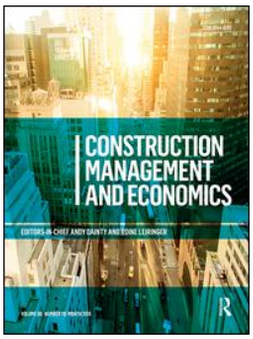

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Use of attitude congruence to identify safety interventions for small residential builders

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The construction industry has experienced high numbers of occupational injuries and fatalities over the years. To address this issue, differences in safety attitudes and behaviours were explored among construction workers, first-line supervisors, and project managers in small residential construction companies with respect to recommendations for safety interventions. A triangulation design consisting of observation (shadowing), subjective quantitative (questionnaire), and subjective qualitative (interview) methods was used to obtain different but complementary data on the same safety challenges. Shadowing was utilized to explore onsite safety problems and/or risky behaviours resulting from safety attitudinal discrepancies among the three groups. Questionnaires were administered to identify salient themes for the observed practices. Semi-structured interviews were conducted to explore the causes of the observed safety problems. Results revealed that first-line supervisors did not enforce safety rules strictly or consistently, and that significant differences in safety attitudes and risk perceptions were observed among the three groups. Results also support a tendency among subcontractors to practise risky behaviours, even though they generally articulated a desire to avoid injuries. The recommended interventions include holding regular safety meetings between managers and workers, implementing informal training to supplement formal training, and closely examining and reviewing the appropriateness of health and safety policies.

Keywords: Safety, small business.

Introduction

The construction industry, which consists primarily of small contractors (Hester *et al.*, 2003), is one of the most hazardous industries in the United States. According to the US Census Bureau (2006), smaller firms represent 91% of the total number of construction establishments. Smaller firms, which are those with 20 or fewer employees (Kines, 2003), tend to have a higher frequency of lost-time injuries compared to larger firms (Lingard and Holmes, 2001). Occupational injury and illness statistics (US Bureau of Labor Statistics, 2008) showed that specialty trade contractors—most of which are small contractors (Wilson and Koehn, 2000)—accounted for the majority (67.5%) of injury and illness cases. Studies (Lin and Mills, 2001; Shalini, 2009; Cheng *et al.*, 2010) found that the safety performance of smaller firms is poorer than that of larger firms in important occupational health and safety (OHS) system elements, such as contract review, training, inspection and testing, corrective and preventive action, etc.

Smaller builders differ from larger construction firms in several ways. As observed by Lingard and Holmes (2001), the organizational attributes of small construction firms include shorter periods of employment, frequent changes in jobsites, high worker turnover, and a higher number of workers with sporadic work patterns. The manner in which small construction firms implement safety management strategies to reduce safety problems may also have limited effectiveness. For example, as indicated by Methner (2000), in the small-business construction industry contractors often choose not to have—or cannot afford to fund—health and safety monitoring programmes (e.g. safety and health audits and evaluations of workers' hazard exposure levels). As a result, because of differences in the Occupational Safety and Health Administration

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(OSHA) reporting requirements and the absence of formalized safety systems in many of these smaller organizations, the injury and illness statistics for small builders are frequently underestimated and/or under-reported. Moreover, as described by Mayhew and Quinlan (1997) in their five-year comparative review of injury/illness rates between small and large firms, smaller builders showed disproportionally higher rates than their larger counterparts. As illustrated by Wilson and Koehn (2000), these trends—coupled with such recognized construction industry characteristics as dynamic work settings, worker inexperience and demographic composition, and work coordination problems across a variety of contractors and subcontractors—mean that safety management efforts among small builders continue to be problematic. Moreover, since most of the available literature addresses the safety concerns and workplace safety strategies of larger construction firms (McVittie *et al.*, 1997), additional research is needed to discern those relevant human factors considerations that could impact on the efficacy of safety interventions for smaller organizations (Haro and Kleiner, 2008).

OSHA requires a contractor (i.e. employer) to provide its workers with a place of employment that is free from hazards (US Bureau of Labor Statistics, 1999a). However, this general mandate becomes somewhat murky in the construction environment. Research shows that subcontracting can transfer financial and OHS risks away from principal contractors (Uher, 1991; Arditi and Chotibhongs, 2005). The confusion about who should be responsible for jobsite safety has been shown to undermine OHS control systems (Holmes *et al.*, 1999; Arditi and Chotibhongs, 2005). As noted by Holmes and Gifford (1996, 1997), some small business employers even believe that OHS risks are largely created by employees; therefore, they view risk control as the responsibility of their workers. Even though OSHA's safety regulations are relatively stringent for principal contractors, they are far less so for smaller subcontractors. This has led to attitudinal discrepancies towards safety among the various constituencies (Methner, 2000). Researchers have also described how discrepancies in safety attitudes among the different levels of construction personnel could negatively impact on safe jobsite behaviours (Glendon and Litherland, 2001; Neal and Griffin, 2004; Fung *et al.*, 2005).

Safety attitudes and safe work behaviours are positively correlated. As an example, Cox and Cox (1991) asserted that improving safety attitudes can lead to safer working practices, less scepticism toward the usefulness of safety measures, and a greater willingness to learn safety guidelines. In addition, according to Ajzen's theory of planned behaviour (TPB) (1991), an individual's attitude is one of the major predictors of an intention to perform a specific behaviour, and an individual's intention, in turn, can drive behaviour. TPB also holds that only specific attitudes toward a given behaviour can be expected to reliably predict that behaviour. In a similar vein, Eagly and Chaiken (1993) argued that while attitudes can be preceded by cognitive, affective or behavioural processes, they can yield cognitive, affective and behavioural responses as well.

The small business construction industry has long been characterized by multi-employer worksites. Nonetheless, few studies thus far have examined discrepancies in the safety attitude among management, supervisory and worker groups in the small business residential construction industry, and its potential impact on injury and accident rates. Most safety interventions that are typically used (e.g. formal classroom training) have been developed to address the needs of larger companies and do not reflect the work context (e.g. the changing and non-union workforce) or the environmental constraints (e.g. the lack of financial resources) of smaller companies. As such, these interventions may not be effective or valid for small subcontractors. The question is, then, how can smaller companies do a better job at managing their occupational health and safety needs in order to reduce their disproportionally high accident and fatality rates?

To answer this question, we used a mixed methods approach that included shadowing, a questionnaire, and the use of an interview to investigate safety attitudes and behaviours of construction personnel—at both the managerial level and worker level. This triangulation enhanced our ability to provide recommendations of effective safety interventions or control strategies that could mitigate identified and potentially harmful attitudinal gaps. We selected a mixed methods approach because, as suggested by Lin and Mills (2001), this approach (although generally not used in connection with construction research) helps researchers obtain richer insights on safety challenges. It should be noted that for this study, the term 'managerial personnel' refers to a residential jobsite's foreman, supervisor or project manager, since the multi-layer employment patterns in the residential construction industry routinely necessitate that supervisory personnel assume a variety of roles.

