
Using Sensemaking Theory to Improve Risk Management and Risk Communication: What Can We Learn?

Emily J. Haas and Patrick L. Yorio

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/intechopen.75725>

Abstract

Risks and communication surrounding risks must be interpreted and responded to by employees in a way that honors the organization's health and safety (H&S) goals. This chapter integrates sensemaking theory and organizational risk management processes. In doing so, information is gleaned about gaps in risk communication messaging and dissemination. This proposed model has the potential to enhance the organizational and communication processes necessary to support the cognitive, motivation, and social coordination components in risk communication messaging that underlie H&S decision making.

Keywords: behavior change, decision making, health and safety management systems, risk communication, risk management, sensemaking

1. Introduction to risk management and communication

Health, safety, and risk management systems are designed to establish and achieve occupational goals, serving as primary mechanisms to control risks in the workplace [1, 2]. Their effectiveness in preventing loss and harm, however, depends upon the execution of behaviors necessitated by this overarching system. Despite the continued emphasis on the importance of organized action in risk management (RM) activities throughout the plan-do-check-act cycle, research suggests that implementation efforts often fail due to misinterpretation [1, 3, 4]. Although much effort has been dedicated to the behavioral aspects of RM primarily in the form of leadership/communication theories [5–10], organizational climate theories [8, 11–13], and knowledge/motivation theories [14–16], as a discipline we lack a framework that provides relevant information

around RM practices including workplace risk identification, perception, and mitigation. As a result, cognitive, motivational, and social coordinative components in the workplace cease to evolve [17]. Mainly, because all employees are responsible for executing strategic health and safety (H&S) goals, it is challenging to track, troubleshoot, and control the entire system across managers, workers, shifts, job processes, and changing hazards [18–21]. Also, little theoretical work has been postulated to help understand the process by which risk practices are behaviorally executed throughout a continuous risk cycle [20, 22, 23].

The purpose of this chapter is to build upon an existing framework—sensemaking theory—to enhance the risk communication surrounding cognitive and motivational fundamentals of H&S behavior. This chapter makes one of the first attempts to formally integrate sensemaking theory with the cyclical RM process and thereby more formally explains the theoretical processes that link organizational health and safety management systems theory with behavior-based systems theory. We intentionally design the argument and theoretical application to be generalizable across high-risk occupations, and as a result, avoid contextualizing this framework using industry-specific examples. Thus, the goal of this chapter is to provide a model that can be adapted to integrate sensemaking and the accompanying organizational and communicative components needed to facilitate risk management within any high-risk organization to identify and mitigate hazards.

2. Traditional risk management cycle

Five stages are often included in a continuous RM cycle [24–26]. First, *risk identification* consists of identifying a hazard or acknowledging a risk [27]. Common examples include accident records, root cause analysis, hazard inspections, and workplace audits [28, 29]. *Risk assessment* is the process of determining if the hazard poses an unacceptable risk that could result in an incident and therefore, needs to be reduced to prevent an incident [1, 27]. *Risk mitigation* incorporates the “plan” and “do” of the H&S management cycle via the development and implementation of previously developed RM strategies (e.g., machine guarding, work flow, building design, proper/adequate equipment and tools, personal protective equipment) and includes all those involved in the risk [28–30]. A *risk response* entails any type of follow-up effort to mitigate the hazard such as elimination, reporting/placing a work order, or changing a work task or behavior to minimize the threat [1]. Finally, *risk monitoring* encompasses continued observation and awareness of the hazard [27]. Organizations select various sets of distinct practices aligned with each phase of the RM cycle [28]. Risk management practices include any action that can help prevent incidents, as well as enhance workplace perceptions and performance [26, 31].

2.1. The role of communication in managing risks

Risk communication is the “process of exchanging information among interested parties about the nature, magnitude, significance, or control of a risk” ([32], p. 359). This communication can entail a formal or informal estimate of whether something poses a high or low threat to

personal safety and based on that perceived threat, how to respond [33]. Risks are best managed through consistent dialog between employees and managers [34, 35], and engaging employees in ongoing risk response and monitoring in order to build knowledge, awareness, and motivation of workers [36]. Communication is often noted as a basic component of RM, but several barriers exist that hinder risk communication between two entities within an organization.

2.2. Barriers that inhibit communication throughout the risk management cycle

Several barriers exist that hinder communicating about and executing risk practices to prevent incidents. One barrier is the varying levels of risk perception that individuals have and the potential for them to misjudge the potential severity of those hazards [37]. Reason [38] argues that “the inability of individuals being able to recognize and respect the full extent of operational hazards can lead to the creation of more and longer-lasting holes in the defensive layers” (p. 82). For example, previous research has pointed toward optimistic bias and overconfidence as a challenge in identifying and preventing incidents on site [39, 40]. Specifically, individuals in both occupational and recreational settings commonly discuss a low perceived likelihood that something bad will happen to them as a result of a hazard or risk in their space [41].

