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Exploring the use of situation awareness in behaviors and practices of health and safety leaders

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Abstract

An understanding of how health and safety management systems (HSMS) reduce worksite injuries, illnesses and fatalities may be gained in studying the behaviors of health and safety leaders. These leaders bear the accountability for identifying, understanding and managing the risks of a mining operation. More importantly, they have to transfer this knowledge of perception, recognition and response to risks in the mining environment to their workers. The leaders' efforts to build and maintain a mining operation's workforce that consistently executes safe work practices may be captured through more than just lagging indicators of health and safety performance. This exploratory study interviewed six leaders in occupations such as site-level safety supervisors, mine superintendents and/or general managers at surface and underground stone, sand and gravel and metal/nonmetal mine sites throughout the United States, with employee populations ranging from 40 to 175. In exploring leaders' perspectives on how they systematically manage health and safety, examples such as approaches to task training, handling near-miss incidents, identifying future leaders and providing workers with feedback offer insights into how leaders translate their knowledge and management of site-level risks to others.

Keywords

Health and safety management systems; Situation awareness; Behaviors; Practices

Introduction

The mining industry has long accepted the importance of a more integrated approach to recognizing and responding to site-specific risks, encouraging the adoption of a risk-based management framework. Recently, the National Mining Association (NMA) led the development of an industry-specific health and safety management system (HSMS) built on the strategic frameworks of the American National Standards Institute's ANSI Z10, the Occupational Health and Safety Assessment Series OHSAS 18001, the American Chemistry Council's Responsible Care, and the International Labour Organization's ILO-OSH 2001 (Watzman, 2014). All of these standards provide strategic guidance and focus on how to

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incorporate a plan-do-check-act cycle into the identification, management and evaluation of worksite risks (Haight et. al, 2014). With interest growing in determining the effectiveness of HSMS in reducing worksite injuries, illnesses and fatalities, there is opportunity to study how an HSMS operates on the front lines of an organization. Analyzing the leaders' behaviors and practices associated with managing health and safety risks can be important in identifying the how and in what ways leader characteristics best teach, coach and manage the mine's workforce (Rost et. al, 2015). In the present study, a theoretical framework is used to analyze these leaders' behaviors within the systematic management of mine site health and safety risks.

In high-risk environments such as mining, maintaining an adequate understanding of the work environment is critical to preventing accidents (Naderpour, Lu and Zhang, 2015). This awareness or understanding is referred to as situation awareness. Viewed as a cognitive ability to link tasks and conditions in a process of three elements, including perception, comprehension and then prediction of future states based on actions or situations, situation awareness is of interest to those studying how to improve health and safety behaviors (Nazir, Colombo and Manca, 2012). Endsley (1995) defines these three elements as follows: (1) perception is an individual's awareness of relevant knowledge or data about a particular situation or environment, (2) comprehension is an individual's ability to understand the significance of that knowledge or data about a particular situation and combine that information based on the needs or role of that individual, and (3) prediction is an individual's ability to make future decisions and take action based on an appropriate synthesis and interpretation of that knowledge or data, the situation and the individual's needs or role in that environment.

The ways individuals build effective situation awareness has been studied at both the level of an individual and through distribution or transaction among individuals in teams (Endsley, 1995; Sorenson and Stanton, 2016). Several researchers have conducted studies measuring how to enhance situation awareness focusing on improvement related to training efforts and communication practices (Endsley and Robertson, 2000; Stout et al., 1999; Rafferty, Stanton and Walker, 2010; Stanton et al., 2010; Salmon et al., 2009). Others have identified team-based interactions in dynamic situations, and shared interactions and behaviors that lead to sensemaking of a situation or problem (Salmon et al., 2008; Endsley, 1995; Baran and Scott, 2010). Several researchers (Nazir, Colombo and Manca, 2012; Walker et al., 2009; Salmon et al., 2008; Salmon, Walker and Stanton, 2015; Sorenson and Stanton, 2013) cited situation awareness as a key skill necessary in the operation and maintenance of safety-critical environments, whether at the level of system performance, operational execution or frontline worker performance.

