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ORIGINAL ARTICLE

Managing business continuity in the Arctic: Experiences from mining

Jacob Taarup-Esbensen[1,2]

[1]University of Stavanger, Stavanger, Norway

[2]University College Copenhagen, Copenhagen, Denmark

Correspondence
Jacob Taarup-Esbensen, University College Copenhagen, Sigurdsgade 26, 2200 Copenhagen N, Denmark.
Email: jata@kp.dk

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Abstract

This article presents a model for business continuity capacity, which shows how organizations can analyze possible gaps in their business continuity capability and thereby increase their capacity to recover value-adding critical activities. Using an example of a flooded mine on Svalbard, the study investigated how the mining company Store Norske Spitsbergen Coal Company (SNSK), with considerable experience with similar events and an excellent safety record, could fail to manage a well-known event and reduce recovery times of its critical activities. The analysis explored how experience in safety and incident management does not necessarily mean that these abilities are transferable to a new but similar event. The study sought to answer the research question: To what extent does SNSK's systematic work with safety, and experience with flooding events, improve business continuity capacity?

In the Arctic, emergency response can take hours or days to arrive after the event. A structured recovery system can support pre-existing platforms aimed at safety, to include the critical activities needed to ensure an organization's overall survival. Systematic work can improve performance and make the organization engage in a virtuous cycle by implementing management structures, risk identification systems, competency development, and processes for the in situ evaluation of hazards. However, as seen here, the organization needs to pay attention to changes that could affect risk assessments and threat levels well-known events. These insights can be utilized by other organizations seeking synergy when strengthening their safety and business continuity performance.

KEYWORDS
Arctic, business continuity management, mining, safety

1 | INTRODUCTION

On July 26, 2020, a significant mine flooding incident occurred in Mine 7 during an abnormally hot summer (SNSK, 2020a, 2020c). The mine is the last of the coal mines operated by Store Norske Spitsbergen Coal Company (SNSK) after scaling down its activities in 2016. The mine produces coal for the nearby town of Longyearbyen and employs around 40 people. The flooding occurred as Svalbard experienced an all-time high temperature of 21.7°C, prompting the glacier above the mine to melt, causing meltwater to penetrate through cracks in the mountain (Meteorologisk institutt, 2020; SNSK, 2020a). Within a few days, water had found its way into the older part of the mine, where it was discovered during a routine inspection. Events like this are not unusual for the company and SNSK has previously successfully managed similar types of flooding. The company had experienced incidents in the same mine in 1984, 1998, and 2013, and in another mine managed by the company in 2000 and 2003. Acknowledging the risk, the company installed pumps and drafted plans for dealing with these types of events. However, these resources proved inadequate and SNSK lost control within 3 days of identifying the event, resulting in a 3-month shutdown.

Improving an organization's ability to manage risks involves continuous engagement in at least three tasks: risk

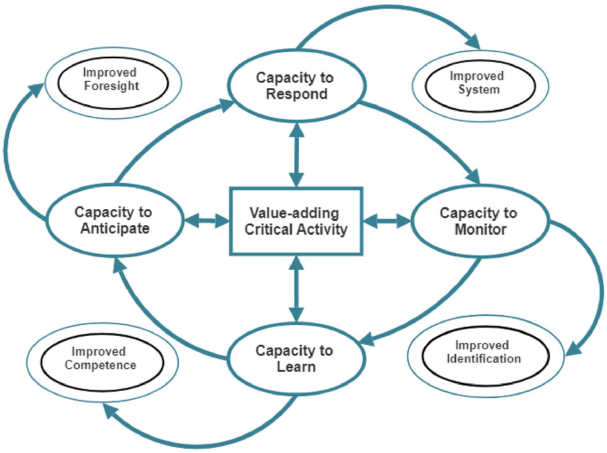

FIGURE 1 Business continuity capacity model

identification, risk analysis, and risk response (Aven, 2016; SRA, 2021). The assumption is that organizations can enter a virtuous cycle, improving their ability to control future risk events and recover their operation if an event occurs. In this way, an organization improves its ability to identify harmful elements by conducting analysis and placing a quantifiable measure on their frequency and consequences. This approach shapes the organization's ability to muster an adequate response by either preventing a hazard through adequate preventive barriers or, if an event should emerge, building protective barriers to stop or mitigate consequences (Dianous, 2006; Markowski & Kotynia, 2011). By working with historical events, near misses, and experiences from exercises, the belief is that, over time, this approach will bring known risks into the managerial domain and thereby under control. The intention is to raise awareness and bring about effective hazard mitigation.

This study explored how a company such as SNSK has built expert knowledge of safety and risk management, which has resulted in an excellent safety record (Figure 1). By relentlessly striving to make safety improvements in every process that had failed in the past, it has built appropriate regimes for conducting business operations in the Arctic with very few breakdowns, injuries, or deaths. The capacity to manage major incidents, such as the 2020 flooding, does not seem to benefit from the same performance trajectory. Many of the safety and risk management learning points can be transferred to business continuity, including continuous improvement systems, skills training, exercises, and risk assessments. However, it would seem that, in this case, these capacities are not directly transferrable. Using SNSK as an example of a successful mining operation in the region, this article discusses the research question: To what extent does SNSK's systematic work with safety, and experience with flooding events, improve business continuity capacity?

The article starts with a review of the current safety and risk management history, and discusses to what extent previous experience with safety and flooding events improves business continuity capacity at SNSK. The section is followed by an account of the methods used to investigate the case and a theoretical discussion of business continuity management (BCM). At the end of the section, a theoretical framework is proposed through the business continuity capacity model. The analysis explores how the model applies to the specific case of the mine flooding and to what extent previous experience with flooding events improves business continuity capacity at SNSK. Based on these findings, the discussion focuses on the practical implementation of a resilience-based approach using the attributes of the model. Finally, the article answers the research question and proposes a way forward for companies seeking to benefit from their existing record on safety and risk management.

2 | METHODS

The research combined on-site observations, interviews, and archival evidence of mining operations in Svalbard. The observation studies were conducted from September to November 2020 and April 2021, including visits to Mine 7 and the SVEA mine. The SVEA mine (60 km south of Mine 7) was officially closed in 2016 but was used to store spare parts and emergency response equipment to be sold or transferred to Mine 7. The data collection included 12 interviews with key managers responsible for safety and risk management at the mine and involved in the flooding event in July of the same year. Where possible, the research also used official reports to support individual testimonials. Other sources included maps, corporate reporting, and the local media, providing anecdotal evidence of the event and SNSK's history. These sources offer a comprehensive overview of how the company manages its projects, the risks associated with Mine 7, and the mitigation initiatives deployed as the event unfolded.