Another barrier is that everyone has responsibility throughout the RM cycle and, because an individual’s or group’s practices may be aligned with one phase of RM, it can be difficult for each person to understand how their role and decisions fit into the process. If such compartmentalization occurs, it is more likely that individuals cognitively interpret hazards and risks in a vacuum. For each individual to be clear about what actions are acceptable and unacceptable in preventing incidents [42], risk communication must be understood and responded to appropriately at all levels within an organization [43].

Last, even if individuals possess a sense of personal responsibility to mitigate risks and feel comfortable expressing concerns, the communication they receive about such risks must be perceived as important to respond efficiently and safely [44]. Without shared cognition and communication about these experiences, individuals are more likely to only observe bits and pieces of risk management with no reference as to how it “works” and fits into a more proactive process.

3. Incorporating sensemaking into risk management

Sensemaking has been applied as a communication tool and organizing framework to examine threats, risks, and hazards in the context of the healthcare industry [45–47], nuclear power plants [48], organizational crises and disaster response [49, 50], and gaps in organizational leadership [51]. Retrospective root cause analyses have also been framed to facilitate sensemaking within organizations in regard to RM activities [52]. Sensemaking is a process that can improve interpersonal communication when people must make decisions during extreme events and has been used to mitigate organizational crises [53]. To date, sensemaking has yet to be theoretically integrated into the RM cycle and remains absent in the literature that discusses dynamic workplace contexts [45, 53].

3.1. Overview of the sensemaking process

Because sensemaking can help engage workers in organizational RM, we focus on the process of sensemaking among receivers of messages to better understand how to communicate about risks and motivate participation in risk mitigation activities. Below, we debrief the four-step sensemaking process (i.e., *ecological change*, *enactment*, *selection*, and *retention*) (**Figure 1**).

First, to initiate sensemaking an event has to occur (*ecological change*) that is noticed by an individual, group, or organization. Examples include acknowledging the presence of the prescribed practices included within an organization's H&S goals, seeing a new workplace hazard or risk, or a co-worker/personal work-related injury. *Enactment* occurs when organizational leaders or workers choose to pay attention to the event [54]. After the event is noticed (*enactment*), the members of the organization must make sense of it and then do something about it (*selection*). At the worker level, *selection* entails choosing the appropriate behavioral response in accordance with the perceived meaning behind the H&S practices within the workplace. From a leadership level, *selection* entails deciding on the proper policy choice when responding to a previously unforeseen risk.

If these implemented responses and policy solutions are effective in reducing equivocality, they will likely be retained for subsequent sensemaking and become engrained into an organization's reaction to a situation [54]. Therefore, *selection* has important implications for long-term decisions and actions, as these decisions are often used to prevent future incidents or avoid injuries [55]. Eventually, *retention* occurs when ways of making decisions, handling workplace hazards, or preventing risky situations become part of an organization's policies, procedures, routines, and methods of organizing [56].

3.2. Risk recognition initiating ecological change

Cognitive recognition that a hazard exists is necessary before sensemaking begins. In the context of occupational health and safety it is the risk intertwined with job and task execution that must be recognized. This recognition is the beginning of a conscious decision to act upon what has been noticed. In the context of occupational H&S, however, because hazards inherent to work processes are likely to be encountered daily, both managers and workers can become used to "seeing" these hazards and in some ways, complacent or unaware of their presence [45]. Slip, trip, and fall hazards at occupational worksites is a common example.

In response, communication from leadership, situated in the middle of the integrated model (**Figure 2**), plays an important role in encouraging situational awareness of ecological changes

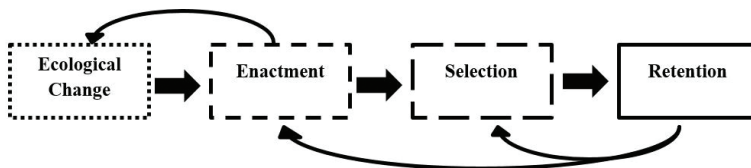


Figure 1. Organizational sensemaking process (Weick, 1999).

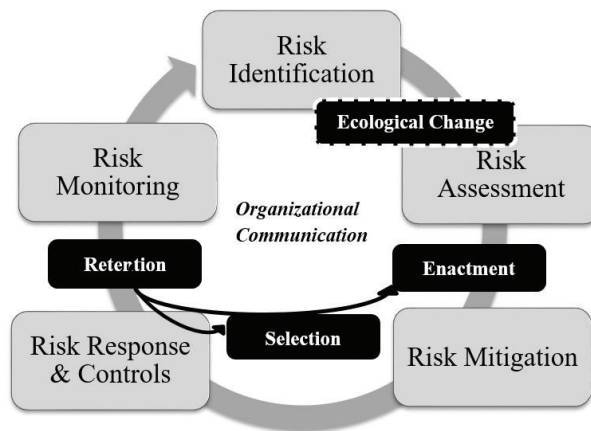


Figure 2. Sensemaking within the risk management cycle.

in the workplace—including the propensity to notice and the motivation to respond to potential hazards and present risks. From a management perspective, proactive hazard and risk identification activities are integral to the HSMS (e.g., job hazard analyses, health and safety audits, system safety studies, etc.). Workers must also be vigilant and seek out unanticipated hazards and risks that have passed through risk control activities unchecked. Tools such as pre-task job task briefings, worker self-checking, and stop-think-act-review activities are examples of practices often incorporated within behavior-based management systems that empower and engage workers in the first of the four step sensemaking process as well as planning within their RM processes [58]. This recognition is the beginning of a decision to act upon a hazard that has been noticed within the organization, initiating the sensemaking process (*ecological change*).