We studied safety attitudes to inform safety interventions for two reasons: (1) the self-disclosed safety attitudes of employers and employees (i.e. humanware) can play a vital role in construction safety outcomes (Jaselskis *et al.*, 1996), since OHS risk control should focus on the changes that individuals are willing to make (Lingard and Holmes, 2001), instead of external technological controls; and (2)

TPB recognizes the role and criticality of attitude (as a construct) in driving behaviour and studying safety attitudes with the goal of identifying safety interventions has been shown to be successful, as described by Young *et al.* (1997). We also investigated risk perceptions among construction personnel, since the safety attitudes of construction workers have been shown to be inter-correlated with their perception of risk (Rundmo, 2000; Mohamed *et al.*, 2009).

Literature review

Theory of planned behaviour

One of the most influential models for illustrating the attitude–behaviour relationship is Ajzen's theory of planned behaviour (TPB) (Ajzen, 1991). This theory proposes that behaviour is influenced by intention, and that intention is determined by attitudes, subjective norms, and perceived behaviour control. TPB clearly defines several important concepts:

- *Attitude* refers to an individual's positive and negative judgment of performing a behaviour.
- *Subjective norm* refers to an individual's perception of the social pressures for performing or not performing the behaviour in question.
- *Perceived behaviour control* refers to an individual's perceived ability to perform a behaviour and perceived effectiveness of the behaviour in order to avoid negative consequences.

Generally speaking, individuals will intend to perform a behaviour when they evaluate it positively and/or when they are influenced by social pressure. Ajzen's theory was criticized for overlooking moderators in predicting behaviour—for example, emotion (Dutta-Bergman, 2005) or the views of an opinion leader (Chan and Lau, 1998). Despite its detractors, TPB's proposed attitude–behaviour relationship has been applied in many fields and confirmed by construction safety literature (Mohamed *et al.*, 2009; Wang and Yuan, 2010). Since attitude plays an important role in shaping behaviour, it would be imperative to study safety attitudes at all levels of the construction industry for better managing workers' risk-taking behaviours.

Safety attitude congruence in occupational health and safety management

Safety attitudes reflect an individualized construct of beliefs (perceptions) and emotions regarding safety policies, procedures and practices (Rundmo and Hale, 2003; Neal and Griffin, 2004), as well as one's personal commitment to and sense of personal responsibility towards safety. As such, improving the safety attitudes of all personnel in an organization is one of the objectives of occupational health and safety training (Cox and Tait, 1998).

A number of studies investigated the relationships between safety attitudes and workplace safety. For instance, Donald and Canter (1993) concluded that safety attitudes are positive predictors of safety performance. They showed that one could predict the likely accident rate within a department by surveying the safety attitudes of its employees. Similarly, Siu *et al.* (2004) concluded that safety attitudes could be used to predict the likelihood of occupational injuries. Tam and Fung (1998) stressed the importance of workers' safety attitudes, stating that 'training can improve safety performance only to a limited extent. Safety performance is, instead, highly dependent upon the individual's attitude and responsibility towards their own safety' (p. 52).

The importance of safety attitudinal congruence can also be found in Fung *et al.* (2005). These researchers conducted a safety attitude survey to investigate any attitudinal discrepancies among the different levels of construction personnel. Their results revealed that management personnel tend to have more positive attitudes towards safety than workers in each of the following areas: (1) organizational commitment and communication; (2) reporting of accidents and near misses; (3) line management commitment; (4) personal role; and (5) workmates' influence. Following the work of Mohamed (1999), who investigated the Australian construction industry and documented the importance of an institutional-wide commitment to safety management and positive safety attitudes, it is important that construction labourers possess the same level of safety attitudes as management to cultivate a good organizational safety culture.

Risk perception congruence in occupational health and safety management

Risk perception is defined as a person's beliefs, attitudes, judgments and feelings towards hazards, dangers and risks (Mearns and Flin, 1995). Studies have shown that inadequate risk perception contributes to risk behaviours and accidents (Leonard and Karnes, 2000; Garcia *et al.*, 2004). For example, Bohm and Harris (2010) found that the risk perceptions of construction site dumper drivers did not correspond to measures of objective risks derived from accident data. They indicated that workers' poor risk perceptions, in addition to situational factors (e.g. co-workers' behaviour and safety rules), negatively influenced their risk-taking behaviours. Furthermore, Lingard (2002) demonstrated that improving the risk perception of workers had the advantage of increasing their perceived

probability of suffering a work-related injury or illness, which the author concluded could lead to better risk-control behaviours.

Bailey (1997) noted that risk perception and safety attitude congruence in an organization do influence the safety behaviours of workers, since there is a connection between management's enforcement of safety, labourers' perception of safety management and accident/injury rates. In their study of risk perception and safety consequences, Mark and David (2002) categorized people into three levels based on job responsibilities and their influence within an organization: operational (workers), tactical (supervisors) and strategic (managers). They then investigated risk perception among the three groups. The authors concluded that: (1) the compliance decisions of workers were influenced by risk perception; (2) supervisors at the tactical level influenced workplace safety by the manner in which they allocated limited resources and balanced the demands between production and safety; and (3) managers at the strategic level were instrumental in affecting the health and safety of all employees since their risk perceptions directly influenced their decisions and judgments on how a project was performed.

Studies also identified differences in attitudes and perceptions among workers with differing job titles (Findley *et al.*, 2007), with many concluding that conflicting views about risks constitute a social and political problem of considerable magnitude in many contexts. For example, Hallowell (2010) argued that shared values, attitudes and perceptions across the employee spectrum are essential to construction safety. To support his argument, Hallowell conducted a survey-type study involving structured interviews with construction workers at different levels. He asked them to estimate the frequency of accidents of various injury severity levels (from negligible to fatality). He found that managers and workers did not tend to share the same safety perceptions regarding how often accidents are likely to happen. He concluded that such differences could translate to a weak institutional safety culture (defined as shared norms and values among all employees) and could lead to OHS problems. Based on the research, an accurate perception of organizational risk at all levels is essential for effective safety and health management. Conversely, discrepancies in risk perception that may occur between personnel at different organizational levels could have a negative impact on workplace safety.

Risk perception and safety attitude

Risk perception is comprised of safety attitudes, which typically encompass one's beliefs about the nature, consequences, history and justifiability of a risk cause (Renn, 1998). Zohar (1980) noted that safety attitude is one of the dimensions of safety climate, and is associated with risk perception and risk behaviours. As other studies have shown, risk perception is inter-correlated with safety attitudes for a number of reasons (Rundmo, 1997; Smith-Jackson *et al.*, 2010). For example, Smith-Jackson *et al.* found that risk perception correlated with attitudes about safety climate and perceived vulnerability of toxic exposure in crop production. Rundmo's (1997) results indicated that the perception of risk was a dimension of attitudinal beliefs about the causes of the risk. In a recent construction study, Mohamed *et al.* (2009) found that workers' safety behaviours can be explained by their perceptions of any workplace risk, as well as their attitudes towards their own safety responsibilities.