The interview guide was constructed around five themes connected to resilience in organizations (the value-adding critical activities and the capacity to respond, monitor, learn and anticipate events). Each theme related to the organizational resilience framework presented below included questions designed to explore the strategic outlook from a safety and risk management perspective and how the mine managers, supervisors, and personnel reacted to the flooding event. The questions sought to explore how the disruption affected value-adding critical activities and the perceived capacity to respond, monitor, learn, and anticipate how the event would unfold. For example, when connected to the ability to respond, questions were asked about availability of staff, physical resources like pumps, and the management systems used to ensure the quality of actions taken. The same approach was used when respondents were asked about monitoring systems. The questions were directed at to what degree data from passive monitoring systems, such as water level and rock movement sensor information, were systematically collected and included in the management decision-making process. Questions related to the capacity to learn focused on training programs and the exercises that

TABLE 1 Coding scheme

Disruption of critical activities	Capacity to respond	Capacity to monitor	Capacity to learn	Capacity to anticipate
Financial impact	Management systems	Information systems (passive and active sensors)	Training and exercises	Situational awareness
Value-adding critical activities	Resources	Warning technologies	References to previous experiences	References to future events
Production at Mine 7	Enactment			

SNSK had conducted to ensure that staff knew how to use equipment and engage in crisis management. Finally, regarding the capacity to anticipate events, the questions focused on how individuals evaluated the flood risk and the role of past experiences with similar events. Table 1, describes the coding scheme used for the five categories to identify organizational resilience and business continuity capacity. SNSK is an interesting case because it has operated under Arctic conditions for more than 100 years and is one of the most experienced mining operators in the region (Kvello, 2006; Westby, 2003). Its experience with the Arctic and its systematic work on risk management make it one of the few companies that have conducted safe mining operations in the region in the last decade. The research was undertaken as a case study, using a qualitative systematic review approach, enabling a thematic analysis of a selective sample of individual organizations (Grant & Booth, 2009). The case study took a deductive stance (Yin, 1994), answering the research question by investigating how approaches associated with business continuity and resilience engineering methodology can be used to safeguard value-adding critical activities in the mine.

This approach enabled identifying and analyzing key elements of business continuity and their application. The deductive analytical approach used extant literature on BCM and was also the basis for identifying keywords and categories used in the coding scheme (Bhamra et al., 2011; Harvey et al., 2019; Hassel & Cedergren, 2019; Herbane, 2010; ISO, 2012; Tammineedi, 2010). The coding scheme focused on empirical evidence that related to how the event impacted critical business activities at SNSK and how the company has responded, monitored, learned, and anticipated recovery of its operations (see Table 1). Each coding theme corresponds to identified business continuity capacities described in the theory section.

Besides the primary empirical evidence collected on-site, the study also used secondary sources from local media. This method provided the most conservative approach to reliability and generating themes, establishing the relationship with the business continuity model presented later. Three criteria for quality assurance apply when evaluating the sources that are complementary to those used as secondary sources (Franzosi, 1987).

First, they should have a direct link to one or more of the four capacities and value-adding critical activities, either individually or within a group of other categories.

Second, individual themes should be mutually exclusive.

Third, they should maintain a close resemblance to the language used by other sources.

The use of these sources exposed the research to the possibility of bias, which could influence the analysis and the final recommendations. Therefore, the following steps were taken. First, a baseline of resilience capacities was constructed using extant literature on BCM. Applying a deductive approach limited the likelihood that gaps in the corporate risk assessment were under- or overrepresented. Second, the data were supplemented by primary sources such as on-site observations and interviews with key stakeholders, which reduced the chance that the author influenced the results.

The approach made it possible to identify how managers, supervisors, specialists, and miners at SNSK understood and used their capacity to identify threats to its critical activities using its ability to muster an adequate response, the effectiveness of monitoring systems, the capacity to learn from experience, and anticipation of future events. The study focused on its cultivated capabilities rather than specific business continuity vocabulary, and the coding scheme was used to translate the practice of these individuals into the theoretical framework.

3 | THEORY

The following section discusses the relationship between resilience engineering and BCM as an approach to building business continuity capacity through a continuous learning system. A central point is the ability of an organization to incorporate learning points from previous events and put them into practice. The idea is that organizations can enter a virtuous circle where they build capabilities to anticipate, assign resources, and manage future events.

Resilience engineering seeks ways for organizations to adapt to changes in context and thereby ensure organizational integrity (Curt & Tacnet, 2018; Hassel & Cedergren, 2019). This adaptive capacity "is the potential for adjusting patterns of activities to handle future changes in the kinds of events, opportunities and disruptions experienced. Therefore, adaptive capacities exist before changes and disruptions call upon those capacities" (Woods, 2019). A resilient organization can recognize and make appropriate changes to its structure, thereby accommodating and adapting to events that would otherwise significantly impact its output. According to resilience engineering, such organizations can adapt by continuously responding, monitoring, learning, and anticipating changes in context (Linkov et al., 2018). The capacity to respond means that the organization is ready to take different actions depending on how it makes sense of a given change in context (i.e., it is flexible and can adapt; Lay et al., 2015; Woods, 2016). Knowing what to do implies trade-offs between different alternatives of action and then applying the solutions that best fit the specific event as decision makers perceive it. Such an organization can respond to regular and irregular events in a practical, flexible manner to produce desirable outcomes that preserve, protect, or recover value-adding critical activities. The responding organization understands its readiness level and can acquire the necessary information for practical actions against an emerging change in context. The capacity to monitor is the ability to process information regarding a given context and detect deviations from the norm. Knowing what to look for and, based on this knowledge, designing passive and active systems that can provide warning of changes in a form that decision makers can perceive, is central to effective monitoring. Changes in information patterns are the precursor to interruption and require an organizational response. Effective monitoring can lead to increased readiness and facilitate early responses, hence improving the allocation and use of resources. This ability includes internal systems that will provide feedback to the process owner in events such as machinery breakdown, and external monitoring systems that provide evidence of upcoming events, effective guidelines that decision makers can follow and may lead to effective use of information that can be utilized to predict threats.

Business continuity constitutes a risk management perspective shift from a scenario-based approach to protecting and recovering critical activities (Herbane, 2010; Zio, 2018). Like resilience engineering, the approach is less concerned with the actual hazard itself but rather with how it will impact the organization's capacity to perform certain activities to achieve its strategic objectives, that is, value-adding critical activities. Private and public organizations often use BCM to analyze impacts and vulnerabilities and to develop recovery plans. The perspective is well suited to organizations operating in contexts where the frequency and consequences of events are uncertain, prone to multiple coinciding or cascading events, and for which there is less knowledge of how to respond effectively due to context specificity. Strategic business continuity aligns the organization's goals through the business impact analysis into a coherent whole that focuses on recovering the organization's value-creating activities. First, business continuity emphasizes the link between the overall aspirations of a given organization, that is, its mission, vision, and strategy, and its approach to managing risks (Herbane, 2010; Hiles, 2014; Kato & Charoenrat, 2018). It ensures that activities produce reliable and consistent outputs through standardized structured approaches to all processes within each organizational unit by identifying interdependencies between different activities across the whole organization (Adamou, 2014; Hassel & Cedergren, 2019; Hiermaier et al., 2019). Finally, it emphasizes operational feasibility to ensure operational reliability under live conditions and provide results aligned across the organization (Farr & Bailey, 2019; Kendall et al., 2005). Hence, the approach links the organization's strategic aims to its value-creating activities and the increased complexity of global business, processes, supply chains, and a growing reliance on information systems (Elliot et al., 2010; Hassel & Cedergren, 2019). The concept embraces the idea that not all risks can be mitigated or completely eradicated and that a need exists to utilize approaches adapted to shifting contexts. The following business continuity capacity model (Figure 1) links strategic aims and the need to be resilient to disruptions that affect its value-adding critical activities. such as weather forecasts. Learning means knowing what has occurred by analyzing the process(es) influenced and the organization's ability to absorb this experience by adjusting or changing its response to protect value-adding activities. An organization's ability to generalize from specific past events to action for future events involves being able to acquire the right lessons from experiences; to analyze how events have been perceived as unfolding, and transforming this knowledge into courses of action going forward. Finally, working with these characteristics allows an organization to anticipate future developments, opportunities, and threats that arise internally and externally, potentially disrupting or altering its ability to function. Knowing what to expect entails the development of Focusing on value-adding critical activities provides a foundation for decision-making and a platform for analyzing robustness and threats to business continuity. Organizational resilience is a strategic ability that an organization can possess to recover from a catastrophic event, while BCM is a set of organizational processes and resources integrated into a coherent management system, providing continuance of activities deemed critical due to their strategic importance (Farr & Bailey, 2019; Hassel & Cedergren, 2019; Hiermaier et al., 2019). What is deemed valuable can differ between organizations based on their strategic importance. They can be economic, focusing on how value is created or linked to reputation, competencies, or supply chain, but all will be associated with activities contributing to organizational goals. Organizations can hence define value-adding critical activities as their brand for stakeholders, can have knowledge of specific activities, or provide a service like water/electricity or ensuring that the sewage systems work. There is, in this way, a connection between the strategic aim of being resilient and the operational use of business continuity systems. Such an approach encompasses the elements of resilience engineering, the capacity to respond, monitor, learn and anticipate, and enact operational capacities through the systematic use of standards to recover value-adding critical activities. The elements translate into four characteristics that can be analyzed: the capacity to structure organizational systems, identification of emerging hazards, competence to resolve critical events, and evaluation of future events. Through the business continuity model, there is a connection between strategic aims to protect and recover critical activities and tactical priorities that would enable the enactment of such aims.

