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Construction health and safety (H&S) is usually managed using a top-down approach of regulating workers' behaviour through the implementation and enforcement of prescriptive rules and procedures. This management approach privileges technical knowledge over knowledge based on workers' tacit and informal ways of knowing about H&S. The aim is to investigate the potential for participatory video to: (1) identify areas in which formal policies and procedures do not reflect H&S as practised by workers; (2) encourage creative thinking and elicit workers' ideas for H&S improvements; and (3) provide an effective mechanism for capturing and sharing tacit H&S knowledge in construction organizations. Interviews were conducted in two case study organizations (CSOs) in the Australian construction industry. The results suggest reflexive participatory video enabled workers and managers to view their work practices from a different perspective. Workers identified new hazards, reflected about the practical difficulties in performing work in accordance with documented procedures and reframed their work practices and developed safer ways of working. Workers described how the participatory video capturing the way they work enabled them to have more meaningful input into H&S decision-making than they had previously experienced. Workers also expressed a strong preference for receiving H&S information in a visual format and commented that video was better suited to communicating H&S 'know how' than written documents. The research is significant in providing initial evidence that participatory video has the potential to improve H&S in construction.

Keywords: Australia, health and safety, participatory management, training, visualization

Introduction

We examine and argue for the potential of participatory video (PV) techniques in health and safety (H&S) in the construction industry. We propose this in response to what can be seen as the growing proceduralization of H&S: Bieder and Bourrier (2013) express concerns about the over-proceduralization of organizational management systems, suggesting that critical information needed by workers is buried inside long and overly complicated documents; and Fucks and Dien (2013, p. 32) warn that the over-bureaucratization of H&S can result in the reduction of people to mere 'robots' for whom an unthinking compliance with rules takes precedence over working safely.

While there is a long history of use of video in safety induction and training, these are usually produced in a top-down manner and shown to workers as stand-alone presentations. In such scenarios workers become audiences to generic video materials. Moreover research shows that particularly for migrant workers with low host-country language skills induction can be little understood (Pink *et al.*, 2010). By contrast, *participatory* video offers workers alternative, and we argue deeper and more effective, ways of engaging with H&S. It can also overcome issues related to low literacy levels and build on workers' existing media practices, often developed outside work.

Below we first critically review the proceduralization of workplace H&S, which is the context for our discussion. We then outline benefits associated with uses of video to research, analyse and understand complex social and organizational issues, and in workplace learning. We argue that bringing together these two facets of

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video in applied research offers key benefits for the management of construction H&S. In developing our argument we draw on the findings of a qualitative interview-based study. This explored the potential for PV to address problems related to the proceduralization of H&S, H&S management and developing workers' H&S capability, and indicated starting points for future uses of PV in construction. We describe the research approach and methods and report on qualitative data collected within two organizations. Finally, we outline the potential and suggest future research directions for using PV to improve H&S in the construction industry.

The context: from proceduralization to participation

Although work policies and procedures are important in any organizational context, Bieder and Bourrier (2013) argue that it is inherently dangerous to rely exclusively on a rule-based bureaucratic approach to H&S. This is because, no matter how complex, rules and procedures cannot cover all eventualities and workers, by necessity, must adapt them in the field. In reality H&S arises through ongoing interactions between formal rules and informal adaptive behaviours (Fucks and Dien, 2013). Thus it is unsurprising that gaps emerge between the prescriptions contained in formal H&S documents and how work is carried out in practice (Borys, 2012). Problematically, if procedures do not adequately reflect the reality of task demands, they may be ignored. Over-reliance on compliance with H&S procedures can moreover have the negative effect of diminishing people's capacity to understand and analyse situational risks, particularly in dynamic and complex work environments (Hollnagel, 2010). Writers on organizational resilience emphasize the importance of people constantly questioning procedures or practices that are not effective (Reason, 2000).

Hale and Borys (2013) identify two approaches to achieving workplace H&S. One is a 'top-down' approach which emphasizes enforcing workers' compliance with rules. When workers make errors these are attributed to individual behavioural issues, for example, laziness, complacency, or a tendency to take risks (Hayes and Hopkins, 2014). However, an alternative approach considers rules to be dynamic, and locally situated. Here, workers are seen as experts whose competence enables them to adapt rules to suit their particular situation (Hale and Borys, 2013). When errors occur, they are seen in the context of the design and organization of work (Dekker, 2007).

