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Common hazards and their mitigating measures in work zones: A qualitative study of worker perceptions

Ashim Kumar Debnath *, Ross Blackman [1], Narelle Haworth [2]

Centre for Accident Research and Road Safety – Queensland, K Block, Queensland University of Technology, 130 Victoria Park Rd, Kelvin Grove, QLD 4059, Australia

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ABSTRACT

Road construction and maintenance activities present challenges for ensuring the safety of workers and the traveling public alike. Hazards in work zones are typically studied using historical crash records but the current study took a qualitative approach by interviewing 66 workers from various work zones in Queensland, Australia. This supplemented and enhanced the limited available data regarding the frequency and nature of work zone crashes in Australia, provided worker insights into contributing factors, and assessed their opinions on the likely effectiveness of current or future approaches to hazard mitigation. Workers may not be aware of objective data regarding effectiveness, but their attitudes and consequent levels of compliance can influence both the likelihood of implementation and the outcomes of safety measures. Despite the potential importance of worker perceptions, they have not been studied comprehensively to date, and thus this study fills a significant gap in the literature. Excessive vehicle speeds, driver distraction and aggression towards roadworkers, working in wet weather, at night and close to traffic stream were among the most common hazards noted by workers. The safety measures perceived to be most effective included police presence, active enforcement, and improving driver awareness and education about work zones. Worker perceptions differed according to their level of exposure to hazards.

1. Introduction

Reports from highly motorized countries such as the United States (US), Great Britain, and the Netherlands show that about 1–2% of road fatalities occur in work zones (NWZSIC, 2012a,b; SWOV, 2010). While this is a relatively low proportion of all road fatalities, crash rates appear to increase significantly during roadworks compared to pre-work periods (Garber and Zhao, 2002; Khattak et al., 2002; Whitmire et al., 2011) and work zone crashes are also more severe than other crashes (Pigman and Agent, 1990).

Hazards in work zones have typically been studied through analyses of historical crash data to identify the factors contributing to the frequency of work zone crashes (Chen and Tarko, 2012; Daniel et al., 2000; Harb et al., 2008; Khattak et al., 2002; Khattak and Targa, 2004; Qi et al., 2013; Venugopal and Tarko, 2000) and their injury severity (Khattak et al., 2002; Khattak and Targa, 2004; Li and Bai, 2008b; Qi et al., 2013). However, the crash data-based approach is often hampered by the lack of detail in official datasets (Chen and Tarko, 2014; Cheng et al., 2012) and the likelihood of under-reporting of work zone crashes (Debnath et al., 2013; Schrock et al., 2004).

To understand the hazards in Australian work zones, the conventional crash data analysis approach taken by researchers across the world is not a feasible option. This is because detailed and accurate data on crashes in Australian work zones are not available in official records (Debnath et al., 2013; Haworth et al., 2002). In Queensland, work zone crashes are identifiable in police-reported crash records only if 'roadworks' is reported as a circumstance contributing to the crash and a public vehicle is involved. A similar situation exists in Victoria, where work zone crashes only need to be reported as such if the work zone is determined by police to have contributed to the crash. For example, a crash may not be recorded as a work zone crash where a driver crashed due to speeding or dangerous driving in the work zone. The crash data deficiencies limit the scope for untangling the common hazards in Australian work zones and therefore little is known about their relative contribution to crash causation.

Studies utilizing crash data from other countries provide valuable insights into work zone hazards, but relatively little is known about what roadworkers think regarding work zone hazards. To

* Corresponding author. Tel.: +61 731388423; fax: +61 731380111.
E-mail addresses: ashim.debnath@qut.edu.au (A.K. Debnath), ross.blackman@qut.edu.au (R. Blackman), n.haworth@qut.edu.au (N. Haworth).
[1] Tel.: +61 731384638; fax: +61 731380111.
[2] Tel.: +61 731388417; fax: +61 731380111.

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the authors' knowledge, only one study has focused on roadworker perceptions (Haworth et al., 2002). This study examined safety by analyzing perceptions of roadworkers working in small groups (up to 6 people). However, medium to large scale work zones involve large groups of workers, whose perceptions about safety in work zones are still not rigorously examined. Therefore, there remains a key gap in the current literature—it is not well-understood what roadworkers perceive to be the hazards in work zones and what countermeasures they perceive to be effective in mitigating these hazards.