Many researchers are interested in the most effective ways situation awareness is shared and distributed among members of work teams and workgroups (Salmon et al., 2008; Stanton et al., 2006; Stanton, Salmon and Walker, 2015). Often the focus is on leadership, but how researchers characterize leadership and empirically assess its role in how situation awareness is created differs. When assessing situation awareness in a group environment, the ways it is shared and communicated through behaviors and actions varies based on research disciplines (Weick, 1993; Weick and Sutcliff, 2007; Spillane et al., 2008; Baran and Scott, 2010). In

using situation awareness as a theoretical framework to explore the ways mine site health and safety leaders manage health and safety risks, this study sought to uncover how and in what ways leaders may use situation awareness skills through patterns in their practices and behaviors. It is through description and interpretation of these leaders' practices and behaviors that the components of situation awareness are revealed, and the results can be used to understand how mine site leaders are building, distributing and managing knowledge of site-level hazards and risks.

Methods

Researchers used the U.S. Mine Safety and Health Administration (MSHA) and National Mining Association (NMA)'s Sentinels of Safety Award to identify companies that may exhibit best practices in terms of managing worksite health and safety. This award is the oldest established award for occupational safety (MSHA, 2005). The award program is now evaluated exclusively by the NMA. The award "recognize[s] achievement of outstanding safety performance, to stimulate greater interest in safety and to encourage development of more effective accident prevention programs among the nation's mineral (coal, metal and non-metal, stone, sand and gravel) mining operations" (NMA, 2017).

For the present study, I identified 24 mine operations who received this award at least three times from 2005 to 2010 and inferred that these operations, as multiyear site recipients, had some sort of established and consistent process or system for managing safety performance. I used this criterion for the sample and study participation to garner additional validity and reliability of leaders' responses. Upon identifying the 24 mines who met the criterion for participation, a convenience sampling approach was used to recruit mine leaders through phone and email communication (Babbie, 1998). I contacted all 24 mines in the sample and was able to secure participation from 25 percent of the sample (Corbin and Strauss, 2015). These site leaders were in occupations such as site-level safety supervisors, mine superintendents and/or general managers at surface and underground stone, sand and gravel and metal/nonmetal mine sites throughout the United States with employee populations ranging from 40 to 175. Six interviews were completed with mining companies between October 2011 and January 2012, at which point the researchers started to hear recurring themes among leaders, indicating saturation of content (Denzin and Lincoln, 2011).

A moderately structured interview protocol was developed and used to understand empirically defined indicators of an effective HSMS (Bennet and Foster, 2005). These indicators and an example interview question for each indicator are presented in Table 1. The interview protocol was designed so participating leaders from each mine could discuss their organizational behaviors and practices associated with systematically managing health and safety at the mine site. The interview protocol was approved by the Institutional Review Board (IRB) of the U.S. National Institute for Occupational Safety and Health (NIOSH).

The six interviews provided 450 pages of transcribed data. I coded the data looking for explanatory themes and patterns (Boyatzis, 1998). More specifically, I analyzed the interviews for thematic examples of how organizational health and safety leaders managed risk at their respective sites through a situation awareness theoretical framework. This

analysis resulted in the identification of four themes. Through a process of initial and focused coding, I analyzed the interview data in alignment with these themes (Boyatzis, 1998). This coding effort produced 10 codes aligned with the themes. These codes also included narrative examples from quotes given by all leaders interviewed, indicating a consistency in the meaning, perspective or experience across the leaders. These codes and narrative examples are discussed in the results, with verbatim quotations indicated by italics.

Results

Situation awareness and executing health and safety behaviors

All leaders interviewed spoke about many practices and processes that they perform through general daily activities in their respective health and safety role. It was clear through these discussions that the leaders' role requires them to integrate their understanding of risks and hazards into their decision-making, and their situation awareness influences their decision-making and action. Within a situation awareness framework, leaders described behaviors of perceiving risks in the work environment, comprehending them, and then predicting/projecting forward how to mitigate them in some way. After the decisions are made, their approaches to act in their managerial capacity are reflected in the following practices, as described in this section.

