

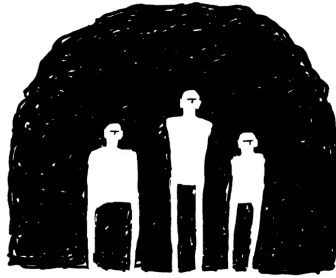
Excavating an understanding of safety management

Experiences and perspectives from the Swedish mining industry



Erik Sundström

Human work science



Excavating an understanding
of safety management:
*Experiences and perspectives
from the Swedish mining industry*

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Erik Sundström

Luleå, February 2025

Summary

This thesis explores the conditions for, interpretations of and reactions to safety management strategies and practices implemented in the Swedish mining industry. The concept of 'safety' is depicted as one of the more important aspects of organisational management in mining industry contexts by both the mining industry itself and by researchers in related research fields. However, due to the complex nature of mining industry operations, interpretations of 'safety' and priorities regarding its development can vary greatly between people from different roles operating in mining workplaces. A machine operator with a more practical perspective on safety management may for example prioritise the physical safety of themselves and their colleagues and considers themselves safe when there is mutual trust and cohesion within their team. Meanwhile, managers and safety specialists with more strategic perspectives might instead focus on efforts to develop cultural values which promote safer attitudes and behaviours, and on balancing productivity with safety goals. These perspectives both seek to address important issues that safety management efforts may aim to address, yet they are characterised by different approaches to safety.

While many different studies have explored safety and its management in mining contexts, the most common approach has been to consider safety based on the conceptualisations of leaders and managers. Few studies have approached safety management from the perspectives of personnel and contractor employees closer to the practical work. Fewer still are the studies that have emphasised these differences in approaches to safety in mining organisations and have examined how they can influence the outcomes of safety management efforts. The purpose of this thesis is thus to explore safety management in Swedish mining and highlight nuanced perspectives and experiences of methodologies and outcomes. In doing so, I identify how a broader understanding for and acknowledgement of the characteristics of mining industry safety management can help with addressing challenges for the continued management of safety.

The empirical basis of this thesis is mainly built upon two projects conducted between 2019 and 2024 within and with the Swedish mining industry which focused on studies of safety management strategies and practices. Their contributions consisted of a total of 26 interviews with safety specialists, managers, supervisors, employees and contractor personnel from several different Swedish mining companies. In addition, these projects provided opportunities for document studies of material relating to safety management strategies and practices, and for workplace observations at some of the participating companies' mining operations. The theoretical framework of this thesis focuses on organisational aspects which influence safety management efforts by, e.g., recommending certain approaches to management or exploring factors that can explain assumptions and behaviours relating to safety.

The results show that, while safety management in the Swedish mining industry is generally perceived as having shown progress in recent years, challenges related to aspects such as communication, leadership and differing conceptualisations of safety remain. A shared characteristic of these challenges is that they relate to and involve different groups with nuanced perspectives and conceptualisations of safety. Safety management strategies may for example be difficult for employees to engage with; and physical, social and organisational separations can hinder the development of shared safety cultures between, e.g., client and contractor personnel.

The experiences and examples examined in this thesis have shown how differences in expectations or interpretations can act as obstacles for effective and cohesive safety management efforts. Furthermore, this thesis has highlighted normative and top-driven approaches to managing safety and safety cultures in the Swedish mining industry, and the challenges it faces with addressing aspects such as power relations and underlying cultural values. Ultimately, this thesis suggests that safety management efforts would benefit from striving to understand and address the nuances between the various strategic and practical perspectives of safety involved. By encouraging communication, collaboration and mutual understanding for safety between different hierarchical levels and groups within mining organisations, these differences can be bridged and encourage more cohesive safety cultures.