Significantly, research shows that the ways H&S is spoken and written about on construction sites reflect a culture of top-down enforcement of management-imposed rules (Sherratt *et al.*, 2013). Therefore improving H&S capability is hampered by top-down management approaches that privilege technical expertise over workers' experience (Vella, 2002). Wilkins (2011) argues it is more appropriate for trainers to help construction workers learn about H&S through facilitation and drawing on their experience, rather than by dictation. Indeed, participatory (worker-led) approaches to developing H&S capability produce demonstrably better results in terms of knowledge acquisition and injury prevention than traditional methods (Burke *et al.*, 2006).

The effectiveness of traditional H&S training is also affected by language and literacy issues. Australian construction workers have relatively low levels of educational attainment and literacy compared to workers in other sectors (Australian Bureau of Statistics, 2013) and an increasing number of migrant workers creates additional challenges for communication and comprehension of H&S information (Trajkovski and Loosemore, 2006; Loosemore and Andonakis, 2007). Thus visual modes of information delivery may be more readily understood than text-based approaches.

Video for research and learning in organizations

In a contemporary context where digital video and mobile technologies are affordable and ubiquitous, people are increasingly comfortable being filmed while performing everyday activities (Forsyth, 2009) and disseminating such videos via social media. Video is frequently used by researchers in association with a range of analytical methods for documentation and analysis (Heath *et al.*, 2011; Mitchell, 2011; Milne *et al.*, 2012; Pink, 2013), and offers ways to reveal, understand and collaboratively reflect on research participants' normally unspoken-about activities, practices and experiences (Pink, 2013). Video is also used by educators to stimulate self-reflection in professional training programmes and other educational settings (Lee and Wu, 2006; Moreno and Valdez, 2007; Leap *et al.*, 2009; Harford *et al.*, 2010). Research indicates that video generates higher levels of self-reflection (Cheng and Chau, 2009) and peer-to-peer learning (Chan and Leijten, 2012) compared to traditional modes of delivery. It has been effectively used for reflexive viewing in sports and dance performance contexts (Leijen *et al.*, 2009) and in applied research-based interventions (Pink, 2007).

Uses of visual research and communication methods in construction research are slowly emerging. For instance, Bust *et al.* (2008) trialled the use of images to communicate H&S to migrant workers, while Zhang *et al.* (2014) used photographic images to elicit

perceptions of H&S risks inherent in building designs and technologies. Albert *et al.* (2014) utilized images and augmented reality to support risk-free hazard identification among construction workers. Tutt *et al.* (2013) have used photography during fieldwork on construction sites, inviting participants to use the camera to 'show' aspects of their experiences of safe working, as well as photographing significant aspects of sites. Lyon (2013) has photographed sequences of work practices and Chan (2013) recently used video to facilitate and evaluate learning in construction trade skills. These studies point to the potential for using video further in construction industry H&S research, both to document participants' activities and for workers to better show and communicate about their experiences of working safely. Because video can reveal tacit ways of knowing, beyond what is normally spoken about in interview studies, it is ideally suited to the depiction of knowledge relating to 'know how' rather than 'know what', making it potentially very effective as a method to represent ways of working safely.

Indeed video is increasingly used to analyse and understand complex environments, behaviours and practices (van Nieuw-Amerongen *et al.*, 2011) in high-risk organizational settings, often related to healthcare. This includes using visual ethnography re-enactment methods for understanding hand gel use for H&S in healthcare (Pink *et al.*, 2014b), video ethnography in operating theatres (Lammer, 2007) and conversation analytic methods (Hindmarsh and Pilnick, 2007) in research into interaction in anaesthetic rooms. In medical emergency situations video research revealed how omitting important steps in the procedure of patient airway management was related to aspects of the physical environment and pressure exerted by other team members (Mackenzie *et al.*, 2004). In an industrial context videos of truck drivers performing routine delivery tasks were analysed by workers and ergonomists to stimulate discussion about work-related risks and possibilities for improvement (Reiman *et al.*, 2014).

Existing research also reveals how reflexive video methods enable learners to better understand gaps between theory and practice (Perry and Talley, 2001) and learn from their *in situ* experiences by identifying how the reality of what happens differs from what is supposed to happen (Shaw, 2012). The benefits of using video in projects designed to bring together research and worker learning and reflection are also demonstrated in health research, where video has offered insights into complex socio-organizational interactions. For example, Iedema *et al.* (2006) describe how, when viewing video footage of 'corridor' conversations in a spinal pressure area clinic, clinicians noticed numerous infection hazards associated with the physical work environment, as well as taken-for-granted work practices. Building on this, Iedema *et al.* (2009) engaged clinicians to view and reflect on video footage of the everyday communication practices that occur when doctors and nurses 'hand over' between shifts. This resulted in a significant redesign of handover practices in a hospital to reduce risks to patient safety associated with poor communication (see also Carroll, 2009). Playing back video footage of *in situ* work practices is a particularly powerful way of bringing habitual or taken-for-granted practices to the fore, opening them up to critical review and questioning. Carroll *et al.* (2008) describe how, in a hospital, 'the visual medium [of video] enables clinicians to recognize the distributed, unspoken and risk-prone dimensions of their taken-as-given sayings, knowings and doings' (p. 381).

