



Safety Initiatives in Support of Safety Culture Development: Examples from Four Mining Organisations

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Abstract

Having seen significant improvements to accident rates in the last 40 years, companies in the Swedish mining industry now show a greater focus on the development of safety cultures throughout their organisations and workplaces. However, there is a lack of research examining the different safety initiatives and strategies practiced in the industry today. This study explores the potential influence and consequences such initiatives may have on the development of safety cultures in the Swedish mining industry. Twelve interviews with experts on safety initiatives from four different Swedish mining organisations were conducted and analysed in a process based on qualitative thematic analysis to identify notable connections to safety culture development. The results of these interviews highlight proclivities in the implementation and use of safety initiatives such as subjects of focus, methods and desired effects. This enables the interpretation of the conceptualisation and methods for the development of safety culture in these organisations based on their approaches to safety development. We believe the results of this study can serve as support for discussions on safety culture development in the Swedish mining industry, and be of interest for international mining industries, in addition to approaches to research in this field. However, we also believe it is important to emphasise the opportunities to approach safety culture in mining from different perspectives than those common today.

Keywords Mining industry · Safety culture development · Safety management · Safety initiatives

1 Introduction

Since the 1980s, organisations within the Swedish mining industry have seen a significant reduction in accident frequency rates [1]. In their study on the experiences of people in supervising positions within mining organisations regarding the development of safety management over time, in addition to what that could have contributed to the reduction in accident rates in the industry at large, Lööv and Nygren [1] highlight three contributing factors: (1) technological development; (2) regulations and (3) organisational strategies and focus areas.

According to the informants of the study, technological development played a major role in the significant reduction during the 1980s and the 1990s and has continued to play an important role in the modern mining industry. The

amount of physically demanding work has, for example, been reduced thanks to improvements to work equipment. A number of greater technological strides have also been taken in relation to the physical work environment in both mines and refineries, through the implementation of safer machines and the automation of tasks that were previously handled manually. In the early 2000s, an increasing amount of attention was paid to organisational issues in general and health and safety management in particular. To a certain extent, this development was linked by the informants to changes in the demands made by health and safety regulations, especially the implementation of regulations for systematic work environment management made in 2001 that, amongst other effects, contributed to a more effective risk management. The informants did also note that the organisations began to develop new areas of focus for safety management during the 2000s which subsequently played a role in different safety programs and educational initiatives [1]. A significant focus area during the 2000s has thus been the development and implementation of new forms of organisation and strategies for improving safety and further reducing accident rates. A

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notable reoccurring subject in this context is *safety culture*, i.e. that cultural factors will have an impact on how safety is managed on different levels of an organisation.

1.1 Safety Culture Development

The concept of safety culture has been defined and interpreted in several different ways; however, it most commonly involves shared aspects such as values, behavioural patterns, attitudes and perceptions relating to safety amongst individuals within an organisation or workplace [2, 3]. Other approaches to defining safety culture focus on organisational structures and systems, or on the ties between shared attitudes and values and organisational and management practices that influence safety [4]. While research commonly focuses on organisation-wide safety cultures, individual groups and workplaces can develop subcultures of their own that may differ from the rest of the organisation [5]. According to Bisbey et al. [6], safety cultures are enabled by a variety of factors that each contribute to people adopting and developing assumptions, values and norms that together constitute the culture. Examples of these contributing factors include organisational policies relating to safety, group cohesion, psychological safety and individuals' commitment to safety. These factors influence people's conscious and unconscious behaviours in safety-related issues, which in turn impacts the resulting safety outcomes, for example by having higher incident reporting rates lead to more risks and issues being addressed. The safety culture is then further developed by the feedback from these outcomes; if behaviours such as effective collaboration and communication result in positive safety outcomes, the employees may come to value and strive for such traits in the future [6]. It is important to note that developing and changing a safety culture are a long process that cannot easily be expedited [3, 6, 7]. Reinforcing desired values and norms must be done with consistency and stability over time, as wavering support for safety strategies and values may result in a loss of trust and cooperation from the employees, which in turn could negatively affect safety outcomes.

Of the several different interpretations that exist of safety culture as a concept, Guldenmund's [3] pragmatic approach to organisational safety culture is especially suitable when discussing its development. Grounded in experience and expert judgement rather than empirical research of cultures, this approach claims that there are three important aspects of an organisation that interact to provide a certain level of safety performance: organisational structure, culture and processes. Structure is defined as the formal framework of an organisation, e.g. the delegation of tasks and roles; culture refers to an organisation's underlying tacit convictions, values and assumptions; and processes involve the patterns of activity throughout an organisation, e.g. production

processes, quality controls and the formulation of policies. Guldenmund [3] asserts that these three organisational aspects are closely connected and that changes to one aspect will affect the other. The interactions between organisational structures and processes for safety improvements will thus subsequently affect the safety culture which will, in due time, influence behaviours and safety performances within the organisation. As an example, safety management can essentially be defined as a process from this pragmatic perspective [3]. Its practical application depends on structural factors such as the distribution of roles and responsibilities within an organisation. By working to develop the processes within a company and ensuring a clear division of roles and responsibilities, this can ultimately impact the culture, that is, the basic assumptions and values regarding, for example, safety issues. As such, process, structure and culture contribute to establishing the conditions for certain types of behaviours within the organisation at individual and group levels—behaviours that can be more or less favourable for safety depending on how well the three parts interact with each other.

There is a lack of research regarding the strategies and structures of work that have been implemented in the modern Swedish mining industry for the purposes of safety improvement. Furthermore, few studies have related these efforts to the establishment and development of safety culture. As such, the purpose of this study is to investigate safety initiatives and their experienced effects in four Swedish mining organisations, with the goal of analysing the initiatives' potential influence on safety culture development.

2 Methodology

This explorative study of safety initiatives in the Swedish mining industry and their influence on safety culture development is based on empirical data collected from representatives of four Swedish mining organisations. In order to provide more nuanced perspectives of the field and the development of safety-related matters, the companies involved in this study included both mining companies and contractors working for the mining companies.