Sammanfattning

Denna avhandling utforskar förutsättningarna för, tolkningarna av och responsen till strategier och insatser för säkerhetsarbete som implementeras i den svenska gruvindustrins organisationer och arbetsplatser. 'Säkerhet' som koncept skildras som en av de viktigaste aspekterna av organisatorisk styrning i gruvkontext av både gruvföretag och forskare i anknutna forskningsfält. Gruvdrift medför dock ofta komplexa organisatoriska strukturer som gör att tolkningar av 'säkerhet' och de prioriteringar som görs gällande dess utveckling kan variera mycket mellan de olika rollerna som är aktiva på gruvarbetsplatser. En maskinoperatör med mer praktisk syn på säkerhetsarbete kanske prioriterar den fysiska hälsan av sig själv och sina kollegor, och känner sig säkrast i grupper som har utvecklat ömsesidigt förtroende och god sammanhållning. Samtidigt kan fokus för chefer och säkerhetsspecialister med mer strategiska perspektiv vara att utveckla kulturella värden inom organisationen som främjar säkrare attityder och beteenden, eller på att balansera produktiviteten med deras säkerhetsmål. Personerna i dessa exempel strävar båda efter att hantera viktiga frågor kopplade till säkerhetsarbete, men de karaktäriseras av skilda tillvägagångssätt och synsätt på säkerhet. Av dessa perspektiv är det ledares och chefers conceptualisering av säkerhet som är mest förekommande bland studier som utforskar säkerhet och system för dess utveckling inom olika gruvkontext.

Få studier om gruvindustrin som utforskat säkerhetsarbete har fokuserat på anställdas och leverantörers mer praktiska tolkningar av säkerhet och synsätt på säkert arbete. Ännu färre är de studier som betonar dessa skillnader i synsätt och undersöker hur de kan påverka förutsättningarna för och resultaten av säkerhetsinsatser. Syftet med denna avhandling har därför varit att utforska den svenska gruvindustrins säkerhetsarbete för att lyfta fram nyanserade perspektiv och upplevelser av olika tillvägagångssätt och deras påföljder. På så sätt identifierar jag hur en bredare förståelse för och bekräftelse av säkerhetsarbetets kännetecknande aspekter inom gruvindustrin kan underlätta hanterandet av utmaningar för den fortsatta utvecklingen av säkerhet.

Den empiriska grunden för denna avhandling byggs huvudsakligen på två projekt som utfördes mellan år 2019 och 2024 tillsammans med den svenska gruvindustrin, vars fokus var att studera strategier och insatser för säkerhetsarbete inom den industrin. Bidragen bestod av totalt 26 intervjuer med säkerhetsspecialister, chefer, arbetsledare, tjänstemän, kollektivanställda och leverantörspersonal som arbetade för flera olika svenska gruvföretag. Vidare möjliggjorde dessa projekt även för dokumentstudier av material om säkerhetsprogram och strategier, samt för arbetsplatsbesök och observationer vid några av de deltagande företagens gruvanläggningar. Det teoretiska ramverket jag nyttjade mig av för denna avhandling fokuserar på organisatoriska aspekter som har en påverkan på säkerhetsarbete och insatser för säkerhetsutveckling. Exempel inkluderar rekommendationer för ledning och styrning eller utforskande av faktorer som kan förklara antaganden och beteenden relaterade till säkerhet inom organisationer.

Avhandlingens resultat visar på att många utmaningar gällande kommunikation, ledarskap och conceptualisering av säkerhet kvarstår för arbetet med och utvecklingen av säkerhet, trots att det upplevs ha förbättrats med tiden inom den svenska gruvindustrin. Gemensamt för dessa utmaningar är att de kan kopplas till att säkerhetsarbetet involverar olika grupper med nyanserade perspektiv av och förståelser för säkerhet. Till exempel kan strategier för säkerhetsutveckling vara svåra för anställda att involvera sig i, samtidigt som främjandet av gemensamma säkerhetskulturer mellan anställda och leverantörspersonal kan motverkas av de fysiska, sociala eller organisatoriska gränserna mellan dem. De upplevelser och exempel som studerats i denna avhandling har visat på hur skillnader i förväntningar för eller tolkningar av säkerhetsarbeten och strategier kan bidra till att förhindra utvecklingen av effektivare och mer sammanhållande säkerhetsinsatser. Vidare har avhandlingen även belyst utmaningarna för gruvindustrins normativa, ledningsstyrda säkerhetsarbete med att hantera viktiga aspekter såsom maktrelationer och latent kulturella värderingar. I slutändan hävdar jag att den svenska gruvindustrins arbete med säkerhetsinsatser skulle gynnas av att undersöka, förstå och ta itu med nyanserna mellan de olika strategiska och praktiska perspektiven av säkerhet och säkerhetsarbete som förekommer inom fältet. Genom att främja kommunikation, samarbete samt gemensamma förhållningssätt till säkerhet mellan olika hierarkiska nivåer och grupper inom gruvorganisationer kan dessa skillnader bryggas och uppmuntra värdet av sammanhållning bland industrins säkerhetskulturer.