Video for participation and pedagogy

As this existing work shows, reflexive uses of video have much potential for exposing, understanding and designing interventions in relation to the previously noted gaps between work as imagined and work as performed in the construction industry. However the work discussed above has tended to focus on researcher-produced video, as distanced observation (suited to conversation analytical techniques) or in direct collaboration with research participants (suited to ethnographic interpretation). PV involves participants in research and learning processes differently, in that it involves them directly in the production of video-based ways of knowing. Generally, PV comprises a set of techniques involving a group or community in creating their own film (Lunch and Lunch, 2006, p. 10). Unlike documentaries, in which subjects rarely have a say in shaping the content, PV enables people to 'shape issues according to their own sense of what is important' and decide how they want to be portrayed (Lunch and Lunch, 2006, p. 10). This approach has often been used to provide insight into and share the experiences and daily realities of marginalized or disadvantaged groups of people. For example, Foster (2009) used PV to explore the experience of parenting in situations of economic disadvantage. Buchanan and Murray (2012) describe how PV enabled users of mental health services to express and communicate the realities of suffering from mental health disorders to others. PV is particularly useful in providing a voice to people who may not otherwise be able to articulate their position or participate substantively in discourse about a particular issue.

Yet as a participatory mode of production, video has a further advantage, as a pedagogical tool. There is

evidence to suggest that some people have a preference for visual rather than verbal learning (Mayer and Massa, 2003). Indeed, as a pedagogical tool that draws on the often unspoken consciousness of ordinary people, and effectively shares their knowledge and experience with others, video has long since been established in educational and media pedagogy literature and practice (Goldfarb, 2002). Most recently digital student-produced video is increasingly popular in formal and informal learning environments, and researchers and educators have called for further engagement with video for learning (Azzarito and Kirk, 2013).

Video therefore offers new opportunities in the Australian context, where Ayers *et al.* (2013) have shown that, despite the existence of a statutory requirement to consult workers about aspects of work that could have an impact on their H&S, most construction organizations do not involve workers in making strategic decisions about H&S. PV has the potential to engage workers in the design of workplaces or systems of work that might affect their health or safety. Because PV is widely believed to enable and empower communities or groups to pursue social change from the bottom up (see White, 2003; Shaw, 2007) it could potentially address some of the inherent limitations of the predominantly top-down approach to H&S management adopted in the construction sector.

Research design and methods

To examine the potential of PV in H&S in the construction industry further in practice, we developed an exploratory project, which aimed to set a starting point to underpin future work in this field. To do this we undertook open-ended interviews and observational methods during the implementation stage of a PV intervention designed to capture and reproduce H&S knowledge in two case study organizations (CSOs).

PV processes bear some similarity to participatory action research (PAR) whereby the research subjects are co-learners in change processes. In a PAR approach researchers actively engage with research subjects as participants in the generation of context-specific solutions to their own problems through a process of reflection, change and evaluation (Patton, 1990). In contrast to using PAR as our own research method, our research focused on an existing industry-derived participatory intervention. Both CSOs were selected because they were utilizing a novel PV system for the development of visual H&S procedures for construction work. This system was developed by a small Melbourne-based firm, CodeSafe Solutions, established in 2012 as a niche H&S/media consulting organization.

At the start of CodeSafe Solutions' PV intervention, a facilitator visits the workplace and talks to workers about how they perform their daily tasks, and, in particular, how they work safely. A storyboard and script are then developed for a visual work procedure. This is shared with workers, who are invited to edit or change the story/script as much as they wish. Once the story/script has been agreed upon, the workers are provided with basic media training and engaged in acting and filming their story. The videos depicting the work procedure are reviewed by the workers involved. Once completed, the visual procedure is made available digitally using quick response codes so the knowledge captured is accessible by all workers using smart phones and other devices.

The research examined three key questions: (1) Can PV create a different view of work that can be used to improve H&S? (2) Can PV encourage creative thinking and elicit workers' ideas for H&S improvements? and (3) Can PV provide an effective way to capture and share H&S knowledge in the construction industry?

