			✓	✓	
Knowledge and understanding	Insufficient knowledge	✓			✓	✓	
	Failure to understand	✓			✓	✓	
	Failure to interpret	✓			✓	✓	
Training	Inadequately/ inappropriately training	✓			✓	✓	
	Unqualified/underage driver	✓	✓		✓	✓	✓
Non-compliance/ violation	Intentional non-compliance/violation	✓	✓	✓	✓	✓	✓
	Unintentional non-compliance/violation	✓	✓	✓	✓	✓	✓

Key: ✓ = Reasonable level of data available; ✓ = Some level of data available.

POTENTIAL USES OF THE TAXONOMY

The potential uses of the taxonomy, including how the data can be analysed to highlight associations between factors, are commented upon below:

- To assist in the development of improved data collection techniques, e.g. for police to systematically capture a wider and more detailed collection of contributory factors data at the scene of an accident.
- To use established models of system safety to identify contributing factors in accidents, and importantly, to use statistical techniques to examine the association between error types and contributory factors. This approach has been used recently with aviation data and is consistent with the philosophy of systemic models.
- To help road safety stakeholders to understand the chain of events and contributing factors to accidents and consider the wider system implications (e.g. road design guidelines, organisational factors) that contribute to accidents..
- To determine suitable countermeasures and error-management strategies that have the potential to yield traffic safety benefits at all types of intersections.

CONCLUSION

The taxonomy is still in its infancy and more work needs to be undertaken on its development, particularly as more data is gathered as part of the pilot study. Real-life accident examination will be particularly useful in validating and further developing the taxonomy.

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