3.3. Enacting a plan to assess and mitigate risks

After a hazard has been recognized (*ecological change*), any practice that can be used to avoid or minimize risk can be *enacted*. After workplace risk has been recognized (an *ecological change*), they must be assessed and risk control plans that address an organization's unique hazard and risk profiles along with the unique behavioral responses necessary to avoid and/or minimize risk must be developed. These assessments consist of gathering and analyzing safety-relevant information on production processes, machines, equipment, chemicals, workspace layout, existing personnel, laws and regulations, etc. Assessment results should ultimately lead to a thorough understanding of all the hardware and human safety risks the organization is faced with and a plan to help mitigate these risks [57].

3.4. Selecting and executing practices to control risks

At the foundation of ecological change is the recognition that workers who identify H&S hazards are motivated and able to raise their concerns. Tools such as pre-task job briefings, worker self-checking, and stop-think-act-review activities are RM practices that empower and

engage workers throughout the sensemaking process [58]. Management, in turn, responds to and engages workers in planning risk mitigation activities. Given limited resources, implementing all possible risk control options may not be feasible [59]. Thus, organizational leaders are usually responsible for choosing an appropriate course of action to reduce the risk (i.e., *selection*). Examples include minimizing physical hazards through proper engineering controls, preventative and predictive maintenance, providing proper equipment, worker training and education, and defining specified patterns of behavior [28].

3.5. Continuous monitoring and retaining outcomes for future risk practices

Finally, the selected action is monitored, assessed, and checked to ensure that the given risk has been minimized to the point of acceptability. Evaluating such efforts could represent both proactive (prior to a safety incident) and reactive (after a safety incident) activities designed to check for workplace hazards and risks that were overlooked or not accurately assessed, or that emerged because of a breakdown in executing certain activities [18, 59]. Examples of *checking* include hazard inspections or audits (proactive checking), and incident investigations (reactive checking) [28]. Risk control practices that successfully reduce uncertainty warrant *retention* of the decision for future use. However, if residual risk is unacceptable, the organization can collectively act to change the initially selected risk control activities. **Figure 2** illustrates how sensemaking can occur parsimoniously within the identification, decision-making, and implementation of the RM cycle.

Figure 2 is depicted to show how the four steps of the sensemaking process can be integrated with the RM cycle to foster an understanding of how to more completely implement an organization's risk management system and continually improve upon it. This integration, however, illuminates the futility of attempts to implement health and safety practices without the necessary organizational infrastructure to support the complete and ongoing sensemaking process throughout the cycle. Organizational and RM characteristics should be structured to support the cognitive, social coordination, and motivational needs that underlie complete sensemaking throughout the cycle. In the following section we discuss these characteristics while continuing to provide general examples of practices within high-risk industries (i.e., mining and construction).

4. Components that facilitate sensemaking

Sensemaking around a consistent organizational RM framework should facilitate a clearer understanding of risks and form a collective sense of what is expected of employees on the job and why. A complete sensemaking process around RM should create a unifying order of how things typically work within the organization. However, if risk practices are not clear and the associated values within an organization are not conducive, employees may not be afforded the opportunity to openly participate in the sensemaking process. The four sensemaking components discussed previously highlight conditions necessary for complete sensemaking around health and safety issues in the workplace to occur. Based on how leaders

deliver specific information or lead activities, the organization can be perceived as having various procedures, rites and rituals [60]. Without similar commitment to the organization's goals, workers may have disparate perceptions [61]. Engaging in complete and ongoing sensemaking of H&S risks may help develop and maintain individuals' cognitive, social coordinative, and motivational components needed to accurately perceive and participate in risk management.

4.1. Risk communication to enhance workers' cognitive components

Developing and fostering cognitive components are necessary to facilitate workers' consistent identification of workplace risks, understand the practices necessary to mitigate those risks, and have the efficacy to execute risk practices [62]. Sensemaking, described as "organizing through communication" – can be a helpful alignment process ([63], p. 137). Sensemaking has been shown to help individuals respond to organizational risks or events to prevent workplace accidents [64], demonstrating support for enhanced worker cognition. According to Dixon [65] to "make sense" is not to find the right or wrong answer, but to find a pattern that helps give specific events meaning and direction to the individual, group, or organization. Engaging workers so they have the ability to perceive and initiate responsibility, regardless of the risk, is essential to managing a dynamic environment.