At each CSO semi-structured interviews were conducted with managers to explore their experiences and reflections about the PV process. Managers were asked open-ended questions about how the PV process worked in their organizations, their own response to the PV and their perceptions of the workers' responses. At CSO 1 this interview was conducted retrospectively. We could not interview workers who had participated in the PV process in this organization because the project was complete and the subcontracted workforce had dispersed.

CSO 2 provided access to a 'live' project where the PV intervention was taking place. Here we undertook observation of workers engaged in the facilitation session, focusing on how the facilitator interacted with the workers, and workers' responses to the PV process. We interviewed five workers, using open-ended questions about their experience of the PV process. All interviews were audio-recorded, transcribed and analysed in response to the three research questions.

Findings

We discuss the findings of the study in three sections. The first two reflect on the use of PV from a management perspective. Significantly, not only do they show what managers believed video contributed for workers, but also through an analysis of their comments, we argue that using video opened up processes that enabled managers to communicate with workers in new ways.

Case study organization 1

CSO 1 was an alliance between a major construction company, an engineering design firm and a

government-owned statutory water authority. CSO 1 was responsible for improving, maintaining and expanding water storage systems and the distribution network for reliable and high-quality water. Following a review of CSO 1's injury/incident statistics, video recording was implemented in relation to the following work tasks:

- use of a demolition saw;
- asbestos removal;
- dealing with chemical spills;
- working in a confined space; and
- building a mobile scaffold tower.

The research at CSO 1 focused on an interview with a project manager. While his reflections indicate how the video intervention enabled workers to engage differently with H&S, they also demonstrate the impact of such uses for enabling shifts from procedural to participatory approaches in organizations. What is of interest here is therefore not simply the observations that the manager reports, but how he frames these with his perspectives on the positive nature and experience of worker engagement developed through PV techniques. The manager described how initially, he saw the principal benefit of the video-based intervention as its ability to communicate H&S information to workers visually thus taking a traditional 'top-down' approach to communicating documented policies and procedures. However, he described how, during the implementation process, the content of some of the formal policies/procedures targeted for video production was questioned by workers. For example, a video was made showing workers coating concrete sewerage channels with epoxy to prevent corrosion. This task is very dangerous because the channels contain aerated liquid. Falling into the channel would almost certainly result in death. In order to apply the epoxy to the channel beams, work is performed from a barge. When viewing the video showing entry to the barge, workers identified a problem that left them at risk of falling into the sewerage channel. The project manager explained: 'even just a little thing, how they hooked themselves onto the safety line we identified there was a little gap. Like, there was virtually a 10 second gap [during which time] they weren't hooked on.' The danger inherent in the method of entry to the barge had never been noticed before, but as the manager pointed out it was 'only when [the workers] acted it out that they were conscious of "hang on … you have to actually undo [the harness] from the side and attach it to the base of the boat."' Thus, the workers observed there was a period of time during which they had no protection against falling into the sewerage channel. As a result, a new work process was developed whereby multiple connection points were used. Thus the reflexive viewing process enabled workers to bring

their own knowledge into formulating H&S, while simultaneously making the benefits of a bottom-up approach clear to the manager.

The project manager described how in subsequent videos made at the alliance new forms of worker engagement with H&S emerged as: '[The] crews themselves were the film crew and we had them act out their safe work method statement, actually role play that out and train them and supervise [them] how to use the cameras'. Despite being initially sceptical, he remarked how 'pretty soon the guys started coming to us with ideas about more stuff we could do'. Indeed, from this project management perspective he reflected that: 'One of the benefits we saw was it [the PV process] allowed us to build great engagement with the workforce … it just created that openness that "Look, we're here to listen to what you want to say and we're willing to put in place your ideas into our systems" and that's what makes safety more credible really.' He emphasized how 'during the [PV] process it's amazing how many things the crews themselves picked up … they said "oh actually what we do in practice is not what the document says. Actually we do this." So it actually I think resulted in improvements to written safe work method statements to better reflect what crews were doing.' An example he gave demonstrates this well. Here, members of a scaffolding erection crew were viewing video footage depicting the standard erection procedure for a mobile tower scaffold. While watching and reviewing the footage, the workers identified a period of time during which work was performed adjacent to an unprotected live edge. He recounted how: 'There was just one phase, for 30 seconds, where they were unprotected … so we went back out to the worksite with the crew [and] the supplier and said "how do you reckon we fix it?"' The crew spent several hours trying different erection sequences and eventually worked out a new method for erecting the scaffold tower, using temporary platforms and horizontal bracing. This eliminated the requirement to work adjacent to an unprotected edge at any stage in the erection sequence. As the manager's comments show, the insights from this example emphasize a method through which workers' tacit knowledge and experience can be engaged *and* an appreciation of this achieved at a management level: 'the previous way of building [the scaffold] had been custom and practice for decades … no one had sort of thought twice about it but once you saw it on the screen it didn't look quite right … and we just got the guys who had been doing it for years to try and find a way to fix it and in the end they did.' Thus showing how PV can engender forms of management that evade the problems of top-down procedural H&S processes, towards more engaged and worker-informed approaches.