The capacity to respond can be by identifying how the organizational structure aligns its organizational and technical resources toward recovering its critical activities (Lay et al., 2015; Waters & Adger, 2017). It encompasses activities before, during, and after an event when the organization prepares, manages, and finally recovers the affected activities. Such systems may fail when an event saturates its capacity to respond and runs out of resources as a disturbance grows in scope (Woods, 2019). All resilient systems have limits on the scale of possible events they can adapt to. Brittleness occurs if events push these systems beyond their limits, unless other external resources can be called upon to stretch performance and thereby decrease vulnerability. Thus, all such systems must be able to recognize when a given hazard event is saturating their capacity to respond, and then deploy new response capabilities. An effective business continuity effort requires utilizing and prioritizing organizational, technical, and options to request external resources as they are required. An example of a structured system can be having emergency response capacities with the correct equipment available, a systematic approach, and knowing when an emerging flooding event exceeds the capacity to muster an adequate response.

An organization must have a working monitoring system to recognize when its capacity to respond is nearing its limits (Hinkel, 2011; Linkov et al., 2018). This ability to systematically identify emerging hazards provides insights into its approach to, and the effectiveness of, its monitoring system. These systems can include passive systems like "tell-tales" used in the mine to monitor rockfall, or active monitoring like video or physical inspections. As an event evolves, monitoring must also include identifying when the limits of organizational resources to respond are stretched or depleted. It is possible to identify the effectiveness of an organization's monitoring system through the degree to which it has implemented a systematic system and a transparent chain of responsibility for how information on capacities is shared throughout the organization. For example, when the temperature in Longyearbyen reaches 20°C, it would trigger additional inspections to identify possible emerging flooding, which would require additional response resources.

The competence to resolve a critical event illustrates how an organization has evolved its learning capacity. Organizations strengthen their adaptive potential by learning directly from past events and preparing, through training and exercises, for future disruptions that are likely to occur (Schaffer & Schneider, 2019). Making sense of an event is directly linked to the competencies of individual decision makers and those acquired through experience. Individuals rely on their knowledge of previous events (through self-experience or training) to strengthen their ability to make sense of available information during an event. Making sense is hence a cognitive process in which individuals evaluate risks based on a process based on cues and partial pieces of information that provide inferred evidence that an event will unfold in a certain way, and how these provide insights into the trustworthiness of the information that they contain in the social and physical environment. It examines plausibility as the functional deployment of meaning and how we impose labels on interdependent risk events in ways that suggest how acts of managing, coordinating, and distributing will be enacted similarly despite differences in time and space. Learning is a continuous process that relies on how the organization structures knowledge in a form that individual members can apply in practice. It means the organization develops a capacity to recognize interactions not previously observed and build relations with key stakeholders who might hold necessary response resources. For example, having employees with previous experience with flooding will help the process if the knowledge is available, and decision makers can translate lessons from previous experiences to the new event. However, such previous knowledge can, at the same time, be a hindrance when an event that holds some of the same cues as seen before is unfolding differently.

Organizations can evaluate the possibility of future events and thereby evolve their capacity to anticipate how they will evolve (Hollnagel & Fujita, 2013; Vecchiato & Roveda, 2010; Woods, 2009). A structured approach to foresight can be witnessed when an organization can bring knowledge forward when and where it is needed instead of constraining thinking by relying on past experiences and engrained routines. The ability to foresee how decisions in the present have consequences for future events is a complicated process in which enactments (response), information (monitoring), and past experiences (learning) support the creation of a hypothesis of how the future will unfold. Although it is easy to identify failures of foresight, it is less easy when it comes to when a hypothesis is formulated based on the systematic inclusion of these capacities or if a given result is down to luck. Decision makers develop scenarios for what to expect when engaging with an event or recovery process, and envision alternative trajectories for how the event can evolve. Adapting to past decisions happens in situ as new information becomes available and is processed and enacted through new responses. Decision makers are, in that sense, considered to be path-dependent on the choices of actions they can meaningfully take (Teece et al., 1997). Such an approach works well when changes are slow and incremental but less so when action is needed for events that entail decisions for which the consequences are largely unknown. Exercising foresight strengthens the capacity to envision and manage imagined future events. Revisiting pre-existing presumptions of how events in the future will unfold is one way of reducing the adverse effects of path dependency. For example, a pre-shift meeting is a source from which anticipation plays an active role in preparing a workgroup for what to expect when the workday starts, thereby creating foresight.

The proposed business continuity capacity model supports organizations' efforts to produce reliable and consistent outputs that align with their strategic aims. It uses standardized structured approaches that continuously improve the organizations' ability to withstand and recover from disruptions. The approach improves the identification of interdependencies between activities across the organization. Thereby, it illustrates a path forward for how it is possible to analyze to what degree a given organization has the right capabilities to recover its value-adding critical activities, by linking strategic aims with systemic capabilities, hazard identification, competence, and foresight. Alternatively, if it has structural

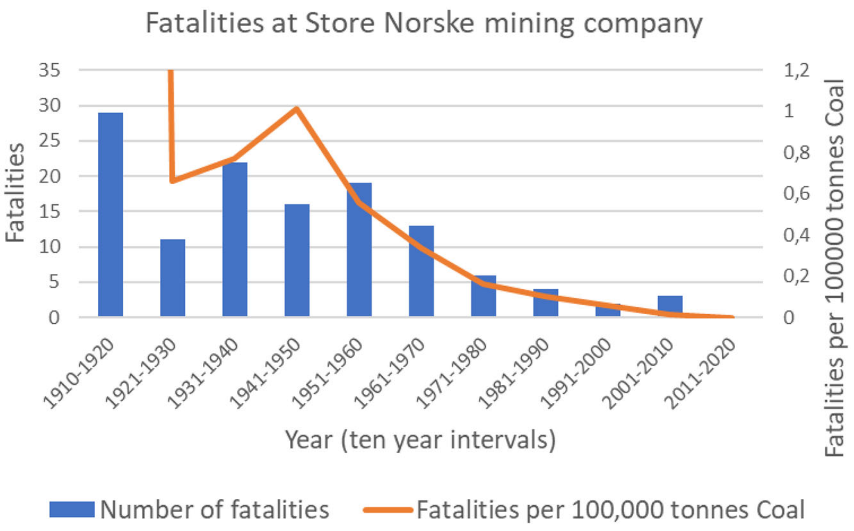

FIGURE 2 Safety record of SNSK 1916–2020

weaknesses, that would slow down or hinder such a process and thereby slow down business continuity.

