SAFETY CLIMATE

The Derived Importance of Personal vs. Situational Factors in Mining

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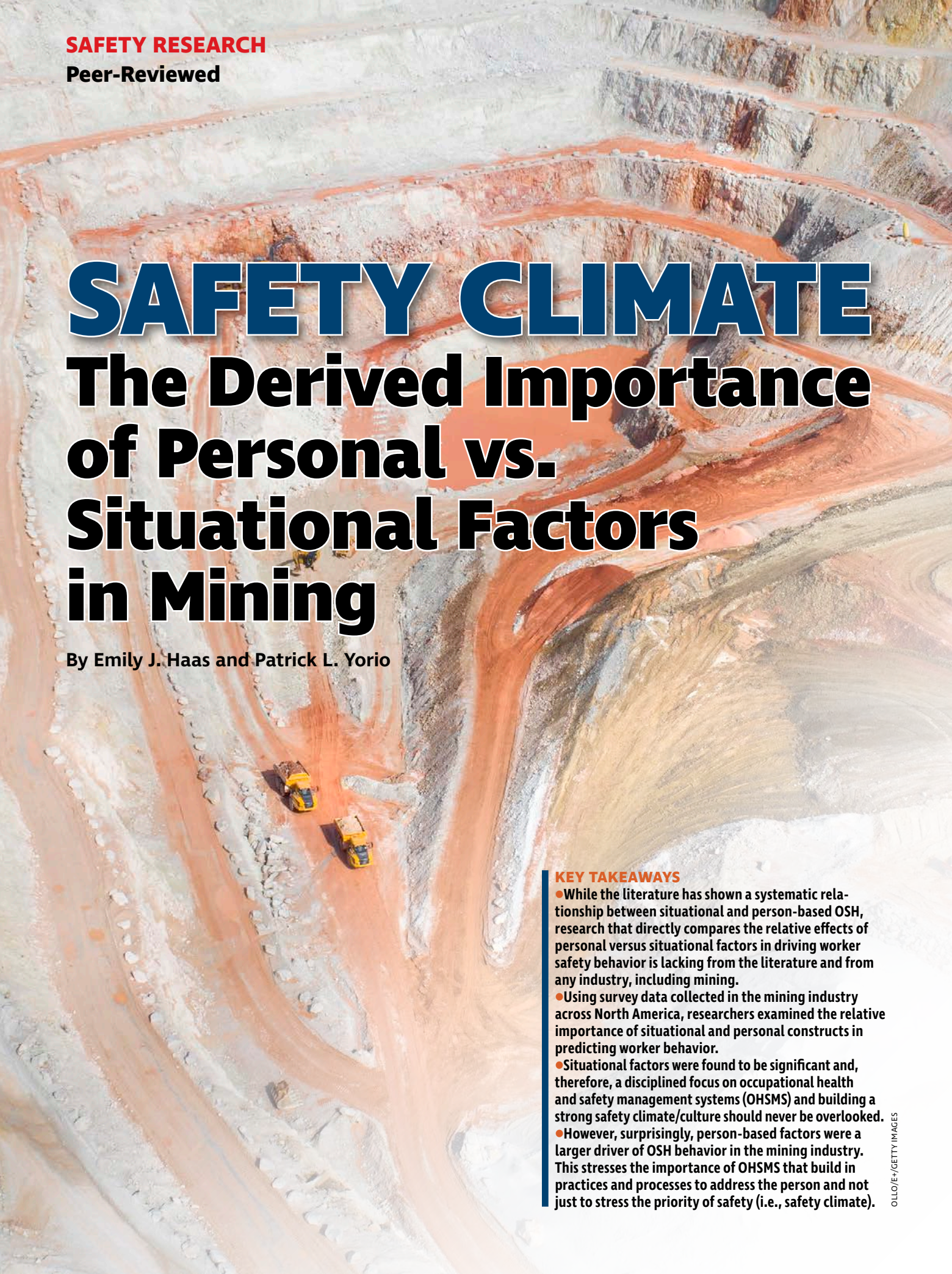