Case study organization 2

CSO 2 supplies and installs insulation and energy efficiency products in the residential and commercial building sectors of the Australian construction industry. CSO 2's top risk areas are:

- electrical safety;
- working at heights;
- traffic management;
- mobile plant; and
- working in hot conditions.

In CSO 2 workers were engaged in a participatory process to develop videos about electrical isolation, load restraint procedures, trailer hitching, working in hot conditions and accessing ceiling spaces. As for CSO 1, the interview with the H&S manager at CSO 2 shows how, for her, the process of making the videos opened up new ways of engaging workers in a two-way conversation about H&S.

She described workers' antipathy to written H&S procedures and contrasted this to the worker-developed video, observing: 'They [the workers] can see that it's not fixed in concrete. They have an ability to improve it and contribute to it and it's made up of what comes from them.'

The H&S manager reflected on how, prior to the introduction of PV in CSO 2, field-based workers were reluctant to communicate with professional/managerial staff in the corporate office. Having made several videos using the participatory process, she observed that workers were much more comfortable talking to her about H&S and sharing their ideas for improvement, commenting: '[Previously] there was no way you could get the operations guys to come in the office because they thought they were going to be, yeah, performance managed … and now they're coming in quite freely and making a point of dropping by in here, so it's good.' The H&S manager described how the largely contracted workforce had become more actively engaged in CSO 2's activities and events and attributed this to them being interested in and engaged in the video process. She described how the organization 'had 100% [of workers and contractors] turn up for the end of year barbeque and they all wanted to see the … video, and that's never happened before.'

She also believed that workers felt that their opinions were valued as a result of participating in the video production process and this created a level of trust that allowed new ideas about how to improve H&S to flow from workers to managers. She commented: 'The camaraderie is great, which opens up free thinking and free speech and things come forward. When you ask their [the workers'] opinion, they feel valued.' For example she described how during the scripting and development of a video about working safely in the heat, a worker observed that eating hydrating foods is important to restore energy and fluid in the heat. The H&S manager noted how: 'everyone talks about hydration but no one talks about hydrating food and when you lose your appetite and don't eat it can add to your fatigue.' The workers suggested the slogan 'rehydrate and refuel' and the video they produced included a sequence showing a worker taking a rest break, opening a small portable insulated food container and eating fresh pineapple. The advice relating to the importance of eating hydrating food was also added to the company's written H&S manual.

At CSO 2, the video development process also revealed a significant gap between work as imagined and work as performed. Much of the installation work undertaken by the company involves accessing ceiling manholes at a height of between 2.4 and 2.7 metres from the floor. The company's safe operating procedure for the use of ladders and working at height was the subject of one of the videos made during the PV intervention. Here a video script was based on the procedure document and distributed for comment. The H&S manager noted while 'no one had an issue with it [the script] theoretically', but a very different picture emerged once filming; since 'to place a straight ladder at the 1:4 ratio just doesn't work, you can't get a body in there as well because it blocks off the access and you have to contort yourself to actually get in [to the ceiling space]'. In this case, the safe operating procedure for this task required the ladder to extend 900 mm beyond the 'step off' point, which was almost impossible to achieve due to conduits, cables, beams and other obstructions. Moreover, the small size of the manholes did not allow adequate entry for the ladder, the worker and the pack of insulation to be installed. The H&S manager described how to pass ceiling packs through the manhole workers used a straight ladder which meant they had to contort their bodies to manoeuvre themselves into the ceiling space, then move the ladder to get the packs in, explaining that 'It's pretty cumbersome'. However, if the workers used an 'A-frame' ladder, 'which they do because they can't use a straight ladder', they were forced to work unsafely because they had to step off the top rung of the 'A-frame' to get their bodies up into the ceiling space.

