Preprint 19-059

EXAMINING TRENDS IN INDIVIDUAL RISK FACTORS: ORGANIZATIONAL APPROACHES TO EMERGENCY MANAGEMENT

C. L. Hoebbel, CDC NIOSH, Pittsburgh, PA
E. J. Haas, CDC NIOSH, Pittsburgh, PA
M. E. Ryan, CDC NIOSH, Pittsburgh, PA

DISCLAIMER

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. Mention of any company or product does not imply endorsement does not constitute endorsement by NIOSH.

ABSTRACT

It has been suggested that effective disaster prevention and response in mining requires that elements of emergency management be incorporated into everyday operations, planning, and decision-making, much in the same way that the industry approaches routine risk management. Since Congress passed the MINER Act in 2006, the newly mandated structural and technological advancements in mine emergency response preparation have been made and are apparent, but measureable improvement in mineworker emergency preparedness is difficult to ascertain. To begin exploring whether measurable indicators of mine workforce preparedness can or should be addressed within a risk management framework, NIOSH researchers examined the datasets from two separate research efforts—one which measured the organizational safety climate and self-reported safety performance, and the other which measured individuals' perceptions of their own self-escape competency.

INTRODUCTION

In response to the mine disasters in 2006, the United States Congress passed the Mine Improvement and New Emergency Response Act (MINER Act), which strengthened existing regulations [30 CFR, Part 48] and introduced new provisions to improve mine emergency response. Since that time, new technological and structural features, such as mandated redundant communication systems, personnel tracking systems, and lifelines in primary and secondary escapeways, have been installed in underground coal mines across the country. Additionally, mine operators are required to develop emergency response plans, provide adequate supplies of breathable air throughout the mine, provide more frequent and realistic expectations training, and are required to immediately notify the Mine Safety and Health Administration (MSHA) in the event of an accident.

While the structural and technological advancements in emergency preparedness are readily observable and easily measured, levels of individual mineworker preparedness remain difficult to assess. There is a general consensus that deficiencies in competence in the non-routine tasks required for individual miners to effectively respond to a mine emergency likely remain (e.g., National Research Council [NRC], 2013), and NIOSH research continues address this concern (Haas, et al., 2015; Hoebbel et al., 2018). To maximize an operation's capacity to effectively prevent disasters and/or respond to emergency events, it has been suggested that individual and emergency management efforts be incorporated into everyday operations, planning, and decision-making in much the same way organizations manage routine risks to health and safety (Haddow et al., 2017). To the authors' knowledge, the mindful intersection of routine risk management policies and practices and emergency prevention and response readiness have yet to be empirically studied within the mining industry.

To begin to explore whether measurable indicators of disaster prevention and response knowledge, skills, and abilities (KSAs) can or should be addressed within a risk management framework, researchers from the National Institute for Occupational Safety and Health (NIOSH) examined quantitative datasets from two research studies to identify similarities or differences in the relationships among individual characteristics and self-reported safety performance and perceived self-escape competence. Findings such as these can provide the foundation for future research to identify individual characteristics such as job tenure and industry experience and organizational factors such as safety climate that might contribute to workers' self-escape KSAs and safety-related behaviors.

Identification of the individual and organizational factors that are associated with both everyday safety performance and self-escape competency could aid in the development and implementation of interventions that jointly address both routine risk management and non-routine emergency management.

Emergency Management in the Mining Industry

The National Mining Association's (NMA) CORESafety (2014), a "scalable" HSMS specifically designed for the U.S. mining industry, includes Emergency Management (EM) as one of twenty core elements of an effective system. In the 2014 worksite handbook, EM is defined as, "Planning for and responding appropriately to emergency and crisis situations through emergency prevention and action plans" (p. 1). "Training and Competence" and "Fatality Prevention/Risk Management" are also included in the CORESafety initiative, which emphasizes continuous improvement through the adaptation and integration of its core elements into existing HSMSs. Until the mining industry can consistently achieve zero incidents, having an established (and fully integrated) EM system is necessary to protect and prepare workers on the job (Asian Disaster Preparedness Center [ADPC], 2013).

Some scholars and organizations may use disaster management, emergency response, or emergency preparedness as being synonymous with EM, but in this paper the term is used to encompass all of these activities. It is the authors' position that effective EM in mining must include a variety of inter-related functions and requires a broad array of organizational activities and conditions, such as disaster prevention through hazard identification and mitigation, structural response readiness through the installation and maintenance of required mine emergency response features and apparatuses, and workforce preparedness developed through adequate training, reinforcement, and assessment.

Understandably, EM efforts in the mining industry center around the structural, technological, and organizational MINER Act requirements that include the development and maintenance of emergency response plans (ERPs), which outline very specific requirements that include, but are not limited to:

- Post-accident communication and tracking systems;
- Breathable air supply (e.g., wearable and cached self-contained self-rescuers [SCSRs] and refuge alternatives [RAs]);
- Locations of escapeways, characteristics of escapeway markers;

- Presence of lifelines in both the primary and secondary escapeways.

All of these requirements were put in place to improve the post-accident survivability of mineworkers. In addition to these provisions, ERPs also contain requirements related to training, the responsible person, and local coordination and logistics related to emergency response. Naturally, these human-centered elements of EM are those that are more difficult to assess and manage than structural elements. That is, although it might be fairly straightforward to install and maintain an adequate inventory of available SCSRs, measure distances between caches, or test the communication and tracking systems to ensure compliance, it is not as easy to measure the preparedness of individual mineworkers or their potential for effective performance in preventing or responding to an emergency.

Although training and assessment is critical to EM and the MINER Act outlines the required content as well as frequency and duration of training, it does not specify how mines should assess emergency preparedness among individual workers. However critical, it is also unlikely that mandated training alone can fully prepare mineworkers to identify risks and mitigation opportunities or to effectively respond to the low-probability, high-risk events that remain inherent to this work.

To foster the integration of emergency prevention, mitigation, and response activities into overall HSMSs, organizations should identify day-to-day opportunities to enhance readiness through awareness, repetition, and practice. This way, if and when a crisis cannot be averted, workers are better prepared to effectively respond. To promote this mindset, EM must be viewed more prominently, from an organizational perspective, as one of several critical elements of an effective HSMS.