Executing formal organizational practices

Leaders described examples of how they used all three elements of situation awareness — perception, comprehension and prediction — to make changes to formal organizational policies/practices or procedures. Some leaders walked through examples of purchases that were made based on awareness of injuries captured through information such as fatalgrams. For example, Leader 1 said [through reading a fatalgram], "I think a delivery person that got run over by a high-lift and a high-lift that hit a foreman and hit somebody. So we had the idea of getting fluorescent vests for everybody underground…And I've got to tell you, when you're underground you can see them a long, long way. One of the best things I think we've done as a company is those vests." Understanding this example from a situation awareness perspective, the initial interpretation of the fatalgram shows a leader's ability to perceive the type of risk represented in that fatalgram. Then the leader comprehended the risk and interpreted it as risk related to visibility that led to the injury. Finally, this leader projected the risk of visibility in his assessment of visibility issues at his site. His decision to purchase the vests and resulting belief in its positive impact on the management of health and safety at his site occurs particularly when cost was factored in: the company paid "six or seven dollars apiece" for them.

Through the interviews, it was clear that leaders often have to use situation awareness to make decisions. Recognition by health and safety leaders of changes in the site environment to reduce risks for workers as they execute their work tasks serves as an example. Leader 5 described his own iterative learning process, which moves him back and forth among situation awareness perception, comprehension and projection, to get the right-size rollers on conveyors to move product safely at a surface mine site: "You need to build them right. We did some things wrong. The return rollers where you constantly — you have material

coming off of them. You put a big enough roller guard down there so that the material will fall through, not get hung up there, and then — because it gets hung up, then your people are going to, one have a possible risk because they're going to have to drop that guard, and then if they drop that guard and they're always having to clean it out, it's not right, so they're going to leave it off."

Even with the changes to address one type of risk through a formal change in the built environment, the leader recognizes and struggles with the fact that the workers might now have an enhanced risk associated with the change. Other leaders may use their own situation awareness to influence their decision-making and make a change in formal work practices to address the perception of limited situation awareness of new employees. As Leader 2 noted, "[We] adopted a two-year Orange Hard Hat Program. It's just an FYI. It was just making everybody on site know that this person is less familiar with what's going on here than maybe [one of the site supervisors] would be. It's just an added extended awareness to look out for them, coach them, teach them, things like that." This work practice shows the leader's efforts to help establish situation awareness within the workforce by making it visibly clear who may have less situation awareness. The leader's description of it as a for-your-information (FYI) may point to the fact that he wants others to perceive that these workers have less knowledge of what's going on here and that others should coach them and teach them, which would be helping them to comprehend what is going on around them and predict how their work practices and behaviors may have an impact on their level of risk.

Leaders' descriptions of formal organizational practices that showed examples of situation awareness considerations also occurred through practices associated with maintaining the worksite. Their examples describe practices they execute, but more importantly speak to how they may transfer their situation awareness of site risks and hazards through interaction with others. Leader 3 represented this in his description of organizational exposure assessment and sampling practices: "The successful part I see is getting the hourly employees to actually request to be sampled. Not everybody likes to wear pumps and dosimeters and things, they can be kind of cumbersome, we get calls and requests all the time saying, 'Hey, could you sample me again,' which is pretty good." This leader identifies the unsolicited request by mineworkers to be sampled as something positive that can be interpreted as workers increasing their self-awareness of situation awareness as it relates to perceiving and comprehending the purpose of occupational exposure assessment at the mine site. He also detailed the organizational effort — "first, we tell them what we're doing, why we're doing it" — which is trying to provide workers background and awareness for sampling assessment. Then, in noting the multistage follow-up, the leader improves the transference of knowledge and awareness to not only an individual who wears the sampling device but the work crew: "First of all, we get with the employees one-on-one afterward and explain the results…And then we explain the results to the crew."