Papers included in the dissertation

Paper 1

Understanding the mining safety research field: Exploring organisational safety measures and programs in international research.

Sundström, E. & Nygren, M.

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Paper 2

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

Sundström, E. & Nygren, M.

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Paper 3

A framework for safety performance indicators: The case of the Swedish mining industry.

Nygren, M. & Sundström, E.

Submitted for review to the International Journal of Mining and Mineral Engineering.

Paper 4

Workers' perspectives and experiences of mining industry safety management.

Sundström, E.

Submitted for review to the International Journal of Occupational Safety and Ergonomics.

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1 Introduction

In this thesis, I explore the potential of examining the characteristics of safety management approaches in the Swedish mining industry to identify opportunities for the continued development of safety. Workplace safety and its management are complex subjects to discuss in relation to the contexts of mining industry organisations. Interpretations of what ‘safety’ entails and how it is best improved can differ greatly when examining the various perspectives present in the field. A fleet supervisor’s main priority might be to organise today’s mining vehicle traffic to reduce the likelihood of accidents occurring while a work environment developer might be exploring methods for encouraging employees to provide more constructive feedback for the organisation’s safety strategies. Strategic, long-term development and practical daily safety measures are both valuable and important aspects of safety management. However, differences in priorities and conceptualisations of safety—and how such differences may obstruct safety management efforts—are rarely approached in research exploring safety improvements.

The mining industry has for a long time had an image of being a dangerous industry, in large part due to the numerous different risks involved and accidents that have occurred in its workplaces (Saleh & Cummings, 2011). Not only does this include dangers specific to mining such as rockslides, tunnel collapses, use of explosives or dust exposure, but also general workplace risks such as fires, traffic and air pollution that are exacerbated by the environment, especially in underground mines (Hansen, 2021). According to the European Statistical Office (Eurostat, 2022), mining and quarrying work ranked fifth out of ten in numbers of non-fatal workplace accidents with 1 535 incidents per 100 000 people employed. The rate of fatal accidents in this industry is the highest in the European Union, with an incident rate of 10 deaths per 100 000 people employed. Safety and its development are thus important subjects of focus in mining industries across the world, with the Swedish industry being no exception.

Many different initiatives, practices and strategies for safety development have been developed, implemented and promoted in both the mining industry and the surrounding research field. While these have previously focused on and continue to involve technological and practical solutions such as implementing new machinery, other measures focusing on organisational initiatives and aspects for improving safety have become more common since the 2000s (see, e.g., Kohler, 2015; Lööw & Nygren, 2019). Studies indicate to an increase in measures focusing on the organisation and management of work through the development of work procedures, efforts to organise work to minimise stress and exhaustion, and methods for better management of work groups. In addition, efforts to address the values, behaviours and attitudes of personnel have become more prominent among mining researchers and organisations. Mining organisations want employees that are more aware of the dangers in their environs and the potential consequences to themselves and others that these risks can incur. The promotion of these values can include statements encouraging employees to, for example, ‘look out for one another’ and to ‘be open to give and receive feedback’. Other ways include highlighting and promoting important positive behaviours relating to safety, or by rewarding the reporting of risks and accidents. These subjects are commonly approached in the context of establishing a desirable safety culture—basic assumptions regarding safety that will influence attitudes and behaviours (Guldenmund, 2000)—in the organisation. Interpretations of safety culture varies based on context and perspective, however, with some instead approaching safety culture as a substance possessed by organisations with a strong commitment to safety (Edwards et al., 2013).