4.2. Risk communication to enhance workers' motivational components

Equally crucial to the consistent communication and interpretation of risks, however, are workers' motivation to execute behaviors needed to prevent an incident. Workers need to believe that if they carry out the desired, or necessary behaviors by way of certain RM practices, they will avoid a negative consequence or receive a positive consequence [10, 12, 14]. However, communication alone is not likely to impact everyone's risk assessment and motivation. In response, a primary task of top-level leadership is to create an organizational culture that values and rewards assessment and communication pertaining to risk-related events [66].

Organizations can use sensemaking processes to help facilitate a more organized, communicative process that involves the interpretation of events in the environment, social interactions to interpret those events, and constructing the responses necessary to mitigate a problem or improve a process [67, 68]. Along these same lines, a social component is necessary regarding, namely the importance of everyone being on the same page both cognitively and motivationally. More specifically, because risk mitigation often depends on the collective work unit and because the work is increasingly interdependent, it is important for everyone to establish a common perception of, agreement about, and response to workplace risks [63].

4.3. Designing risk communication

Based on a review of the organizational psychology and strategic management literature, we suggest that sensemaking around risk management should be structured so that three inter-related characteristics are clearly illustrated to employees: (1) Distinctiveness; (2) Consistency; and (3) Consensus. These three characteristics have been theoretically associated with having

positive effects on the strength of sensemaking primarily by enhancing vertical and horizontal trust within the organization, thereby facilitating the open flow of critical information and in turn facilitating the implementation of organizational management systems [68–70]. We argue that these three characteristics are prerequisites of vertical and horizontal trust around H&S issues. We further suggest that this enhanced sensemaking leads to the consistent execution of routine H&S behaviors and the ability to manage risks in dynamic and uncertain contexts. **Figure 3** illustrates this model.

4.3.1. Message distinctiveness

Distinctiveness refers to the features of the practices that facilitate the execution of desired activities to stand out in the workplace, while capturing the attention and interest of workers [69]. These authors state that visibility is a “basic prerequisite for interpretation involving whether a practice and its component parts are disclosed to employees, affording them the opportunity for sensemaking” (p. 208). Visibility is a fundamental component for how workers attend to and organize risk-based information on the job. Unclear aspects of these practices could influence what risks workers choose to pay attention to (i.e., enact), and how they respond (i.e., select). A distinctive system also fosters well-understood values and associated practices by workers [69]. If workers do not understand particular H&S risk practices, they will not know which choices (i.e., selections) are shared among the organization and, potentially misunderstand why certain behavioral responses may be desired and how to execute these practices. Alternatively, conscious and open sensemaking conversations function as a sense of empowerment for workers, because they can identify and respond to smaller incidents in an effort to prevent larger problems [65].

Features of distinctiveness highlight the importance of communication to increase accuracy and uniformity in message interpretation. All risk communication should be visible and understandable between managers and workers to allow personal experience at both levels to be incorporated into selecting and retaining best practices [11]. In this regard, risk communication

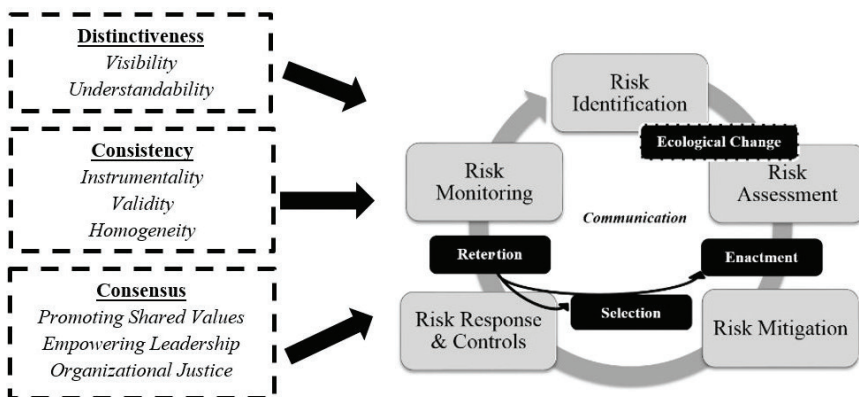


Figure 3. Characteristics of risk communication that facilitate sensemaking.

theories can guide and improve message distinctiveness within organizations to help motivate appropriate behavioral responses. For example, gain and loss-framed messages can be used to persuade a desired response, depending on whether or not the group responds better to a negatively or positively valenced message [71].

4.3.2. *Message consistency*

Consistency is established over time when the same outcome occurs in response to the same incident [70]. Sensemaking is also contingent upon what is consistently reinforced, expected, rewarded, and reprimanded within the organization [71]. Additionally, from a risk communication perspective, including normative language helps an organization's survival and strategic adoption to crises over time [70]. Several features of consistency exist. First, *instrumentality* encompasses a clear, "perceived cause-effect relationship in reference to the management systems' desired content-focused behaviors and associated employee consequences" (p. 210). Workers' perception of the organization's instrumentality is formed by reinforcement and repetition of messages and outcomes over time [47, 69]. Therefore, reinforcement of desired H&S practices may be better achieved when an organization has a strong internal communication system with built-in redundancies [4]. As a result, similar incentives and consequences associated with workers' selection, or decision-making within the organization, may improve workers' motivation to participate in the RM cycle.