KEY TAKEAWAYS

- While the literature has shown a systematic relationship between situational and person-based OSH, research that directly compares the relative effects of personal versus situational factors in driving worker safety behavior is lacking from the literature and from any industry, including mining.
- Using survey data collected in the mining industry across North America, researchers examined the relative importance of situational and personal constructs in predicting worker behavior.
- Situational factors were found to be significant and, therefore, a disciplined focus on occupational health and safety management systems (OHSMS) and building a strong safety climate/culture should never be overlooked.
- However, surprisingly, person-based factors were a larger driver of OSH behavior in the mining industry. This stresses the importance of OHSMS that build in practices and processes to address the person and not just to stress the priority of safety (i.e., safety climate).

OLLO/E+/GETTY IMAGES

SAFETY CLIMATE IS OFTEN STUDIED AND REFERENCED as a leading indicator of incidents (Beus et al., 2010; Haas & Yorio, 2016; Mearns et al., 2001) and must be considered within any occupational health and safety management system (OHSMS; National Research Council, 2013). Further, the consideration of safety climate and attending to employee attitudes and values becomes more important as lagging indicators plateau (Reason, 2008; 2016). This trend has become the case within the mining industry worldwide, which has seen dramatic reductions in severe incidents and fatalities. Safety climate and safety culture have distinctions that make them unique, yet the terms are often used interchangeably, both in the literature and in practice (Cox & Flin, 1998). However, safety climate provides an understanding of the current safety conditions and insights into areas that can be addressed (Curcuruto & Griffin, 2018). In other words, safety climate can be more readily measured to improve safety behaviors. This study focused on safety climate rather than culture to provide targeted feedback into what aspects of an organization's climate can be developed or more effectively implemented through an OHSMS.

Generally, safety climate is measured to provide benchmarks for improvement. However, identifying and implementing tangible methods to improve an organization's safety climate is not well understood, particularly in organizations whose environments constantly change. In the current study, the authors argue that determining this derived or relative importance may be a valuable insight to empirically guide management decisions. To advance a more tangible understanding of safety climate and its impact on organizational strategy, NIOSH surveyed members of 39 mining workforces about experiences at their respective operations. The results can be used to guide how high-risk industries choose valid, high-impact indicators to prioritize decisions and improve organizational behavior while also elucidating the importance of individual-level interventions in the workplace.

Importance of Situational vs. Person-Based Safety Climate Constructs in Occupational Safety Research

There is a void of research investigating the weighted importance of safety climate as well as the influence that situational and personal constructs, specifically, have on behavior when a direct comparison is made between them. A derived-importance approach determines the weight of specific characteristics and is often used in marketing research to understand what influences purchase intent and customer satisfaction (Anton, 1996; Berger et al., 1993; Chu, 2002; Klaus & Maklan, 2013). A primary purpose of safety climate research is to understand the perceptions and values that influence workers' safety behavior (Mearns et al., 2003; Zohar, 1980). Because the core components of customer satisfaction and safety climate are based on tangible and intangible elements of individuals' perceived experiences, it is plausible that adopting a derived-importance model is a viable approach for organizations to prioritize actions within their OHSMS. Therefore, although this study utilizes a similar survey approach, it uses a derived-importance framework to analyze and present the results. This study examined which situational and personal constructs are most influential in supporting proactive and compliant behavior among mine employees.

Methods

Researchers assembled a survey to assess employee safety climate perceptions. After receiving approval from the Institutional Review Board and Office of Management and Budget, data collection occurred from February 2016 through March 2018. Individual researchers traveled to each mine location to introduce, distribute and collect the hard copy surveys. Data collection often occurred during an annual refresher or task training on site or nearby training location. The survey took approximately 15 minutes to complete.

Participants

Participants consisted of 2,683 employees, both salaried and hourly, at 39 mine site locations throughout 17 states. The locations represented nine major mining companies and three mining subsectors (Table 1). Additional demographics are displayed in Table 2. Mine sizes (i.e., number of participants per mine) ranged from 7 to 280 with an average of 69 participants per location.