Interaction with noncompany individuals

All leaders interviewed spoke about different interactions with noncompany individuals in the course of conducting work and managing worksite risks. These interactions may occur with contractors performing work tasks onsite, vendors bringing in equipment or attempting

to sell equipment, customers picking up products, or medical staff inquiring about a worker injury. Leaders described examples of these interactions, and when considered through a situation awareness framework, they recognized that others may not have a level of situation awareness appropriate to complete their respective task and the effort leaders take to manage those situations. Interactions with contractors and customers often occur on a daily basis at some mines. Keeping those customers safe while they are onsite is a large concern for all mines. Leader 3 expressed the expectation that other company employees are looking out for these customers, as procurement standards and rules reviewed in the office only go so far: "So then, all the people that are out in the yard are babysitting those folks to make sure they get right back to the dispatch to get that load ticketed and out the gate. And it's — It could be a 15-to 45-minute window where they're in our yard at all times. And so you're hoping that — Because we don't have an individual sit-down, these are the rules, we're hoping that all of our folks that are out there can help."

Subcontractors can be a challenge for mine sites as well. The work they do is needed, but leaders worry whether they have the training or hazard recognition skills to do the work safely. Leader 2 noted this challenge: "And I think sometimes some of these subcontractors they just don't get enough training over the task they do sometimes and they just assume that they're right. We — My inspector caught a subcontractor here with a grinding wheel, a grinder, without the guard on it. And of course my guys all know that. They know that they can't have a grinder without a guard on it, and that guy should have known too but somehow — You've got to really watch the subcontractors."

As part of risk management efforts, health and safety leaders have to help not only their own workers build perception, comprehension and prediction knowledge and skills, but also help subcontractors, through communication and coaching, build their situation awareness as they may not recognize hazards as they perform work. This coaching can occur informally and in the moment. A challenge for a leader is to determine whether the information is received and becomes part of the subcontractor's situation awareness knowledge and skills. A secondary challenge is navigating whose — the mine company's or the contractors' — system or approach toward applying risk management policies and procedures is most appropriate in a given interaction and how ambiguity is identified and resolved.

Contrasting the experience with subcontractors, in the case of interaction with medical personnel, Leader 1 shared experience with a formal process for local medical providers about work operations to assist in the organization's injury management efforts: "We have physicians come out and take a look so they know exactly what's going on and have a better idea of what kind of limitations the employee can have and what kind of demands are going to be put upon the employee…We've had PAs and doctors come out to the site to see what a truck driver does, how — I mean how much exertion it takes to get into a piece of equipment and get out of the piece of equipment, take a look at their seats, look how they're designed as air rides, etc. We'll have them look at what a crusher-operator does, what our leach pad operators do…they know what every piece of equipment can do and what the employee has to do to make it work."

From this leader's perspective, being proactive and formally engaging with the local medical community to give medical providers a greater understanding of work operations may assist those providers' own situation awareness perception and comprehension of the risks associated with working at a mine. In turn, when and if an injury occurs, the process of determining reportable and recordable injuries is more accurately tuned to the work realities of that mine.

Training workers

Leaders spoke of the variety of activities they use to train their workers on how to do their jobs safely and correctly. From a situation awareness perspective, these formal organizational activities are designed by the leaders, through their descriptions, as communication practices that help build or improve the situation awareness perception and comprehension skills in workers in order to raise their situation awareness predication abilities. All six leaders interviewed spoke about using some form of recurring training such as annual refresher, cross-training, and task training. For example, when discussing task training, three leaders described using the practice of having another worker, considered to be proficient at the job/task, serve as the teacher. Leader 2 explained: "That operator is probably somebody that we feel comfortable with that he's task trained and that he can train somebody, and he will train them. And usually we'll start with somebody down in the pit where there are no trucks, there is nothing. We'll teach him how to…go through all the procedures and what we do." In walking another employee through the task and going through all the procedures it is more than just task training explicitly — but also implicitly the other worker is communicating his or her situation awareness in offering information on what to perceive and comprehend about risks in executing the job task. In choosing someone to serve as a task trainer, a health and safety leader is implicitly communicating who he or she thinks has appropriate situation awareness skills and can translate that skill to others.