4 | ANALYSIS: SNSK AND THE HISTORY OF SAFETY AND FLOODING

SNSK is a coal mining company on Svalbard that operates one of the last remaining coal mines in Scandinavia (Store Norske, 2021). The company started with a small production site in 1916 and has been conducting mining operations in one of the most extreme working environments in the world for more than 100 years. SNSK is a state-owned company that has operated 13 different mines in Svalbard throughout its life span. Over the years, the company has experienced numerous accidents resulting in fatalities for at least 125 employees. However, systematically working on safety and risk management has reduced its accident rate to a level where the company has had no fatalities in the past decade (see Figure 2). The company's track record is something that management and employees are proud of, mentioned as one of its great achievements. When asked how the company achieved these results, one safety manager stated, "It is probably very much the system and routines. We have had many injuries and deaths in the past, but the system has created a strong safety culture. The system focuses on creating a barrier, and we have a good system for handling deviations. The most important thing is the barriers that are in place that can prevent an incident from happening."

Over the years, the company has taken incremental steps to improve its safety record. The working conditions have improved significantly as the years have passed (Table 2). Although there have been significant individual events, such as an explosion in 1920 with 26 fatalities and a gas explosion in 1952 that caused six fatalities, it is more common to experience one or two deaths per event. As stated by one of the foremen, "Before, maybe one or two men died a year from rockfall, and then we had gas explosions which took anywhere from six to twenty men." This illustrates how serious accidents were part of the norm in the company and the mines. In recent years, the work has focused on reducing the complexity of the systems to a more manageable size. A manager stated that "there are more activities now compared to before. We are working on simplifying the system, reducing the number of procedures, and getting better things that are safety critical. More focus on what is important and less on the less important things. A simplification."

TABLE 2 Type of accidents with fatal outcomes (1996–2020)

Type of events (1916–2020)	Number of fatalities
Avalanche	3
Drowning	1
Electric shock	2
Explosion	29
Fall	3
Fire	6
Gas explosion	6
Heavy equipment	8
Oxygen deprivation	1
Rockfall	37
Accidental shooting	4
Steam	1
Suffocation	2
Transport	21
Unknown	1
Total	125

In the past decade, the safety record for SNSK has been extraordinary, with no registered fatalities. The safety and risk management culture in SNSK is impacted by its history, and success in implementing a safety regime that has produced significant results. The introduction of "telltales" in 2004 was key to these improvements. Also, the

TABLE 3 Historical flooding events at SNSK

Year	Flooding event
1984	August, Mine 7, resulted in a 1-week production stop: 5000 m^3 per day was pumped out of the mine. Also, Mine 3 experienced minor flooding where 1000 m^3 per day had to be pumped out.
1998	July, Mine 7: 19,000 m^3 per day was pumped out of the mine
2000	June, SVEA mine. The lack of adequate equipment for pumping was one of the leading causes.
2003	July, SVEA Mine. More water than expected despite increases in pumping capacity of 30,000 m^3 per day. Production stopped for several weeks.
2013	Mine 7 flooded twice in the late summer: 12,000 m^3 of water was pumped out of the mine daily.
2020	July, Mine 7 was flooded.

introduction of conveyor belt technology increased the safety of coal transportation within the mine. According to the company, combining management systems with training and procedures improvements has also helped reduce fatalities.

4.1 | Experience with flooding

SNSK has experienced flooding at Mine 7 and the mine at SVEA. From 1984 to 2020, six production stops were caused by water entering the mines from the glaciers above (Table 3).

In late August of 1984, Mine 7 was flooded by meltwater from the glacier above the mine (Svalbardposten, 1984). The company had to pump 5000 m^3 daily to reduce the mine complex's water level. The temperature in Longyearbyen was between 4°C and 12°C. The event occurred at a time when production was at a low level due to the summer holidays and lower demand in the market. Also, Mine 3, further to the west, experienced minor flooding.

In 1998, Mine 7 almost flooded, resulting in meltwater from the glacier above entering the mine. Two pumps were used, which only barely held the water at bay. At the time, the temperature in Longyearbyen was between 3°C and 6.5°C. A testimony to the scope of the incoming water was that, while maintenance was being done on a leaking pipe, the water rose 60 cm in 3 h. Extra pumping capacity had to be brought in from the SVEA mine further south, which eventually managed to lower the water level and clear the complex of water. The shift supervisor at Mine 7 (Stiger) stated, "Actually, a mine can withstand enormous amounts of water. However, Svalbard has a dry climate, and we are not used to dealing with such a large influx of water as now. In addition, we have been spoiled with very little water in recent years" (Svalbardposten, 1998)—providing testimony to the challenges faced by the miners at the time. The pumping efforts were delayed as some of the pumps had been lent out to the SVEA mine, thereby reducing local capacity. A supervisor described the situation: "Using our full capacity, we have only managed to keep the water level stable, so it will not take much for the water level to rise." The staff needed to procure more pumps from one of the other mines (Svea) to create enough capacity for the water level to fall, but as the equipment was somewhat cumbersome, it was not easy to get it into the relatively confined spaces in Mine 7. A supervisor described the situation: "It is difficult to operate this kind of pump. It weighs nine hundred and thirty kilos and needs to be maneuvered through narrow holes to reach the site. The mine can accommodate an enormous amount of water. However, we have been lucky with very little water in recent years" (Svalbardposten, 1998).

Three years later, a layer of permafrost melted in Svea North, some 60 km from Longyearbyen, which caused problems with flooding (Svalbardposten, 2000). The temperature at the time was between −1.5°C and 0.5°C. The general manager then said, "Working in water is uncomfortable. We did not expect to have to get started so quickly with what we call wet drilling. Therefore, we still lack the equipment to use in the production areas. As soon as this equipment is in place, working conditions will be far better, and there will be no danger of glacier water penetrating the mine."

At the start of July 2003, another Svea mine was flooded again. The company needed 12 pumps with a total pumping capacity of approximately 30,000 tons per day to manage the water. "The thaw came later this season, but we were significantly better prepared than last year. However, we noticed the warm weather this weekend." The temperature in Longyearbyen was, at the time, between 5°C and 10°C, with a peak of 14°C in late July.

In August and September 2013, Mine 7 experienced two flooding incidents—at its peak, some 500 tons of water had entered the mine. The temperature was at the time between 6°C and 10°C, with a peak of as high as 15°C in early July. The incident meant that production would not meet the target of 79,000 tons of coal during the summer period. In this case, the water entered an old part of the mine around 4 km deep, which delayed discovery and hence also the response. One of the concerns was that the water would freeze as it was situated well below the permafrost layer, which would delay the recovery efforts.

Given all these events, SNSK was not unfamiliar with flooding and how to respond, monitor, learn, and anticipate events at its production sites. Although there were commonalities between the different events, which all occurred during the summer or late summer months, there were also unique aspects to each event.

4.2 | The flooding of Mine 7 in 2020

A routine inspection of Mine 7 led to the discovery of a large inflow of water from some of the old mine works. The mine manager assessed the situation: “We do not yet know how long it will take to regain full control, but we are more optimistic now than we were earlier today.” On Sunday, July 26, SNSK began a comprehensive operation to remove the water, and initial reports were optimistic.

As water levels continued to rise and the pumps in the mine could not improve the situation, more equipment was brought in from Svea, with help from the Norwegian Coast Guard. As events unfolded during the summer holidays, help was provided by all available staff, including some from subsidiaries. During the coalmining, cracks would appear in the rock up in the mountain and in all probability, water from the glacier above entered through these cracks. “Our employees worked on several fronts with various tasks, some on the mainland and several in the mine. We also received help from Svea mine, Pole Position Logistics, the Governor’s office, and Air Transport.”