Despite the fact that safety attitudes and risk perception were found to be inter-correlated, Rundmo (2000) concluded that the causal relationship between the two concepts was not clear. He asserted that although safety attitudes may affect risk perception, it could also be that risk perception causes behavioural choices based on one's safety attitudes. A critical factor in the associations between safety attitudes and risk perception is attitude/perception congruence among personnel at different levels of the organization. Specifically, conflict between roles and responsibilities, as well as ambiguities between what workers perceive and what management perceives, can lead to a number of negative outcomes within the organization. Researchers in organizational culture point out that conflicts in attitudes and perceptions between workers and management may interfere with work tasks, role commitments, and productivity (O'Reilly *et al.*, 1991; Jehn, 1994). Thus, safety incongruence or safety attitude conflicts may undermine the ability of an organization to prevent or control on-the-job accidents or injuries.

The studies reviewed herein reinforce the significance of safety attitudes and risk perception, as well as how congruency at all organizational levels can improve workplace safety. Workers and management should be congruent in terms of their positive safety attitudes and risk perceptions. Such congruence becomes even more important in smaller construction firms where strategic and tactical input may emanate from a single individual (i.e. the managerial personnel or safety director) (Huang and Hinze, 2006), and where employment patterns are more transient. Therefore, this study explored mechanisms to assess the degree of congruence between management and workers within small construction companies.

Method

Mixed methods research design

The attitude–behaviour relationship recognized by Ajzen's TPB was used to frame this study. Moreover, to explore the moderating role of the 'views of an opinion leader' in predicting behaviour, this study viewed 'managerial personnel' as a type of 'opinion leader' and investigated the attitudinal differences towards safety behaviour among them and workers. This study employed a three-stage mixed methods approach (Johnson and Christensen, 2004) incorporating a triangulation design (Creswell *et al.*, 2003), which uses ethnographic-based research, qualitative and quantitative techniques to obtain different, but complementary data on the same research objectives. Triangulation was preferred for the following reasons:

- There is a need for both quantitative and qualitative approaches in construction research (as indicated by Lin and Mills, 2001). One approach alone would have been inadequate for obtaining a complete picture of the small construction industry in order to inform the design of safety interventions.
- Safety systems used in the small construction industry tend to be dynamic. Quantitative data alone could not capture in-depth knowledge, whereas qualitative data could not specify trends and generalizations of participants' perspectives. There was a need to enhance the research with a second source of data.
- Quantitative data can be enhanced by qualitative data and vice versa (Creswell and Clark, 2007). In our study, the use of qualitative information helped to explain the unsafe behaviours caused by safety attitudinal incongruence, while the quantitative data we collected helped to explain the significance of the attitudinal incongruence.

Figure 1 illustrates the research methods we employed and the procedures for the triangulation design. First, an ethnographic research technique—shadowing—was used to examine observable behavioural patterns and customs to generate an information-rich description of a cultural or social system. Our premise was that a qualitative exploration was needed at the beginning because workers' behavioural patterns resulting from safety attitudinal incongruence were not clear in the small construction industry. Shadowing was used because it has been successfully adopted in different professions to examine people's onsite actions and patterns of behaviour (Leysia and Marilyn, 2002; Munir and Kay, 2005). In addition, shadowing a worker—especially at the beginning of a job or task—enables a researcher to uncover any duty-related problems, including safety issues (Judi *et al.*, 2005). The use of shadowing allowed us to achieve relatively higher external validity compared to the external validity of a highly controlled experimental study. The unsafe behavioural patterns we identified, which again, we assumed were tied to poor safety attitudes, were used as a basis to formulate research questions for the questionnaire.

Second, a questionnaire was administered for the purpose of seeking convergence, corroboration and correspondence of the problems and results (Maxwell and Loomis, 2003) obtained from the shadowing process. The questionnaire enhanced the descriptive results, as well as enabled us to identify statistically significant themes for the observed practices. If problems identified from either shadowing or the use of the questionnaire were demonstrated to be 'significant', it would be necessary for small construction firms to introduce corresponding safety measures or interventions.

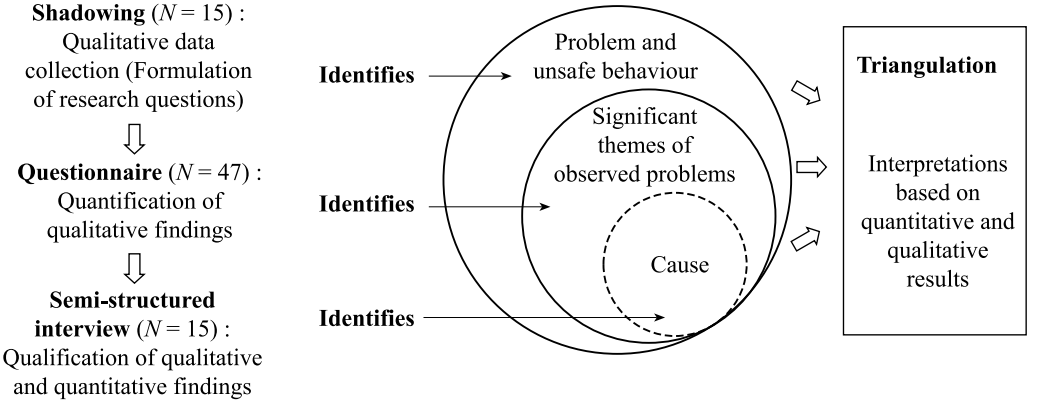

Figure 1 Conceptual diagram of the mixed methods approach

Third, since the small business construction industry is dynamic with ever-changing circumstances and attendant problems, the use of only shadowing and questionnaires was expected to provide only some attributes of the organization under scrutiny (Judi *et al.*, 2005). Therefore, semi-structured interviews were included to complement these instruments, since they are particularly well adapted to probe the causes of observed safety problems. These interviews were also essential for providing insights regarding how and why any unsafe behavioural pattern occurred and the potential usefulness of the recommended safety interventions. We anticipated that this knowledge could help to bridge the attitudinal discrepancies between construction labourers and managerial personnel and promote increased worksite safety. To minimize any threat to internal validity, every individual whom we shadowed also completed the questionnaire and was interviewed.

Participants

A criterion sampling technique (Patton, 1990) was used to select information-rich cases for this study. The following criteria were employed: (1) participants must have worked in a company with fewer than 20 employees; (2) participants had to be at least 18 years old; and (3) participants must have worked on at least one residential construction project in the past month. These criteria ensured that participants had a minimum level of experience in interacting with company personnel, and were aware of the types of safety systems normally used in small residential construction companies, thereby minimizing any threat to the external validity of the data. We used 20 workers to help us distinguish the differences between small and large construction firms, since this is a minimum number generally utilized in the area of construction research (Lin and Mills, 2001; Kines, 2003).