Once these practical difficulties and the impossibility of following the documented procedure were demonstrated, the filming was halted. As the H&S manager put it: 'shooting it and viewing it through the camera's eye, we had to stop … the camera doesn't lie.' The company then embarked on a project to find a solution to this problem. The H&S manager consulted workers and, together, they identified an alternative

access system used by arborists. This access system has curved rungs which envelope the body 'so it is easy to get three points of contact and you don't need the 1:4 ratio lean so you can place it so it does not encroach on the manhole opening space and there is a clear shaft opening for the ceiling packs'. Here again it is evident that using video in this way facilitated new forms of worker participation and manager–worker interactions.

Workers' experiences at CSO 2

A member of the research team spent a day on an apartment complex construction site with David (who is the founder of CodeSafe) and workers engaged by CSO 2. The researcher observed the consultation stage of the video script development and undertook interviews with five workers who participated in the development of a script about electrical isolation in the commercial construction sector. Here we see how workers' interaction with the facilitator (David) as well as the PV approach can elicit workers' insights.

When David talked to the workers at the site he spoke from a personal perspective, looking them in the eye and talking about his own time in the construction industry, how he once experienced a work-related injury, and how this changed his approach to H&S. David began by explaining to the workers that he was at the site to help them make a video about how they work safely. He explained he was looking for the workers to contribute to the video content, inviting their input by saying, 'Well I know you lads know the best way to do things because you're the ones doing it'. The workers seemed amenable but were not very enthusiastic until some began to be interested when David talked about how he is not keen on reading, and this is the reason he works with video. David conducted the session informally, chatting to the workers about the work they were doing that day. He gathered three crew members together in the building basement and, sitting on the ground, started to talk to them about some of the challenges they had experienced installing insulation at the site. The workers explained how they had arrived at the site after the services had been installed and the power supply was on. This was a problem because they had to shoot nails to fix the insulation in ceilings and wall cavities that had cables running through them. They explained that they had to assume that all cables they encountered were live but David asked how they knew if there is a cable running through a wall cavity or ceiling. After some discussion, the workers said they would normally ask the principal contractor's foreman but they had encountered previous instances where such requests had annoyed the principal contractor who considered them to be a nuisance. The H&S manager, who was also present, mentioned the company's standard operating procedure states that installers should not shoot the nails closer than 600 mm to any cabling or conduit. None of the workers were aware of this rule, highlighting the problems inherent in relying on written procedures for communicating critical (and potentially life-saving) H&S information. They agreed that this information was essential to include in the video, but also, drawing on the experience of the workers, the video should provide information about the need to confirm the location of cables with the principal contractor before commencing work and make the assumption that all cables are live in such circumstances.

Five of the insulation installation workers at the site were also interviewed about their experience of the video intervention. These workers were selected because they participated in the video production and the intention was to gain insight into their experiences of this process. Workers were asked about:

- their preferences for receiving H&S information, i.e. through documents, videos or formal training activities;
- how they currently access knowledge about H&S;
- whether they liked making the H&S videos; and
- whether in the process of making the video they were learning new things about H&S.

Perceived benefits associated with visual communication

All five workers commented that, for them, receiving H&S information visually is more helpful than through text-based methods. One observed the difference between informing workers of H&S requirements and showing them how to work safely, commenting: 'It's a lot easier to show someone what we're trying to say. We could just sit here and verbally speak about it but if you put your verbal words into a video, people are going to sit back and go "now I know what he's actually trying to say".'

The workers generally agreed that it was easier to retain and recall the content of videos as compared to text-based H&S resources. One remarked: 'If you watch [something] that's it, that's going to be keeping in your brain. You remember more in one movie than one letter, paperwork or newspaper or whatever you read. You remember what you see.' They also pointed out that in construction, workers generally do not engage with written material, for a number of related reasons: one worker commented: 'You get a lot of people, especially in the construction industry, a lot of people who sit there and don't take in what they see on paper. They're more "hands on" like. The whole construction industry is. It's more "hands on".' Another

commented: 'I think it [video] is the best way for people to learn. I mean, just from my point of view, being on a building site I don't read too much at all, especially when I get on site. I'm here to do a job, you know what I mean?' Indeed traditional procedures can be inaccessible due to the length and complexity of H&S documentation, as one worker expressed it: 'There's just so much information and it's just not practical to sit there for three, four hours because I'm not very good with the English language so for me to read a document like that would take me half a day and they're not going to let you sit there and do that … you're also going to embarrass yourself in a room with 20 other people … so there's pressures to sign them off.'