Additionally, to foster consistency within the organization, it is important to consider and communicate the validity of each H&S practice desired by the organization. System practices must exhibit consistency between what they intend to do and what they actually do [69]. If an ecological change occurs that is not perceived as relevant, enactment on behalf of an individual may not occur. This premise suggests that mandated H&S behaviors incorporated into activities must be explicitly relevant to actual risk presented by work processes. If workers are not able to make a cognitive connection between a given H&S practice that they are expected to perform and the outcomes promised by the organization, then the message to workers is potentially contradictory and inconsistent with the purpose of the practice. As a result, enactment and selection of what these workers pay attention to may change over time.

Contradictory practices included within an organization's strategic goals undermine its structural consistency. Internal alignment and support of RM practices help workers perceive consistent values of the organization and thus, respond appropriately during an ecological change. For example, if certain skills are given priority during training of new employees, these same types of skills should be observed and rewarded on the job so workers understand and see the importance of transferring these skills to on the job tasks in an effort to mitigate identified risks during the training.

Finally, the structural characteristic of consistency can be influenced by what the various organizational decision makers pay attention and respond to each day [55]. In order for the RM process to be consistent, communication and coordination among various levels of organizational management is crucial. Heterogeneity across organizational leaders in the reinforcement of which types of health and safety behaviors are important undermines HSMS consistency. Therefore, managers must relay the same message to the workers on each shift

so the organization's goals and values are consistent, regardless of who is communicating at the time. Workers' communication is both enabled and constrained by the values that make up the culture of an organization [4]. For sensemaking to be effective in workplace safety, the culture of the organization has to be conducive to unimpeded information flow such as the reporting of near misses and other risky events noticed [72]. Impediments to free-flowing communication in this case may consist of fear of management reprisal or co-worker judgment [54, 56]. Therefore, fostering an environment free of negative consequences by peers and managers, is an important feature needed for sensemaking.

4.3.3. *Message consensus*

Finally, the structural characteristic of consistency can be influenced by what the various organizational decision-makers pay attention and respond to each day [55]. *Consensus* is agreement among workers, as to what H&S practices, and their associated behaviors, lead to intended organizational outcomes (e.g., reduction in H&S incidents) [69, 70]. Achieving consensus on an individual and organizational level can be difficult, but is critical for organizational function [73]. Because sensemaking is best facilitated through a just culture with strong organizational values, shared values and worker involvement are important to establishing site-wide consensus. Consensus requires competent leaders who are willing to engage in open dialog with workers. In response, leaders' sensegiving should possess intuition, logic, emotional intelligence, self-awareness, inductive/deductive reasoning, and the ability to look for and provide strategic evidence to support the RM decisions made [63]. In addition, it is important to know if workers perceive the organization to be fair and just. Perceived fairness is associated with workers' attitudes and behaviors as well as influences their acceptance of the H&S practices, rules, and regulations they are expected to follow [74].

4.4. **Bringing it all together**

Albeit this theoretical integration appears complex, in practice this process serves to reduce ambiguity encountered through unexpected, potentially risky events and near misses, which occur daily by rank-and-file workers in high-risk jobs. Because sensemaking is an active process of assigning meaning, it can only occur through human reflection [45]. Within this chapter, we argued that this reflection can occur best if organized and presented through the risk management process, along with joint participation from hourly workers and their management. To put this argument into practice, consider the following example on a job site:

Sensemaking is initially triggered by a situation that creates ambiguity for the worker—take for example a key piece of machinery experiencing problems that may make it unsafe to operate. This malfunction occurs while employees have a high work order they are in the process of filling—with the deadline for shipment fast approaching. This occurrence is likely to cause a discrepancy between what management expects and what the workers experience. This breakdown initiates enactment on behalf of the workers, triggering a risk assessment about whether or not to keep running the machine. In this case, the worker may choose to consult the job task analysis for the piece of machinery, consult a coworker who is in the maintenance department, or contact management for next steps. These assessment results should help

minimize ambiguity and lead to a thorough understanding of the potential risks if the site keeps operating with the equipment. Based on this information, the workforce can select an appropriate course of action to minimize the risks—whether it includes providing additional protection for workers who operate the machine, putting a new engineering control in place, or stopping production to fix the machine.

Whatever action is selected, the sensemaking process continues with monitoring and assessing if the risk was controlled appropriately to see if the decision should be retained. Although this example is hypothetical, we can all glean that stopping production would be the safest, least risky option for the workforce, even if it means production and delivery obligations temporarily suffer. This is when the concepts of organizational messaging discussed in the chapter become critical for reducing ambiguity. If messages received by the workers from their management up to this point have been distinctive, consistent, and encompass justice and shared values, coming to this decision is expected to be easier by the workers involved in this uncertain situation.

