Profiling the features of risk control culture in the NSW mining industry using automated text analysis.

Heather Jackson, BSc, PhD-fellow<br />Nic Croce, BEc<br />Maya Guest, PhD<br />Pete Kines, PhD

*School of Health Sciences, Faculty of Health and Medicine, University of Newcastle, Callaghan, New South Wales, Australia; *Statistical Support Service, University of Newcastle, Callaghan, New South Wales, Australia; *Mine Safety Performance, New South Wales, Maitland, Australia; *Pete Kines, Division of Safety Research, National Research Centre for the Working Environment, Denmark.

Abstract: Safety culture assessment can potentially provide valuable information about practices which may indicate possible mechanisms of future incidents. However, rather than seeking to understand the meaning of behaviour within the context of the organisational features and human factors within a soci-technical system, safety culture has been misunderstood and the practical application diminished to a pursuit for compliance with safety management processes and work procedures. While questionnaires have been widely used to measure perceptions on defined dimensions of safety climate additional qualitative information which provide context and added meaning to the climate mean scores has been less often used. As part of a mixed-method approach the current study used qualitative data collected through semi-structured focus group interviews to understand beliefs of workers in the NSW mining industry about incident causation and approaches to controlling risk. An opportunistic sample comprising 226 workers from 14 mines representing four companies participated in 17 focus groups. An automated text analysis program which applied a mathematical algorithm to learn from the data was used to extract concepts and themes relevant to the topic. The results identified six themes associated with beliefs about and practices associated with risk control. The themes were: 'Risk management' which reflected beliefs about the controllability of risks arising from mining hazards; 'Job demands' which reflected work practices required by the safety management system and the work environment; 'Trust in ability' which reflected manager and worker competence and training around risk control; 'Work environment' which included work design, fit for purpose equipment, operator skill and experience and work pressure; and 'Individual risk management' which reflected the role of personal risk management tools to identify and control risks. The study found that workers believed that risks associated with mining hazards could be reduced but not controlled to a point where there would not be issues. A range of views were expressed about the relative importance of behaviour and higher order controls as risk control measures. The findings suggested that the behavioural controls were more visible to workers than higher order controls. In light of the recent fatalities experienced in the industry these findings suggest that the industry may need to refocus worker information and training on the range and nature of hazards associated with occupational tasks and increase the visibility of higher order controls.

Keywords: ergonomics, hazards, hierarchy of controls, behaviour safety, procedures

1. Introduction

Safety culture as a safety management tool has been criticised in both academic and safety management literature. The criticism stems from the perceived lack of clarity over what safety culture is, how to assess a safety culture and whether it is possible or even ethical to influence the culture of a group of people. It is generally accepted that safety culture is a subset of organisational culture (Cooper 2000, Glendon and Stanton 2000, Guldenmund 2000). The concept of safety culture was first used by the International Nuclear Safety Advisory Group and was defined as 'that assembly of characteristics and attitude in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance' (International Nuclear Safety Advisory Group 1991). Hence the priority safety has over other organisational goals
may determine the resources, systems and processes allocated by an organisation to manage safety. For a contemporary review and discussion of the strengths and weaknesses of different conceptualisations and safety culture the reader is referred to a review article by Edwards, Davey et al. (2013).

This paper has adopted a definition proposed by Guldenmund (2010) as: ‘those aspects of the organisational culture which will impact on attitudes and behaviour related to increasing or decreasing risk’. This specific definition sits within a broader conception of safety culture as acquired assumptions shared by groups which give meaning to management and worker actions. Guldenmund described three broad approaches to safety culture assessment; ethnography, questionnaire (safety climate) and experience based. While questionnaires and surveys have commonly been used to assess safety climate or gauge compliance with procedures, ethnography and other qualitative methods of culture assessment have largely been limited to academic research (Guldenmund 2010). However, assessment of organisational culture can potentially provide valuable information about practices which could indicate possible mechanisms of future incidents as well as information on which to base safety interventions (Guldenmund 2000).