2.1 Data Collection

The primary method of data collection for this paper was a series of semi-structured interviews, where people from four participating companies were interviewed in a total of 12 interviews. Audio-only recordings of the interviews were made with the consent of the participants for use in transcription. Following a methodology similar to Kallio et al. [8], interview guides with open-ended questions were designed for each company. The questions focused

on establishing an understanding of two different safety initiatives and contributions to safety development at each company, and on exploring the participants' experiences of positive or potentially improvable aspects of these initiatives (see Appendix). The participants of this study included people from a variety of different safety-related managerial or supervising roles at the companies such as safety representatives, health and safety managers, section heads and fire safety representatives (see Table 1). The interview participants were selected based on their experience of and involvement in their company's safety initiatives. Contacts within each company provided recommendations for potential participants, prioritising people with experience with either the development, implementation or management of at least one of their safety initiatives. Based on their experience, expertise and knowledge of the studied safety initiatives and safety management efforts in their respective companies, the participants were regarded as experts on the relevant safety initiatives following the methodology of expert interviews as described by Flick [9]. By focusing on experts, a more detailed and reliable description of the companies' safety improvement processes could be obtained, albeit limited to a management perspective in line with the purpose of the study [10]. Their statements about the functionalities and purpose of the safety initiatives were further validated using policy documents provided by the contacts from each company.

In order to ensure the ethical collection and management of data, each interview participant was informed of the purpose and goals of the study. Each interview also began with asking for their consent to have the audio of the interview recorded for transcriptional purposes. We offered all participants the option to skip questions they could not or did not want to answer, and to cancel the interview should they wish or need to. During the transcription process, the data was anonymised by removing mentions of the names and gender of the participants and of anyone mentioned during the interviews. Each participant was also offered opportunities to review the finished transcriptions and analysis results in order to validate our interpretations of their statements.

Together with interviewing multiple representatives on the same safety initiatives and supplementing these descriptions of the initiatives with document studies, it served to establish construct validity for the material [11].

In addition to semi-structured interviews, this study included an overview of policy documents, presentations, web pages and other gathered documentation from the participating companies. This material provided a basis for understanding the different companies' safety measures and systems while also providing performance data and concrete examples of what the companies considered to be successful or desirable examples of initiatives and strategies.

2.2 Data Analysis

We analysed the interview material through a process based on qualitative thematic analysis, as described by Braun and Clarke [12]. Statements made in the transcribed interviews were coded using Microsoft Excel based on the subject matter (i.e. a specific safety initiative) and the explicit, semantic meaning of the data. These codes, i.e. aspects that the participants considered to be important, were then collated into themes under each of the specific examples of safety initiatives (see under the heading "Description" in Table 2). With this, we could better analyse the shared themes of the different mining companies' safety initiatives and their possible contribution to safety culture development in the mining organisations.

While the data of this study is based on interviews with people that could be considered as experts with regard to safety-related issues within each of their respective companies, we acknowledge that it consists of the interview subjects' personal perceptions, experiences and knowledge. As such, we do not seek to generalise the results with regard to the effects of specific safety initiatives and assume they can necessarily be recreated with other similar methods in other companies. Instead, by studying the interview participants' experiences with and knowledge of the different safety initiatives in their positions as experts, in accordance with Flick's [9] definition, we consider the data suitable for

Table 1 List of interview participants categorised by company

Company	Participants			
Company A	Health, safety, environment and quality (HSEQ) specialist			
Company B	Head of health and safety	Environment, health and safety manager	Applications manager	Work environment developer
Company C	Environment, health and safety manager	Safety representative	Supervisor	
Company D	Fire safety representative	Head safety representative	Section head	Work environment coordinator

Table 2 List and summaries of investigated safety initiatives

Company	Safety initiative	Description
Company A	Development of organisational structure and culture	<p>Goal of developing an organisational structure and a culture that promotes the following:</p> <ul style="list-style-type: none"> • High levels of ambition for work environment quality • An openness to share and receive feedback • An increased control and responsibility for safety management for site managers • Adjusting work structures, systems and organisational frameworks to the needs of the people who use and work with them
	Operational safety system	<p>Establishing and maintaining high quality management of work environments through strategies for and focus on the following:</p> <ul style="list-style-type: none"> • High-quality, flexible work environment management • Coaching employees on work environment and safety • Promoting thorough and careful attitudes and mind-sets
Company B	Organisational safety management program	<p>Encompasses initiatives aimed at establishing shared mind-sets and attitudes to safety such as</p> <ul style="list-style-type: none"> • Themed events for collective learning and discussions about different safety-related subjects • Sharing the results of risk reports and events between workplaces • Promoting an openness for discussion and communication about safety between colleagues
	Implementation and application of digital positioning system	<p>Managing the resistance and reactions towards the implementation of new technology through the following:</p> <ul style="list-style-type: none"> • Clearly communicating the purpose and goals of the change • Providing transparency in its usage and capabilities • Demonstrating the benefits and improvements that the new technology provides
Company C	Improvement of risk reporting practices	<p>Improvements to the number of risk reports submitted by their employees was attributed to several factors, including</p> <ul style="list-style-type: none"> • Persistent efforts from supervisors to promote risk reporting • A preventable accident emphasising the importance of reporting and addressing risks • Training to improve manager-employee communication • A focus on fostering individuals' commitment to safety <p>These factors were stated to have been considered as guidance for future EHS initiatives</p>
	Environment, health and safety management practices	<p>Guiding principles for the management of workplace safety and quality focusing on the following:</p> <ul style="list-style-type: none"> • Developing a safety culture promoting engagement in workplace safety • Supporting candid and open communication within and between organisational levels • Ensuring the inclusion and prioritisation of safety in the management of workplace development
Company D	Fire safety management	<p>The experienced success and quality of fire safety management was attributed to the following:</p> <ul style="list-style-type: none"> • Participation in industry-wide collaborations for the development of fire safety regulations • A qualified and earnest fire safety coordinator with a high degree of decision-making power • Efforts to develop awareness of and commitment to fire safety at all levels of the organisation through training and communication efforts
	Development of accident investigation processes	<p>Improvements to accident report rates and investigations of severe risks through the following:</p> <ul style="list-style-type: none"> • Promotion and support of new attitudes to accident reporting • New accident reporting system contributing to improved ease of use and review processes • Procedures to investigate leading causes of accidents <p>Further development of minor risk investigation rates and feedback on implemented solutions were however identified as necessary</p>

exploring industry perspectives on initiatives for improving safety performance and their relations to safety culture development in mining organisations.