Workers' ways of knowing about H&S

Therefore, rather than through reading, most workers commented that their primary source of H&S knowledge was through observing and imitating those around them. One described how he knew about H&S by 'just sort of learning from the people that I was with'. Another described how 'the young learn from the old, don't they?'. However, the limitations of relying on informal on-the-job learning about H&S became evident when one worker described how information about the need to maintain clearance before shooting pins into masonry adjacent to condui ts was discussed during the video scripting process. He commented: 'I thought it would have been something that someone would have told me in my whole learning process of being here … but it does not seem to be happening.'

It became clear that there is a need for new methods to ensure that such forms of learning are possible, as another worker described how it is sometimes hard for written and verbal instructions to fully capture H&S knowledge, in that 'We can't put everything in there [the H&S procedure] because sometimes it's something you can't write in there because it's knowing … You can make a note but, yeah, it's hard to describe everything in words.' In contrast it was felt that because the video emerged from the participatory context it would better achieve this, as one worker said: 'I think it's the best way because if [the material] is from people working on the site, it's going to be spot on. Exactly what is happening.'

Workers' involvement and engagement in the video-based intervention

The workers moreover appreciated being involved in making the H&S video. As one expressed it: 'It's good to give people input, especially when you realize that it's going to improve something.' Indeed they described

how they felt valued because the company had taken the time to really understand (from their perspective) how they work and the H&S aspects of their jobs. For example, one commented: 'It was good. It was actually good, you know, getting my voice heard and actually people sitting there and actually taking it in what I was saying, rather than just going over someone's head or just turning a blind eye to it. It actually feels like something or progress can be made or people actually listened.'

Opportunities to learn about H&S

Several of the workers commented that they had learned important new H&S information when reviewing and discussing the content of the video. For example, one worker stated: 'Some things I didn't actually fully take into consideration before, got brought to my attention … so it was actually good … there was actually some points there I'm glad that got brought up and that would not normally be brought up.'

Workers described how sharing information from different perspectives in the video development process presented an important learning opportunity. One commented: 'It's good having different points of view from people that have, you know, got different outlooks on different things … Like with guys [like us] we work on the site – and then getting like another vision from someone that's just come into it and you go "okay, actually what about this then?" And you sit back and go "oh actually we didn't take that into consideration".'

Several of the workers described how they were previously unfamiliar with some of the important H&S information written into the video. One commented: 'I learned that you're not to shoot a pin less than 600 mm from a live wire. Never knew that at all … and that's a big one. I also learned that conduit sometimes is running through the concrete slab. I didn't know that.'

Discussion

Creating a different view of work

Pink *et al.* (2014a) note how institutional and informal knowledge intermingle in workers' H&S practice. Iedema *et al.* (2009) describe how video footage of day-to-day work practices helped medical practitioners to re-apprehend and reframe their work processes, and provided the opportunity to redesign these processes in their everyday practices. According to Iedema *et al.* (2009) moving images place people in a space of transformation because viewing one's work on a screen generates a higher level meta discourse about how work is

performed. Video captures the audio and visual aspects of work as it is undertaken *in situ* and provides people with a different view of their work. Our research shows how video created the opportunity to reframe H&S within a broader understanding of how work is done. For instance, the mobile scaffold and barge entry examples reveal how hazardous aspects of work, that were enacted by workers on a daily basis, were identified as being unacceptable only after they were viewed on screen. Iedema *et al.* (2009) describe how a video enables people to view their work 'from under a different aspect' (p. 299). In our examples this ability did more than facilitate conversation about the work tasks that were shown, it also prompted viewers (both workers and managers) to consider larger questions relating to acceptability of H&S risk. The video was also a catalyst for creativity and the development of safer, more effective ways of working.

The example of the ladder access to ceiling spaces also illustrates how video can reveal the difference between espoused theory and practice. The content of the taken-for-granted safe operating procedure for entry into a ceiling space had been accepted as being correct 'in theory'. However, filming revealed the impossibility of working in accordance with this procedure. A substantial gap between knowledge about what should be done (as documented in the safe operating procedure) and workers' knowledge about how to perform the task was readily apparent. Once understood, this gap could be addressed and a safer, practical and effective way of accessing ceiling spaces was found.

Stimulating creative thinking and workers' ideas

A key feature of PV is that it 'firmly locates expertise about practice (and possibilities for its redesign) with participants' (Forsyth *et al.*, 2009, p. 215). The research reveals how H&S improvements can be realized when workers are engaged, through PV, in critiquing their own work practices and designing better ways of working.