For example, if distinctive communication had been fostered by management, workers should know how to attend to and organize these unexpected events on the job—meaning they would interpret the situation as a risk and understand that immediate action was needed. In response, if management does not actively provide visible priorities to their workers, they should reassess current modes of communication to ensure that safety is a priority over production. This concept flows into the consistency of such messaging as well. Even though some modes of communication may visibly show this priority, management has to be on board and consistently say and support this same message. Therefore, if a worker had received praise for going around a risky situation in the past to meet a production goal, it is likely this worker would do the same thing (i.e., retained the same action in their last sensemaking for future use). However, if this action received negative consequences, then a different, safer option would be selected. Therefore, all managers must support the same actions among their workforce, not just one. This consistency also helps foster consensus on the job site, establishing the same health and safety goals for both workers and management [69].

5. Conclusion

This chapter focused on the barriers to RM and potential benefits of both leaders and workers engaging in sensemaking processes to help deliver, influence, interpret and execute desired RM practices. This integrated, cyclical system may result in the following: (1) workers may be more confident in and committed to the organization due to a more accurate interpretation of their work environment; (2) workers may share the same interpretation of what is important, expected, and rewarded in that environment; and (3) workers may be more interested in helping the organization achieve its strategic goals [69]. Therefore, sensemaking can be viewed as a RM process which allows everyone to identify hazards, communicate about the risks, and respond accordingly. Although the communicators within the system are key players in fostering consensus and fairness in the system, how organizations progress through structural communication barriers remains a challenge [71]. If we can better identify and understand tangible behaviors of organizational leaders that are perceived as positive and encourage

worker engagement, it may be easier to support organizations in improving structural deficiencies and eventually, execute a consistent health and safety management system to predict, identify, and mitigate risks.

Conflict of interest

Replace the entirety of this text with the ‘conflict of interest’ declaration.

Author details

Emily J. Haas^{1*} and Patrick L. Yorio²

*Address all correspondence to: ejhaas@cdc.gov

1 National Institute for Occupational Safety and Health, Pittsburgh Mining Research Division, Pittsburgh, PA, USA

2 National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, Pittsburgh, PA, USA

References

- [1] Boyle T. Health and Safety: Risk Management. New York: Routledge; 2012
- [2] Frick K, Wren J. Reviewing Occupational Health and Safety Management: Multiple Roots, Diverse Perspectives and Ambiguous Outcomes. Systematic Occupational Health and Safety Management: Perspectives and International Development. Amsterdam: Pergamon; 2000. pp. 17-42
- [3] Guidotti TL. Communication models in environmental health. Journal of Health Communication. 2013;18:66-79
- [4] Keyton J. Communication and Organizational Culture: A Key to Understanding Work Experiences. 2nd ed. Thousand Oaks: Sage; 2011
- [5] Barling J, Hutchinson I. Commitment vs. control-based safety practices, safety reputation, and perceived safety climate. Canadian Journal of Administrative Sciences. 2000; 28:76-84
- [6] Hofmann DA, Morgeson FP. Safety-related behavior as a social exchange: The role of perceived organizational support and leader-member exchange. The Journal of Applied Psychology. 1999;84:286
- [7] Zacharatos A, Barling J, Iverson RD. High-performance work systems and occupational safety. The Journal of Applied Psychology. 2005;90:77

- [8] Zohar D. Modifying supervisory practices to improve subunit safety: A leadership-based intervention model. *The Journal of Applied Psychology*. 2002;**87**:156-163
- [9] Zohar D, Luria G. The use supervisory practices as leverage to improve safety behavior: A cross-level intervention model. *Journal of Safety Research*. 2003;**34**:567-577
- [10] Zohar D, Polachek T. Discourse-based intervention for modifying supervisory communication as leverage for safety climate and performance improvement: A randomized field study. *The Journal of Applied Psychology*. 2014;**99**:113-124
- [11] Hale A, Borys D. Working to rule, or working safely? Part 1: A state of the art review. *Safety Science*. 2013;**55**:207-221
- [12] Hofmann DA, Morgeson FP, Gerrass SJ. Climate as a moderator of the relationship between leader-member exchange and content specific citizenship: Safety climate as an exemplar. *The Journal of Applied Psychology*. 2003;**88**:170
- [13] Hofmann DA, Stetzer A. The role of safety climate and communication in accident interpretation: Implications for learning from negative events. *Academy of Management Journal*. 1998;**41**:644-657
- [14] Christian MS, Bradley JC, Wallace JC, Burke MJ. Workplace safety: A meta-analysis of the roles of person and situation factors. *The Journal of Applied Psychology*. 2009;**94**:1102-1127
- [15] Griffin MA, Parker SK, Mason CM. Leader vision and the development of adaptive and proactive performance: A longitudinal study. *The Journal of Applied Psychology*. 2010;**95**:174
- [16] Griffin MA, Neal A, Parker SK. A new model of work role performance: Positive behavior in uncertain and interdependent contexts. *Academy of Management Journal*. 2007;**50**:327-347
- [17] Dohmen T, Falk A, Huffman D, Sunde U, Schupp J, Wagner GG. Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association*. 2011;**9**:522-550
- [18] DeJoy DM, Schaffer BS, Wilson MG, Vandenberg RJ, Butts MM. Creating safer workplaces: Assessing the determinants and role of safety climate. *Journal of Safety Research*. 2004;**35**:81-90
- [19] Flach JM, Carroll JS, Dainoff MJ, Hamilton WI. Striving for safety: Communicating and deciding in sociotechnical systems. *Ergonomics*. 2015;**58**:615-634
- [20] Yorio PL, Willmer DR, Moore SM. Management systems through a multilevel and strategic management perspective: Theoretical and empirical considerations. *Safety Science*. 2015;**72**:221-228
- [21] Zohar D. Safety climate and beyond: A multi-level multi-climate framework. *Safety Science*. 2008;**46**:376-387