3 Results

3.1 Company A

Company A is a contractor active in Sweden as well as in the international mining industry. The company mainly focuses on specialised work in mining shafts and tunnels, including drilling and maintenance and repair work. At the time of the interview, the company operated in several Swedish mines and employed approximately 250 people in total. The company's stated guidelines include focusing on long-term sustainability and profitability; offering meaningful, safe and stimulating work for their employees through leadership and continuous improvement; reducing their impact on both external and internal environments; remaining transparent and factual in their communication with employees; and ensuring that all employees receive sufficient training.

3.1.1 Organisational Structure and Culture

According to the interview participant from Company A—a specialist focusing on matters related to health, safety, environment and quality (HSEQ)—the company's expressed goal with their organisational culture and their safety culture is to *maintain a high level of ambition for work environment quality and development within the organisation*. As a company focusing on contractor services, their stated goal is to achieve a higher quality in their work environment development than their customers do, and they thus seek to maintain an organisational culture independent of their customers. With this, they can better adapt to and fulfil the needs of Company A's organisation and the people within it. Similarly, the HSEQ specialist believes that the company's position as a contractor provides better conditions for establishing well-designed and effective work environment management compared to other larger companies in the industry. This is due to the potentially extensive adjustments of the work environments and the propagation of cultural values within the organisation being easier to achieve in smaller organisations. Organisational management is another example of a process they believe can benefit from a smaller organisational structure, for both the centralisation and the decentralisation of control and responsibility. Company A's goals regarding culture also include *fostering an organisational climate where people can be receptive to guidelines while also feeling comfortable in sharing feedback and critiquing those guidelines*. Criticism towards changes that are

unsuitable for the workplace is encouraged, even if those changes come from the top of Company A's organisation.

One subject of note that the interview participant emphasised was the *promotion of control and responsibility for site managers*. As each of their site managers works with a relatively small workforce, between four and thirty employees, they are considered to be a strong contact point between the employees and higher management levels. Company A's upper management thus focuses on developing relations with their site managers through cooperation and by providing assistance with issues such as the implementation of changes. The stated goal is for the site managers to feel comfortable in taking responsibility for and to work with issues relating to the work environment while also being *open to both giving and receiving feedback* from the upper levels of the organisation. Company A also works with establishing a shared organisational culture to which all workplaces can relate; however, they do not wish to regulate and micro-manage each manager and workplace to ensure they all work in the exact same way. The goal is instead to guide and encourage each workplace and site manager to work towards the same culture, even if the methods may differ. According to the HSEQ specialist, Company A is aware of the risks with homogenised groups in the workplace and is thus working to diversify their work teams both by employing more women and by employing people from different backgrounds and ethnicities.

Regarding the link between work environment management and culture, the HSEQ specialist stated that Company A strives to *adjust work structures, systems and organisational frameworks to the needs of the people who use and work with them*. This involves improving usability and accessibility for all users in order to improve the utilisation of the systems and frameworks. As an example, Company A seeks to increase the amount of risk and accident reports by designing the report system to be as easy to use as possible. While ease of use is of significant focus for the company, they are aware of how all systems, routines and frameworks will eventually generate questions and confusion, no matter how accessible and clear their design is. The HSEQ specialist noted that it is possible to prepare for this with supportive documentation and an organisational climate where people feel comfortable asking and answering questions. These control documents must be made available to provide guidance regarding work environment questions. However, people must also feel safe to question and discuss the contents of the documentation if something is false or is not being enforced, similar to how directives from upper management levels should be questioned when necessary.

To expound on the subject of communication, the HSEQ specialist claimed that there exists an understanding within Company A that accidents and incidents will always be

discovered eventually, even if those accidents are not reported. The company also takes care to communicate that the purpose of these reports is to solve problems, not issue blame, and that obscuring these incidents instead of reporting them can worsen the situation. As an example, the HSEQ specialist explained that not reporting an accident could escalate into an emergency, or it might lead to Company A's customers interpreting it as an attempt to obscure faults and thus lose confidence in them. This is an important issue for Company A as they want to demonstrate how responsible they are with the management of work environment quality, and because they wish to establish trust, both from the customers and within their own organisation.

3.1.2 Operational Safety System

Company A's Operational safety system (OSS) can be described as the company's operational work with safety, where the goal is to *establish and maintain high quality management of work environments*. This work is according to the HSEQ specialist based in many aspects upon tried and tested systems, methods and approaches. The OSS is primarily driven by the company's HSEQ department, but their work concerns the entire organisation. While there are many different aspects that comprise the OSS, four of them were mentioned by the HSEQ specialist as being especially important.

The first aspect relates to Company A's long-term strategy to maintain a *higher quality work environment management* than their customers and competitors in order to retain self-sufficiency. Simultaneously, the HSEQ specialist describes how they want to be *flexible* enough to adapt themselves effectively to the needs of their customers. In order to achieve this, Company A believes a shared organisational culture and mind-set in the organisation regarding safety must be strived for.

The second aspect of the OSS is the training and development of the employees, which involves educational initiatives for personnel with the goal of discussing work environment, safety and how and why they implement changes. These discussions are also meant to cover subjects such as how to handle shift changes or how the workplace is meant to be kept clean and orderly. The HSEQ specialist compared this type of initiative to coaching of the employees. They continued by describing how HSEQ employees are sent out to workplaces after training has taken place in order to review the subjects that were brought up and implemented with the help of a questionnaire.