A total of 47 participants from six companies (specializing in duct work finishing, framing, drywalling, plumbing and masonry contracting—trench and foundation) in both rural and urban geographic regions in Virginia and North Carolina participated in the study, including 27 construction managerial personnel (foremen, supervisors, and project managers), and 20 workers—all of whom responded to the questionnaire either on site or through a web-based tool. Among the 47 participants, 11 workers and four supervisors volunteered to be shadowed by the trained observers and to engage in the semi-structured interviews.

Shadowing

In this study, three trained observers monitored participants' work procedures in five different construction jobs—duct work finishing, framing, drywalling, plumbing and masonry contracting (trench and foundation), since these areas encompass most of the residential construction hazards (e.g. fall, electricity, debris, noise, dust and ergonomic) identified by Methner (2000). The observers were taught to identify 'critical incidents' using the critical incident technique (Flanagan, 1954), which employs specific procedures to collect observations of events, activities or human behaviours that are considered critical to the performance of a system or process. A critical incident was defined in this study as an observable behaviour (an action or activity) that had the potential to lead to a workplace accident or injury (adapted from Flanagan, 1954). Basically, observers took notes and recorded the following information: the managerial personnel and labourers involved, the actions they took, the ways that work was performed by the workers, any tools they used, and the locations associated with the observed critical incidents. In sum, this information provided important information about the organization's safety practices. Based on Ajzen's TPB, the study presumed that a worker's observed safety behaviours were largely driven by his/her safety attitudes. Thus, by analysing the observed actions or activities, personnel, locations or physical environments associated with any critical incidents that took place (Hung and Winchester, 2008), we anticipated being able to identify important attitudinal discrepancies among participants.

For shadowing to be effective, observers should remain as unobtrusive as possible to avoid influencing the behaviours of those observed. To avoid biasing effects, the observers did not share any details concerning the research or the manner/frequency in which notes would be taken. Successful shadowing also necessitates that the observer attain a certain level of trust and openness so that he/she can be accepted as non-judgmental and non-threatening. To achieve these goals, before the observers began to shadow participants, they obtained their informed consent, as well as talked with them to put them at ease and familiarize them with the pending observation. These techniques support the findings of Flick (2006), who asserted that the more public and unstructured the site is, the easier it will be for an observer to take a role that is not conspicuous and does not influence the site. Since the construction sites in this study were mostly unstructured, the observers were able to remain relatively unobtrusive, thereby lowering the risk of undue influence.

Another purpose of the study was to monitor workers' overall safety behaviours on the construction sites without making any judgments about how participants performed their jobs within their trades. We conducted a total of 15 hours of observations (one hour for each participant), which was thought to be sufficient for

observing any unsafe work practices involved in job-related tasks for the following three reasons. First, since safety problems tend to be more prevalent on smaller construction sites as discussed earlier (McVittie *et al.*, 1997; Lin and Mills, 2001; Kines, 2003), it would make identifying them easier over the course of an abbreviated time span. Second, any safe/unsafe job-related habits of workers would be easily observable regardless of the tasks and the time spent on the job. Third, this amount of data (including workers' work habit and interactions with other personnel, tasks and physical environments, etc.) was believed to be sufficient to note the salient phenomena of unsafe work practices/behaviours in small residential construction sites. Any critical incidents noted by the observers were later discussed and categorized into themes of unsafe behaviour patterns, which were subsequently used to formulate research questions for the questionnaire and interview.

Questionnaire

After shadowing, the observers discussed the critical incidents together and then designed question items that they believed would explain the observed unsafe behaviours. A questionnaire was administered to every participant. To achieve an acceptable level of measurement validity, the wording for each item had to be agreed upon by three shadowing observers. The questionnaire items for measuring safety attitudes were selected and adapted from the validated safety attitude questionnaire of Fung *et al.* (2005). The response categories used a Likert-type scale with anchors from 1 (strongly disagree) to 5 (strongly agree). The questionnaire also included items for measuring risk perception since, as previously noted, risk perception is often linked to attitudes that a person holds about the cause of the risk. The items for measuring risk perception were selected and adapted from the validated risk perception questionnaire of Leonard *et al.* (1989). The selected items were those relating to different construction hazards. The response categories used a Likert-type scale with anchors from 0 (not at all risky) to 8 (extremely risky). The participants' ratings on the question items were analysed using SAS^{TM} 9.1, which provides researchers the flexibility to manipulate data with simple commands and can generate results for multiple analyses simultaneously.

Semi-structured interviews

For this study we employed the funnelling technique, which begins with general questions or topics followed by more specific probes. Interview questions were developed from the observed unsafe work behaviours identified from the shadowing sessions and as a result of the questionnaire. For the remainder of the interview, questions and topics evolved naturally during the course of the interview, allowing both the interviewer and the participant the flexibility to discuss problems in a more informal manner (Donohue *et al.*, 2006). Participants' responses were recorded, and content analysis was performed. Any information in the responses that could be used to explain the identified unsafe behaviours and the questionnaire results was coded and discussed by the researchers in order to inform design recommendations for safety interventions.

Results and discussion

The ethnicity of the sample consisted of 85% Caucasian/White, 13% African-American/Black and 2% Latino. The mean ages of the managers (M = 44.84, SD = 12.95) and the supervisors (M = 46.43, SD = 11.30) were higher than the workers' mean age (M = 39.95, SD = 15.06). The education levels of the managers and supervisors were senior high school or above; whereas the workers' education levels ranged from elementary school to college. Most of the managers and supervisors had more than five years' working experience, while only half of the workers had more than five years' work experience. The sample demographics are shown in Table 1.

Shadowing

As discussed, one of OSHA's key requirements (referred to as 29 CFR 1926) (US Bureau of Labor

Table 1 Sample demographics

Participants	Total no.	Gender		Ethnicity			Education level				Working experience (year)	
		M	F	Caucasian/ White	African-American	Hispanic	Elementary	Junior high	Senior high	College	1–5	> 5
Manager	13	11	2	11	2	0	0	0	3	10	2	11
Supervisor	14	14	0	13	1	0	0	0	8	6	4	10
Worker	20	19	1	16	3	1	2	3	13	2	10	10

Statistics, 1999a) is intended to ensure that workers follow safe employment practices. This study presumes, therefore, that the task of rectifying construction workers' unsafe behaviours is primarily the responsibility of managerial personnel. Thus, it was necessary to shadow both workers and supervisors. For this study, 11 workers and four first-line supervisors of the sample participated in the shadowing sessions, whose trades involved duct work finishing, framing, drywalling, plumbing and masonry contracting (trench and foundation). From these sessions, we identified a number of critical incidents, which are categorized and presented in Table 2 and discussed below.