Given the dynamic nature of a mine site, the interactions between the worker, equipment and the environment are in constant need of leaders' awareness and vigilance to reduce hazards and risk. Other types of training serve as communication practices by leaders with workers to help build their situation awareness of this ever-changing work environment. As Leader 5 noted: "The minute you cross that track we give you site-specific training so that you're aware of all the conditions at the mine, so that you understand this could happen." Leader 3 noted the value of executing hazard recognition classes in helping workers perceive, comprehend and project their knowledge on risks in the workplace: "We put everybody through it and afterward you could see a light bulb turn on. And a lot of them even commented on, 'Wow, where was this before, this is good stuff'…now, when you go out and talk to people about their task, what they're doing, about their field-level risk assessment, you get completely different answers than you did before. I mean they're thinking about all the hazards that are out there, whether they're controlled or not — which is kind of neat to see. A lot of them, they'll point out a fire extinguisher. It's controlled, but hey, there's pressure in there and I've got to make sure I'm aware of that."

Leader participation in organizational activities

Interaction and engagement in organizational activities in support of broader corporate risk management practices and procedures can serve as opportunities to improve leaders' situation awareness projection capabilities. This situation awareness skill building may occur through both managerial peer interaction and upward communication and feedback. Formal organizational level activities or tools for safety reporting through safety committees and audits can serve as ways to interact and communicate in organizational activities at a peer-to-peer level or in communicating up into an organization. Leader 4's example of site-to-site communication notes an opportunity to gain a different perspective on a health and safety issue while building situation awareness capabilities: "We have a Safety Leadership Team from our sister sites in the district, and a lot of times we'll review that, at least the trends in general, and help stimulate conversation about, 'Hey, this is what we're seeing. You guys know why this is happening or what we can do to fix it,' or similar items like that."

Asking others their perspective on a health and safety risk or assessment of trends also showed to help increase situation awareness capabilities. These sorts of internal cross-organization communication practices provide opportunities for leaders to learn from others about health and safety issues by having access: "like a department store of buffet… to choices and tools and opportunities for you to instigate those conversations or to lead your folks or to prevent these similar incidents from happening at your site," according to Leader 2. Often multimine site companies conduct safety audits at each specific site. These audits can be the most visible example of peer-to-peer communication between health and safety site leaders. While described as stressful, these audits offer an opportunity for self-awareness of situation awareness skills, but also allow leaders to learn from others, as they are a fresh set of eyes and have different situation awareness knowledge about hazards and risks, as noted by Leader 2: "Now you've got to be pretty comfortable when you have your peers and some of your bosses come in. And it's a little unnerving sometimes because you can think you do it right all the time but it's like, 'Wow, there're 40 sets of eyeballs walking around here. But out of that they've identified some risks, they've identified some hazards, they've identified— little things, not major things where we said, 'Oh, shoot, let's shut down,' but little specific things like, 'You know what, you did a great job here on the lighting. Why didn't you do this shop?' 'Oh okay, we thought we were ample there, but….'And so there's a lot of stuff that's come out of it, just different perceptions of risk."

Discussion

The results of this analysis demonstrates that interpreting health and safety leaders' behaviors and practices through a situation awareness framework can offer insight into understanding how leaders manage risk at mine sites. With that situation awareness perspective in mind, the following discussion focuses on behaviors and practices leaders could consider that may also help to establish and improve situation awareness among the workforce.

Characterizing and addressing near misses

In high-risk industries such as mining, there is an obvious focus to address near misses. In talking to leaders, they recognize the challenge to ensure consistent characterization of a near miss when one occurs. From a situation awareness perspective, recognizing a near miss requires all three situation awareness skills to be of a certain level of knowledge and ability. In the struggles that mine health and safety leaders describe in dealing with near misses, these incidents serve as checkpoints related to how the behaviors and practices described in the results section of this paper are influencing site-level health and safety. When near-miss incidents are identified or occur, they serve as a visible reflection of the situation awareness skills and abilities of a workforce but also show how the leaders themselves are doing in communicating, coaching or teaching situation awareness to workers.