Integrating Emergency Management into Risk Management Processes

Researchers have long argued that crisis EM and routine risk management (RM) are inextricably linked (Mitroff et al., 1992; Pauchant and Mitroff, 1992). A paradigm shift from an emphasis on disaster response to disaster prevention and risk mitigation was seen in the 1990s (Sahlin, 1992), and principal recommendations of EM that emphasize the adoption of routine RM policies have been made (e.g., Peters and McEntire, 1997). In the mining industry, one could surmise this shift in emphasis is evidenced by the marked decrease in U.S. mine disasters in the late 20th and early 21st century which may have led to the perception that large-scale mine disasters were a thing of the past. It is possible that a sense of complacency contributed to inadequate EM preparation among both mine operators and individual mineworkers that may have contributed to a less effective response to and mitigation of the catastrophic events in 2006 (Mine Safety Technology and Training Commission [MSTTC], 2006; Government Accountability Office [GAO], 2007; and McAteer et al. 2006a, 2006b). Furthermore, the tragedy that occurred at Upper Big Branch in 2010 was largely attributed to a poor safety culture as well as ineffective RM and disaster prevention efforts on the part of the mine operator (McAteer et al., 2011). This event reinforced the importance of preparing individual mineworkers to both effectively identify and mitigate unsafe and potentially disastrous conditions at their mine sites (whether that be through speaking out about potential dangers to mine management or being able to immediately respond to a dangerous situation on the job). Globally, there has been an increasing call for organizations to integrate elements of EM into routine work activities in order to improve operational readiness to respond to emergencies (ADPC, 2013).

Gebbie and Qureshi's (2002) concept of emergency preparedness, which is identifying "who needs to know how to do what" (p. 50), contends that these EM processes should transfer to any work task, job, or event on site. Therefore, by integrating EM into overall HSMS implementation strategies, organizations and may see improvements in workers' awareness of site-specific hazards (Preble, 1997), along with improved ability to readily and effectively respond to both everyday safety hazards and emergencies. CORESafety (2014) also stresses the importance of the integration of all elements of health and safety (H&S) management and explicitly states that effective EM requires training on "who needs to do what when an emergency occurs" (NMA, 2014, p. 2). Through the integration of EM within routine RM activities, it is possible that knowing the "who," the "what," and the "how" of EM can be reinforced and possibly even developed to the point of being automatic.

Individual Characteristics, Routine Safety Performance, and Emergency Preparedness

Before it is possible to develop strategies to incorporate emergency management (EM) activities into daily risk management (RM) processes, it is necessary to have some baseline measurement of routine, perceived safety performance, and perceived emergency response competence in order to better understand: 1) individual characteristics of the worker (the "who"), 2) EM knowledge (the "what"), and 3) skills and abilities (the "how"). This information is useful to begin identifying potential gaps in workforce-specific KSAs, which could, in turn, reveal other weaknesses in HSMS elements, such as leadership development, training, culture, and, fatality management. Aggregate measurement of worker competence and safety performance also enables organizations to identify change in health and safety outcomes that might result from specific organization-level interventions and continuous improvement efforts.

To begin to identify the ways in which these two constructs (i.e., safety performance and emergency response competence) might relate to other worker characteristics and one another, the authors conducted an exploratory analysis of results from two separate NIOSH studies. This research was completed simultaneously over the course of two years, and each effort had its own purpose: 1) to assess workers' organizational safety climate perceptions as they relate to safety performance (proactive and compliant safety behaviors) and 2) to measure individual workers' perceived competence (or "confidence") in their ability to perform the tasks needed to respond effectively in a mine emergency.

Study Objectives

The value of examining data from these two separate studies holistically is to identify and explore any trends among individual factors and routine safety performance and perceived competence in non-routine KSAs. The results of this analysis may provide insight into the usefulness of examining characteristics of individual mineworkers (the "who") to design and target interventions for both high-frequency/low-severity events (near misses, accidents and injuries) and low-frequency/high-severity events (mine emergencies). To accomplish these goals, the following research questions (RQs) were posed:

1. What individual factors, if any, are significantly related to hourly workers' perceptions of his or her own safety performance (i.e. proactivity and compliance)?
2. What individual factors, if any, are significantly related to hourly workers' perceived self-escape competency (i.e., confidence in one's own KSAs)?
3. Is there any overlap of individual factors that are significantly associated with the outcome variables across the two datasets?

Additionally, to begin to explore whether and how an organization's safety climate affects either worker safety performance and/or self-escape confidence, a subset of the data was examined to answer the following question:

4. Is there an association between workers' safety performance on the job and self-escape confidence, and if so, do worker perceptions of the organizational safety climate affect this association?

METHODS

Approximately 2,700 surveys from two research projects were administered to mineworkers over a two-year period between 2016 and 2018. For the purpose of this paper, these data were analyzed to identify any associations among individual mineworker characteristics and workers' perceptions of their own safety performance, and their own confidence in their ability to effectively escape from a mine emergency. These two survey efforts are described below.

Safety Climate Methodology

Safety climate has been linked to many safety-related outcomes (Clarke, 2006; DeJoy, 2005; Neal and Griffin, 2006), and in response to broad questions surrounding safety climate and safety performance, NIOSH developed a safety climate survey for the mining industry. Data from this survey were used to examine mineworkers' individual factors (e.g., age and experience) as potential predictors of workers' safety performance. Additionally, the construct of organizational safety climate, formulated using each of the external factor scales in the survey (i.e. organizational support, supervisor support, supervisor communication, coworker communication, worker engagement, and H&S training), were examined to address RQ4.

Safety Performance Survey Development

Worker safety performance, as a scale variable, was comprised of measures of compliant and proactive safety behaviors which have each been found to predict safety performance (Fuller et al., 2010; Griffin and Neal, 2000; Thompson, 2005). Each measure is defined below:

- **Safety compliance** is related to workers' participation in safety-related activities, as dictated by organizational policies and procedures, to work in a safe manner (Neal et al., 2000; Griffin and Neal, 2000).
- **Safety proactivity** refers to anticipating future events, taking initiative to improve current conditions, self-starting and taking charge, speaking out with ideas, and overcoming barriers to being safer rather than passively adapting to existing conditions (Crant, 2000; Parker et al., 2010).

The safety performance scale was adapted from Neal et al. (2000) and was comprised of four items to measure compliance with safety policies and procedures, and five items were adapted from Zacharatos et al.'s (2005) safety initiative survey to measure proactivity. These adapted scales used a six-point Likert scale (strongly disagree to strongly agree) with six being the highest value, indicating the highest levels of compliance and proactivity. In this sample, both the proactivity (α = .875) and compliance (α = .851) scales demonstrated high internal consistency reliability (Nunnally, 1978; Cronbach, 1951). The nine questions that subjectively assessed worker safety performance are outlined in Table 1.