The team constructed a dam at the entrance to protect the rest of the complex and the crucial power supply. A supervisor recounted, “It looked very hopeless, and the water had almost reached the entrance of the mine. We started with what we did best, which was to improvise and work hard. We had to create solutions for the job in hand and fix the broken equipment as safely as possible. Pumps were deep in the mine without ventilation, and there was no continuous ventilation, so there were quite a few things that needed attention at the same time.” The account shows that in addition to the flooding, the mineworkers also faced the possibility of breathing contaminated air as they struggled to pump out the water.

On 30 July, the crew experienced a setback as the pumping capacity began to deteriorate. Later, the power source providing electricity to the pumps failed due to water overflowing the previously established barriers (SNSK, 2020b). An alternative recovery plan included excavating a ditch to protect facilities and equipment. However, it was clear that efforts to empty the mine would be unsuccessful.

The water had entered Mine 7 in two different places. The first was around one of the emergency exits, and the second was somewhere further inside the mine. The priority was to empty the innermost part as flooding affecting the inner workings could damage expensive equipment in the production areas located some 7 km inside the complex. Restoring electricity became a priority as all work in the mine depended on functioning ventilation, pumps, and lighting. A power cable was stretched across the glacier, providing an alternative power source to the mine’s inner part, using manual labor.

This task was not simple, even in Svalbard. At the same time, the weather had turned a little colder, which meant less meltwater was entering the mine. Assistance also arrived from other stakeholders to support recovery efforts. “The Coast Guard assisted with transporting equipment. In addition, the two airlines, Air transport and Airlift, provided us with helicopters. Crews from the company Assemblin helped with ordering cable and laying it out. We got invaluable help from our partners.”

It took almost 2 months to empty the mine in the production area. Everything in the flooded area had to be replaced or checked, including power supplies, ventilation, bolting, and emergency equipment. It took just over 3 months before the mine could start production again. Luckily, there was less structural damage than anticipated, which also helped the recovery process. The mine manager described the course of events:

In such a dramatic situation, there is much uncertainty—not only physical insecurity but, perhaps even more importantly, mental insecurity, which needs to be managed. When working to manage the situation in the early days, we sometimes lost control, and we did not always know what to do to regain this. The mental strain was huge. I witnessed a disaster that could have stopped the entire mine production, and we would all have lost our jobs. We could feel pressure from our surroundings.

The work proved more extensive and challenging than expected, and including drainage installations extending up toward the glacier. Although existing coal stockpiles were sufficient to fuel the power plant until at least the end of the year, there was a real possibility that these would not be enough. The community supported the mine during the crisis, providing personnel, logistics, and equipment, which significantly impacted the outcome. A supervisor at the site recalled, “When this kind of disaster occurs, it is important to understand that this is our problem, and we have to solve it. We are in the best position to solve the problem. This type of team building is impossible to recreate under any other conditions.” However, in small Arctic communities, there is much more at stake than the mine, as the mine manager stated:

> It is not only the mine but also the surrounding community in danger. In this case, the community was very supportive. There was positivity and a very supportive atmosphere in the local community. For everyone who works here, there was, of course, uncertainty about whether this would work. Do I have a job in the future? Some coped with this very well, while others found it difficult when you have a family.

On October 30, the mine resumed production after sustaining significant damage to the affected areas. Work focused on strengthening the older parts of the entrance and the mine infrastructure mentioned above, such as electricity and ventilation. Luckily, the water never entered the mine’s current production areas, which meant that equipment mostly remained available and intact.

4.3 | BCM capacity at SNSK

An organization’s capacity to recover its critical activities and protect its created values depends on four abilities: to respond, monitor, learn, and anticipate. The following section analyzes how these capacities were used as the events at Mine 7 unfolded.

4.3.1 | The capacity to respond

The capacity to respond relies on aligning technical and organizational resources to reduce the recovery time of critical activities. As the event occurred in the summer, it was possible to drive to the mine without difficulty. SNSK has a significant store of different technical equipment to be utilized in a flooding event. Although some of the equipment was stored at the SVEA mine some 60 km away, it was possible to transport pumping equipment, hoses, and generators to Mine 7 with the help of the Norwegian Coast Guard. Locally at the mine, there was extra capacity besides the pumps inside the mine that could quickly be deployed. There was hence a capacity to respond to the event regarding technical resources. However, as it was the holiday season and most of the staff were on vacation, there was little in terms of organizational resources either to manage the event or coordinate the crisis response at SNSK. The existing staff created a barrier to stem the water from impacting the power supply and maintenance areas. However, this did not stop the water from rising and flooding the electricity supply.

The extra pumps from the SVEA mine helped keep the water at bay, but they were insufficient to reduce the water level. The barrier provided time for staff to arrive at the site, reducing the challenges of insufficient resources but not enough to reduce the consequences of water entering large parts of the complex. The general manager stated, “In the last few days, we have been working hard to deal with the situation and get the water out of Mine 7. We have brought in more equipment, more pumps and more people. We have never seen such large amounts of water in the mine before, and last night this led to a power cut and the water pumps being put out of action.” Although there was a power cut, which caused all pumping to stop and resulted in a loss of control, it gave management an idea for how to proceed and manage the consequences.

While the protective barriers mitigated the consequences, the response seemed appropriate, given the existing procedures and time constraints. Therefore, this behavior fits the description of an organization that can respond to a critical event in terms of observed individual behavior and engaging in complex organizational measures. However, the lack of organizational resources increased vulnerability when the likelihood of flooding was high.

4.3.2 | The capacity to monitor

The company has implemented a series of both passive and active monitoring systems. These systems include employee reports conveyed at handover times between shift supervisors or at operational meetings. Information sharing, and discussions about possible changes, breakdowns, and hazards, occur at the beginning of each shift and during a morning meeting. A shift supervisor with 14 years of experience stated, “At start-up meetings, we take Health, Safety, and Environment (HSE) considerations as the first agenda point if we have deviations or remediation that need attention. This is the first thing we deal with.” These meetings would, under normal circumstances, have identified possible increases in water levels within the complex. However, as the mine was not operational at the time, this part of the monitoring system was not working.

Other monitoring systems include video surveillance for the conveyor system and the above-mentioned “tell-tales” to monitor movements on the mountain. A personal tracking system ensures awareness of how many people are in the mine and where they are. These trackers are essential in an emergency, supporting situational awareness and forming the basis for effective recovery plans. Air quality “sniffers” and airflow monitors also ensure safety in the work areas.

An active monitoring system identified the flooding as part of a routine physical inspection. Although there had been multiple similar events, the company had not implemented passive systems, which could have provided more advanced warnings of flooding. Temperatures were 4°–5° above normal in July, and on the 25th to 26th of the month, the temperature was above 21° (Meteorologisk institutt, 2020). The average temperature for that month is usually between 4.7° and 6.3°. As previously shown, the connection between high temperatures and mine flooding is known. The warm weather could have accelerated the melting of the glacier and reduced the time that decision makers had to muster an appropriate response.

Time is an essential parameter in a scaled response to an adverse event. In any case, the ability to build situational awareness based on an effective monitoring system is a factor in the recovery effort. The monitoring capacity supports this process and provides decision makers with evidence-based indicators of hazard events. Partial sources of information provide inferred evidence that an event will unfold in a certain way and provide insights into the trustworthiness of the information in the social and physical environment. Therefore, monitoring systems provide valuable information that can prompt a faster response and possibly a better outcome before an event unfolds.