As for the third aspect, it comprises Company A's work with developing and implementing systems and tools for following up reports on risks and accidents, in addition to the work with continuous improvements of their work

environment management. This includes ensuring that all projects within the organisation must have up-to-date method descriptions and risk assessments.

The fourth and last of the important aspects of the OSS involves the work with encouraging mind-sets and work procedures that focus on being thorough and careful, ensuring that proper procedures and methods are applied. Company A wants their employees to carefully think through decisions before they are made, and to support keeping workplaces clean and in order. The work with supporting such a mind-set is included in the work environment courses and training at all the company's workplaces. The goal is to promote dialogue and discussion, get people engaged in work environment, and build an understanding for how the employees' roles and actions make a difference.

In addition to their training and educational efforts, Company A also use the OSS to promote the motto "We care" within the organisation, which is part of the company's work with promoting openness and good relations between people in the organisation. One example of actions taken to promote this motto is the encouragement of administrative management and people in executive positions to visit the workplaces and get involved with the employees to establish better relations. This is especially important for Company A due to the size of their organisation, as they believe accommodating cooperative relations becomes more important the fewer people there are in the workplaces and in leadership positions compared to larger organisations.

Regarding leadership development in Company A, the HSEQ specialist described how it focuses much on promoting the mind-set that the management team should jointly own everything done in the OSS. Changes and initiatives should not be attributed to individuals and should instead be owned jointly by the group and the organisation. This is meant to both avoid placing undue pressure on individuals and avoid leaders becoming less committed or engaged in safety-improving efforts they are not personally responsible for. The leadership development also involves efforts to implement solutions for work environment issues together with site managers instead of the HSEQ group at Company A forcing the changes through. This is for the added benefit of ensuring that site managers' problems and needs are not forgotten, and to support them becoming less dependent on the HSEQ group.

3.2 Company B

Company B is a mining company operating underground and open-pit mines in Sweden mainly focusing on copper, zinc and gold. It also operates several ore processing and smelting plants adjacent to the mining facilities, employing

approximately 5000 people in total. In their safety policy, the company states that their aim is to strive for continuous improvements of health and safety performance, and to approach safety in a systematically planned manner. In order to maintain work environment quality, they promote a shared safety culture focusing on trust within the organisation, individual's responsibilities for safety and preventative safety measures.

3.2.1 Organisational Safety Management Program

The three interviewees from Company B described the organisational safety management program (OSMP) as a concept that constitutes the organisation's approaches and strategies regarding safety. The intended purpose of this program is to *establish shared mind-sets and attitudes to safety* throughout the entire organisation. According to the interview participants, its essential principles include ensuring that everyone works safely and feel comfortable in the workplace, and that people should feel a level of personal responsibility for ensuring their own and their colleagues' safety. In addition, the program promotes being receptive to both give and receive constructive criticism and comments regarding safety.

The OSMP began in Company B as a contract between the employees and their managers, where both parties signed stating they were taking responsibility for working safely, maintaining safety procedures and encouraging others to work safely as well. This contract was initially mandatory to sign but was changed over time to be voluntary. While some of Company B's operations still use a contract similar to the initial version, the compulsory nature of it has been removed at many of the other operations. Instead, the OSMP has developed into a representation of Company B's safety work and their safety culture. The goal was to make the management of safety less complicated by organising safety activities and systems under the same strategy instead of managing different individual concepts and projects for safety improvement. Some examples of activities and systems that are part of the OSMP strategy include event days focusing on health, environment and safety, and a system for categorising information regarding safety into two categories for knowledge-sharing purposes. According to the interviewees, the first category called "safety alerts" contains information regarding serious accidents and incidents that is disseminated within the organisation in order to raise awareness for risks and improve the readiness for their reoccurrence. The second category, "safety recommendations", instead contains improvements that have been made at one of the company's workplaces to facilitate their analysis and potential dissemination throughout the rest of the organisation. Both categories of information are uploaded to a company-wide internal network that everyone in the organisation can access.

When asked about the event days included in the OSMP strategy, the interview participants described how

safety-themed days for education and recognition have been implemented as a recurring feature. These are dedicated events where both the employees and managers at Company B's workplaces *collectively learn about and discuss different safety-related subjects with their colleagues*. Each of Company B's mining operations holds their own event days and decides themselves on which subjects and themes to focus on. As each workplace may have faced different challenges and issues, this allows them to tailor these event days according to their needs. An example of a theme during an event day given by the interview participants is the exploration of alternative strategies for safety development. One such strategy was the 'Total Safety Leadership' concept, which involved 2 days of safety training for employees, supervisors and managers focusing on understanding safe behaviours and how to promote them. During the event days, Company B's mines sometimes invite people from other mining sites in order to share what they have learned while working with their choice of themes and subjects. The focus of the event days commonly lies on what the interview participants call "softer" subjects such as developing communication, safe behaviours and values. "Harder" subjects such as technological safety improvements are instead managed by a protective materials group, in which representatives from several teams participate. According to the interview participants, attendance at the event days is mandatory for all employees, and different shifts are booked for separate times so that everyone can attend. In order to further encourage participation, the event days are considered to be "proactive activities" when calculating bonuses. Employees who participate in three proactive activities relating to health, environment and safety during a certain period of time are entitled a bonus to their salary. Proactive activities can include safety rounds; participation in risk analyses; and writing proactive, spontaneous event reports.

In order to communicate and disseminate the OSMP strategy and its principal strategies within the organisation, a variety of methods are applied. The OSMP strategy and its principles are highlighted on signs, stickers and message boards, and during meetings in order to encourage and remind people of the organisation's stance on safety-related subjects. Company B offers people the opportunity to sign up as an OSMP representative, who are responsible for learning more about safe work practices and to disseminate the OSMP strategy to their colleagues. OSMP representatives are also encouraged to be attentive of unsafe working conditions and to provide constructive feedback to their colleagues on how to work safer. Representatives wear work clothing and equipment marked with the logotype of the OSMP strategy, which indicates to other employees that the representative is available to answer safety-related questions.