However in 2010 Guldenmund lamented that the value of safety culture as a safety management tool had been diminished through misunderstanding its origins within an organisation and its many levels of manifestation. In the safety management field, safety culture assessment has focussed on the assessment of processes and behaviours and has often failed to consider the meaning of that behaviour within the context of the organisation (Guldenmund 2010). Hence, while retrospective studies of safety culture using investigation reports of major disasters have identified the nature of underlying beliefs and basic assumptions which shaped the safety systems and practices of the respective organisation, there have been a limited number of published prospective studies of safety culture which achieve a similar depth of insight. There are a number of reasons which may explain this situation ranging from practical considerations to lack of a theoretical framework and inadequate methodologies (Guldenmund 2010). Still, there are several published researches which have made substantial contributions to approaches to studying safety culture (Richter and Koch 2004, Farrington-Darby, Pickup et al. 2005, Reiman, Oedewald et al. 2005, Jeffcott, Pidgeon et al. 2006, Parker, Lawrie et al. 2006, Shaw, Blewett et al. 2007, Antonsen 2009, Gunningham and Sinclair 2012, Mariscal, Herrero et al. 2012). Many studies triangulated data from several sources and the predominant method of data collection was semi-structured interviews. Analysis of interview transcripts can be time consuming and subject to the researchers’ bias (Colley and Neal 2012). A recent study conducted by Colley and Neal (2012) adopted automated text analysis to explore safety schema among railway workers and examine qualitative differences between workers, supervisors and managers. They concluded that the concept learning algorithms employed by the software was able to identify meaningful safety themes which corresponded to existing safety climate dimensions while limiting the prior expectations and beliefs of the researcher.

1.1 Research setting and approach

This study was part of the NSW Trade and Investment, Mineral Resources and Energy, Mine Safety (the Department) safety culture assessment and benchmarking project and is endorsed by the NSW Mine Safety Advisory Council (MSAC). The project methodology was developed and piloted by Shaw Idea Pty Ltd in 2010 and modified through a further trial in 2012/13. A safety climate questionnaire was administered and then followed up with semi-structured focus group interviews. Following a substantial increase in the number of fatalities in 2014 the Department commissioned a review of the causes and factors contributing to these incidents. While no common underlying mechanisms were identified, the findings suggested there was a failure to adopt higher order controls. This study utilised the qualitative focus group data to explore beliefs about incident causation and risk control.

2. Methods

2.1 Participants

Focus group participants worked in both underground and open cut mines in the coal and metalliferous sectors of the NSW mining industry. The study utilised an opportunistic approach to the recruitment of workplaces based on self-nomination which generated a sample that included fourteen mines, of which six were open cut coal mines, five underground coal mines and three underground metalliferous mines. Eleven mines were operated by a single company. Focus group participants
were nominated by the mine. The site contacts were urged to select a representative sample of workers, supervisors, professionals and managers but only one mine achieved this ideal where a sample of 77 workers from across all levels and departments participated in four focus groups. In some instances the Work Health Safety (WHS) committees were utilised. Overall, 226 workers participated in the focus group discussions. Four groups had less than ten participants, nine groups had between ten and 20 participants. Most of the participants were male mine workers, operators (of plant) and tradespersons. A small number of supervisors, managers, professional workers, female operators and managers were represented in the sample.

2.2 Focus group protocol and prompt questions

The focus groups were facilitated by the mine health and safety co-ordinator or a member of the Industry Assistance Unit of the Department. A semi-structured interview protocol was developed with open ended questions designed to stimulate discussion around the relative value of safety and explore beliefs about a range of features thought to influence the safety culture of a mine. The questions often presented opposing positions on a theme and were designed to stimulate group members to challenge each other’s views and thereby delve into the more deeply held beliefs about work health and safety (Schein 1992). The protocol included 15 questions addressing a range of themes including the relative priorities of: safety and production; collaboration versus direction; compliance versus independent assessment; control directed at behaviours versus at the source of the risk; and finding the root cause versus a responsible individual. The interview protocol was modelled on the instrument developed by Colley and Neal (2012). The questions relevant to the topic of risk control were: ‘Do you think it is possible to control mining hazards or do you think that mining is just dangerous work? What leads you to think this way?’; ‘What is valued more as a way of preventing incidents/injuries (1) behaviour safety or (2) barriers/hard controls? What gives you this impression?’ and ‘Do you think work design and procedures here reduce or increase the potential for human error? What gives you this impression?’