The benefits associated with engaging workers in the reflexive viewing of video footage were immediately apparent in the problems identified and H&S improvements that were achieved in developing a safer way of erecting the mobile tower scaffold and entering the barge to coat the sewerage channel. However, past research reveals that actively seeking employee participation and feedback in H&S planning, decision-making and improvement results in high standards of H&S performance (Health and Safety Executive, 2005, Törner and Pousette, 2009; Lingard *et al.*, 2014). The interviews conducted at both CSO 1 and CSO 2 indicated that, in addition to making practical improvements to featured work tasks, broader environmental and cultural benefits

were also realized. These included improved two-way communication about H&S, increased worker involvement in H&S activities and elevated levels of trust between workers and managers.

A mechanism for capturing and sharing workers' tacit knowledge

The traditional top-down approach to H&S management has privileged technical expertise over workers' knowledge about how to work safely. However, as Pink *et al.* (2014a) note, workers engage tacit and informal ways of knowing when they practise H&S. Tacit knowledge is difficult to transfer to another person by means of writing it down or verbalizing it (Polanyi, 1958). Such knowledge can be described as 'know how', rather than 'know what'. For example, knowing how to use a complex piece of equipment or perform a complicated work task safely are forms of tacit knowledge. Frequently people who possess tacit knowledge are unaware of their knowledge or do not understand its potential value for others. Construction workers are also unlikely to possess the skills to easily communicate knowledge to others. Workers at CSO 2 described the difficulty of describing aspects of their work 'in words' and indicated that they found it easier and more effective to show this in a video.

The worker interviews at CSO 2 also revealed that traditional ways of knowing about H&S were largely based on observation and on-the-job learning. However, these methods produced gaps and inconsistencies. For example, the participants expressed some surprise that they had never been made aware of the requirement for minimum clearance when installing fixings adjacent to conduits. These workers also commented that the PV process had permitted different workers' perspectives and knowledge to be captured, shared and critiqued. As far as they were concerned, the resulting video would be a more complete and realistic representation of how to work safely because the content was developed collaboratively and subjected to workers' peer review.

The interview data also suggests that video may be a more effective way of sharing and communicating H&S information among construction workers than alternative text-based methods.

Conclusions

While there has been widespread use of PV across a range of sectors, use of video in construction H&S has been limited to using video to communicate the H&S knowledge of technical specialists to workers via instructional videos. This approach privileges technical

expertise over experience. It is also underpinned by the assumption that H&S can be maintained as long as workers' behaviour can be regulated.

Our intention in this article was to: first demonstrate how key examples from the large existing body of PV practice can inform our understandings of its use for H&S in construction; and second, to evaluate whether and how preliminary examples of PV in construction can bring benefits. The implications of both our discussion of the benefits evidenced through the use of PV in other contexts, and the findings of our own research, are that PV offers an effective route towards communicating and learning about H&S in the construction industry. This is because PV reverses the logic of traditional H&S thinking, locating expertise about good practice with workers, who are the creators and subjects of the videos. Our research showed how workers' critical and reflexive analysis of video footage revealed H&S problems inherent in taken-for-granted work tasks. Video also revealed inconsistencies between work as imagined and work as performed, and, in one instance, highlighted the practical impossibility of working in accordance with standard documented work procedures. The new insights generated by viewing video footage from the perspective of an outsider allowed ways of working to be reframed, with the result that high risk work tasks were redesigned to improve H&S. Workers and managers at both CSOs described high levels of worker engagement, open communication and trust arising as a result of the PV process. Workers also preferred visual ways of learning about H&S: they explained that most of their current H&S knowledge was gained through observing others rather than reading H&S documents; and that H&S information representing 'know how' is sometimes difficult to verbalize but can be much more easily demonstrated.

Our work also demonstrates two key areas where future research is needed to advance further our understandings of the theoretical and practical implications of applying this technique in H&S. First, we focused on a particular stage of the PV process: the production phase. Once completed, the worker-created videos are made available to other workers at the respective CSOs' worksites using quick response code technology. Workers access these videos using their mobile phones or other digital devices. Further research is needed to follow through these post-production uses of video. This forms part of our ongoing research into how construction workers use mobile/digital technology to interact with and use this video content. Second, our research was limited to two CSOs in Australia, making it difficult to generalize the findings to other construction organizations. The results suggest that PV has the potential to address some key challenges associated with management of H&S in the construction industry,

notably an over-reliance on written procedures, ineffective training approaches and a heavy emphasis on enforcement of rules rather than engagement of workers. These results are moreover consistent with the approaches that we have noted above, and explain how and why the kinds of knowledge revealed through video are suited to this context. However, further research following the roll-out of these methods will enable further insights into best practice and understandings.

Disclosure statement

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