According to the interview participants, the work with OSMP has contributed to changing the behaviours of

people in the organisation. People seem to be more receptive to opinions and constructive criticism regarding safe work practices, and are better at accepting such feedback as something positive rather than seeing it as an offence. This shift in behaviours has also affected discussions surrounding what the interview participants call “soft subjects”; people have become more comfortable with discussing how they are feeling, their personal burdens and how they are doing outside of work. Furthermore, they believe that the OSMP strategy has caused the management of Company B to adopt more safety-positive behaviours. Since its introduction, they have observed an increase in new technologies and changes to the organisation that bring safety improvements to the workplaces.

3.2.2 Digital Positioning System

In addition to their organisational safety management program, the participants from Company B were also asked about a digital positioning system that has been implemented in their underground workplaces. This positioning system allows for the tracking of the position of all employees, visitors and vehicles present in their underground mines by tracking work phones and devices connected to the local network, estimating their position based on their distance from network points. The smart work phones also help facilitate communication between employees, and the delivery of emergency warnings and instructions from the positioning system. According to the interview participants, vehicles in Company B’s mines are being equipped with digital tablets that are meant to act both as a tracker and as a map, allowing drivers to monitor the positions of people and other vehicles.

The primary use of the digital positioning system described by the interview participants is to automatically determine the status of people in the mines during emergencies: who is safe, who is unaccounted for, which rescue chambers are people using and so forth. The previous method for this was to manually report in whenever entering the mine and when reaching a rescue chamber. One benefit of the digital positioning system is that the time to ensure the safety of everyone in the mine is reportedly halved. This function of the system was lauded by the interview participants as its greatest benefit. Another function mentioned during the interviews was to use the positioning system to examine where and how people travelled and worked throughout the mine in order to plan the positioning of rescue chambers. This would also help with traffic management, as the vehicles equipped with tablets can get a better overview of the mine and can better avoid traffic-related accidents. Furthermore, the interview participants mentioned how the positioning system was being used to control the ventilation system in different sections of the mines. By reading what kinds of vehicles that are present

in a section and their diesel emissions, the system automatically adjusts the ventilation system in order to provide a safe working environment. Future usage of the positioning system planned by Company B is to implement what the interview participants called a “man-down” system, where an emergency signal can automatically be sent if a person in the mine is believed to be hurt or in danger.

During the introduction of the digital positioning system and its trackers, the management at mines implementing the technology was faced with scepticism from employees and the union. There were worries and criticism levied at the potential for misuse as the system could be used to control and monitor the employees more intrusively, intruding on peoples’ privacy. According to the interview participants, however, these criticisms were met by Company B by demonstrating the capabilities, benefits and limitations of the system in order to *provide some transparency in how they apply the technology*. After such demonstrations, and after the employees had experienced working in the mine after the technology had been implemented, the number of complaints about and the mistrust against the system had reportedly been reduced.

3.3 Company C

Company C is a contractor active in Sweden as well as in the international mining industry. The company specialises in drilling, including raise boring and exploration diamond drilling. They employed 210 people in total in 2017, of which about 90 worked in Sweden. The safety strategy of Company C is based on the management systems OHSAS 18001 and ISO 14001. The focus of their strategy lies on continuous safety improvements, a clear delegation of responsibilities and establishing high standards for work environment quality.

3.3.1 Risk Reporting Practices

During 2019, Company C saw an increase in the amounts of reported risks and accidents by their employees. This apparent improvement of reporting procedures in the organisation was credited by the interview participants to several different factors, one of which was a serious accident that occurred in one of Company C’s workplaces in 2018. An employee was injured badly in a gas-related incident that was described to have been preventable if people in the workplace had reported the problem when it was first discovered. As a seemingly preventable incident had injured one of their colleagues, the interview participants claimed that the incident had served as a revelation about the importance of reporting risks and incidents. This included employees at other workplaces than where the accident had occurred, as details about it had spread through informal networks in the organisation.

Another factor mentioned by the three interview participants that they believed contributed to the improvements in reporting procedures was the goals and the commitment of the supervisors. In the workplaces that had seen the greatest increase in the number of reports made, the supervisors had focused specifically on efforts to promote risk and incident reports. Furthermore, one of the supervisors had stated that their previous experiences as a safety representative had provided them with better knowledge and understanding of how to create safe workplaces in their role as a supervisor. As such, while experience as a safety representative is not required to become a supervisor at Company C, the interview participants believed that acquiring such experience can be an opportunity for improvement for supervisors. They also believed that this has caused Company C to consider *an individual's commitment for improving safety* to be an important resource in the development of safety performance, and that they should provide support for such dedication.

Company C has also dedicated more resources to provide training for supervisors and production managers that focuses on improving their communication with their employees regarding the state of the workplace. This was intended to help identify and spread information about potential risks, incidents and changes in the workplace. People in the organisation are also encouraged to report any measures taken for the purpose of disseminating that information within the organisation and to other workplaces, as the reports can be accessed through an internal network. This encouragement often takes place during Company C's workplace meet-ups, where supervisors, safety representatives and employees hold meetings and discuss subjects such as risks and reports. These meetings are often held without representatives from higher management levels being present, in order to promote a more open environment for discussion.

The final contributing factor for improving the reporting procedures at Company C mentioned by the interview participants was the generational shift occurring amongst the employees. According to them, their newer and younger employees are more likely to report risks and incidents in their workplace, including seemingly insignificant incidents such as lightly tripping on the floor. One interview participant speculated that the lower incident reporting frequencies from experienced personnel might be due to professional pride and not wanting to be seen as having made a mistake.