First, by observing how the workers performed their work, we found that they often displayed awkward postures (as described in some of the examples in Table 2), which might cause acute or chronic musculoskeletal injuries. Second, we found that not wearing personal protective equipment (PPE) was common, implying both poor safety practices among workers, as well as problematic safety management practices. Consider, for example, the mechanics of installing drywall. To put up drywall, a worker must cut the drywall with a knife, place the drywall on to the framed wall, use a hammer to drive the drywall into place, hold the drywall steady while a partner nails the drywall into place with a screw gun, and then cut away the excess drywall. During the course of this process, a worker was observed that did not wear any PPE (e.g. gloves, face mask, eye protection, ear plugs), even though he was working right beside his first-line supervisor. He did not seem to be aware—nor was he told by his supervisor—that he had exposed himself to various hazards, such as dust, noise and sharp objects (e.g. keyhole saws, knives and nails). These observations suggest that both worker and supervisor disregarded proper safety practices. Third, when we examined the physical environment of the jobsites, we found that scattered materials, hand tools, equipment and power cords in the workplace limited the available working space, impeded easy access to equipment and tended to inhibit adherence to safety regulations (as described in some of the 'inattention' examples in Table 2)—all of which increased the chances for workers to get injured (e.g. tripping over debris). We also noted that the loose materials and/or equipment were either laid down by the workers in our study, or by other trades workers from other companies. The participants (either workers or first-line supervisors) did not seem to care about these hazards during work. Fourth, when we observed how workers completed tasks that required the use of equipment, we found that they were sometimes not aware if they had set up the equipment improperly, which could create additional onsite hazards. For example, workers were observed to place a ladder on an unstable work surface without tying the top and bottom of the ladder to fixed points. This might increase the likelihood of falls when using the ladder.

Importantly, our observations revealed that although workers routinely practised unsafe work habits, the

Table 2 Summarized critical incidents identified from shadowing

Category/theme	Representative examples	Possible OHS* consequence
Awkward posture	(1) Stood on the ladder and repeatedly bent and twisted their body to reach the driller that was hung on the ladder step	Acute/chronic overexertion injuries or back injuries
	(2) Lifted materials with severe bodily forward flexion and twisting without adopting proper lifting techniques	
Not wearing personal protective equipment	(1) Cut the drywall with a knife (generating large external contact stress) with bare hands	Cuts and/or scratches
	(2) Used a pneumatic paint gun without wearing masks	Chronic respiratory illness
	(3) Used a electronic circular saw to cut pipes without wearing goggles	Eye injuries from flying particles and sparks
Inattention	(1) Left construction materials, power cords and tools beside the working area	Back injuries caused by trips and slips
	(2) Chatted with colleagues while using pneumatic nail guns	Puncture wounds
	(3) Hung duct work for the air conditioning system while underneath another worker was cutting sheet metal	Contusion and/or concussion
Setting up equipment improperly	(1) Placed a ladder on an unstable work surface (rocky, muddy, uneven)	Fall injuries due to loss of balance
	(2) Walked on joists with a harness; however, the length of the rope was longer than the height of the joists	Fall injuries due to loss of balance
	(3) Placed the long keyhole saw in the tool belt's back pocket and retrieved it repeatedly when working on the ladder	Puncture wounds on the back due to falls

Note: * = occupational health and safety.

primary safety problem identified through observing personnel interactions was that first-line supervisors did not correct their workers' unsafe behaviours. As an example, supervisors did not tell workers to use PPE. In fact, more often than not, when workers were observed to follow safety rules it was usually in the presence of their project managers (i.e. *second*-line supervisors), not because they had been instructed to do so regardless of the circumstances or who happened to be present in a supervisory role. Moreover, despite the fact that we learned from the shadowing process that construction managers seemed to care about work-site safety, first-line supervisors did not strictly enforce safety rules. Therefore, workers were more inclined to ignore safety procedures because safety was not shown to be highly valued by immediate supervisory personnel. Hence, discrepancies in attitudes and perceptions towards construction safety between project managers and supervisory personnel (many of whom might be job-specific subcontractors) and their workers may exist and could compromise safety management efforts, including the efficacy of any safety intervention.

The shadowing sessions resulted in the formulation of the following three study questions:

S1: The construction sites we visited varied by project type, related tools/equipment needed for the job and type of worker required to do the job. *What is workers' collective understanding of how to improve jobsite safety regardless of the type of hazard(s) inherent in the job?*

S2: Workers displayed different safety behaviours in the presence of first- and second-line supervisors. *What are the discrepancies in safety attitudes or risk perception among managers, supervisors, and workers?*

S3: First-line supervisors did not strictly enforce safety rules. *What is the level of enforcement of safety rules among first-line supervisors?*

The questionnaires that were implemented in the next phase of the study were intended to validate whether these discrepancies could be verified using quantitative ratings as metrics.

Questionnaire

The questionnaire was designed to statistically corroborate the description of the three questions identified from the shadowing sessions, as well as to isolate specific discrepancies between the attitudes of participants (labourers and managerial personnel) towards safety. Table 3 illustrates the question items selected and adapted by the observers to measure safety attitude and risk perception.

We used SAS^{TM} 9.1 to perform a correlation analysis to assess the reliability of the questionnaire items. The Cronbach coefficient alpha of the index of safety attitude was r_{alpha} = 0.77, with an inter-item correlation ranging from an r of 0.31 to 0.66 (with a significance level of 0.05). The Cronbach coefficient alpha of the index of risk perception was r_{alpha} = 0.85, with inter-item correlations ranging from an r = 0.37 and 0.79, respectively. These statistics indicated that the questionnaire design was effective in eliciting participants' responses in a consistent (reliable) manner. The construct validity of the questionnaire was accessed by

Table 3 The question items used to measure safety attitude and risk perception and their relationships to the research questions identified in the shadowing sessions

Index	Question item	Research question (identified from shadowing)
Safety attitude	Q1: You know how to improve safety at your construction site	S1, S2
	Q2: Your company cares for workers' health and work safety	S2, S3
	Q3: Your company requires workers to follow the safe working procedures when they are working	S2, S3
	Q4: You know the hazards associated with each task	S1, S2
Risk perception	Q5: Not wearing ear plugs in a high-level noise environment	S2
	Q6: Not wearing steel toe safety shoes on the job	S2
	Q7: Not wearing a hard hat in construction areas where posted signs state that they are required	S2
	Q8: Walking on slippery surfaces while at work	S2
	Q9: Not wearing fall protection when working at elevated heights	S2

Notes:
S1: Knowledge of safety improvement.
S2: Discrepancies in safety attitudes or risk perception.
S3: Safety enforcement.

The response categories for safety attitude are from 1 (strongly disagree) to 5 (strongly agree). The response categories for risk perception are from 0 (not at all risky) to 8 (extremely risky).

a correlation analysis on the indices of safety attitude and risk perception. The correlation coefficient, r (45) = 0.37, $p < 0.05$, indicated that safety attitude and risk perception were correlated, which is consistent with the findings of Rundmo (2000) and Mohamed *et al.* (2009).