All leaders interviewed spoke about near misses and issues to address them. The first hurdle is often worker identification of the hazard and the willingness to communicate it, because leaders can then use it to teach other workers and build their situation awareness perception abilities: Leader 5 said, “If somebody turns something in on a near miss we want to take and teach that and recognize not necessarily the individual if they don’t want that but recognize the hazard that was prevented because they brought it up.” The second hurdle is often the timing of when a near miss is identified and communication occurs from a worker noticing something to when they report it to someone in a leadership position. In the following example, Leader 3 noted that timely identification by a worker who sees something is critical in addressing a near miss, as in this case between a light vehicle and a haul truck: “Well, that was reported at about one o’clock in the afternoon. And then one guy—another operator got on the radio said, ‘Yeah, well I seen that,’ and we said, ‘Oh, okay well, we’ll need your report.’ So we got everybody together and we looked at the second operator’s report and he said, ‘It happened at like 10 o’clock.’ We says, ‘No, no, no, no, no. This just happened at one. Said, ‘Oh, I seen another one. It happened at 10 o’clock.’ And we’re like, ‘Why didn’t you report it?’ It was the exact same scenario…we made corrections by three o’clock that afternoon…two quick fixes were done within minutes…But I guess back to my point, if the first one would have been reported immediately we could have taken care of it where the one o’clock one wouldn’t have ever happened, so…”

A health and safety leader is relying on workers to identify and communicate near-miss incidents and expecting them to be able to use their situation awareness prediction skills. Where leaders can work to ensure that situation awareness knowledge — perception and comprehension — are communicated can occur through near-miss assessments. These assessments, whether formal root cause analysis activities, safety committee assessments or informal leader assessments and observations, are an opportunity for leaders to really coach and teach workers about situation awareness skills through real-life near-miss examples. As Leader 1 noted, “After I’ve figured out exactly how it happened and why, what was the circumstances for it,… then we’ll go over those situations and say, ‘What can we do or what should have we have done so it’s preventable for the next time.’” It is during these communication activities, whether in a formal safety meeting, preshift tailgate talk or while talking with an employee that is waiting in the break room to clock into the shift, that leaders

have the opportunity to drive home any key messages about perceiving and comprehending risks and share their own situation awareness prediction abilities with their workforce.

These near-miss events can serve as a clear example for leaders to assess whether workers are using their situation awareness projection skills successfully in avoiding incidents and reporting incidents. Leaders can also use these incidents to assess their own individual situation awareness projection skills and adjust organizational practices accordingly. In either case, communicating with the workforce to keep them from occurring in the future is part of the process of building shared sensemaking among the leaders and the workforce as it relates to site-level risks and management of those risks.

Building future leaders and an empowered workforce

The results suggests that effective leaders are constantly using their assessment of workers' situation awareness projection skills to shape their thinking on the safety knowledge, skills and abilities (KSAs) of the workers and determining who might be future leaders. They are checking for KSAs in current staff and current leadership, and also using them as a way to identify future leaders who "would go kind of above and beyond and look for the next thing. I kind of look at how safe they are working," according to Leader 3. Leaders are looking for actions in their employees that can point to increased situation awareness prediction through addressing and solving issues without involving higher levels of management. Said Leader 6, "We have enough folks on staff here now with enough experience, and we've seen it enough and been through it enough that it doesn't take a meeting to determine it's snowing…sometimes you've just got to pull the pins and say, 'Enough is enough.' We're going to the house."

In workplace terminology, some situations suggest that workers should be empowered to act or use the stop button. As Leader 3 noted: "I think we've certainly at all the locations empowered the people, not only just the foreman. I mean, we're not expecting the foreman just to be the empowerment out there. We've given it to everybody by saying that, 'You have control of the stop button. Everybody's got the stop button.' At any given time, 'Why did you or why didn't you?' And I'll be the first one to tell you, I've been upset with conversations with employees. I said, 'Why didn't you push the stop button?' We preach that all the time. You could have avoided this, this, this or this. We wouldn't be in these particular situations."

Empowerment is more than the ability to act; workers have to trust in their ability to act and make the right decision in addressing hazards or risks in the mine environment. The workers' KSAs to use situation awareness appropriately and correctly are built through time and experience. Leaders may try many activities to build situation awareness and check it in their current staff, but sometimes it is really just in their own heads and getting it out and translating it to others may be the true challenge: Said Leader 2, "Like in the mine, as I'm driving in I'm still looking to ventilation. I'm looking to see if there are any rocks under it. Although I'm going somewhere to get somebody to do something, in my mind I'm still…10 different things I'm thinking about on the way, and we hope that's what my foremen do."