2.3 Focus group procedure

The study adopted an action research philosophy and aimed to build industry skills in evaluating their own safety culture. The focus group procedure therefore utilised site Work Health and Safety co-ordinators as facilitators supported by a member of the Industry Assistance Unit (IAU) of the Department. Facilitators were prepared with some guidance on group facilitation techniques. Results of a safety climate questionnaire (Nordic Occupational Safety Climate Questionnaire – NOSACQ-50) were presented at the commencement of the focus group. Four to five hours was allocated during work time for group discussion. Participants were advised that participation was voluntary and participants’ consent was obtained to record the discussions and that the recordings were professionally transcribed.

2.4 Data analysis

Leximancer v4 was used to analyse the focus group transcripts. Leximancer uses a mathematical algorithm based on Bayesian probability theory to analyse text and extract the semantic meaning and develop relationship maps. Prior to loading the data into Leximancer the transcripts were edited to minimise the impact of interruptions, broken sentences and missing words or phrases. There are four interactive phases in the automated analysis process utilised by Leximancer v4. The four phases are briefly described below.

The first phase uploads the data into the program. Individual mine transcripts were grouped into folders based on the sector and type of operation to enable analysis at either site level or sector/type of operation. As the primary interest was to investigate the differences in beliefs and approaches to risk control based on sector, it was decided to load the data using the folders rather than individual files. The second phase applies the text pre-processing settings and establishes the sentence and paragraph boundaries for the concept search. Due to the somewhat rambling nature of the transcript data, three sentence blocks were chosen as the boundary for concept search instead of the default two sentence blocks. Leximancer samples sentence blocks from within the data set and the default setting ‘every nth block’, was used in this study. During this stage words with limited semantic meaning such as ‘and’ and ‘of’ are excluded from the analysis. The default list was edited and the following were removed; call, hard, near and up from the stop list to enable compound concepts prevalent in the text to be created; call-up, pull-up (terms which refer to stopping the job), hard-barrier, hard-control and near-miss. As we were particularly interested in participants’ views on controlling
mining hazards and risks, we turned off the automatic concept identification setting to enable the ‘profiling’ function to be selected during phase three. Finally, we selected ‘Tag folders’ to enable comparison of conceptual content by sector/type of operation. At the end of this phase, seed words are determined based on the words which appear most frequently in the text.

Phase three uses the seed words to build a coding dictionary or thesaurus which is used to code the text, measure co-occurrence between concepts and produce themes based on clusters of concepts. During this phase ‘auto defined’ concepts were deselected and ‘user defined’ concepts related to risk control were selected. Seed words selected from the available concepts were: control, hard-barrier, hard-control; identify, identification; hazard; risk; design; engineer; procedure; behaviour, behavioural; pull-up, call-up, stop-the-job; 3TC, Take 5, SLAM (personal risk assessment tools); MATEs and peer-to-peer, safety interaction (safety interaction tools). Leximancer then uses these seed concepts to ‘learn’ more about the concept of interest and generates a thesaurus containing both user defined concepts and additional concepts learnt from within the text.

Phase four enables compound concepts to be created and refine the selection of concepts and data ‘tags’. During self-learning, several variants of the one word were identified e.g. assessment and assessments, so these were merged and compound concepts - risk assessment, safety interaction – were created. Concepts that were determined to be artefacts of the transcript were ‘killed’ e.g. facilitator, male and female. At the end of phase four Leximancer produces concept statistic outputs and generates a concept map which locates the concepts within a three dimensional space. A topical network or linear algorithm was selected to generate the map. The purpose of the map is to provide a framework or structure for the content analysis including meaning and relationships. During this phase concepts with limited semantic meaning e.g. terms (in terms of) were ‘killed’ and additional concepts representing specific mining risks e.g. truck, road, cable, conveyor belt were added to enable exploration of risk control related to specific examples discussed by participants in the focus groups.