To identify any attitudinal discrepancies between managers, supervisors and workers, we conducted one-way ANOVA tests on the rating scores of the participants. The rating scores were obtained by totalling and then averaging the rating scores of the questionnaire items under safety attitude and risk perception. Tukey's studentized range tests were then performed to examine which pairs of group means were significantly different with respect to safety attitude and risk perception. The results are shown in Table 4. The ANOVA tests confirmed that overall safety attitude scores and risk perception scores were significantly different across the three groups: safety attitude, F (2, 44) = 4.38, $p < 0.05$; risk perception, F (2, 44) = 14.73, $p < 0.0001$. Tukey's studentized range tests indicated that supervisors reported significantly higher overall safety attitudes than workers, and that both managers and supervisors reported significantly higher overall risk perceptions than workers (as illustrated in Figure 2). Table 4 also illustrates the analyses for each question item under safety attitude. The ANOVA test on knowledge of safety improvement (Q1) shows that the rating scores differed across three participant groups, F (2, 44) = 3.45, $p = 0.05$. Tukey's studentized range test on knowledge of safety improvement (Q1) showed that the supervisors gave significantly higher rating scores than workers (Figure 2), suggesting that supervisors knew more about how to improve the safety of construction sites as compared to workers. No group differences were found for the other items under safety attitude. This finding revealed that participants had (1) a similar understanding towards the particular hazard associated with each task; and (2) a belief that the organizations under scrutiny cared for the health and safety of workers and required them to follow safe working procedures. It should be noted that our statistical analyses did not expose any differences in the rating scores between supervisors and managers, which may be due to the fact that their roles tend to intermingle according to the construction project to which they are assigned.

Overall, the small construction firms surveyed in this study failed to adequately train workers to manage worksite safety, corroborating existing evidence in the literature. We also confirmed that managerial personnel and workers did not display the same level of risk perception. In combination, these findings explain the observed recurrent risk-taking behaviours (also shown

Table 4 Results of one-way ANOVA test and Tukey's studentized range (HSD) test

Question item		Tukey's studentized range (HSD) test					ANOVA
		Group mean	Group comparison	Difference between means	Simultaneous 95% confidence limits		
					Lower	Upper	
Safety attitude	Q1 to Q4	M = 4.21	M – S	0.30	–0.1294	0.7421	F (2, 44) = 4.38, p = 0.018*
		S = 4.51	S – W	0.47	–0.8746	–0.0861*	
		W = 4.04	M – W	0.17	–0.5771	0.2290	
	Q1	M = 3.92	M – S	0.37	–0.3922	1.1175	F (2, 44) = 3.45, p = 0.041*
		S = 4.29	S – W	0.74	–1.4187	–0.0528*	
		W = 3.55	M – W	0.37	–1.0713	0.3251	
	Q2	M = 4.31	M – S	0.40	–0.1537	0.9669	F (2, 44) = 2.31, p = 0.111
		S = 4.71	S – W	0.41	–0.9212	0.0926	
		W = 4.30	M – W	0.01	–0.5259	0.5105	
	Q3	M = 4.46	M – S	0.11	–0.4144	0.6342	F (2, 44) = 1.98, p = 0.15
		S = 4.57	S – W	0.37	–0.8458	0.1029	
		W = 4.20	M – W	0.26	–0.7465	0.2234	
	Q4	M = 4.15	M – S	0.35	–0.1615	0.8538	F (2, 44) = 2.43, p = 0.1
		S = 4.50	S – W	0.40	–0.8593	0.0593	
		W = 4.10	M – W	0.05	–0.5234	0.4157	
Risk perception	Q5 to Q9	M = 6.83	M – S	0.30	–1.555	0.95	F (2, 44) = 14.73, p = 0.000*
		S = 6.53	S – W	1.99	–3.122	–0.8555*	
		W = 4.54	M – W	2.29	–3.449	–1.132*	

Notes: M = manager, S = supervisor, W = worker; * = comparisons significant at the 0.05 level.

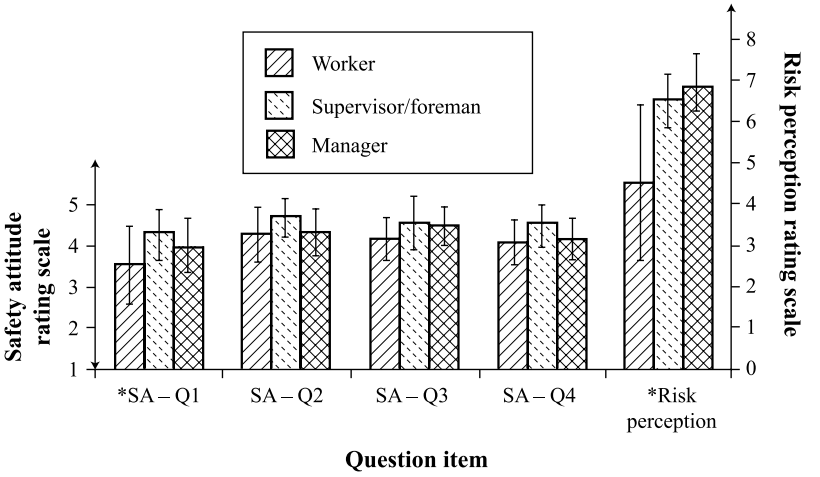

Figure 2 Mean ratings of the questionnaire items
Note: *denotes significant results; SA: Safety Attitude.

by Williamson *et al.* (1997) to be correlated with poor risk perception) among workers in the shadowing sessions, e.g. not wearing PPE. These results suggest a need for small construction firms to reinforce safe working practices through such interventions as proper training, supervision and enforcement.

Semi-structured interviews

The third stage of the study employed specific questions to determine the causes for any discrepancies we uncovered during the shadowing sessions and as a result of the questionnaire. We asked the following questions in the semi-structured interview, in addition to any unstructured follow-up questions to clarify participants' responses:

(1) Could you explain how to minimize the hazards with respect to your current task?
(2) How are safety controls enforced in your company?
(3) Why did you/workers not wear personal protective equipment during work? (This question was asked because the participant did not wear personal protective equipment.)
(4) Do you know what could happen if you were injured?

The first question we wanted to investigate was why workers failed to follow safe work practices on a routine basis. In addition, we explored the question of why supervisors did not strictly enforce safety rules, as required by OSHA and project managers (e.g. wearing PPE).

The participants reported the following reasons during their semi-structured interviews:

(1) Since first-line supervisors and workers were often required to perform multiple tasks (sometimes in multiple locations) on any given work day, they found the task of putting on/taking off the PPE somewhat bothersome and slowed down their work progress, thereby shortening their time for work at other construction sites.
(2) Workers did not believe they would ever get injured and therefore never thought of improving their worksite safety. As one worker commented: 'I've been working 20 years and never got injured'. Although they did admit that certain tasks had certain hazards and risks, most of them chose not to wear PPE, but instead chose to rely on their luck (aka external locus of control).
(3) Workers believed that because they were all experienced construction workers and/or close friends (or sometimes even relatives), they would neither injure themselves nor be injured by each other.