Table 1. Worker Safety Performance Items.

Compliance Questions
When I am at work, I…
• Go out of my way to address potential hazards.
• Voluntarily carry out tasks that help improve workplace H&S.
• Make new suggestions to improve how H&S is handled.
• Try new things to improve workplace H&S.
Proactivity Questions
When I am at work, I…
• 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.

Survey Recruitment and Data Collection

After approval by the Institutional Review Board (IRB) and Office of Management and Budget (OMB), the survey was validated through pilot testing, and research data collection occurred between February 2016 and March 2018. Upon contact with stakeholders (e.g., corporate H&S leaders, mine operators, H&S managers), researchers explained the purpose of the study, answered any questions, and upon consent, scheduled site visits at the convenience of interested mines.

Survey administration usually occurred during pre-shift meetings or MSHA annual refresher trainings, although sometimes researchers traveled throughout the mine site to catch workers at breakrooms or more remote locations (e.g., quarries, workshops, etc.). Workers were briefed about the purpose of the survey, informed that their participation was voluntary, their responses would be anonymous, and their answers would not be seen by their supervisors.

The survey took approximately 15 minutes to complete. Researchers collected the hard copy surveys and subsequently entered responses into the SPSS software for data storage, cleaning, and analysis. Although both salaried and hourly workers participated in the survey, this current analysis focuses on the results of hourly workers exclusively because they are most likely to be the targeted population for routine RM interventions.

Self-escape Competency Methodology

Fortunately, large-scale mine emergencies are low-probability events. Consequently, due to their low frequency of occurrence, there is limited data related to such events and the factors that might contribute to the post-disaster survival of underground miners. The limited research into actual events suggests that gaps in critical KSAs required for non-routine tasks can lead to tragic consequences (e.g., McAteer et al. 2006a, MSHA, 2007). Based on this conclusion, several of the MINER Act provisions were designed specifically to better prepare individual mineworkers through improved emergency response training and assessment. Although significant efforts to accomplish this have been made in the last decade, it is impossible to know with any certainty whether these efforts have been effective. The purpose of this survey effort was to identify potential gaps in underground coal mineworkers' critical KSAs from the perspective of a sample of underground coal mineworkers themselves.

Self-escape Competence Survey Development

Since it is difficult and dangerous to simulate the dynamic and stressful conditions of an actual mine emergency and standard self-escape competency and assessment protocols are yet to be developed, it was necessary for researchers to develop an instrument that could most readily identify and quantify gaps in self-escape competency among mineworkers. Previous research suggests that when competence is difficult or impossible to measure, self-reported confidence in one's ability to perform a task can serve as a reliable predictor of performance, particularly in very specific task domains (Bandura, 2006; Pajares, 1996). In this study, workers' confidence in their ability to "properly demonstrate or explain" critical self-escape tasks was used to quantify perceived competence.

Based on the results of a preliminary task analysis conducted as part of the larger NIOSH response to the aforementioned National Academy of Sciences' report, "Improving Self-escape from Underground Coal Mines" (NRC, 2013), NIOSH researchers developed a 28-item self-report survey measuring perceived confidence in critical self-escape tasks. These 28 items were selected to cover those KSAs that all miners, regardless of self-escape role, should be able to confidently demonstrate or explain. Using an 11-point scale, participating miners were asked how confident they were that they could correctly demonstrate or explain each of the 28 tasks to a brand new miner (see Table 2).

Questions also captured demographic data including age, time in mining, time in job, and time in current mine, and other background questions related to leadership experience, specialized training, and/or emergency response experience. In addition, there were three questions related to organizational and personal commitment to mine emergency training and preparedness, which were not examined in this analysis.

Survey Recruitment and Data Collection

Upon receiving IRB and OMB approval in late 2016, NIOSH researchers used existing contacts, mining conference presentations, and other stakeholder meetings to invite underground coal mine operations across the United States to participate in the survey. Although the hope was to visit mines in all geographic regions, interest in the survey feedback came primarily from mine operators in the Eastern U.S., and all data were collected in the Appalachian Region.

Researchers collected survey data from eight different mine sites and administration procedures varied slightly by mine site. All survey administration was conducted in above-ground facilities either during pre-shift meetings or during scheduled training activities. Researchers described the purpose of the study, explained to participants how the data would be used, and addressed any questions or concerns. All mineworkers were informed that participation was voluntary, their responses would remain confidential, and they could refuse participation by leaving the room or simply not completing the survey. In total, 696 hourly mineworkers from eight mines consented to participate in the study. It took approximately 10 minutes to complete the survey.

Table 2. Self-escape Confidence Items.

On a scale from 0–10, how confident are you that you could correctly demonstrate or explain the following to a brand new miner?
1. Your mine's emergency response plan (ERP)
2. The chain of command for reporting a mine emergency
3. The location of your mine's primary and secondary escapeways
4. Where your mines' escapeway maps are located
5. Where to report in the event of a mine emergency
6. How to read mine map symbols
7. Lifeline symbols
8. If or when to fight a fire
9. How to fight a fire
10. How to identify an explosive atmosphere with a gas meter
11. Your own role in your mine's emergency response plan
12. When to don an SCSR
13. Where your mine's SCSR caches are located
14. How to properly don an SCSR
15. What to expect when wearing an SCSR
16. What alarms/alerts mean
17. How to test roof conditions
18. Ventilation/smoke leakage
19. How to re-establish ventilation
20. Where your mine's refuge alternative(s) is/are
21. When to enter your mine's refuge alternative
22. How to operate your mine's refuge alternative
23. When to construct a barricade
24. How to construct a proper barricade
25. Your mine's communication and tracking system(s)
26. How to use nonverbal communication
27. Where your mine's tetherlines are located
28. How to use a tetherline

Participants

Safety climate survey participants consisted of 2,020 hourly mineworkers (78% of the total sample) from 39 mine sites. The 39 mines represented nine major companies and three mined commodities (i.e. coal; stone, sand, and gravel; and industrial minerals). The breakdown of participation by commodity was stone, sand, and gravel (n = 1,055, 52%); industrial minerals (n = 650, 32%); and coal (n = 315, 16%). The number of participants from each mine ranged from 7–246 (M = 52).

Self-escape confidence survey participants consisted of 696 hourly workers from eight underground coal mine sites. The number of participants from each mine ranged from 16–213 (M = 87). Complete demographics for both samples are reported in Table 3.