Survey Instrument

A review of existing OSH literature in high-risk occupations was completed to identify situational and personal measures used to predict worker safety behavior. Previously validated measures were reviewed, and items were adapted for use within the mining industry. Through this deductive reasoning, six situational constructs [i.e., organizational support for OSH (3 items); supervisor support for OSH (3 items); supervisor communication (7 items); employee engagement (4 items); coworker communication (3 items); and OSH training (3 items)] and four personal constructs [i.e., adaptability (3 items); sense of control (4 items);

TABLE 1
PARTICIPATION BY MINE SUBSECTOR

Mine subsector	Survey count	Percent of sample
Coal	358	13
Industrial minerals	907	34
Stone, sand and gravel	1,418	53

TABLE 2
PARTICIPANT DEMOGRAPHICS

Demographic characteristics	Survey count	Percent
Gender (72 missing)		
Male	2,438	93.4
Female	173	6.6
Job classification (94 missing)		
Salaried	569	22.0
Hourly	2,020	78.0
Age range (79 missing)		
18 to 24	134	5.1
25 to 34	523	20.1
35 to 44	596	22.9
45 to 54	730	28.0
55 to 64	561	21.5
65 and over	60	2.3

thoroughness (5 items); and risk tolerance (4 items)] were identified and deemed necessary to foster a positive safety climate that could also influence proactive and compliant OSH behavior (9 items). The survey used a six-point Likert scale, with responses ranging from strongly disagree to strongly agree. Each item relates to one of a series of constructs, and responses were used to calculate a mean score for each construct. Survey questions are listed in the "Survey Questions" sidebar. For more information about survey development, validation of the survey constructs, and the Scantron version of the survey, refer to Haas et al. (2020).

Analysis

The surveys were entered into IBM SPSS (Version 25) for cleaning and analysis. First, an exploratory factor analysis was completed and showed that each of the survey items loaded into their identified theoretical constructs with no cross-loading of items. Three lower loadings were removed from the model prior to additional analysis. Then, internal consistency was assessed for each of the survey construct factors. The Cronbach's alphas were acceptable, ranging from .60 to .93 (Bland & Altman, 1997; DeVellis, 2012). A relative weight analysis was used to derive the importance for each of the 10 safety climate constructs in impacting worker safety behavior. The regression equation, done using R (Tonidandel & LeBreton, 2015), was estimated with worker safety proactive and compliant behavior as the dependent variables and the 10 constructs as independent variables.

Results

The results show the ranking of each factor based on its contribution to R^2. R^2 is the percentage of the variation in the dependent variable(s) that is explained by each factor when determining contribution to worker proactivity and compliance. For easier interpretation, the rescaled relative weights (RS-RW) are presented. The RS-RW percentages for each predictor within the tables sum to 100%.

Employee Proactivity

All 10 constructs were significant predictors of employee proactivity ($p < .05$). The overall model fit was $R^2 = .32$, or 32.24%, indicating a large effect size (Cohen, 1988). Table 3 (p. 38) indicates the RS-RW of each construct, which is the importance of each construct predicting safety proactivity.

For employee proactivity, or employees' willingness to take initiative and report or fix OSH issues, a personal sense of thoroughness and control over their job tasks—both personal constructs—were the highest predictors at 21% and 17% of the 32% variance, respectively. In addition, workers' personal levels of risk tolerance (13% of the total variance) and their involvement or engagement in OSH activities on site (12% of the total variance) were also greater predictors of proactivity.

Employee Compliance

The compliance model also showed that all 10 constructs were significant predictors of worker safety and health compliance. The overall model fit was $R^2 = .46$, or 46.70%, indicating a large effect size (Cohen, 1988).