Making thinking visible in feedback

Health and safety leaders offered many examples of ways they use situation awareness in informal, or everyday, interactions. For those in health and safety positions, these may just appear to be routine common activities, but when viewed through a situation awareness perspective, these are the moments where the knowledge, skills and experience that inform a leader's situation awareness are used to make quick but important decisions regarding site risk management. Sharing with the employees the thought process behind decisions associated with worksite observations or worker observations make these common informal interactions richer and more beneficial in translating a leader's situation awareness knowledge and skills. As an example, mine sites are outdoor operations that need to adjust to the weather. Leaders make worksite observations using situation awareness perception and comprehension skills such as mentioned by Leader 1: "Right now, the weather is changing…going from mud to frozen solid at night and in the morning—and use situation awareness prediction skills to make decisions about communication with employees and suggest behaviors to reduce risk—and if somebody slips or stumbles, has a near miss or an incident that's talked about throughout the day, just to be sure that, okay, their awareness is up on that, take smaller steps, be sure of your footing."

Going the extra step to walk employees through the situation awareness thought processes of perception, comprehension and prediction may help to integrate that awareness into the workforce more quickly. During informal worker observations, leaders provided many examples that recognized the importance of timely and immediate feedback. Leader 3 said, "If I drive through the yard I'm watching. If I'm coming up on a guy I'm listening for his back-up alarm, I'm watching to see if he's going to turn his head or what. If he doesn't turn his head I'm going to stop and go talk to him, say something to him." For a health and safety leader to consider "making his/her thinking visible" to the employee during these feedback moments can go a long way in getting an employee to build a bigger picture perspective on recognizing, understanding and proactively responding to the risks of the job. For a leader to consider using a situation awareness framework to communicate his or her perception, comprehension and prediction, it may make clearer to an employee that these are teachable moments and that the intention is not trying to catch someone doing something wrong.

Conclusion

While this study describes how leaders translate their situation awareness knowledge of mine site risks through practices and behaviors, a limitation of this study is that the author asked mine site leaders their thoughts on organizational behaviors and practices associated with systematically managing health and safety at the mine site, not specifically about how they developed their situation awareness to systematically manage site health and safety. Future empirical studies capturing what informs mining health and safety leaders' situation awareness and how they use it may serve as data for indicators of leadership and leadership development potential. While also not within the scope of this exploratory study, future research could seek to identify situation awareness skill building practices and assessment and their relationship to worker empowerment efforts as part of building a safety culture. Situation awareness skill building and assessment may fit into the "check" aspect of

measuring the effectiveness of risk management practices, which has been identified as a gap in previous studies (Willmer and Haas, 2016). Finally, in hazardous industries such as mining, situation awareness skills could also be assessed in relation to stop work authority practices as implemented in a systematic management of health and safety through a formalized risk management approach like an HSMS. Mine health and safety leaders work very hard to determine how best to transfer their knowledge of perception, recognition and response to risks in the mining environment to their workers. Through this exploratory research, it is suggested that leaders' efforts to build and maintain a mining operation's workforce that consistently executes safe work practices are visible when assessed through a situation awareness framework.

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Table 1

Interview structure with HSMS indicators and example question.

HSMS indicator	Example question
Occupational health management	"What happens if someone gets hurt during the shift?"
Senior management commitment	"What are some of the short-term and medium-term measures and targets used to check whether the company is meeting its safety goal?"
Continuous improvement	"Describe a health and safety problem that was identified and dealt with in a way that people think is successful."
Risk management	"How is an incident evaluated by the organization? Can you give me an example to describe the evaluation?"
Communication	"What activities or practices does the company use to communicate health and safety messages?"
Competence	"How does the company make sure that the employees know how to do handle emergencies?"
Employee involvement	"What are other ways you think employees could get involved in improving company health and safety?"