Worker perceptions provide an alternative source of information about work zone hazards in the absence of reliable and detailed crash data and guidance regarding the likely acceptance of potential countermeasures. Furthermore, even if historical crash data are available, inadequate information in crash databases often restricts safety analysts' ability to understand the causation process of a crash and, consequently, the hazards associated are difficult to identify. Workers perceptions are also expected to provide additional information when reliable crash data is present. In addition to helping to understand the hazards, worker perceptions could also provide valuable insights into which countermeasures could be useful in improving work zone safety, as such perceptions include firsthand knowledge from experience of working in work zones. The effectiveness of work zone safety countermeasures (e.g., different forms of signage, traffic control devices, regulation and enforcement) has been a subject of considerable research through field evaluation studies (e.g., Benekohal et al., 2009; Brewer et al., 2006; Debnath et al., 2014b; Fontaine et al., 2000; Hajbabaie et al., 2009; Maze et al., 2000; Medina et al., 2009). However, the level of acceptance by workers of some interventions (changes to traffic control methods, technologies or communication protocols, for example) can influence their actual effectiveness (Carder and Ragan, 2003; Mullen, 2004) and is thus important to understand when considering countermeasure deployment.

This study explores workers' perceptions of the hazards in work zones and their potential mitigating measures. Interviews with sixty-six personnel from various work zones in Queensland, Australia, were qualitatively analyzed to identify the major issues and themes. The analysis identifies common work zone hazards and how they affect the safety of workers. In addition, the study examines workers' perceptions of the effectiveness of countermeasures to improve safety. This paper seeks to fill a significant gap in the current literature by providing a thorough understanding of worker perceptions of hazards and mitigating measures. The paper presents the methodology of the qualitative study, followed by the major themes reported on work zone hazards and how these hazards could be mitigated effectively. Major findings and their implications for work zone safety are then discussed.

2. Method

2.1. Study design

In this study, people directly involved in roadworks participated in semi-structured interviews designed to explore the common work zone hazards and their potential mitigating measures. As noted by Mullen (2004), who conducted semi-structured interviews to investigate factors influencing workplace safety behavior, "the semi-structured format allowed the questions to be asked in different sequences that resulted in the issues emerging naturally throughout the conversation". The current study adopted this use of generally broad, unobtrusive and non-directive questions to avoid leading participants toward particular responses or stated positions that may be construed as biased (socially desirable responses for example).

Participants were recruited from government and private organizations undertaking road construction, maintenance and traffic control in Queensland. Participant recruitment was facilitated by the industry partners of this study, including the Transport and Main Roads, Leighton Contractors, GHD, and Australian Workers Union. These organizations were first provided with a brief description of the study to distribute among potential participants, after which consenting volunteers were interviewed. Interviewees were assured that their anonymity would be preserved in any subsequent reports, publications or correspondence with stakeholders and their employers. The QUT Human Research Ethics Committee approved the study in May 2012 (Approval Number 1200000195).

During the interviews, participants were asked "In which situations at roadworks do you feel unsafe and what are the particular dangers in those situations?" to initiate discussion about the common hazards in work zones. Depending on the progress of the conversation, additional questions were asked, including "Do you consider the work vehicles and machinery as dangerous to you as passing traffic?", "Are there any particular types of vehicle you consider more dangerous to you than others?", "If so, why do you think these vehicles are dangerous to you?", "What do you feel is a safe speed?", "Do you think that vehicles travel too fast past where you are working?". To initiate discussion about measures to mitigate hazards in work zones, respondents were asked "What safety practices are used at your worksite and how effective are they?", followed by "What changes would improve the safety of your worksite?" and "Are there any effective measures you are aware of that are not used at your work site?". This range of questions allowed respondents to discuss the effectiveness of familiar safety measures, as well as new, innovative or unfamiliar measures, including those used outside Queensland.

After piloting with two groups of four and five participants, it was decided to conduct individual interviews to remove the possibility of some participants dominating discussion in a group setting. A total of 66 participants (63 face-to-face and 3 by telephone) were interviewed individually by two researchers. The interviews were recorded using digital voice recorders and later transcribed. Interviews ranged in duration from 7 to 38 min, with the majority (72%) taking between 10 and 20 min.

2.2. Participants

The 66 participants had an average of 9.84 years of roadwork-related experience. Nine participants were categorized as inexperienced in roadwork (less than 2 years), 35 were experienced (2–10 years) and 22 were very experienced (more than 10 years). Approximately two-thirds of participants ($n = 43$) were working at urban sites when the interviews were conducted. Some participants had experience in both urban (low-speed and motorway) and rural (mostly high-speed undivided) settings. In Australia, most rural roads are undivided with one lane in each direction, with some higher standard sections (two lanes each way, divided) nearer to major cities. Most of the participants were male ($n = 61$) and aged between 30 and 54 years ($n = 48$). There were five participants aged below 30 years and 13 participants aged above 54 years.

Respondents included 25 traffic controllers, 15 laborers and machinery operators, 21 managers, engineers, or supervisors, and five directors, planners, or designers. The participants were classified based on their exposure to traffic. The traffic controllers, who are the first to interact with traffic in a work site, were categorized as 'fully exposed to traffic'. The workers, who usually work behind barriers or have some form of physical protection/separation from traffic, were categorized as 'semi-exposed to traffic'. The remaining participants, who mostly work from offices with occasional visits to work zones, were categorized as 'non-exposed to traffic'.