3. Results

3.1 Concepts

The final map generated by Leximancer contained 54 concepts. The number of times individual concepts occurred in the sample of sentence blocks selected by Leximancer ranged from 632 for the concept ‘job’ to four for ‘hard-control’. Figure 1 shows the 54 concepts clustered together in two dimensional space. The relevance value for the top 20 concepts ranged from 11% to 2% and included; ‘job’, ‘hazards’, ‘procedure’ ‘risks’ ‘place’ (put a control in place), ‘control’, ‘report’, ‘drive’ (drive a truck or program/outcome), ‘happened’ (occurrence of or feedback on outcomes of an incident), ‘training’, ‘involved’ (in an incident or job decision), ‘use’ (use a control or safety tool such as JSA), ‘mining’, ‘fix’, ‘truck’, ‘reporting’, ‘important’, ‘ability’ ‘near-miss’, and ‘JSA’ (job safety analysis). Thirteen of the top 20 concepts were closely associated with ‘hazards’ and a further five were closely associated with ‘job’. With reference to the top 20 concepts ‘training’ and ‘truck’ occurred independently.

1 Relevance indicates the relative strength of a concept’s frequency of occurrence i.e. percentage of frequency of text segments which are coded with that concept relative to the frequency of the most frequent concept.
3.2 **Thematic clusters**

Leximancer clusters concepts which co-occur to create themes. Leximancer enables the theme size to be varied. Increasing the theme size results in more concepts being captured within primary themes. With the theme size set at 45%, six meaningful themes emerged. The peripheral theme, ‘Individual risk management’, was represented three times in the map and reflected the different personal risk management tools used by different mines in the three sectors/type of operation. The final number of themes and their labels were determined following a review of all selected text excerpts associated with each concept. The importance of a theme is determined by the number of concepts and the degree of ‘connectedness’ between the concepts. The concept map depicted in Figure 2 shows the relative importance of the themes indicated by the location within the map and the colour but not the size of the circle. The primary theme, labelled ‘Risk management’ (connectivity value\(^2\) of 100%) represented participants’ beliefs about incident causation and risk control. Associated with this theme were two smaller themes labelled; ‘Trust in ability (14%),’ which reflected perceived competence of managers, supervisors and co-workers to manage risk and ‘Rules’ (9%), which reflected rules governing fatal hazards. The second primary theme labelled ‘Job demands’ (46%) reflected work practices required by the safety system. A fifth theme labelled ‘Work environment’ (15%) included the concepts; work design, fit for purpose equipment, operator experience and work pressure. The remaining themes labelled ‘Individual risk management’ reflected personal risk management tools and worker right to stop a job or indeed production based on risk to health and safety. These themes also contained elements of safety justice associated with supervisor support for that action and had connectivity values that ranged from 3% to 7%.

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\(^2\) Connectivity indicates the relative importance of a theme to the most important theme. The most important theme is allocated a connectivity score of 100%.
4. Discussion

This study used automated text analysis to explore beliefs about controlling hazards and risks in the NSW mining industry. The results provide some insight into beliefs about the extent to which mining risks can be controlled. The emergent themes correspond to some extent with the Digging Deeper features (Shaw, Blewett et al. 2007) Trust in management, Workgroup cohesion, Role clarity, Supervisor support and Organisational justice. Furthermore many of the concepts also corresponded with factors included in the coding framework developed through a literature review by Farrington-Darby, Pickup et al. (2005) for their study of factors influencing unsafe behaviour in railway maintenance.

More specifically, workers believed that risks associated with the principal mining hazards were well controlled but not the risks associated with occupational tasks and the work environment in general. Furthermore, whilst there were a range of beliefs about possibility and competence with respect to controlling mining hazards, the overriding belief appeared to be that risks can be reduced but not controlled to the extent that they would not be an issue. While there was a naive recognition of the role of organisational factors in incident causation, the overriding belief expressed was that individual human factors were the primary cause of incidents. These issues and their relevance to improving the capacity of industry to improve risk control assurance are discussed below.

4.1 The mining environment and risk control

The mining industry has undergone a significant shift in safety culture since the late 1990’s and early 2000’s. The fatalistic view on the controllability of mining hazards identified by Johnston (1999) has been replaced by ‘zero harm’ policies (Walters, Wadsworth et al. 2014). The improvement in risk control was widely acknowledged by focus group participants. However there is a view that ‘zero harm’ policies run the risk of alienating workers by failing to acknowledge the significant risks associated with the changing nature of both underground and open cut mining environments:

(source UG coal) I believe that we recognise hazards; we work down in a dark, dirty and dangerous environment all right? You’ve got the three D’s there. We don’t ignore them, we work in that environment and we steel ourselves against whatever hazards we can see.