- [22] Kirsch P, Hine A, Maybury T. A model for the implementation of industry-wide knowledge sharing to improve risk management practice. *Safety Science*. 2015;**80**:66-76
- [23] Robson LS et al. The effectiveness of occupational health and safety management system interventions: A systematic review. *Safety Science*. 2007;**45**:329-353
- [24] Baker S, Ponniah D, Smith S. Risk response techniques employed currently for major projects. *Construction Management and Economics*. 1999;**17**:205-213
- [25] Boehm BW. *Software Risk Management*. Piscataway, NJ: IEEE Press; 1989
- [26] British Standards Institution. *Occupational health and safety management systems – Specification, BS OHSAS 18001*; 2007
- [27] Smith SP, Harrison MD. Measuring reuse in hazard analysis. *Reliability Engineering and System Safety*. 2005;**89**:93
- [28] Haas EJ, Yorio P. Exploring the state of health and safety management system performance measurement in mining organizations. *Safety Science*. 2016;**83**:48-58
- [29] Janicak CA. *Safety Metrics: Tools and Techniques for Measuring Safety Performance*. 2nd ed. Lantham, MD: Scarecrow Press; 2011. Government Institutes
- [30] Makin AM, Winder C. A new conceptual framework to improve the application of occupational health and safety management systems. *Safety Science*. 2008;**46**:935-948
- [31] Brassell-Cicchinit LA. The shareholder value of crisis handling. *Risk Management*. 2003; **50**:48
- [32] Covello VT. Risk communication: An emerging area of health communication research. In: Deetz SA, editor. *Communication Yearbook*. Newbury Park, CA: Sage; 1992
- [33] Cuny X, Lejeune M. Statistical modelling & risk assessment. *Safety Science*. 2003;**41**:29
- [34] McComas KA. Defining moments in risk communication research: 1996-2005. *Journal of Health Communication*. 2006;**11**:75-91
- [35] Palenchar MJ. Risk communication. In: Heath RL, editor. *Encyclopedia of Public Relations*. Thousand Oaks, CA: Sage; 2005. pp. 752-755
- [36] Coombs WT. *Ongoing Crisis Communication: Planning, Managing, and Responding*. 3rd ed. Thousand Oaks, CA: Sage; 2012
- [37] Brun W. Cognitive components in risk perception: Natural versus manmade risks. *Journal of Behavioral Decision Making*. 1992;**5**:117-132
- [38] Reason J. *A Life in Error: From Little Slips to Big Disasters*. Burlington, VT: Ashgate Publishing; 2013
- [39] Weinstein ND. Optimistic biases about personal risks. *Science*. 1989;**246**:1232-1233
- [40] Zohar D, Erev I. On the difficulty of promoting workers' safety behaviour: Overcoming the underweighting of routine risks. *International Journal of Risk Assessment and Management*. 2006;**7**:122-136