The improvements to the reporting procedures at Company C have according to the interview participants thus contributed to people reporting more than previously, including reports of risks previously considered to be insignificant. They do not want to discourage any specific type of reports, as that could be detrimental for people's motivation to make reports in general. One of the interview participants

noted that it can be valuable for Company C to make reports even if their customers (i.e. mining companies) do not consider it necessary. Furthermore, reports that are not relevant for the customer may still be interesting for Company C to examine for reviewing and sharing with other workplaces. In order to manage the larger influx of reports this approach yields them, the responsibility to investigate and solve less significant reports lies on site managers and supervisors while reports beyond their capabilities are handled by the upper management.

3.3.2 Environment, Health and Safety (EHS) Management

Company C's management of environment, health and safety issues, which they call EHS management, is governed by a number of different concepts. Firstly, *the management of work environments should be sufficiently prioritised and accounted for in decisions made within the organisation*. The implementation of changes and improvements to production must thus also analyse the impact on working environments, for example by analysing the impact on noise levels when implementing a new drill. According to the interview participants, this approach also applies to safety in Company C's EHS management; the stated goal is to *maintain focus on safety within the organisational culture and in the workplaces*. Furthermore, the EHS management is meant to promote candidness and a willingness to both provide and receive feedback regarding safety and work environment issues. Other subjects mentioned in the work with EHS included the utilisation of the employees' experiences and knowledge; the encouragement of involvement in proactive safety work; and the promotion of reports of incidents, risks and accidents observed and occurring during work. As a contractor, Company C is hired by different mining companies to supplement their workforce, which sometimes require extensive adjustments in order to adapt to the customers' workplaces, equipment and procedures. Company C's interaction with their customers' safety and work environment management thus depends largely on the customers' commitment and involvement, requiring a flexible EHS management. This includes striving to manage safety more independently with less engaged customers and in closer cooperation with their more active and invested customers.

In order to develop these EHS concepts and disseminate them within the organisation, Company C uses several different channels of communication. One such channel includes the forums for employees and safety representatives, where they can meet and discuss challenges and problems in their work through meetings. While an EHS representative sometimes participates to provide context and convey results, the meetings are at other times held without anyone from the upper management. The purpose of this according to the

interview participants is to *support a more open climate for discussions regarding workplace and safety issues*. The decisions taken by the upper management are communicated to the employees primarily through weekly meetings, where reports regarding risks and incidents, comments on implemented measures, and plans for future changes are described and discussed. Furthermore, the interview participants mentioned how the people responsible for the EHS management spend a lot of time out in the workplaces performing safety inspections in order to better understand the state of their organisation. With these channels of communication, they consider the level of communication between the upper management and site managers to be effective. The communication between the upper management and the employees, however, was considered to be less effective and needed further work to improve.

3.4 Company D

Company D is a mining company operating an underground mine in Sweden, producing mainly zinc, lead and copper. As a subsidiary of a larger mining group, it employs about 400 employees and performs prospecting, mining, enrichment and transportation. Based on the parent company's policy, Company D's safety strategy focuses on responsibility, both for management to prioritise the health and safety of employees and contractors and for the employees to actively report risks and participate in safety development initiatives. The company's core values focus on aspects such as "integrity" and "respect".

3.4.1 Fire Safety Management

According to the four interview participants from Company D, their fire safety management is based on the Swedish Mining Association's fire safety manual, developed by representatives from several Swedish mining organisations such as Company B, C and D. Fire safety management at Company D functionally focuses on identifying and eliminating risks through risk reporting, fire safety rounds, maintenance and inspections. These include technical inspections of potential fire risks in new equipment and recurring fire safety inspections of vehicles operated in Company D's workplaces. As an additional initiative, employees who are particularly committed to fire safety and are familiar with the mine they work in may apply for an emergency guide role. In case of a fire emergency, these guides are tasked with leading people to safety, taking care of the injured, and informing and directing emergency services when they arrive. For this purpose, emergency guides are provided training in smoke diving and participate in exercises held by emergency services.

According to the interview participants, the interest for and *commitment to fire safety is high in all levels of the organisation*, although this commitment may present

itself differently on different organisational levels. On the employee level, the awareness and knowledge of fire risks in the work environment are high due to their experience with and proximity to those risks. Miners at Company D are according to the interview participants knowledgeable regarding procedures for when fire accidents and incidents occur and show high awareness of potential fire risks such as missing fire extinguishers in vehicles. Commitment amongst supervisors can be identified by an extensive general knowledge of different fire risks in the different areas of the operation. This general knowledge is achieved through supervisor participation in fire safety training with the employees and by visiting the workplaces during safety inspections. Finally, the management level's commitment to fire safety is made apparent through the measures and initiatives that they design and implement which contribute to improving fire safety. Examples included the development of routines for fire safety inspections of every vehicle operating within the mine, the creation of the emergency guide role, and the enforcement of strict demands for fire safety evaluations when purchasing and implementing new technology and equipment. One of the reasons given for the strong commitment to fire safety in general within Company D was the fact that the workplaces mostly consist of underground environments. People are made aware of the increased risks in underground mining during safety training, such as smoke development in enclosed spaces, and that awareness contributes to their dedication to prevent fires.

Another significant contributing factor to the quality of fire safety management at Company D mentioned by the interview participants was the fire safety coordinator role. With their expertise, dedication to and knowledge of fire safety management, they were described as the reason behind many of the improvements made to the procedures and solutions relating to fire safety. In addition to the attributes of a particular individual, the improvements to fire safety were also said to have been made possible by the level of decision-making and control offered to the fire safety coordinator role. In Company D's organisation, the fire safety coordinator is given a greater degree of freedom when deciding on which fire risks and incidents to prioritise and resolve. This allows the coordinator to focus on addressing and solving neglected fire safety reports that had previously been regarded as unimportant and had not been properly evaluated, such as addressing fire safety concerns in the design of different workplaces that had not been accounted for. According to the interview participants, these efforts had resulted in the statistics for follow-up of fire incidents being more successful than in other areas, such as the follow-up of general accident and risk reports. The fire safety coordinator also acts as Company D's representative in the Swedish Mining Association. This involvement further contributes to the coordinator's expertise and allows them to better adapt

to developments to fire safety management in the mining industry.