Workers also recognise that to some extent they rely on the knowledge and experience of co-workers, engineers and managers to maintain the integrity of the controls. More in depth analysis of the data indicated that a sub theme within ‘Trust in ability’ was an awareness of the existence of limitations in hazard and risk awareness at both the industry and individual level. At the individual level one worker stated ‘I can’t control what he’s going to do...he could be a hazard to me’. There was also a common
view that some hazards, for example gas and strata stability, are not visible to workers. Workers rely on management and industry knowledge to control these:

(source UG Metal) So experience plays a part in it but how do we use the industry's experience to identify the hazards because people will be competent in what they're aware of. So if you don't know that the hazard exists and the ramifications or the consequences for it and don't spend the time to actually work through what those consequences are, how are you going to manage and control it?

Many of the recent fatalities in the industry have been related to risks associated with the performance of service jobs and jobs involving mechanical equipment rather than with the major mining hazards. Control of risks associated with these jobs appeared to rely on worker competence in identifying hazards and controlling the risks. The expressed belief at the management level was that tools such as Take 5’s and SLAM’s should provide workers sufficient resources to control the associated risks or if not, the justification to stop-the-job. However, experiences discussed in the focus group suggest that this has not always achieved the required level of control:

(source UG Coal) So what happened to him was he's a 60 year old man and we all stood there and went, like, how did that happen? Six people did not look at that hazard once, did not look at it once. What we were looking at was; let's not wreck the cable, don't break the cable.

A final point worth making is the significant health related exposures associated with dust, noise and operating equipment on rough roads. References were made to a lack of priority being given to road standards in both underground and open cut mines with respect to dust management and prevention of musculoskeletal injury. With reference to 'zero harm' it was commented “We talk about that [zero harm] and people are just laughing. It's not attainable. If you remove people from the pit then they won't get hurt out there.” From management perspective too, there was some acknowledgement of a belief in an acceptable level of risk and that time and resources limited the capacity to engineer higher level controls. As one manager stated; ‘It's risk for reward. It's not an exact science'.

The safety climate literature has concluded that workers establish the real priority of safety by assessing the consistency between policy and practice (Zohar 2010). While ‘zero harm’ is an admirable goal, the findings of the current study suggest that this may not be consistent with underlying beliefs about the nature of mining, or achievable, given time and resource constraints. Therefore industry, together with the regulator, could do well to look for concepts which are consistent with current beliefs that could be developed into a message that resonates better with workers (Colley and Neal 2012).

4.2 Human factors, incident causation and risk control

Safety culture theory purports that the deeply held beliefs of an organisation drives organisational systems which then drives behaviours and ultimately sets the safety climate (Schein 1992, Guldenmund 2010). Although the critical controls for the major mining hazards have been reduced, multiple fatality incidents, the number of single fatalities, serious bodily injuries and musculoskeletal injuries and disorders remain a concern for the industry. Although companies use a range of performance indicators, including some input or safety activity indicators, lost time injury frequency rates remain as a key performance indicator for mines; ‘I think some people drive their outcomes more than their hard controls’. The qualitative data indicated that behaviour safety programs and a focus on procedural and rule compliance supported by disciplinary programs were common strategies employed to control the risk of injuries.

(source OC coal) That's such an emotive issue though, it's so hard to control because....we talk about your blame-free cultures and everything else but at the end of the day someone's accountable for doing something wrong.

Yet, despite there being concerns about investigation outcomes being unfair and inconsistent, the findings of the current study indicated a stated belief in individual behaviour being a major contributing factor to incidents and behavioural-safety as the best control. This perception about the value of behavioural-safety appeared to be based on a view requiring people to think about safety, improved learning and about how to work safely:

(source UG metal) When I first started it was barriers and hard-controls but nowadays with peer to peer safety interactions I think it's coming around to just general behaviour safety and getting the message through that way.
Even though the hard controls will always be there I think they’re more under the surface now and its more actual safety talk. However there was some evidence of a naïve understanding of the role of organisational factors as evidenced by the statement that; ‘Someone’s behavioural actions have already put the guard there - it's who invented the guards’. While it was frequently acknowledged that design and procedures reduced the potential for human error, several examples of lack of early involvement in equipment purchases and mine/plant design were raised. Still, as stated by one of the manager’s; ‘I guess my gut feel is that often we come to the conclusion that it is human based or behavioural based. However, I suspect we don’t look far enough’. A range of issues from over reliance on paperwork, lack of timely action on identified manual task hazards, failure to rectify equipment faults and road standards through to poor design were identified as factors which contribute to incidents and injuries.