These various responses obtained during the semi-structured interviews reinforced the questionnaire findings—that construction workers had poorer safety attitudes and did not know exactly how to improve worksite safety. These responses also indicated that neither supervisors nor foremen strictly enforced OSHA's safety rules (e.g. requiring workers to put on PPE), despite the fact that they had a better understanding of how to identify risks and improve safety as

compared to their workers. In addition, during the course of this study participants were asked to state how safety controls were enforced in their companies. Surprisingly, we found that even though general contractors nominally enforced safety policies, most first-line supervisors and workers did not take these policies very seriously since they were just subcontractors and not strictly subject to OSHA's regulations, and had not ever been visited by OSHA officers in the past. For example, although completing safety forms during a safety meeting at the beginning of the day might have been required by a general contractor, it was not routinely practised by subcontracting workers. This could explain why workers were observed to follow safety rules only in the presence of their project managers, as we discovered during the shadowing sessions.

We also asked the participants to describe what would happen if they got injured. We found that most of the workers had no idea about the consequences of a workplace injury. Two typical replies included 'I don't know', or 'Small injuries are common, but it is not a big deal to have a small cut on my finger or breathe in dust'. Some of the workers intuitively believed that their employers would take care of their medical bills if they became injured. In essence, they left the responsibility of their health and safety to their companies (aka, external locus of control). However, the management perspective was different. Some supervisors said that workers should share these responsibilities. This indicated another discrepancy between the two groups—neither group believed they should be fully responsible either for worksite safety or for the repercussions associated with an injury. The results of the semi-structured interviews indicated that safety tended to be undervalued or ignored by workers and even first-line supervisors. This finding reinforces the need for attitudinal changes that put a higher premium on safety; only then will safer jobsite behaviours at all levels become more fully ingrained.

Recommendations for the design of safety interventions

The purpose of this effort was to explore attitudinal discrepancies between workers, supervisors and managers in small construction companies with regard to recommendations for safety interventions. As a result of shadowing the workers and their supervisors, we found that a discrepancy may exist among construction personnel with respect to attitudes towards and perceptions of construction safety. This was revealed by the fact that the workers' unsafe jobsite behaviours were not corrected by their supervisors (who were also likely to have poor safety attitudes), but were corrected by their managers (who were more likely to have positive safety attitudes). From the results of the questionnaire, we learned that supervisors typically had more knowledge of how to improve construction safety, as well as had higher risk perceptions than their workers. From the semi-structured interviews we learned some of the reasons why workers took shortcuts and engaged in risky behaviours, as well as why first-line supervisors ignored worksite safety, while at the same time instinctively trying to avoid injuries.

Table 5 illustrates the research approach employed in this study and the attitude incongruencies we identified, which we believe are important factors in on-the-job accidents and injuries. To identify safety interventions for enhancing and establishing safety attitude congruence in small residential construction firms, we examined the main attitude incongruencies using a systems safety perspective (Swallom *et al.*, 2004), which looks at the interactions between construction personnel, social-technical system and work environment from a safety standpoint. We found that the first and second attitude incongruencies were associated with the breakdown between the social-technical subsystem (considered as 'construction management') and the personnel subsystem (i.e. worker, foreman, supervisor, manager, etc.)—for example, poor safety management enforcement. The third attitude incongruency was associated with the breakdowns between the environmental subsystem (e.g. educational, cultural, political, etc.) and both the social-technical and the personnel subsystems—for example, ambiguous regulations on safety responsibility assignment (US Bureau of Labor Statistics, 1999b) and poor safety training practices. Therefore, to address these breakdowns, we recommend two safety interventions (safety management enforcement and safety training) and the health and safety legislation.

Enforcement of safety by management

Construction managerial personnel should take proactive steps to reduce safety communication discrepancies between management, supervisory and worker groups. One means by which this could be accomplished is by holding regular safety meetings with general contractors, project managers and subcontractors to align attitudes about safety and commit to using the *same* methods to facilitate safety compliance. These parties should then meet with workers to make sure *everyone* is congruent on safety attitude and risk perception and is concerned about safety, and that *everyone* has a stake in maintaining jobsite safety. Since small

Table 5 The mixed methods approach and findings in this study

Mixed methods approach—triangulation			Research findings Interpretation on qualitative and quantitative results
Stage 1: Shadowing	Stage 2: Questionnaire	Stage 3: Semi-structured interview	
Formulation of research questions	Quantification of qualitative findings	Qualification of qualitative and quantitative findings	
1. What is workers' collective understanding of how to improve jobsite safety regardless of the type of hazard(s) inherent in the job?	*SA-Q1, SA-Q4	Semi-structured questions (e.g. Could you explain how to minimize the hazards with respect to your current task?)	• Three main attitude incongruencies: • First, general contractors (as project managers) were more concerned about safety than subcontractors and workers. Conversely, workers 'pushed their luck' and demonstrated that they did not realize the consequences of risky behaviours, which may be due to their poor safety attitudes or first-line supervisors' ignorance of safety policies and practices.
2. What are the discrepancies in safety attitudes or risk perception among managers, supervisors, and workers?	*SA, *RP	Semi-structured questions (e.g. Why did you/workers not wear fall protection when you walked on joists?)	• Second, managerial personnel (i.e. supervisors and project managers) were better able to distinguish risks as compared to their workers, who tended to underestimate them. • Third, workers in small construction firms tended to leave issues of worksite health and safety to their employers rather than taking responsibility for their own welfare. However, the managerial personnel of these enterprises expected their workers to share these responsibilities.
3. What is the level of enforcement of safety rules among first-line supervisors?	SA-Q2, SA-Q3	Semi-structured questions (e.g. how safety controls were enforced in your company?)	

Notes: SA = safety attitude; RP = risk perception; Q = question item; * = significant.

construction firms typically face challenging work deadlines and may not have the physical space for holding scheduled meetings with employees, these safety meetings could be held within the context of scheduled or impromptu project status meetings or in connection with 'toolbox talks'.

In addition, to help establish safety attitude congruency among workers, construction management could also implement behaviour-based safety programmes, such as the DuPont STOP programme (Dupont, 2010), that focuses attention on worker carelessness and unsafe behaviours. In fact, the DuPont STOP programme begins with observing workers and identifying their at-risk or 'unsafe' actions and taking immediate action to correct these behaviours. Therefore, management could (1) promote the use of a peer-review system where workers have the authority to stop co-workers if they observe a critical safety incident; and (2) give praise, rewards or recognition to workers if they contribute to the good performance safety record of their employer. In so doing, small construction firms could facilitate the development of a heightened internal locus of control in order to avoid worksite accidents.

Safety training

Safety training has been demonstrated by a number of studies to be an effective means for preventing worksite accidents (Lingard, 2002; Lipscomb *et al.*, 2004). However, safety training programmes can cover a wide range of areas. In the case of small residential construction firms, we recommend the following training strategies for mitigating any identified safety attitude incongruencies between supervisory personnel and workers: (1) improve safety awareness at all levels; (2) demonstrate the consequences of risky behaviour; and (3) make sure every worker regardless of job title can distinguish risks and hazards. Workers must realize that worksite injuries and accidents can never be prevented merely by 'luck'; they are more likely to occur through risky behaviours and misjudgments on risks and hazards.