Regarding compliance, workers' risk tolerance was the predominant predictor at almost 31% of the total 47% variance. In addition, workers' thoroughness (23% of the total variance) and coworker communication (11% of the total variance) were strong predictors of workers' compliant behaviors. OSH training, although a significant predictor, only contributed about 5% to the model. Additionally, organizational support for OSH only contributed about 4%.

By comparing the average of each construct (identified in Figure 1, p. 38) with the results of their relative weight (Tables 3 and 4, p. 38), it is possible to identify primary areas of focus and maintenance. Figure 1 shows how the combination of these results map out in a quadrant modeled after Abalo et al. (2007).

Discussion

Although previous studies have established the influence of both situational and personal factors on safety behavior (e.g., Guldenmund, 2000; Mearns et al., 2003), research showing the impact of these two areas together has been largely absent. Results showed that each of the situational and personal constructs significantly predicted worker behavior, although the personal constructs had a stronger effect on the behavioral outcomes when compared to the situational constructs. This finding does not diminish the importance of context; rather, the authors argue that it increases an awareness of the importance of person-based attributes in driving worker behavior in high-risk organizations.

Lower-Importance Constructs

Organizational support or priority toward safety and adaptability were two constructs that had low averages and demonstrated little support for safety behavior. In this case, these two factors should be a lower priority and addressed only if resources permit, at least in the short term. Regarding organizational priority toward safety, many OSH studies have shown that organizational or management commitment to safety is the strongest predictor of worker behaviors and injury outcomes compared to other measures (Beus et al., 2010; Christian et al., 2009). Although still statistically significant, this construct had the lowest impact on safety behavior, showing other areas in which organizations can focus attention first. Additionally, two constructs that had higher averages but also contributed little to the relative weights models were supervisor support and safety training. These two factors can be monitored for any changes in importance over time, as they could be opportunity areas in the future. However, directing more resources to these factors could be considered a waste or overkill due to the derived importance being low (Abalo et al., 2007).

Focusing on High-Importance Constructs

Risk tolerance, thoroughness, coworker communication, employee engagement, supervisor communication and sense of control were among the highest relative predictors of worker proactive and compliant safety behavior. Based on these results, it seems prudent for mining organizations to initiate or maintain a strategic focus on these constructs. Although insightful, companies being able to apply these results in a useful way within an OHSMS may still prove challenging. To date, most research in mine safety and health has emphasized the situational vantage point through the lens of safety climate research. The results of this study notably identified that person-based factors are extremely important and may be more important than situational factors in predicting safety outcomes. Consequently, some actions that organizations can take are ranked and outlined here based on their average and predictive weight in the study.

Find Ways to Routinely Engage Workers

Engagement, although measured as an organizational construct in the NIOSH survey, has both organizational and individual origins, which may be one of the reasons it was a higher-weighted predictor of behavior. However, because per-

SURVEY QUESTIONS

The survey used a six-point Likert scale, with responses ranging from strongly disagree to strongly agree (never to five or more times for the last item).

When I'm at work I:
- •go out of my way to address potential hazards.
- •voluntarily carry out tasks that help improve workplace health/safety (H/S).
- •make suggestions to improve how H/S is handled.
- •try new things to improve workplace H/S.
- •try to solve problems in ways that reduce H/S risks.
- •don't take risks that could result in an accident.
- •use all necessary H/S equipment to do my job.
- •use the correct H/S procedures for carrying out my job.
- •always report all H/S-related incidents.

When doing my job:
- •I can pretty much achieve whatever I set out to achieve.
- •I can do something if I am unhappy about a decision that affects me.
- •I can stay healthy/safe if I take the right actions.
- •most of the problems that I experience are completely "out of my hands."
- •I am always thorough.
- •I can be somewhat careless with my work tasks.
- •I am a reliable worker.
- •I work until my task is finished.
- •I know when to seek help during a difficult task.
- •I do not take risks with my H/S.
- •I take risks regularly.
- •safety comes first.
- •I like not knowing what is going to happen.

As far as day-to-day work:
- •H/S rules and procedures are sometimes ignored.
- •it doesn't matter how the work is done as long as there are no accidents.
- •I often have impossible production pressures.