Combined Safety Climate and Self-escape Subset

During the recruitment process, one mine agreed to participate in both survey efforts as one data collection visit. In 2017, researchers visited this mine and collected a total of 78 safety climate surveys from surface and underground mine workers. Those who worked underground also completed the self-escape survey. This subset of data (n = 62) was used to address RQ4.

Data Analysis

Logistic regressions were used to answer RQ 1 and RQ 2. Researchers examined the outcome variables of interest from each dataset (safety performance and average self-escape confidence, respectively) and found both distributions to be negatively skewed. To allow for the logistic regressions, the data were first split into quartiles and then dichotomized by coding values within the upper quartile (Q4) as 1 and values within the lower quartiles (Q 1-3) as 0. This process allowed the highest (most desirable) 25% of scores in Q1 to be distinguished from the remaining 75% of scores (see Table 4). Researchers then identified the demographic factors that were associated with either outcome variable, when controlling for all other variables, by running two separate multiple logistic regression models. Each model contained all of the demographic variables that were shared between the two datasets (i.e. those represented in Table 3).

Table 3. Participant Breakdown for Both Datasets

	Safety Climate Sample (n, %)	Self-escape Sample (n, %)
Time in the mining industry		
< 1 yr	205 (10.4%)	138 (19.9%)
1–5 yrs	397 (20.0%)	292 (42.2%)
6–10 yrs	364 (18.4%)	113 (16.3%)
11–15 yrs	304 (15.4%)	60 (8.7%)
16–20 yrs	189 (9.5%)	
> 20 yrs	521 (26.3%)	89 (12.9%)*
Time on the job		
< 1 yr	329 (16.4%)	83 (12.0%)
1–5 yrs	556 (27.7%)	247 (35.6%)
6–10 yrs	342 (17.0%)	237 (34.2%)
11–15 yrs	256 (12.7%)	77 (11.1%)
16–20 yrs	157 (7.8%)	29 (4.2%)
> 20 yrs	368 (18.3%)	20 (2.9%)
Time at the current mine/company		
< 1 yr	307 (15.8%)	89 (12.8%)
1–5 yrs	444 (22.9%)	214 (30.9%)
6–10 yrs	328 (16.9%)	256 (36.9%)
11–15 yrs	276 (14.2%)	85 (12.3%)
16–20 yrs	162 (8.3%)	30 (4.3%)
> 20 yrs	426 (21.9%)	19 (2.7%)
Age		
18–24	126 (6.3%)	41 (5.9%)
25–34	446 (22.3%)	247 (35.6%)
35–44	461 (23.0%)	202 (29.1%)
45–54	530 (26.5%)	93 (13.4%)
55+	439 (21.9%)	111 (16.0%)
Education (High school [HS])		
HS or less	1,382 (68.8%)	513 (73.8%)
More than HS	621 (31.2%)	182 (26.2%)
Shift schedule		
Set	1,378 (69.0%)	121 (17.5%)
Rotates	620 (31.0%)	571 (82.5%)
Workgroup		
Production	1,153 (57.9%)	461 (66.5%)
Maintenance	454 (22.8%)	138 (19.9%)
Other	385 (19.3%)	94 (13.6%)
Family mining history		
First generation	1,270 (64.9%)	228 (33.1%)
Multigeneration	687 (35.1%)	460 (66.9%)

* These two categories ("16–20 years" and "More than 20 years" of experience in the mining industry) were merged in the Self-escape sample due to insufficient sample size.

Percentages are based on the valid percent of the sample (excludes non-responses).

Backwards selection procedures were used for determining each statistical model, starting with a model that included all of the demographic variables shared across the two datasets and ending with a model that included only the demographic variables whose unique contributions were significantly associated with the respective outcomes. Instead of using SPSS's automated backwards selection procedures, researchers ran each logistic regression model one-by-one, removing one demographic variable at a time, as necessary, until reaching the final models for each logistic regression.

RESULTS

RQ1: What individual factors, if any, are significantly related to hourly workers' perceptions of his or her own safety performance (i.e. proactivity and compliance)?

Table 4. Quartile Ranges.

Distribution of Dichotomous Outcome Variables	Lower Quartiles	Upper Quartile
Average Safety Performance Scores: *From 1 (strongly disagree) to 6 (strongly agree)*	0–5.55	5.56–6.0
Average Self-Escape Confidence Scores: *From 0 (0% confident) to 10 (100% confident)*	0–9.78	9.79–10.0

When using backward selection procedures for the first question, three demographic variables were significantly associated with safety performance: time in current job (p = .017); time in the mining industry (p = .022); and workgroup (p = .000) (see Table 5), and each of these are described below.

Table 5. Logistic Regression Results – Demographics by Safety Performance.

Demographics	OR	95% CI	p-value
Time in current job			**0.017**
Under 1 year	**REF**		
1–5 Years	1.49	(0.97–2.29)	
6–10 Years	1.62	(0.99–2.65)	
11–15 Years	2.72*	(1.57–4.71)	
16–20 Years	2.02*	(1.09–3.75)	
20 + Years	2.09*	(1.21–3.63)	
Time in mining industry			**0.022**
Under 1 year	**REF**		
1–5 Years	0.58*	(0.35–0.94)	
6–10 Years	0.54*	(0.32–0.912)	
11–15 Years	0.37*	(0.21–0.66)	
16–20 Years	0.39*	(0.21–0.72)	
20 + Years	0.47*	(0.27–0.82)	
Workgroup			**0.000**
Production	**REF**		
Maintenance	0.55*	(0.42–0.74)	
Other	0.91	(0.69–1.20)	

*=*p*<.05

Time in Current Job

As shown in Table 5, those who reported time in current job at 11 years or more were significantly more likely to report higher work performance (scores in the upper quartile) compared with those who reported being in their *current job* for under one year, when controlling for workgroup and time in the mining industry. Specifically, those in the job from 11–15 years were 2.7 times more likely to report higher safety performance than those who had under one year of experience in their current job; those with 16–20 years (2.2 times more likely) and those with more than 20 years (2.1 times more likely). There were no statistically significant differences between those with 1–10 years and those with under one year of experience.

Time in the Mining Industry

On the other hand, the odds of reporting "high" safety performance (in the top quartile) was significantly less likely (ranging from 63% to 42% less likely) at all levels of mining experience compared to those with under one year of mining experience, when controlling for job experience and workgroup.

Workgroup

One individual factor predictive of safety performance that was unrelated to experience was the *workgroup* membership. Analysis of this variable showed that *maintenance* workers were 45% less likely to report high safety performance than those in the *production* workgroup (p = .000).