4.3.3 | The capacity to learn

When SNSK was operating several coal mines on Svalbard and employed hundreds of people, there was more emphasis on training and learning. As production has been scaled back in recent years, there has been less focus on building new, or updating existing, competence outside what is legally required. One reason is that the company was entering a period of uncertainty and change regarding the business activities it would carry out once it had ended its mining operations. In recent years, the last remaining mine (Mine 7) has been condemned and reviewed several times, resulting in a lower investment in training. As stated by one of the managers, “Previously, we had a director who placed great focus on learning. He was keen to gain experience from other mining companies. This gave us input on how to make our work better and safer.” Today, the company uses on-the-job training and a buddy system. Long-standing employees with several years of experience with specific tasks team up with a new employee for at least 6 months. Although the organization recognizes the lack of training, acquiring further funding for skills development has proved challenging.

SNSK has developed a comprehensive system for instructions, best practices, routines, and Standard Operating Procesures (SOPs) to increase mine safety. The company uses these systems to respond effectively to known hazards to ensure business continuity and a safe work environment. It comprises two major components that feed into the continuous improvement cycle of the company’s quality system.

First, a deviation report is created when a standard is not followed intentionally or because of an error. The system has been in place with a specific focus on improving mine safety and reducing work-related injuries, but it has also been used as a general risk management tool. In recent years, there has been an expansion in the range of business activities. The mining activities have been scaled down in recent years, replaced by work related to demolishing old mines and production facilities, increasing instances when an activity falls outside the current system. Deviation reports are filled out immediately or upon completion of the shift. Information about the deviation is also entered into the quality management system and later discussed at the supervisor and management level who can make adjustments to the safety system.

Second, when work falls outside established procedures or there is a reason for diverging from the norm, staff can also make a risk assessment or a job safety analysis. The general manager described the usefulness of such reports: “It affects us in so far as people become more attentive than they would be if they were to keep on doing the same thing. We rarely see safety incidents when we do something new.” The assumption that the job safety analysis decreases the number of accidents is also reflected in the number of fatal incidents described above (Figure 1). The safety management system works well for the company. There is a widespread consensus among staff that this is why there are so few accidents. According to one foreman, when referring to the system, “We perform a job safety analysis on virtually all tasks, typically when we have tasks that are not part of our daily routine.” Both of these systems are used as part of the response system deployed by SNSK to ensure that the action taken aligns its organizational and technical resources toward recovering its critical activities

The organization and the site manager contributed comprehensive knowledge on handling flooding events. With 26 years of experience at SNSK, the site manager has been directly and indirectly involved in managing similar events. Due to the summer holidays at the time of the flooding, only a few employees were there with the experience and skills to deal with the event. The company had experienced several flooding events before—most recently in 2013—and considered such an incident highly likely. The capacity to learn may have diminished over time as the company had largely abandoned courses and skills development from outside sources. A supervisor explained, “To be completely honest, I think we might know best, and our knowledge is unrivalled the world over. We should be trainers, and people could come here and see how we do things.” Although it might be true that the staff have cutting edge skills, there can be a risk of being too confident in one’s abilities. The impressive safety record (Figure 1) can be seen as evidence of a highly capable organization regarding safety.

Critical events are a source of learning for any organization, and the lessons that emerge should be treated with the same rigor as individual safety incidents. Each investigation includes one or more key learning points that can be transformed into best practice guidelines, course content, amendments to procedures, or risk assessments if no clear learning outcomes are apparent. Previous incidents provided lessons about the organization’s ability to manage the event by applying operational knowledge. However, the flooding came close to putting an end to all of the company’s future mining operations. It was pure luck that kept the company from losing all its equipment. As described by a senior manager, “We are good on the operational side, but not when it comes to the major areas—there are strategic challenges.” In this incident, a discussion of the consequences of a warmer climate might have produced more robust plans for business continuity if flooding occurred.

4.3.4 | The capacity to anticipate

The capacity to anticipate is the ability to imagine how events will unfold and develop a solution for dealing with this imagined future in advance. The organization’s ability to monitor, detect, and collect information is expected to result in a holistic understanding of how this mental image will cascade into a future scenario. This process presents an opportunity for the organization to see into the future and recognize similarities from the past in patterns emerging in the present. If a change corresponds to past experiences, the assumption is that it will develop similarly in the unknown future based on past experiences. In the case of new types of hazards, the development of possible future scenarios can be based on understanding the context and relying on assumptions of how an event will develop.

The anticipation was that the July 26, 2020 event would develop in much the same way as previous flooding events the company had experienced, the last being in 2013. The mine manager stated at the time, “We do not yet know how long it will take to get complete control, but we are more optimistic now than we were this morning. Although no hazardous work tasks are planned, this is an abnormal situation, and we place safety higher than progress in everything we under-take." Acknowledging that the current resources would not suffice, the staff quickly ordered additional pumping capacity from the SVEA mine. The mine manager continued, "The first thing we now want to control is the water that comes out of the mine. We are digging a channel toward the mountainside outside the mine so the water can be led out and down into a stream valley. That way, we get the least possible damage to buildings and materials." The extra pumps did not lower the water level in the mine but did keep it relatively constant, providing time for more staff to arrive at the site. The arrival of more resources created an initial robust effort and bought more time to make sense of the situation they were facing. Management of the flooding moved from reactive to proactive decision-making, where it was possible to anticipate how the event would unfold, given that the constructed barriers had failed. Although the situation changed 3 days later when the pumps failed, it provided a window during which staff could adapt to the problem.

The ability to anticipate how an event will unfold requires information deemed reliable by the person who receives it. Requisite imagination offers the opportunity to consider what could happen if an event were to take place—in this instance, whether anything could seriously impact the mine's structural and functional integrity. Before the event, the expectation was that flooding was a relatively rare event in recent decades (occurring in 1984, 1998, 2006, and 2013). Using data from Longyearbyen Airport, located not far from Mine 7, it was evident that temperatures and precipitation had risen in recent years and even more since the most recent event in 2013 (Norsk Klimaservicesenter, 2019). The company had been through several years of uncertainty, resulting in less emphasis on knowledge-sharing with external sources. It could have provided decision makers with valuable input as part of their sensemaking processes if this sharing had taken place. When the flooding event occurred and resulted in a loss of control, the anticipation of how well protective barriers would perform may have been overestimated. Although there was an option to bring additional resources to the site, this proved to be inadequate. The event was massive in scale and affected the electrical supply, cutting off the only preventive response.

5 | DISCUSSION

SNSK is not unaccustomed to business continuity events, having experienced several floodings, rockfalls, accidents, and heavy equipment failures over the years. These experiences have resulted in an impressive safety track record in the recent decade. However, it has not proven easy to transfer this knowledge to a business impact and recovery context. While the number of accidents and fatalities is down, the ability to recover the value-adding critical activities has not experienced the same trajectory. Safety events are typically limited in scope and have a small impact on business continuity when excluding the company's voluntary closing down of operations so as to investigate the root causes of accidents. Over time, comprehensive knowledge of safety and work processes was obtained, resulting in a wide range of practical preventive and protective barriers. However, the organization was only able to translate this into a BCM capacity to a limited degree.

There are some fundamental reasons why it is difficult for SNSK to transfer high-performing safety records into a business recovery capacity. First, traditional safety management relies on repetitive patterns in operations. Although operations can be complicated or comprehensive, breaking them down into individual repetitive processes and enabling a continuous circle of positive attributes is possible. Over time, SNSK reduced the number of fatalities by improving its protective and preventive barriers. The strategy works well when the same process is repeated regularly and has a relatively high event frequency. Although flooding had occurred several times in the past few decades, the events did not engender an organizational response in the same repetitive pattern as did work accidents. Despite that, these events constituted more significant operational disruption, with direct consequences that could last for weeks and sometimes months. There was also variation in how the events unfolded. The most recent flooding in 2013 was resolved relatively quickly, using the same strategy that was later applied in 2020. However, the results differed significantly as water levels in 2013 started falling almost immediately, but in 2020, this was not the case.