My supervisor:
- •tries to help me do my job as safely as possible.
- •helps me if I have a H/S problem at work.
- •doesn't notice if I do my job safely.
- •reminds me to follow H/S work rules.
- •closely monitors my H/S work practices.
- •takes action if I don't follow H/S work practices.
- •clearly explains H/S rules to me.
- •regularly informs me of work hazards specific to my job.
- •encourages communication about H/S problems.
- •I am satisfied with my supervisor.

Everyone in my work crew:
- •has confidence in each other to work safely.
- •helps each other with H/S problems at work.
- •informs each other about potential workplace H/S hazards.

When it comes to the health and safety rules and procedures in place at this operation:
- •they are used the same for all employees.
- •I can question the rules and procedures that influence my work.
- •my supervisor makes sure that our concerns are heard before making any new rules or procedures.
- •I am involved in improving H/S rules and procedures.

I know how to:
- •use H/S equipment to follow standard work procedures.
- •maintain or improve workplace H/S.
- •reduce the risk of safety accidents and health incidents at my job.

It is important to:
- •maintain workplace H/S at all times.
- •reduce the risk of workplace safety accidents and health incidents.
- •maintain or improve my personal H/S.

When it comes to health and safety training:
- •the organization provides enough training for me to do my job.
- •it helps me to do my job as healthy/safely as I can.
- •it is not a priority here.

In general, I think that:
- •tried and tested ways of doing things are usually the best.
- •there is no need to change things unless there is a problem.
- •I can handle any changes that come along.
- •changes in my work routine keep my job interesting.

Over the last 6 months on your job how often were you:
- •involved in a near miss?
- •injured requiring first-aid treatment?
- •injured requiring medical treatment beyond first aid?
- •injured severe enough that it resulted in lost time from work?

ceptions of engagement are based on a current situation, it is subject to change quickly. Examples of such efforts going on at some of the operations when the survey was administered included: 1. workers selecting a type of PPE they felt was more comfortable; 2. involving workers on different committees, including participation in walk-throughs and debriefs on site; 3. incorporating additional communication touch points with employees throughout the day.

Maintain Worker Sense of Control & Thoroughness

These results showed that personal factors have a large impact on worker behavior. Individual states can be influenced by organizational characteristics such as decision-making authority or autonomy granted to individual employees, which has been shown to improve safety climate perceptions (Haas et al., 2018). For example, determining whether a safety initiative is not endorsed as it should be can be useful in determining misaligned communications. Through increased engagement and collaboration efforts, it may be easier to facilitate alignment between management and hourly workers.

Increase Accountability Around Supervisor & Coworker Communication

Results illustrate the need to improve communication quantity and quality. Previous NIOSH research has been able to determine specific communication gaps and best practices that can be consulted as well (Haas, 2020). For example, NIOSH used the current results and additional data points to develop communication accountability scorecards to improve the transparency of organizational communication. Using such tools (see Haas et al., 2020) can help make communication more measurable.

Acknowledge & Address Risk Tolerance to Improve Situational Awareness

Risk tolerance was a significant predictor of workers' compliance or decisions to follow rules. However, because risk tolerance can shift over time, it is possible for management to intervene and change this perception. Specifically, workers often can identify a hazard but fail to mitigate it due to a high tolerance for risks (Jones, 2015). Several mine operations that participated in this research proposed their own or adapted

TABLE 3

WEIGHTED IMPACT OF EACH CONSTRUCT ON PROACTIVITY

Weighted impact of situational and personal constructs on proactivity. All 10 constructs are significant at the $p = .05$ level.