- [41] Haas E, Mattson M. A qualitative comparison of susceptibility and behavior in recreational and occupational risk environments: Implications for promoting health and safety. *Journal of Health Communication*. 2016. DOI: 10.1080/10810730.2016.1153765
- [42] Reason J. Achieving a safe culture: Theory and practice. *Work and Stress*. 1998;**12**:293-306
- [43] Wold T, Laumann K. Safety management systems as communication in an oil and gas producing company. *Safety Science*. 2015;**72**:23-30
- [44] Neal A, Griffin MA. Safety climate and safety behavior. *Journal of Management*. 2002;**27**:67-75
- [45] Battles JB, Dixon NM, Borotkanics RJ, Rabin-Fastmen B, Kaplan HS. Sensemaking of patient safety risks and hazards. *Health Services Research*. 2006;**41**:1555-1575
- [46] DeRosier J, Stalhandske E, Bagian JP, Nudell T. Using health care failure mode and effect analysis: The VA national center for patient safety's prospective risk analysis system. *The Joint Commission Journal on Quality Improvement*. 2002;**28**:248-267
- [47] Weick KE. The reduction of medical errors through mindful interdependence. In: Rosenthal MM, Sutcliffe KM, editors. *Medical Error: What Do we Know? What Do we Do?* San Francisco, CA: Jossey-Bass; 2002
- [48] Wreathall J, Nemeth C. Assessing risk: The role of probabilistic risk assessment (PRA) in patient safety improvement. *Quality & Safety in Health Care*. 2004;**13**:206-212
- [49] van Tonder C, Groenwald JP. Of mining accidents and sense-making: Traversing well-trodden ground. *Journal of Global Business and Technology*. 2001;**7**:57-73
- [50] Weick KE. The collapse of sensemaking in organizations: The Man Gulch disaster. *Administrative Science Quarterly*. 1993;**38**:100-124
- [51] Bartunek JM, Krim RM, Necochea R, Humphries M. Sensemaking, sensegiving, and leadership in strategic organizational development. *Advances in Qualitative Organizational Research*. 1999;**2**:37-71
- [52] Battles JB, Lilford RJ. Organizing patient safety research to identify risks and hazards. *Quality & Safety in Health Care*. 2003;**12**(Suppl II):ii2-ii7
- [53] Weick KE. *Sensemaking in Organizations*. Thousand Oaks, CA: Sage; 1995
- [54] Weick KE. *The Psychology of Organizing*. 2nd ed. Reading, MA: Addison-Wesley; 1979
- [55] Millar DP, Heath RL. A rhetorical approach to crisis communication: Management, communication processes, and strategic responses. In: Millar DP, Heath RL, editors. *Responding to Crisis: A Rhetorical Approach to Crisis Communication*. Mahwah, NJ: Lawrence Erlbaum; 2004
- [56] Seeger MW, Sellnow TL, Ulmer RR. Communication, organization and crisis. In: Roloff ME, editor. *Communication Yearbook 21*. Thousand Oaks, CA: Sage; 1998
- [57] Yorlano PL, Willmer DR, Haight JM. Interpreting MSHA citations through the lens of occupational health and safety management systems: Investigating their impact on mine injuries and illnesses 2003-2010. *Risk Analysis*. 2014;**34**:1538-1553

- [58] Wachter JK, Yorlano PL. Human performance tools: Engaging workers as the best defense against errors and their precursors. *Professional Safety*. 2013;**59**:54-64
- [59] Stephens RA. *System Safety for the 21st Century: The Updated and Revised Edition of System Safety*. Hoboken, New Jersey: John Wiley & Sons; 2012
- [60] Schein EH. *Organizational Culture and Leadership*. San Francisco, CA: Jossey-Bass; 1992
- [61] Foldy EG, Goldman L, Ospina S. Sensegiving and the role of cognitive shifts in the work of leadership. *The Leadership Quarterly*. 2008;**19**:514-529
- [62] Barrick MR, Mount MK. Yes, personality matters: Moving on to more important matters. *Human Performance*. 2005;**18**:359-372
- [63] Weick KE, Sutcliffe KM, Obstfeld D. Organizing and the process of sensemaking. *Organization Science*. 2005;**16**:409-421
- [64] Gephart RP. The textual approach: Risk and blame in disaster sensemaking. *The Academy of Management Journal*. 1993;**36**:1465-1514
- [65] Dixon NM. *Sensemaking Guidelines – A Quality Improvement Tool*. Med QIC Medicare Quality Improvement. Baltimore: Centers of Medicare and Medicaid Services; 2003
- [66] Clarke S, Ward K. The role of leader influence tactics and safety climate in engaging employee's safety participation. *Risk Analysis*. 2006;**26**:1175-1185
- [67] Judge TA, Bono JE. Five factor model of personality and transformational leadership. *The Journal of Applied Psychology*. 2000;**85**:751-765
- [68] Wardman JK. The constitution of risk communication in advanced liberal societies. *Risk Analysis*. 2008;**28**:1619-1637
- [69] Bowen DE, Ostroff C. Understanding HRM-firm performance linkages: The role of the "strength" of the HRM system. *Academy of Management*. 2004;**29**:203-221
- [70] Kelley HH. The processes of causal attribution. *The American Psychologist*. 1973;**28**: 107-128
- [71] Cho H. *Health Communication Message Design*. Thousand Oaks, CA: Sage; 2012
- [72] Marx D. *Patient Safety and the "Just Culture": A Primer for Health Care Executives*. New York: Columbia University; 2001
- [73] Vancouver JB, Schmitt NW. An exploratory examination of person-organization fit: Organizational goal congruence. *Personnel Psychology*. 1991;**44**:333-352
- [74] Bretz RD, Milkovich GT, Read W. The state of performance appraisal research and practice: Concerns, directions, and implications. *Journal of Management*. 1992;**18**:321-352