RQ2: What individual factors, if any, are significantly related to hourly workers' perceived self-escape competency (confidence in own KSAs)?

When using backward selection procedures for RQ2 (demographic variables and self-escape confidence) three demographic variables were found to be significantly associated with self-escape confidence: time in the mining industry (p = .023); time at current mine (p =.044); and work schedule (p = .014). See Table 6 for the breakdown of results.

Table 6. Logistic Regression Results for Demographics by Average Self-Escape Confidence.

Demographics	OR	95% CI	p-value
Time in mining industry			**0.023**
0–5 Years	**REF**	**REF**	
6–10 Years	2.59*	(1.33–5.05)	
11–15 Years	2.99*	(1.35–6.62)	
16–20 Years	3.72*	(1.40–9.87)	
20 + Years	3.46*	(1.44–8.32)	
Time at current mine/company			**0.044**
Under 1 year	**REF**	**REF**	
1–5 Years	0.86	(0.45–1.62)	
6–10 Years	0.43*	(0.23–0.82)	
11–15 Years	0.58	(0.25–1.37)	
16–20 Years	0.27	(0.07–1.09)	
20 + Years	0.26	(0.05–1.39)	
Work schedule			**0.014**
Set schedule	**REF**	**REF**	
Rotates/Shiftwork	0.53*	(0.32–0.88)	

**=p<.05*

Time in Mining industry

Because of the small number of participants with under one year of experience in the *coal* mining industry, the 0–1 and 1–5 year groups were combined into one categorical variable (0–5 years). As shown in Table 6, those who reported 6 or more years in the mining industry were significantly more (from 2.6 to 3.7 times) likely to report higher confidence in their self-escape competency than those with 0–5 years in the industry, when controlling for time in current mine and work schedule.

Time at Current Mine

The only significant difference found among the experience groups for time at current mine was that those who reported being at their current mine for 6–10 years were 57% less likely to report high confidence in their self-escape competency when compared with those who reported being at their current mine for under 1 year, when controlling for time in the mining industry and work schedule.

Work Schedule

Finally, workers who did not work a set schedule were 47% less likely to report high confidence than those who did work a set schedule, when controlling for both experience variables.

RQ3: Is there any overlap of individual factors that are significantly associated with the outcome variables across the two datasets?

Three of the five significant predictors of the outcome variables across both datasets were related to experience (time in the mining industry, time in the current job, time at the current mine). The only variable that was found to be significantly predictive of both outcome variables was time in mining industry.

Time in Mining industry

Time in the mining industry was significantly associated with both safety performance and self-escape confidence among mineworkers; however, the direction of the relationships differed. Interestingly, when controlling for job experience and workgroup, those who reported being in the mining industry for 1–5 years, 6–10 years, 11–15 years, 16–20 years or more than 20 years were significantly less likely to report high safety performance when compared with those with under 1 year of industry experience. Conversely, those who reported being in the mining industry for 6–10 years, 11–15 years, 16–20 years or more than 20 years were more likely to report high average self-escape confidence than those who reported being in the mining industry for 5 years or fewer, when controlling for work schedule and time at current mine. Potential explanations for this difference follow in the Discussion section.

Time in Current Job

Time in current job was significantly associated with safety performance, specifically where time in current job was 11–15 years, 16–20 years, and more than 20 years when compared with those with under 1 year of experience on the job. Time in current job was not significantly associated with self-escape confidence.

Time at Current Mine

Time at current mine was negatively associated with self-escape confidence, specifically when time at current mine was 6–10 years when compared with less than 1 year, when controlling for time in mining industry and work schedule. Time at current mine was not significantly associated with safety performance.

RQ4: Is there an association between workers' everyday safety performance on the job and their self-escape confidence, and if so, does an organization's perceived safety climate affect the association?

To answer RQ4, researchers explored a subset of data that included both outcome variables (n = 62). Using the data from one mine who participated in both survey efforts, additional tests were completed to determine if: 1) safety performance and self-escape confidence are associated and 2) if organizational safety climate has an impact on the association between safety performance and self-escape confidence (if a relationship is present).

First, using the same quartile breakdown used to answer RQs 1 and 2, a chi-square test was conducted and found a significant positive relationship between safety performance and average self-escape confidence (p = .016). As shown in Table 7, only 13 out of 62 pairs of outcomes did not agree with one another as high-high or lower-lower.

Table 7. Self-Escape Confidence * Safety Performance.

		Safety Performance	
		Lower Quartiles	Upper Quartile ("High")
Self-Escape Confidence	Lower Quartile	44	6
	Upper Quartile ("High")	7	5

$\chi^2(1, N = 62) = 5.84, p$=0.016

After determining that the two outcome variables were significantly associated, researchers examined if effect modification by organizational safety climate was present in the association. To do this, the distribution of the composite organizational safety climate variable was examined and dichotomized using the same procedure used for the other outcome variables. Again, variables were recoded into dichotomous categorical variables, with 1 = the upper quartile of responses (the top 25% of scores) and 0 = the lower quartiles (the bottom 75%). Chi-square tests evaluating the relationship between safety performance and self-escape confidence were run separately for each of the two categories of organizational climate (4th quartile versus quartiles 1-3 or "high organizational climate" scores versus "lower organizational climate scores").

Effect Modification Results

Results of the chi-square tests suggested that effect modification by organizational climate is present in the association between average confidence and safety performance. Table 8 shows the average confidence * work performance * organizational safety climate results for the lower and upper quartiles.

Of interest is that the association between average self-escape confidence and safety performance is only significant when organizational climate was reported in the upper quartile, but not when organizational climate was reported in the lower three quartiles. This suggests that the relationship between self-escape confidence and safety performance exists only when organizational safety climate is rated highly. Of note, the only five participants (out of 62) who reported both high self-escape confidence and high safety performance were also in the high organizational climate group. Although not unexpected or statistically significant, it is also worth noting that 36 of the 44 who reported both lower self-escape confidence and lower safety performance were also in the lower organizational safety climate group.

Table 8. Self-Escape Confidence * Safety Performance * Organizational Climate (Upper and Lower Quartiles).