Construct rank	Proactivity RS-RW (%)
Thoroughness	20.76
Sense of control	17.06
Risk tolerance	13.16
Worker engagement	12.36
Coworker communication	8.88
Supervisor communication	7.36
Adaptability	7.14
Supervisor OSH support	6.07
OSH training	5.65
Organizational OSH support	1.57

TABLE 4

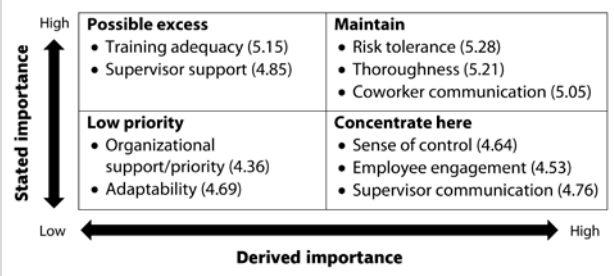
WEIGHTED IMPACT OF EACH CONSTRUCT ON COMPLIANCE

Weighted impact of situational and personal constructs on compliance. All 10 constructs are significant at the $p = .05$ level.

Construct rank	Compliance RS-RW (%)
Risk tolerance	30.60
Thoroughness	23.10
Coworker communication	10.50
Sense of control	8.70
Supervisor communication	5.50
Worker engagement	5.40
OSH training	5.30
Supervisor OSH support	4.60
Organizational OSH support	3.80
Adaptability	2.60

FIGURE 1

RESULTS PLOTTING CRITICAL STRENGTHS & WEAKNESSES



previously identified factors that influence risk tolerance, such as familiarity with the task or hazard, or overconfidence on the job. Management chose to initiate specific conversations around these factors to improve workers' situational awareness (see Haas et al., 2020).

Promote Safety Programs & Trainings That Are Tailored to Person-Based Factors

Research has shown that personal factors are rarely considered when implementing OSH programs (Kwon & Kim, 2013). Based on these results, however, OHSMS efforts should not only emphasize communication and involvement with employees, but also seek to uncover the roles of person-based factors among employees that contribute to the success of organizations such as sense of control and thoroughness. To that end, safety programs focused on developing person-based skills should be incorporated into the greater OHSMS. Examples of interventions that have been effective in behavior change include those that increase collaboration, skills to manage interpersonal conflicts and change management scenarios at work (Häggqvist, 2004). There are also leadership tactics that can develop empowerment attitudes and a sense of belonging among workers, further driving safety outcomes (Hedlund et al., 2010). Additionally, human resources practices such as hiring people who have a drive and motivation to be safe and engage in employee wellness activities could benefit organizational performance (Hedlund et al., 2016). Again, the organization and corresponding OHSMS still has a role in supporting worker safety behaviors; however, based on these results, organizations may opt for some more unique programs and efforts that have historically been absent in mineworker employee development.

Limitations

The results of this research must be considered within its current limitations. First, the sample was based on one of convenience across North America. Researchers did not determine and seek out companies that experienced an influx of incidents in recent years. That said, those who volunteered to participate likely already have a priority toward safety, which could skew the results. Future research can aim to assess locations that have experienced more incidents, near misses or fines, and determine whether the derived importance may be different for the various situational and personal constructs. Also, any responses provided by participants are subject to common method variance problems including social desirability bias and should be considered a limitation of the data. Along these lines, it is important to consider that the timing of any survey administration could impact this snapshot of results.

Conclusion

Because other studies have already conveyed the significant positive relationship between safety climate and safety behavior (e.g., Guldenmund, 2000; Wiegmann et al., 2002; Zohar, 1980), it was important to advance the current thinking and further characterize the impact of these indicators to provide support to mine organizations in tailoring future interventions. These results show the impact that situational and personal safety climate factors can have on worker safety behavior in a high-risk industry. More importantly, what this study contributes to the literature is that we now have empirically derived, demonstrated weights for commonly applied constructs when stacked against each other. Importantly, this study advances the findings and recommendations of previous studies that

have found that, in the absence of empirical data to lean on, OHSMS resource allocations are often made based on feeling or intuition (Robson et al., 2007). By empirically exploring the ranked importance of situational and personal constructs, this study is moving the pendulum in the right direction so that practitioners can prioritize actions and make decisions based on science rather than solely relying on former experience to achieve desired results. **PSJ**

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