(OC coal) There are definitely things that we accept out there that aren’t probably to the standard, or there’s something not quite right with it, but we’re using it. That’s transferring over into, well, I work with that and it's not quite right, so I’m doing this job and I’m not doing it quite right…. Yet another consideration on human factors is the principle described by Hollnagel (2000) as the efficiency-thoroughness trade-off; ‘Risk versus effort is I suppose what it is isn’t it. Everyone weighs up the risk…. less effort is reward’. However, despite there being an acknowledgement of the nature of human nature it appeared that industry may be failing to make the final link between organisational factors and human error; ‘Is it the worker's mistake not to control the risk? Yes probably’. Therefore despite the acknowledged human fallibility, behavioural controls were frequently but not uniformly nominated as the preferred approach to controlling risk. Both approaches were acknowledged as being important and perhaps complimentary yet somewhat confused:

(source UG coal) Before we didn’t have to think about controlling the risk but now it says you have to, so hard-barriers are more important. You want to make the place safe first and then get into personal training and behavioural-safety as well.

(source UG coal) I think behaving safely is probably more important than hard controls. If those hard-barriers are not there looking after someone what have you got? If it is 20 metres away you will probably go to the cross-over but if its 400 metres back up you probably won’t. It comes back to behavioural-safety; I can just duck under the belt and I don’t have to walk all the way back up there.

(source OC coal) It was a bit more than behavioural-safety controls because there was a barrier. Well I think we just had witches hat's down and it's just, oh well, no one will drive through them, but people do. I mean they shouldn't want too but they do. So that comes back to the procedural stuff.

(source UG Metal) Safety manager: It’s been mentioned before that getting people to behave safely or thinking about it is great and that's key to this whole deal. But then people lose focus, or they've got something going on in their lives and they're distracted and so it's at those times where having these hard-barriers as a control really is the difference between something minor and something fatal.

Finally, there was some indication that efficiency-thoroughness trade-off also operates at an organisational level. Reason (1997) put forward the progression towards organisational incidents is characterised by an iterative process of safety improvements being converted to increased production and the boundaries which define safe operation are widened.

(source OC coal) I’m not saying to be unsafe but that's why we look to improve safety but we also look to improve production and make other things that make us more efficient, so running in wet and doing other things that make us more efficient. We’re spending on gravel, we’re putting in training, we're providing all these other systems and we're getting more Cat trucks, designing different ramps and doing all these other things that are enabling us to do it. It's an ongoing journey in terms of safety - what we can implement.
In the final analysis both workers and managers acknowledged that cutting coal and making money was the primary goal for being in business; ‘We cannot engineer every one of those hazards out, otherwise we wouldn’t be here. We’re here to mine coal and we’re here to support that function, because if we don’t make money where would we be? But there has to be a point where safety overrides that because it is more important’. The challenge is therefore to achieve a workable balance between production and safety.

4.3 Implications for industry

The issues discussed above are not new. In fact the issues could be addressed by applying the ‘The ten platinum rules’ articulated as an outcome of the Digging Deeper project (Shaw, Blewett et al. 2007); in particular, controlling risk at the source, deal with the basics of risk control before considering the bells and whistles and making sure the paperwork is adding value. However, the greater visibility of behavioural-safety as a risk control strategy compared with higher order controls may represent some cause for concern. Industry leaders need to give priority to identifying the critical controls for each mining hazard and ensure that those controls are maintained. Although workers believed that personal risk awareness and safety interaction tools had improved safety, further improvement may be achieved through providing more information and education about mining hazards other than the principle mining hazards and clearly specifying the level of control being employed.

Furthermore, both micro and macro ergonomic issues need to be addressed in a more consistent manner. The findings suggested that poor standards of design, equipment operability and road maintenance and dust control may send implicit signals about the relative priority of production and safety which do not align with espoused value of health and safety. The industry needs to take steps to gain a better understanding of individual human factors and organisational level factors and how these contribute to injuries and illnesses. While working towards the long term goal of achieving higher levels of risk control, in the short term managers may do well to consider whether policy positions align with what workers know happens in reality, given the resources and the challenges of the mining environment.