3.4.2 Development of Accident Investigation Processes

The second focus area was Company D's development of the accident investigation process. The interview participants mentioned that this development was connected to a *change in attitudes towards reporting* rather than more accidents occurring in the organisation. People have purportedly become more inclined to report even minor, seemingly insignificant incidents instead of ignoring them and only focusing on more severe accidents. The interview participants attributed this to several factors, such as encouragement during meetings to report all risks or incidents. One initiative that was believed to have contributed significantly to this increase in reports was the change in reporting systems, where a new digital reporting system called GRIA provided benefits that made reporting easier for the employees. Compared to the previous system, the new GRIA system offered a higher ease of use, had less complicated reporting and follow-up processes, and allowed for employees to follow the development of their reports more easily. Supervisors and managers experienced with the accident investigation process lauded the GRIA system for facilitating faster and more efficient investigations, allowing for more risks and issues to be solved.

According to the interview participants, the investigation process in short involves successively analysing the cause of an accident or risk, in order to eventually find the initial source of the issue. As an example, they described how someone tripping on a doorstep could lead to analysing the ergonomic assessments of the workplace that did not identify its size as a potential issue. Their intention with utilising this methodology is to *ensure that they address the leading causes of a problem and not just its symptoms*, as the issue could otherwise escalate if left unchecked. When an investigation is initiated, the managers of that process identify and book meetings with personnel that are or could be relevant to include in order to better solve the issue. It was mentioned that the upper management in particular showed enthusiasm and availability to participate in many of these investigations. When investigating more severe risks or accidents, such as those in the latter accident categories, the process is generally quickly initiated and completed. However, according to the interview participants, the follow-up and investigation processes for minor risks and accidents were in need of improvement. Despite claims of prioritising safety, they would sometimes take a significant amount of time to be initiated and resolved. Of the potential reasons for the delays, the most significant ones mentioned were the number of people involved in the process and the difficulty to schedule these personnel for low-priority tasks. The relevant

personnel could also be working different shifts, which further delays investigations until a time can be found where everyone is available. Similarly, feedback on implemented solutions and measures for previously investigated accidents and risks was considered to be in need of improvement.

3.5 Summary of Safety Initiatives

In Table 2 are summaries of the safety initiatives that are explored in Section 3.1 through Section 3.4.2 as described by the interview participants.

4 Discussion

The purpose of this article was to investigate safety initiatives within four Swedish mining organisations as described by their safety leaders and specialists, which are summarised in Table 2. The goal was to highlight the possible connections between these safety initiatives and safety culture development. By interviewing experts from different mining organisations on safety initiatives developed and applied in their respective companies, opportunities to study examples of how companies in the Swedish mining industry approach safety culture development have been presented and explored.

4.1 Safety Culture in a Broader Organisational Context

The interview participants seemingly share the experience that safety initiatives should reflect and be part of both the general organisational culture and the specific safety culture within the companies. In several of the interviews, the stated ambition of the safety initiatives is that they shall support the development of the companies' safety performance. However, the participants also relate the initiatives to areas of development that broach cultural issues, inferring that they are intended to contribute to more than just effective solutions within a specific area of focus. An example of this is the OSMP in Company B; even if there are a variety of individual activities within the framework of this program that do not explicitly focus on safety culture, their long-term goals are to contribute to developing a desired culture within the organisation.

By analysing the safety initiatives as described by the interview participants, it is possible to identify similarities in how the subject of safety culture is directly and indirectly approached. Several of the safety initiatives, such as the OSMP mentioned above, Company C's EHS management concepts and the fire safety management at Company D, were described by interview participants as management practices and procedures, i.e. top-down controlled efforts

intended to develop and change people's behaviours and attitudes to safety-related issues. This is similar to methods of organisational culture development commonly applied within a normative conceptualisation of safety culture as described by Edwards et al. [4]. It is assumed in this perspective that only organisations which prioritise safety possess a safety culture and that organisations with fewer incidents and accidents must have a stronger safety culture than one with higher accident frequencies. Companies subscribing to this conceptualisation, whether knowingly or not, thus attempt to improve and develop their safety culture by focusing on changeable factors such as the policies, procedures and structures of the organisation. This would align with Guldenmund's [3] pragmatic perspective on culture being affected by and affecting processes and structures. Based on this approach, we believe that it is important to consider how, e.g., an increased focus on improving the division of roles and responsibilities may contribute to safety culture development. This can be seen in Company A's focus on providing site managers with more decision-making power and responsibility, which is an effort to alter organisational structures and safety management processes and, in time, integrate a more active involvement in safety development into the culture. The importance of clarifying different safety roles within the companies, as well as using this as an avenue for inclusion and generating an interest in safety-related matters on different organisational levels, was either directly or indirectly emphasised by interviewees from all participating mining organisations.

Examining the safety initiatives as they were described in the interviews thus highlights another important aspect to consider when implementing new safety initiatives aimed at supporting safety culture development: it is important to not rely solely on management perspectives when designing and implementing the organisation's structures and processes. Instead, the process must be permeated with communication and cooperation, empowerment and distribution of responsibilities, as well as the inclusion of employees at different levels [13]. Company D's effort to improve their system for risk and incident reports is one example of such efforts, where the new system was designed with better usability and more transparency for employees of the resulting investigation processes. Another example is Company A's strategy of providing their site managers with more decision-making powers and responsibilities in their workplaces' safety management. Besides making the employees an active part of the organisational structure and processes, this may also support the development of a workplace culture "owned" by the employees themselves that may become permeated with norms and values which the workforce has participated in establishing. Furthermore, this can also affect how the organisational structures and processes ultimately function given that a supportive culture could promote an increased

interest and participation amongst the employees in safety management. Organisational structures, processes and cultures can thus reflect and strengthen each other. This is, however, a good opportunity to reflect on the management-focused perspectives these descriptions of strategies and initiatives come from. Regardless of the changes to procedures, goals, or structures that leaders may strive to implement, it remains that cultural change is reliant on whether the change brings improvements and new experiences that are eventually perceived to be part of the culture by the people affected by them [14]. As such, the personnel's perspectives are integral to understanding the successes and potential failures of these safety initiatives and strategies to develop organisational cultures and should thus be considered in further research.