Second, the regulatory framework for safety differs significantly from the legal requirements for business interruption in a company. Several of the company's employees were investigated in 2005 when an employee suffocated, and a team leader was found negligent in his duties. Fines are also a strong incentive to improve procedures and routines. In SNSK, this has resulted in compensation settlements amounting to millions of NOK (Norwegian kroner). Events such as these have resulted in the implementation of monitoring systems and daily briefings on changes in the work environment that impact safety. For events that affect business continuity, government involvement is less salient. While flooding events are costly, they have not resulted in fatalities or major injuries. The event in 2020 might have cost as much as $4.6 million, which is quite a significant part of the operating margin for that year. A similar regime of consequence does not exist for business continuity events in SNSK. Instead, the organization treats adverse events as part of doing business in the Arctic, and there is an acceptance that business costs, at least to some degree, are unpredictable. The company benefited from having a surplus stock of spare parts and pumping capacity at the SVEA mine during the flooding event. However, there is less focus on business impact and restoring critical activities regarding the organized ability to respond, monitor, learn, and anticipate. The result of not building capabilities meant that while the organization contained knowledge about business continuity events, it lacked an organized response, which cost time and nearly its production equipment.

Third, safety is centered on the individual, while business continuity focuses on the activity. Accident investigations deal with identifying the root courses of an event and working back through the failures of protective barriers in terms of the hazard itself. When an incident has happened, the focus shifts to protecting and ensuring that future events result in fewer consequences. For example, constructing and maintaining limestone barriers can suppress coal dust explosions, or planning regular drills to muster a rapid response in the event of a fire. The business impact analysis forms the basis for the construction of risk reduction and business continuity plans (BCPs). Management at SNSK clearly understands how activities should be performed as efficiently and safely as possible. Instead of solely focusing on safety, it looks at how a hazard or event will affect its ability to carry out value-adding critical activities. Like safety systems, it uses a quality management approach, where continuous improvements are made by testing the system through exercises and actual events, resulting in a virtuous learning cycle. Developments in personal safety has produced remarkable results for the company, however, value-adding critical activities are defined more broadly in terms of their impact on all aspects of organizational activities. Hence, the organization primarily focuses on improving personal safety rather than this more holistic approach became a threat to business continuity. Although the initial efforts to manage the flood in Mine 7 produced good results in ensuring safety, the lack of focus on preparing for threats to value-adding critical activities came close to ruining the company.

Fourth, context is essential. The safety work at SNSK has focused on improving its procedures and work routines to reduce the number of accidents. This strategy works well when the organization controls the working environment and context. As mentioned above, repetitive patterns have a positive influence on reducing the number of work-related injuries. BCM incorporates procedures for business recovery rather than focusing on the event itself. BCPs are concerned with restoring activities necessary to produce something the organization values, and buildings, machinery, infrastructure, information, logistics, and staff are regarded as resources to achieve this aim. Context matters because it can influence the ability to respond, which will require different forms of monitoring systems, skillsets, and the evaluation of an event. One of the reasons the event did not result in a total loss was plans to ship extra pumping capacity from the Svea mine to Mine 7. There is an overlap between working with safety issues and value-adding critical activities as they supplement each other. In the Arctic, small margins exist both when it comes to safety and business activities. Relatively minor issues can quickly escalate out of control, such as 2 days of above-average temperatures, if monitoring and management systems are not responding accordingly. Organizations need to customize their safety and BC systems to these tighter margins and implement response strategies sensitive to even minor changes in context.

Finally, BCM does not replace safety management. Although BCM is an essential addition to how a company operates and recovers from catastrophic events, it is not a replacement for its work on safety. SNSK would probably not have achieved the same impressive safety record if only focused on restoring critical activities. Instead, there is a suggestion that companies build on their existing systems and expert knowledge to further strengthen their ability to cope with the hazards they face. A lesson learned is that while safety and BC are related, they are not substitutes for each other, requiring unique strategies, skillsets, monitoring systems, and exercises. There are overlaps when the two have common aims; for example, when it comes to monitoring rockfall or flooding hazards. Based on the same fundamental principles, the two can complement and build on individual strengths to improve the organization's performance as one focuses on safety and property assets, and the other on broad activities and resources.

6 | CONCLUSION

This article sought to answer the research question as to what extent SNSK's systematic work with safety, and experience with flooding events, improved its business continuity capacity. The results show high performance in safety, and having previous experience with flooding, do not necessarily mean that these abilities are transferable to a business continuity context. The difference in thinking stems from divergences in the fundamental aims of the approach to risk and the event itself. SNSK has created systems that focus on prevention rather than recovery and which have proven successful in decreasing the number of incidents, but it is also a vulnerability for the organization. Its focus on risk identification and mitigation has reduced the likelihood of events that display repetitive patterns of behavior. So while SNSK has extensive experience with similar events, it has not been able to develop capabilities to ensure the recovery of value-adding critical activities when there are changes in context, for example, when there are above-normal temperatures.

Using the business continuity capacity model (Figure 1), the analysis centered on four capacities: response, monitoring, learning, and anticipation. It was found that many of the traits identified in the existing approach to safety apply and could be adapted to fit the needs of business recovery. The pre-existing systems for managing work accidents are suited to improving the company's ability to respond to change. Monitoring systems are built to save lives and can be adjusted to fit early warnings of impending hazards that could jeopardize business continuity. Developing emergency plans and training for different scenarios would also support recovery and build capacity within the organization. Over time it would be possible to build organizational capability to anticipate by imagining how future events could unfold.

Organizations such as mining companies rely on their resources and capabilities to manage emergencies and recovery. Help from the outside can be far away, and helpers might not have the resources or specialist knowledge to make a difference on the scene. A structured recovery system can support pre-existing platforms aimed at safety to include the critical activities needed to ensure an organization’s overall survival. In the Arctic, where safety margins are tighter, and emergency support can be hours or days away, a structured approach based on the business continuity capacity model can support and improve business recovery efforts.

ORCID

Jacob Taarup-Esbensen https://orcid.org/0000-0003-2923-0056

REFERENCES

Adamou, C. (2014). Business continuity management in international organisations. *Journal of Business Continuity & Emergency Planning*, *7*(3), 221–229.

Aven, T. (2016). Risk assessment and risk management: Review of recent advances on their foundation. *European Journal of Operational Research*, *253*(1), 1–13. https://doi.org/10.1016/j.ejor.2015.12.023

Bhamra, R., Dani, S., & Burnard, K. (2011). Resilience: The concept, a literature review and future directions. International Journal of Production Research, *49*(18), 5375–5393. https://doi.org/10.1080/00207543.2011.563826

Curt, C., & Tacnet, J. (2018). Resilience of critical infrastructures : Review and analysis of current approaches. *Risk Analysis*, *38*(11), https://doi.org/10.1111/risa.13166

Dianous, D. (2006). ARAMIS project : A more explicit demonstration of risk control through the use of bow – tie diagrams and the evaluation of safety barrier performance. *130*, 220–233. https://doi.org/10.1016/j.jhazmat.2005.07.010

Elliot, D., Swartz, E., & Herbane, B. (2010). *Business continuity management*. Routledge.

Farr, M., & Bailey, D. (2019). Uniting business continuity management and operational risk management. *Journal of Business Continuity & Emergency Planning*, *12*(4), 294–300.