4.4 Strengths and limitations

The strength of the current study was the total number of focus group participants and the length of time over which the focus groups ran, which enabled a depth of discussion that tapped into the more deeply held beliefs. The in-house facilitation was both a strength and a weakness. The safety managers who facilitated the groups had rapport with the participants and added a relevant perspective to the discussion. However the use of different facilitators, including the two members of the Industry Assistant Unit, resulted in different approaches to and interpretation of the questions which reduced the degree of standardisation achieved.

Three further limitations were identified. Firstly, only a small number of companies were represented in the sample and due to the large proportion of the mines belonging to a single company, the findings may not be fully representative of industry beliefs and practices. Secondly, the focus group participants were not fully representative of all the people who contributed to safety across the safety management system. Thirdly, the chosen questions themselves may have introduced a bias and some terminology, in particular ‘barriers/hard controls’, may have contributed to some of the confusion evident around behavioural safety and hard controls.

5. Conclusions

The automated text analysis tool was able to identify meaningful themes related to risk control. The major themes identified were associated with beliefs about the controllability of mining hazards, trust in the ability of managers and workers to control risk and the impact of job demands on worker practices. Three minor themes associated with work environment, training, and safety justice were also identified. However, these themes were more prominent when the concept ‘control’ was not specified as a required concept in the text blocks. Specifically the study found that workers believed that mining hazards could be reduced but not completely controlled. Workers also believed that the principal hazards were well controlled but that the smaller hazards were not. A range of views were expressed about the relative importance of behavioural and higher order controls. The findings suggested the behavioural controls were more visible to workers than higher order controls. In light of the recent fatalities experienced in the industry, these findings suggest that the industry may need to refocus attention on critical controls. In addition, workers should be provided with more information and training on hazards
associated with the performance of occupational tasks and increase the visibility of higher order controls.