Another criticism of this perspective of culture development that may be raised is that it relies on a simplified definition of which aspects that constitute a culture within an organisation, and how it can be affected. In other words, a normative or pragmatic perspective can be said to disregard the more detailed explanations and explorations of culture made by authors such as Edwards et al. [4], Richter and Koch [5] and Schulman [7], to name a few. For example, Richter and Koch [5] emphasise that an organisation can contain several different safety subcultures that cover different work groups, teams and departments. While taking risks and circumventing standard procedures may be allowed—and possibly encouraged—within certain safety cultures, others may consider it to be unacceptable behaviour. These individual safety cultures within one company can be characterised by norms and values that are deeply rooted within teams and workforces. Schein [14] describes these as deeply held beliefs that are often taken for granted and can be difficult to affect through changes to the organisation's structures and processes. As an example, the attitudes towards risks and safety had, according to the representatives of Company C, seen more significant change following generational shifts amongst the employees or the occurrence of a prominent accident when compared to other safety management procedures. Experienced employees had been entrenched in old, established norms and values and were thus restraining change efforts through deliberate or unintentional resistance such as neglecting to follow new safety guidelines [15]. Furthermore, according to Edwards et al. [4], a focus on the pragmatic conceptualisation has led to a blurring distinction between safety culture development and safety management practice in general. The deep-rooted aspects of culture that are not easily changeable are what forces a normative approach to instead focus on organisational policies, procedures and structures. Safety culture is used more as a tool for measuring the safety performance of organisational and management policies [4], rather than a description of an individual or group's inherent assumptions, values and behavioural norms [6]. Based on this perspective, it may be prudent to apply a certain degree of humility during safety development efforts

as certain (sub)cultures involved in these efforts may include aspects and values that cannot necessarily be changed through direct interventions focusing on management structure and processes. Issues surrounding macho culture and risk-taking, for example, may require measures that more directly critique workplace norms (through, e.g., targeted educational programs) in their efforts to highlight the realities of working within a modern mining industry. We further believe that research is warranted to explore suitable methods for studying and applying proactive safety measures in the mining industry. A promising avenue is to apply a combination of normative, anthropological and pragmatic conceptualisations of safety culture, as argued by Edwards et al. [4]. A normative conceptualisation, in and of itself, has limited potential to evaluate levels of risk, as aspects of culture negatively associated with safety are not directly explored. Furthermore, focusing on a culture's "strength" as a primarily influential attribute may hinder analyses of the complex relations between the multitude of interconnected aspects of that culture. As such, approaching safety culture from a wider perspective, and applying it to the Swedish mining industry, may be worth investigating in order to explore other cultural aspects of safety development. In doing so, a more nuanced understanding of behaviours and attitudes in relation to safety development could help in creating initiatives that will be better accepted by the mining organisations and their employees. Furthermore, an ambition should be to further involve employees from the mining industry in the research process, production personnel and managers, as they possess experience and knowledge of the structures, processes and cultures that the safety initiatives will be interacting with [10]. Including practitioners from the mining industry in the research process can also help create results that are both practically and theoretically applicable. We would argue that, based on Reiman and Pietikäinen [16], individuals in key positions within companies could be involved in the development and implementation of new practices in the form of, e.g., measurable indicators for safety. This could contribute to the measurements in question, i.e. key performance indicators targeting a specific safety measure, being usable in practice given that the measures will answer an identified need within the companies, as expressed by the key individuals in question. Consequently, a practical connection can be made between safety culture development and safety management programs, as well as means to assess the outcomes of the new initiatives.

4.2 Conclusion

In conclusion, we assert that our study, with a focus on the Swedish mining industry, indicates that safety initiatives focusing on improving organisational structure and processes can be connected to safety culture development—in theory and in practice. The results of this study can thus be used by mining

organisations as a starting point for analysis and discussion on how to best support the development of safety culture on different levels of an organisation. However, it is also important to note the opportunities to explore different perspectives on safety culture outside the normative conceptualisation that is prevalent today. Placing a greater emphasis on and accounting for cultural practices, norms, beliefs and values in addition to management practices and procedures in initiatives for safety development could improve the conditions for their acceptance. Finally, a process permeated by inclusion, communication and cooperation is key for successful safety initiatives according to the interview participants. By working more closely together with mining organisations in a similar manner during research, the research field could discover findings previously unexplored.

Appendix

The following list comprised examples of the interview questions that were asked during our interviews translated from Swedish.

Introduction

- What is your professional role at [company]?
 - What work tasks does that role involve?
 - What responsibilities does that role entail?
- How long have you worked in your current position and role?

[General safety initiative questions]

- Can you describe [safety initiative]?
 - What are the stated goals/aims?
 - What methods and components comprise the initiative?
 - What makes this initiative unique to [company]?
- What effects of [safety initiative] have you experienced, observed, or otherwise been made aware of?
- How does your work interact with [safety initiative]?
 - Has your work been influenced or affected by [safety initiative], and if so, how?
 - Have you been involved in the development, implementation and/or work with [safety initiative], and if so, in what way?
- How have people in the organisation reacted to [safety initiative]?

- How has [safety initiative] affected other people's work?
 - Whose work has been affected?
 - Has [safety initiative] influenced people's behaviours and ways of work, and if so, how?
 - To what degree is [safety initiative] accepted within the organisation?
- What aspects of [safety initiative] have been most successful?
 - What aspects of [safety initiative] have the potential for further development and improvements?
 - How do you see [safety initiative] developing in the future?
 - What are the company's plans for the future of [safety initiative]?
 - How do you yourself see [safety initiative] developing in the future?

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Declarations

Competing Interests The authors declare no competing interests.

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