Lower Quartiles of Organizational Climate

		Safety Performance	
		Lower Quartiles	Upper Quartile ("High")
Self-Escape Confidence	Lower Quartile	36	5
	Upper Quartile ("High")	6	0

$\chi^2(1, N = 47)$ =.82, p=0.366

Upper Quartile of Organizational Climate

		Safety Performance	
		Lower Quartiles	Upper Quartile ("High")
Self-Escape Confidence	Lower Quartile	8	1
	Upper Quartile ("High")	1	5

$\chi^2(1, N = 15) = 7.82, p$=0.005*

DISCUSSION

Under the supposition that non-routine emergency prevention and response preparedness could and maybe should be addressed within a routine risk management framework, NIOSH researchers explored ways in which routine safety performance and self-escape competence were related to one another and to other individual miner characteristics. The purpose of this exploration was to identify meaningful relationships among these constructs in an effort to inform potential strategies to address both routine and non-routine risks through more traditional risk management efforts. To that end, researchers analyzed two existing datasets to answer four research questions.

First, by examining both datasets, it was determined that a number of individual characteristics were significantly associated with safety performance and self-escape confidence. Five individual factors (time in industry, time in current job, time at current mine, work schedule, and workgroup) were significantly related to at least one of the outcome variables. Importantly, of these five individual factors, three were related to levels of experience in either the job, the industry, or the mine in interesting and sometimes unexpected ways. We begin with a discussion of these relationships, potential explanations, and implications.

Time in Current Job

Not surprisingly, this analysis showed a significant positive relationship between job tenure and safety performance. As described in the results section, workers with 11+ years in their current job were roughly 2 to 3 times more likely to report high safety performance than those with less than a year in their current job. These findings support a body of existing literature which offer a number of explanations for this relationship. For example, one suggestion is that job performance is directly associated with job tenure because, over time, workers gain more tacit knowledge and can more effectively perform their jobs (Schmidt, Hunter, & Outerbridge, 1986), or more specific to safety performance outcomes, that as time on the job increases so does the likelihood of workers experiencing near-miss incidents, which result in workers' increased ability to proactively perceive, identify, and respond to risks (Burke, Scheuer, & Meredith, 2007). Time in job was not significantly related to self-escape confidence, suggesting a positive relationship might be specific to routine job tasks.

Time in the Mining Industry

Based on the above findings and wide support within existing literature, one might conclude that increased length of experience is logically and meaningfully related to high work performance, in general. But upon further examination, results from the present study also indicate that time in the *mining industry* is negatively associated with safety performance, which is in direct contrast to the relationship between job tenure and performance. Within this sample of mineworkers, every age group had significantly lower odds of reporting high safety performance than those with under one year of experience in the industry. Again, there are a number of potential explanations for this phenomenon. One obvious explanation for this could be that the longer one performs the same job tasks, the more comfortable and knowledgeable they are about the risks inherent in that particular job, regardless of industry experience.

It is also worth considering that the working population from which this sample was drawn is distinctive, in itself. Mine operations are often, by nature and necessity, located in more rural and remote geographic areas raising the possibility that workers have few options for gainful employment. Ng and Feldman (2013) have suggested that when workers feel bound in their career they might become bored or dissatisfied with their jobs, but lack other job opportunities. In these cases, workers may have changed job positions within their current operation more recently or frequently, which would result in longer industry tenure, but shorter job tenure. Ng and Feldman (2013) go on to suggest that organizations make efforts to engage their workforce in ways that make it more likely that procedural knowledge and skill are maintained, which could also lead to increased satisfaction and commitment to the company. This group of workers (those with long industry tenure and varying degrees of job tenure) deserve further study. Past research suggests that workers who are dissatisfied with their job around the five-year mark tend to move onto a different career path, workplace, or job task (Stout, Slocum, & Cron, 1988), but this is an understudied working population. Further exploration into this effect is necessary to tease out variables such as age, job performance, and job satisfaction as potential confounders, mediators and/or moderators of this effect. The important takeaway here is that job tenure rather than industry tenure is a stronger predictor of safety performance.

As described in the Results section of this paper, industry experience was the only individual factor significantly associated with both safety performance and self-escape confidence. To complicate matters, results show that the direction of this relationship also differed across outcomes. While industry experience was negatively and significantly associated with safety performance, it was positively and significantly associated with self-escape confidence. That is, those workers with 6+ years in the industry were roughly 2-½ to almost 4 times more likely to fall in the high self-escape confidence group. What this might suggest is that these constructs, although associated to one another, have very different relationships to other individual factors.

Several factors could be at play here, but one major difference between these outcome variables is that safety performance is a measure of routine risk management and self-escape confidence is a measure of non-routine risk management. One explanation could be that a cumulative effect of emergency response training over time leads to higher self-escape confidence. Because scientific literature and anecdotal historical evidence related to factors that affect self-escape competency are lacking, researchers are left to speculate as to the reasons for this finding and to more closely examine this relationship through further study.

Time at Current Mine

Again, distinctions among types of experience became apparent as results suggested that *time in current mine* is negatively associated with self-escape confidence. This relationship was less significant than any others discussed here, but worth mentioning. All groups were similarly to less likely to report high confidence than those with under one year at the current mine, with only one group (6–10 years at current mine) being significantly less likely. This finding is somewhat surprising, considering it might be expected that those with more experience in a particular mine might have greater mine-specific self-escape knowledge than those inexperienced in the mine. Again, because little scientific data exists, one can only speculate as to the reasons for this finding.

One potential explanation could be that those new to a particular mine might have received more recent mine-specific training, refresher training, emergency response training, more focused attention from trainers and supervisors, etc. than those who have been with the mine for longer periods of time. Another could be that miners who have moved around more might be reinvigorated by having a new environment and new, varying trainings/resources, maybe making them less likely to become complacent or become “desensitized” to the efforts of mine safety professionals to improve self-escape preparedness. It is even possible that miners with lower risk-tolerance, who find working conditions unsafe or unacceptable at one mine, might be more inclined to change mines when possible. These miners, by nature, might be more cognizant, and therefore vigilant, in terms of their own health and safety. Time in current mine was not significantly related to safety performance.

Workgroup

Workgroup membership was one of the two individual factors unrelated to experience that was significantly related to either outcome variable. Among this sample of workers, workgroup membership was significantly associated with safety performance, with maintenance workers having lower odds of reporting high safety performance than production workers. This finding could have important implications for further study on the specifics of the job tasks, inherent risks, and amount of routine communication and oversight on the part of the supervisor. Workgroup membership was not significantly associated with self-escape confidence.