Appendix A

Table 1: Text excerpts illustrating each theme

<table>
<thead>
<tr>
<th>Theme</th>
<th>Text excerpt</th>
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<tbody>
<tr>
<td>Risk management</td>
<td>(source UG Metal 17) I don't know from my point of view it's got to be behavioural- safety because you can put a bunch of different controls in but you might not be completely addressing any particular hazard, so people need to be thinking about safety and be conscious of what they're doing.</td>
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<td></td>
<td>(source UG Metal 17) Personally I value the barriers and higher controls more, but what you physically see in place on the day when you're doing the task is the behavioural-safety aspect. Because you can't sometimes do the task just with barriers and high controls, you need them both.</td>
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<td></td>
<td>(source UG Coal 3) A hazard's a hazard. You can control the ones you can see. You can't see all hazards, so, I mean gas is the major hazard for us underground, we can't see it.</td>
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<td></td>
<td>(source UG Coal 3) Well that's what I'm saying. All the major hazards get controlled because we have to, they're compliance issues. We have to comply, we have to have outburst management, we have to have inrush management, we have to have dust management and then we will do it. But the small thing we don't manage well.</td>
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<td>(source OC coal 11) I don't think you can control all the hazards... but you can reduce them.</td>
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<td></td>
<td>(source OC coal 6) But even if you used all the controls the hazards can't be controlled to a point where you're not really going to have an issue.</td>
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<td></td>
<td>(source OC coal #) I think to me people behaving safely is probably more important than hard-controls. If those barriers aren't there looking after someone what have they got? You've only got yourself.</td>
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<td>Trust in ability</td>
<td>(source UG Metal 19) Manager: But realistically the cost to do that fix may be beyond what the hazard really is and there's other ways you can actually manage that hazard. It might be administrative control to manage it, but realistically we have to manage a lot of our hazards out there by our administration control because we cannot engineer every hazard out.</td>
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<td></td>
<td>(source UG Metal 12) Risk non-acceptance is the thing that we're battling with at the moment. We identify a hazard - we identify a risk - but we're being sometimes forced into managing or doing something that doesn't manage the risk against our better judgement. As I said before, we run risks in life.</td>
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<td></td>
<td>(source UG Metal 12) Another job that all fell in [fall of ground]. So because we went in, it fell in, so now we're going back around that again, going another way. So that's out of our control.</td>
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<td></td>
<td>(source UG Metal 12) Instead of having them [staff] involved [in developing training], it should have the involvement of people that do know and are experienced in the job.</td>
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<td></td>
<td>(source UG Coal 3) I think if it's a big issue, massive issue that's going to kill someone she's fixed, or a compliance issue legislation wise, but something little like dusty roads yeah, water can't be on there this afternoon. Not for the next 20 hours you can just suck it in boys.</td>
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<td></td>
<td>(source UG Coal 3) We've got sort of over regulated ourselves now and we control the big risks. Over here the big risks are the roof falling in or machine tipping over and squashing a bloke and we have inadvertently added another risk, we've had 30 blokes hit their head and hurt their neck on account of the canopy on the transport.</td>
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<td></td>
<td>(source UG Coal #) I lost control taking the Lincoln locks in and I hit the roof extremely hard going backwards. So my back was against the machine.</td>
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<td>(source OC coal #) I'd like to say yes we do trust the ability and competence to manage hazards. We check, re-evaluate, check, re-evaluate and like getting the geotech advice in for specific hazards.</td>
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<td>(source OC coal 9) Instead of pulling-up for the fog, the supervisor come out and said, let's coach you through it.</td>
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<td>(source OC coal 9) He was that fatigued or whatever. We didn't manage it and there's a hazard there straight away. Just zoom through an intersection and hit a windrow or whatever sort of thing.</td>
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<td>Job demands</td>
<td>(source UG Metal 12) If you're doing a reset or something for a particular reason, a simple reset. How far you let that knowledge go up the ladder as to how you got around - how you got that job sorted, depends on your trust in the next part of the hierarchy and, yeah, who's the authority.</td>
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<td>(source UG Coal 7) If your procedure doesn't go in the direction that you think it should go, then you stand with your work crew and your deputy and you do a JSA to deviate around - but as long as you're - all your hazards are covered and you've got controls in place, it's normally pretty good.</td>
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<td>(source OC coal #) You've got to have an understanding [of the job] the piece of paper is not going to save you. Realistically, if you see some of those safe work procedures, they've been done off-site, like the contractor one particularly. Yep, they've got a 15-page safe work procedure, the guys on the job probably haven't been involved in doing the safe work, developing it all, they've arrived onsite ready to do the job with their safe work procedure ready to go.</td>
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<td>Rules</td>
<td>(source UG coal 15) I think at the moment with our non-negotiable rules, is that's what everyone's focusing on. Everyone focuses on the fatal hazards, which the High Potential Risks always are -- the majority of them are your fatal hazards. So because of our non-negotiables every time we look at a job, the first thing we plan for is the fatal hazard on that job.</td>
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<td>(source OC coal 11) You have non-negotiable rules, other people have golden rules, other people have whatever, but it all comes down to these are the key things that hurt people, from our organisation and our experience and we do not want them transgressed, at all.</td>
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No one's perfect, everyone makes mistake. Like - let's face it that's what happens. Management make mistakes, they break rules. We break rules. We deal with it. We learn from it.

We break rules. We deal with it. We learn from it.

Work environment

We'd all like to have an environment where we control every single hazard. But it's changing that quickly and that rapid, new implementations and machinery it's a very hard thing to achieve. You've got a lot of variability that happens in a day around other people.

There's so much dust in here and where are you going to stand? You're going to tell him oh we've been doing this for the last month mate?

But when you're working so close to those belts it is very noisy so you can't control all your habits by doing what you're doing at one job, looking down and hosing. You've got to constantly remind yourself to look.

Is there something wrong with the intersection? It's not about the people at the intersection. It's about being able to discover why; so is it the intersection?

We're getting the thing that may not be ideal operation wise. So there was a bit of lack of involvement early as far as that design

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You can’t be held accountable for something you have no control over, just because you were involved. That’s the distinction. Blame is something that’s just totally separate.

It's up to the guys to pull-up, providing they can justify, not the road was shitty, this was there so we need to pull-up to make sure we didn't injure anybody. I'm sure there's not going to be a deputy or a supervisor go, well, you're an idiot we don't want you to do that.

A good example of that was when that bloke went to pull-up, so they don't use that operator, they'll put him over there because the supervisors can’t keep him running .and so they'll pick this bloke instead.
References


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