Lipscomb *et al.* (2008) reported some of the unique challenges that impede the effectiveness of formal

training in the small residential construction industry, such as precarious and intermittent work conditions and shorter periods of employment. Thus, for the training to be effective in smaller construction firms, 'informal' health and safety programmes should be implemented to supplement the company's formal safety training (Terry *et al.*, 2008). With respect to how informal training should be delivered, Swanwick (2005) suggested that it should not only fit workers' work context and culture, but also facilitate situated learning. Hence, in additional to providing formal training to their employees, small business residential construction management could engage workers in safety talks during lunch breaks or hold 'toolbox talks' to improve their safety awareness (such as discussing distributed safety brochures, OSHA injury statistics, or workers' past injuries). During these breaks and/or toolbox talks, construction management could also articulate and reinforce the specific repercussions from workplace injuries and/or OSHA safety-related citations (such as the possibility of lost wages, permanent physical impairments, or worse) and ask workers to discuss the addressed repercussions. Consistent with Choudhry *et al.* (2007), we believe that once safety is integrated into the organizational culture, the safety climate will be enhanced and the likelihood of accidents and injuries will decrease.

Health and safety policy

OSHA requires an employer to be responsible for providing workers with a place of employment that is free from hazards (US Bureau of Labor Statistics, 1999a). However, OSHA's multi-employer worksite policy (US Bureau of Labor Statistics, 1999b) is not clear regarding the accountability of employers at different levels of the system, such as project managers or supervisors. Multi-employer jobsites are complex systems, making the causality and accountability for accidents difficult to determine. The sometimes ambiguous 'burden of proof' associated with this policy often leaves the responsibility for safety to smaller subcontractors (Uher, 1991) through a variety of contractual arrangements (Arditi and Chotibhongs, 2005). As a consequence, the policy is less effective because it facilitates shifting of responsibility to smaller contractors who have limited budgets to manage, establish or sustain best practices over time.

Attitudinal incongruency may be a symptom of a system breakdown or a precursor to loss of organization safety and health integrity. Organizational coherence reflects the cross-values between the different levels of employees within a system. If incongruence exists between levels, role conflict will occur (Katz and Kahn, 1966)—and role conflict within a work system increases the likelihood that accidents will occur (Roberts, 1990). Thus, attitudinal incongruence should be viewed as a sentinel event that requires further attention in the form of safety meetings and training or professional development. Use of incongruence as a catalyst for improvement is a proactive approach to safety. From our observations, the subcontractors in our study only practised safety behaviour in the presence of project managers, perhaps because workplace safety contract liability lies with general contractors, not with subcontractors. However, this behaviour may be due to an attitudinal incongruency between the managerial personnel on OHS accountability. To enhance attitude congruency, we suggest that potential policy level interventions and their efficacy (Gray and Scholz, 1993) be investigated and enforced. Such actions could elucidate worksite safety accountability and have a positive impact on safety performance in multi-employer construction jobsites.

Conclusions

The attitude–behaviour relationship recognized by Ajzen's TPB was used to frame this study. Our goal was to explore the attitudinal differences towards safety behaviours among managerial personnel and workers in small construction firms, as well as how these differences could affect safety performance. In the context of these findings, a related goal was to suggest safety interventions for preventing worksite accidents and injuries, and offer guidelines for enforcing them. As discussed herein, few studies have addressed the problems of safety cultural discrepancies among management, supervisory and worker groups in the small residential construction industry. This is partly due to the industry's multi-employer culture and the ability of contractors to outsource OHS risks to their subcontractors through various contractual arrangements.

Qualitative and quantitative methods were used to investigate worksite safety problems. Specifically, a triangulation design featuring the use of shadowing, questionnaires and semi-structured interviews helped to acquire constructive and unifying insights about the safety culture in small construction companies, and also assisted in proposing safety interventions to reduce accidents and injuries. Although this approach—including 15 hours of observation data—was not sufficient to identify *all* aspects of behavioural patterns among employees of small construction firms, the amount of data was sufficient to suggest a pervasive tendency among these workers to practise unsafe work habits. Conversely, the 15-hour observation

component of this study could also be considered a limitation because it was not intensive enough to authenticate accurate safety interventions that would prevent worksite injuries. The limited period for observing each participant was also constrained by their contractor's tolerance for onsite data collection, which varied by site and individual.

Field studies are often challenged by sample size, owing to the realities and dynamics of data collection in a natural environment and the need to reduce interference in work tasks and productivity. As such, statistical conclusion validity as well as external validity are not always as strong as what might be found in larger-sample studies. However, we were not met with this limitation in our study. We conducted a post hoc power analysis of the safety attitude and risk perception question items using O'Brien and Muller's (1993) equation based on a three-group one-way ANOVA. The results for safety attitude showed that the power ranges for workers are from 0.72 to 0.93; supervisors are from 0.54 to 0.80; managers are from 0.51 to 0.76. The results for risk perception showed that the power ranges for workers are from 0.96 to 0.99; supervisors are from 0.86 to 0.99; managers are from 0.83 to 0.99. The minimum power of the analyses (0.51 and 0.72) is considered moderate in social sciences; all others were considered high or acceptable levels of statistical power (Cohen, 1988). Thus, the strength of our study was the ability to draw conclusions based on a sample size that minimizes the probability of a Type II error.

Admittedly, the construction business structure we studied may be different from those in other countries. Their occupational health and safety challenges may not be subcontracted through projects but rather through other mechanisms, which will limit the generalizability of our recommended safety interventions.

Despite the limitations discussed above, results from this study suggest that the small business construction industry is at risk for workplace accidents and injuries, is in need of more safety and health education programmes to keep workers safe, and would benefit from increased management oversight to implement such programmes. Our results also confirmed that general contractors, subcontractors and workers need to share responsibility for jobsite safety, as well as communicating the consequences of risky behaviours. Two considerations for safety interventions are recommended to better manage worksite safety: (1) hold safety meetings consistently between managerial personnel and with workers; and (2) implement informal training to supplement formal training. The study also recommends OSHA to legislate a hard-and-fast rule about accountability on a multi-employer construction jobsite.

During the course of this study, we found that the construction projects we observed were operated by managers who articulated a genuine concern for worksite safety as mandated by OSHA. However, because of the prevalent unsafe work practices among small builders (McVittie *et al.*, 1997; Lin and Mills, 2001; Kines, 2003), this safety ethic may not be held by all project managers. Therefore, it has no chance to 'trickle down' to their first-line supervisors and employees, reinforcing the need for implementing safety interventions and safety attitudinal changes to prevent injuries and accidents. Finally, further research is needed to collect more data for evaluating and validating the efficacy of the recommended safety interventions discussed herein. It is our hope that the small business construction industry can benefit from these results to better understand the consequences of attitudinal discrepancies for the design and deployment of effective safety interventions that could reduce both injury rates and resulting worker compensation costs.

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