Work Schedule

Whether mine workers reported working a “set-schedule” or “rotating schedule/shiftwork,” these variables were significantly related to self-escape confidence. Workers who reported rotating schedule/shiftwork were almost 50% less likely to report high self-escape confidence. Although negative impacts of shift work on workers’ job performance (Ferguson et al., 2011; Muller et al., 2008), situation awareness (Sneddon et al., 2013), and health (Elliot & Lal, 2016) have been documented in the literature, this particular finding should be interpreted with some caution. First, the large majority of the mineworkers surveyed about self-escape confidence were shift workers and of the roughly 15% who worked a set schedule, most worked for a single mine. Although this relationship might be confounded, more formally examining shift work as it relates to these health and safety outcomes in the mining industry could provide some insight into whether and how these groups of workers are different and how any differences might be addressed.

Implications for Mine Safety Practitioners to Improve Safety Performance, Self-escape Confidence, and Organizational Safety Climate

Finally, a subset of data from underground coal mineworkers who participated in both surveys was examined to explore the relationship between the outcome variables. In summary, results indicated that routine safety performance is significantly associated with self-escape confidence and that perceived safety climate is an effect modifier of this association. Interestingly, this effect was only significant for those cases in the upper quartile (high organizational safety climate) where only 5 (out of 62) workers whose responses were in the upper quartile for both outcome measures also resided. In other words, there were no cases where participants with high safety performance *and* high self-escape confidence also reported lower organizational safety climate. Although this subset of data was relatively small and results may be specific to the one mine site for which both surveys were completed, it illustrates the potential for designing future research efforts that further explore all three of these constructs simultaneously.

To summarize, these findings have a number of implications for mine operators, managers, mine safety professionals and researchers. Although not definitive, results lend credence to the idea that mine health and safety (H&S) professionals should not take a "one size fits all" approach to H&S management. At the very least, it has become clear that important individual differences among miners exist and have significant relationships with desirable health and safety outcomes. Mine safety professionals may be encouraged to consider the unique characteristics of their own workforces to become attuned to such differences and approach individuals with different levels of experience, different positions, different schedules, and other potential individual differences accordingly.

It is possible these differences, while not formally measured, are apparent to mine managers and intuitive to mine supervisors and safety trainers, who informally focus efforts on those with the most need. Furthermore, although there is plenty of research to support that safety climate and culture have an effect on safety outcomes in other high risk industries (e.g., DeJoy, 2005; Neal and Griffin, 2006; Neal et al., 2005; Zacharatos et al. 2005), these results provide further support the same might be true in the mining industry. Both formal and informal efforts should be made to improve workers' perceptions of the supportiveness of their organizations' safety climate.

LIMITATIONS AND CONCLUSIONS

There are several limitations to this retrospective exploratory study. First, all of the data was collected to answer specific research questions unrelated to those asked here, so there was likely insufficient information to draw any definitive inferences from this analysis. The projects, by design, targeted different populations. One focused exclusively on underground coal mining and the other included a variety of mining commodities, both surface and underground. Both efforts utilized self-report surveys which present the usual challenges related to social desirability, acquiescence, and concerns about confidentiality, which could all influence responses.

As for research direction, these results provide a unique foundation for further study in the areas of individual differences, safety performance, safety climate, and emergency preparedness. In particular, differences in levels of experience in the job, the mine, and the industry all had some relationship to health and safety outcomes. Some of these findings were expected and others were surprising for the research team. All will be considered simultaneously in the design and implementation of further research into potential benefits of studying performance outcomes for both routine and non-routine tasks. Although results suggest that safety performance and self-escape confidence are related to one another, there are significant differences in their relationships to other individual factors. A larger sample from participants who complete both surveys would be required to better understand the relationships between and among these variables.

For example, is it that the constructs themselves are fundamentally different (routine versus non-routine KSAs) or that these constructs are approached differently within health and safety management systems or across commodities? Once determined, the feasibility of considering individual mine worker differences in targeting health and safety interventions can be examined along with whether and how this might be accomplished through modifications to existing emergency management and routine risk management strategies.

In a very broad sense, these results support the notion that individual mine worker factors are related to important health and safety outcome variables, these outcome variables are related to one another, and perceptions of highly supportive safety climates modifies that relationship. Further research is necessary and warranted so that these relationships and their implications for targeting training, reinforcement, and assessment efforts can be better understood.

REFERENCES

Asian Disaster Preparedness Center, 2013. "*Integrating disaster risk management into the development process,"* Disaster Risk Management Practitioner's Handbook Series. Bangkok.

Into the Development Process," Disaster Risk Management Practitioner's Handbook Series. Bangkok.

Bandura, A., 2006. Guide for constructing self-efficacy scales. In Self-efficacy beliefs of adolescents (pp. 307–337. Information Age Publishing.

Burke, M.J., Scheuer, M.L. and Meredith, R.J., 2007. A dialogical approach to skill development: The case of safety skills. *Human Resource Management Review*, *17*(2), pp.235-250.

Clarke, S., 2006. "The relationship between safety climate and safety performance: a meta-analytic review," *Journal of Occupational Health Psychology*, Vol. 11, No. 4, pp. 315–327.

National Mining Association. 2014. CORESafety worksite handbook. Retrieved from https://coresafety.org/resources/workbook-complete.pdf on August 31, 2018.

Cronbach, L.J. (1951). "Coefficient alpha and the internal structure of tests," *Psychometrika*, Vol. 16, No. 3, pp. 297–334.

DeJoy, D.M., 2005. "Behavior change versus culture change: Divergent approaches to managing workplace safety." *Safety Science*, Vol. 43, No. 2, pp. 105–129.

Elliott, J. L. & Lal, S. (2016). "Blood pressure, sleep quality and fatigue in shift working police officers; Effects of a twelve hour roster system on cardiovascular and sleep health*." International Journal of Environmental Research and Public Health*. Vol. 13. No. 2, pp. 172-179.

Ferguson, S. A., Paech, G. M., Dorrian, J., Roach, G. D., & Jay, S. M. (2011). "Performance on a simple response time task: Is sleep or work more important for miners?" *Applied Ergonomics*, Vol. 42, pp. 210-213,

Fuller, J., Bryan, Jr., Hester, K., and Cox, S.S., 2010. "Proactive personality and job performance: Exploring job autonomy as a moderator," *Journal of Managerial Issues*, Vol. 22, No. 1, pp. 35–51. Retrieved from https://search.proquest.com/docview/89148948?accountid=26724.

GAO, 2007. Better oversight and coordination by MSHA and other federal agencies could improve safety for underground coal miners. GAO-07-622. Washington, DC: U.S. Government Accountability Office. Available at: [http://www.gao.gov/new.items/d07622.pdf].