Franzosi, R. (1987). The press as a source of socio-historical data: Issues in the methodology of data collection from newspapers. *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, *20*(1), 5–16. https://doi.org/10.1080/01615440.1987.10594173

Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal*, *26*(2), 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x

Harvey, E. J., Waterson, P., & Dainty, A. R. J. (2019). Applying HRO and resilience engineering to construction: Barriers and opportunities. Safety Science, *117*, 523–533. https://doi.org/10.1016/j.ssci.2016.08.019

Hassel, H., & Cedergren, A. (2019). Exploring the conceptual foundation of continuity management in the context of societal safety. *Risk Analysis*, *39*(7), 1503–1519. https://doi.org/10.1111/risa.13263

Herbane, B. (2010). The evolution of business continuity management: A historical review of practices and drivers. *Business History*, *52*(6), 978–1002. https://doi.org/10.1080/00076791.2010.511185

Hiermaier, S., Sharte, B., & Fischer, K. (2019). Resilience engineering: Chances and challenges for a comprehensive concept. In M. Ruth & S. Goessling-Reisemann (Eds.), *Handbook on resilience of socio-technical systems* (pp. 155–166). Edward Elgar Publishing Ltd. https://doi.org/10.4337/9781786439376.00015

Hiles, A. (2014). *Business continuity management: Global best practices* (4th ed.), K. Noakes-Fry (Ed.). Rothstein Associates.

Hinkel, J. (2011). “Indicators of vulnerability and adaptive capacity”: Towards a clarification of the science-policy interface. *Global Environmental Change*, *21*(1), 198–208. https://doi.org/10.1016/j.gloenvcha.2010.08.002

Hollnagel, E., & Fujita, Y. (2013). The Fukushima disaster-systemic failures as the lack of resilience. *Nuclear Engineering and Technology*, *45*(1), 13–20. https://doi.org/10.5516/NET.03.2011.078

ISO. (2012). Societal security – Business continuity management systems Requirements. BSI Standards Publication, *36*.

Kato, M., & Charoenrat, T. (2018). Business continuity management of small and medium sized enterprises : Evidence from Thailand. *International Journal of Disaster Risk Reduction*, *27*, 577–587. https://doi.org/10.1016/j.ijdrr.2017.10.002

Kendall, K., Kendall, J., & Lee, K. (2005). Understanding Disaster Recovery Planning through a Theatre Metaphor: Rehearsing for a Show that Might Never Open. Communications of the Association for Information Systems, 16, pp-pp. https://doi.org/10.17705/1CAIS.01651

Kvello, J. K. (2006). Store Norske Spitsbergen Kulkompani - Fra privat til statlig eierskab 1945–1975 (S. Norske (ed.)). Store Norske Spitsbergen Kullkompani.

Lay, E., Branlat, M., & Woods, Z. (2015). A practitioner’s experiences operationalizing resilience engineering. *Reliability Engineering and System Safety*, *141*, 63–73. https://doi.org/10.1016/j.ress.2015.03.015

Linkov, I., Fox-Lent, C., Read, L., Allen, C. R., Arnott, J. C., Bellini, E., Coaffee, J., Florin, M. V., Hatfield, K., Hyde, I., Hynes, W., Jovanovic, A., Kasperson, R., Katzenberger, J., Keys, P. W., Lambert, J. H., Moss, R., Murdoch, P. S., Palma-Oliveira, J., … Woods, D. (2018). Tiered approach to resilience assessment. *Risk Analysis*, *38*(9), 1772–1780. https://doi.org/10.1111/risa.12991

Markowski, A. S., & Kotynia, A. (2011). “Bow-tie” model in layer of protection analysis. Process Safety and Environmental Protection, *89*(4), 205–213. https://doi.org/10.1016/j.psep.2011.04.005

Meteorologisk institutt. (2020). Yr - Longyearbyen - Historikk. YR. https://www.yr.no/nb/historikk/graf/1-2759929/Norge/Svalbard/Svalbard/Longyearbyen?q=2020-07

Norsk, K.. (2019). Climate in Svalbard 2100 – a knowledge base for climate adaptation. In I. Hanssen-Bauer, E. J. Førland, H. Hisdal, S. Mayer, A. B. Sandø, & A. Sorteberg (Eds.), NCCS report no.1/2019 (Issue 1).

Schaffer, A., & Schneider, M. (2019). Towards a responsible resilience. In M. Ruth & S. Goessling-Reisemann (Eds.), *Handbook on resilience of socio-technical systems* (pp. 9–29). Edward Elgar Publishing Ltd. https://doi.org/10.4337/9781786439376.00007

SNSK. (2020a, July 28). Vanninntrenging i Gruve 7. Store Norske Press Release. https://www.snsk.no/nyheter/4749/vanninntrenging-i-gruve-7

SNSK. (2020b, July 30). Vanninntrenging i Gruve 7 mer alvorlig enn antatt. Store Norske Press Release. https://www.snsk.no/nyheter/4753/vanninntrenging-i-gruve-7-mer-alvorlig-enn-antatt

SNSK. (2020c, August 18). Målet er oppstart for Gruve 7 i oktober. Store Norske Press Release, 1–5. https://www.snsk.no/nyheter/4842/malet-er-oppstart-for-gruve-7-i-oktober

SRA. (2021). Society for Risk Analysis Glossary (p. 9). Society for Risk Analysis. https://www.sra.org/sites/default/files/pdf/SRAGlossary-FINAL.pdf

Store Norske. (2021). Store Norske - Corporate website. Store Norske. https://www.snsk.no/

Svalbardposten. (1984, August 31). Svalbardposten Nr 1. Svalbardposten.

Svalbardposten. (1998, June). Svalbardposten Nr. 30. Svalbardposten.

Svalbardposten. (2000, June 2). Svalbardposten Nr. 21. Svalbardposten.

Tammineedi, R. L. (2010). Business continuity management: A standards-based approach. Information Security Journal: A Global Perspective, *19*, 36–50. https://doi.org/10.1080/19393550903551843

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533.

Vecchiato, R., & Roveda, C. (2010). Foresight in corporate organisations. *Technology Analysis and Strategic Management*, *22*(1), 99–112. https://doi.org/10.1080/09537320903438179

Waters, J., & Adger, W. N. (2017). Spatial, network and temporal dimensions of the determinants of adaptive capacity in poor urban areas. *Global Environmental Change*, *46*, 42–49. https://doi.org/10.1016/j.gloenvcha.2017.06.011

Westby, S. (2003). Store Norske Spitsbergen Kulkompani 1916–1945 (Store Norske (ed.)). Store Norske Spitsbergen Kullkompani.

Woods, D. D. (2009). Escaping failures of foresight. *Safety Science*, *47*(4), 498–501. https://doi.org/10.1016/j.ssci.2008.07.030

Woods, D. D. (2016). The risks of autonomy: Doyle's catch. *Journal of Cognitive Engineering and Decision Making*, *10*(2), 131–133. https://doi.org/10.1177/1555343416653562

Woods, D. D. (2019). Essentials of resilience, revisited. In (M. Ruth & S. Goessling-Reisemann Eds.), *Handbook on resilience of socio-technical systems* (pp. 52–65). Edward Elgar Publishing Ltd. https://doi.org/10.4337/9781786439376.00009

Yin, R. K. (1994). *Introduction and designing case study: Case study research Design and methods* (2nd ed.). SAGE Publications. https://doi.org/10.1017/CBO9780511803123.001

Zio, E. (2018). The future of risk assessment. *Reliability Engineering and System Safety*, *177*(June), 176–190. https://doi.org/10.1016/j.ress.2018.04.020

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