Gebbie, K.M. and Qureshi, K., 2002. "Emergency and disaster preparedness core competencies for nurses: What every nurse should but may not know," *AJN The American Journal of Nursing*, Vol. 102, No. 1, pp. 46–51.

Griffin, M.A., and Neal, A. 2000. "Perceptions of safety at work: a framework for linking safety climate to safety performance, knowledge, and motivation," *Journal of Occupational Health Psychology*, Vol. 5, No. 3, 347–358.

Haas, E. J., Peters, R. H., Kosmoski, C. L. 2015. "Enhancing self-escape by integrating competency assessment into training." U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2015-188, RI 9699.

Haddow, G., Bullock, J. and Coppola, D.P., 2017. "*Introduction to emergency management,"* Cambridge, MA: Butterworth-Heinemann.

Hoebbel, C., Brnich, M.J., Ryan, M.E. 2018. "The ABCs of KSAs: Assessing the self-escape knowledge, skills and abilities of coal miners," *Coal Age*, Vol. 123, No. 1, pp. 30–34.

McAteer, J.D., Beall, K., Beck, J.A., McGinley, P.C., Monforton, C., Roberts, D.C., Spence, B. and Weise, S., 2011. Upper Big Branch, the April 5, 2010, explosion: a failure of basic coal mine safety practices. Report to the Governor, Governor's Independent Investigation Panel, p.126. Available at https://www.documentcloud.org/documents/2401616-mcateer-giip-report-on-upper-big-branch-mine.html.

McAteer, J.D., Bethell, T.N., Monforton, C., Pavlovich, J.W., Roberts, D., and Spence, B. (2006a).The Sago Mine Disaster: A preliminary report to Governor Joe Manchin III. Available at: www.wvgov.org and www.wju.edu.

McAteer, J.D., Bethell, T.N., Monforton, C., Pavlovich, J.W., Roberts, D., and Spence, B. (2006b).The Fire at Aracoma Alma Mine #1: A preliminary report to Governor Joe Manchin III. Available at: www.wvgov.org and www.wju.edu.

McEntire, D.A. and Myers, A., 2004. "Preparing communities for disasters: issues and processes for government readiness," *Disaster Prevention and Management: An International Journal*, Vol. 13, No. 2, pp. 140–152.

Mitroff, I.I., Pearson, C. and Pauchant, T.C., 1992. "Crisis management and strategic management: similarities, differences and challenges," *Advances in Strategic Management*, Vol. 8, No. 2, pp. 235–260.

MSHA, 2007. "Report of investigation: fatal underground coal mine explosion, January 2, 2006, Sago Mine, Wolf Run Mining Company, Tallmansville, Upshur County, West Virginia, ID No. 46-08791," By Gates RA, Phillips RL, Urosek JE, Stephan CR, Stoltz RT, Swentosky DJ, Harris GW, O'Donnell JR, Dresch RA. Arlington, VA: U. S. Department of Labor, Mine Safety and Health Administration.

MSHA, 2006. Mine Improvement and New Emergency Response Act of 2006, Retrieved from https://www.msha.gov/MinerAct/MineActAmmendmentSummary.asp.

MSTTC, 2006. "Improving mine safety technology and training: establishing U.S. global leadership. Mine Safety Technology and Training Commission," National Mining Association, Dec. 2006, 193 pp. Available at: http://www.coalminingsafety.org/documents/msttc_report.pdf.

Muller, R., Carter, A., & Williamson, A. (2008). "Epidemiological diagnosis of occupational fatigue in a fly-in-fly-out operation of the mineral industry." *Annals of Occupational Hygiene*, Vol. 52, No. 1, pp. 63-72.

National Research Council, 2013. "Improving Self-escape from Underground Coal Mines." Committee on Mine Safety: Essential Components of Self-escape. Board on Human Systems Integration, Division of Behavioral and Social Sciences and Education. Washington, D.C: The National Academies Press.

Neal, A., Griffin, M.A., and Hart, P.M., 2000. "The impact of organizational climate on safety climate and individual behavior," *Safety Science,* Vol. 34, pp. 99–109.

Neal, A. and Griffin, M.A., 2006. A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. *Journal of applied psychology*, *91*(4), p.946.

Ng, T.W. and Feldman, D.C., 2013. A meta-analysis of the relationships of age and tenure with innovation-related behaviour. *Journal of occupational and organizational psychology*, *86*(4), pp.585-616.

Nunnally, J., 1978. "*Psychometric methods,"* New York, NY: McGraw-Hill.

Pajares, F. 1996. "Self-efficacy beliefs in academic settings," Review of Educational Research, Vol. 66, No. 4, pp. 543-578.

Parker, S.K., Bindl, U.K. and Strauss, K., 2010. "Making things happen: A model of proactive motivation," *Journal of Management*, Vol. 36, No. 4, pp. 827–856.

Pauchant, T.C. and Mitroff, I.I., 1992. "*Transforming the crisis-prone organization: Preventing individual, organizational, and environmental tragedies,"* San Francisco, CA: Jossey-Bass.

Peters, E.J. and McEntire, D.A., 1997. "Emergency management in Australia: An innovative, progressive and committed sector," Retrieved from https://training.fema.gov/.../comparative%20em%20book%20-%20chapter%20-%20e... On October 13, 2018.

Preble, J.F., 1997. "Integrating the crisis management perspective into the strategic management process," *Journal of Management Studies*, Vol. 34, No. 5, pp. 769–791.

Sahlin, M., 1992. Paradigm shift. Speech to the Conference of the National Volunteer Organizations Active in Disaster (NVOAD). Available at www.nvoad.org/articles/paradigm.php. Retrieved August 31, 2018.

Schmidt, F.L., Hunter, J.E. and Outerbridge, A.N., 1986. Impact of job experience and ability on job knowledge, work sample performance, and supervisory ratings of job performance. *Journal of applied psychology*, *71*(3), p.432.

Sneddon, A., Mearns, K., & Flin, R. (2013). "Stress, fatigue, situation awareness and safety in offshore drilling crews." *Safety Science*, Vol. 56, pp. 80-88.

Thompson, J.A., 2005. "Proactive personality and job performance: A social capital perspective," *Journal of Applied Psychology*, Vol. 90, pp. 1011–1017.

Zacharatos, A., Barling, J., and Iverson, R.D., 2005. "High-performance work systems and occupational safety," *Journal of Applied Psychology*, Vol. 90, No. 1, 77–93.