Both in the field of research surrounding mining and in practice, the safety practices employed include strategies or initiatives designed to improve, address or promote certain organisational themes and subjects. Examples from the research field include researchers aiming to promote safe behaviours and attitudes through designing appropriate working environments (see e.g. Wyganowska & Tobór-Osadnik, 2018), the improvement of communication within the organisation (see e.g. Bahn, 2012), and the support of personal ownership of and accountability for creating safe workplaces (see e.g. Haas & Yorio, 2021; Laurence, 2005), to name a few examples. Practical examples include the Swedish mining organisations that implement and employ safety programs with similar behavioural and cultural focus, such as LKAB's (2019) 'Safety first' and Boliden's (2016) 'BeSafe' initiatives.

Over time, accident rates in mining workplaces have been reduced, and losses of life are becoming more and more infrequent. Based on the Swedish Association of Mines, Mineral and Metal Production's (SveMin)s accident frequency statistics, the number of accidents occurring per 1 000 000 worked hours in the Swedish mining industry has reduced from 51,3 accidents in 1981 to 6,0 in 2020 (SveMin, 2021b). Alongside this development, the management of safety has similarly continued to evolve, now including both practical and organisational solutions to address workplace hazards, psychosocial risks and other challenges relating to safety. Laws and regulations regarding safe working practices in Sweden have continued to develop as well, providing the modern mining industry with a more robust regulatory framework (see, e.g., (Swedish Work Environment Authority, 2022; Systematic Work Environment Management, 2001). Alongside new regulations, technological developments and changing employment conditions, the continuously evolving conditions for safety management in the mining industry must be accounted for.

Safety management has been explored from multiple perspectives in international mining industry research. Researchers have reviewed theoretical perspectives (Nowrouzi-Kia et al., 2018), examined documentation (Gunningham & Sinclair, 2014), interviewed safety leaders and managers (Bahn, 2013), approached workers and employees (Es'haghi et al., 2020), and studied mining contractors (Valluru et al., 2020), all relating to safety management. However, while mining employees have been included as study participants in several cases, few have sought their interpretations of safety management practices. The focus has instead seemingly been to apply organisational leaderships' conceptualisations of safety to the employees' perspectives. This can be seen in the multitude of survey studies performed in relation to mining safety management, where employees are questioned regarding their positions on important factors contributing to workplace safety (see, e.g., Jiskani et al., 2020; Parker et al., 2017; Ye et al., 2020). If safety management strategies are explored exclusively based on the perspectives of leaders and managers, researchers and safety practitioners may overlook valuable practical knowledge.

Despite the variety of approaches by the research field, relatively few studies have analysed these perspectives in contrast to each other, with researchers generally taking a top-down approach—i.e., applying management and leadership interpretations—to understanding safety management. More studies that do approach the employees' perspectives have appeared in recent years, often focusing on methods for how to help them understand the safety management strategies that management are trying to implement (see, e.g., Chen & Zorigt, 2013; Gunningham & Sinclair, 2014; Haas & Yorio, 2019). Similarly, organisations in the Swedish mining industry have explored ways to motivate employees to participate in safety management practices (Löow & Nygren, 2019).

What remains relatively unexplored are the motives behind different approaches to safety management efforts, especially from the perspectives of the employees of mining companies and contractor workers respectively. Contrasting the safety goals of organisational leaders with the reactions of those whose work is directly affected can highlight different aspects influencing the management of safety. Furthermore, while it may be more pragmatic to approach research on safety from a top-down perspective, there are more nuances and opportunities to be explored in other perspectives and interpretations.

With the incorporation of organisational safety practices and initiatives in safety management strategies becoming more common, the question arises as to how these might be experienced and received. The people whose daily work is more likely to be affected by safety management changes, e.g., machine operators, supervisors, contractors, may have different perspectives on the strategies and practices than the leaders and managers applying them. They might have different interpretations of their purpose, the benefits and disadvantages with their implementation, and the aspects important for their success. Such differences can be the source of disagreement and organisational resistance (Bellgran & Säfsten, 2005; Jacobsen et al., 2002) while also serving to highlight previously undefined problems and opportunities to be addressed, which is what inspired me to focus on this subject of research. Striving towards well-coordinated, effective safety management strategies and practices requires the contrasting experiences from all participating perspectives. Additionally, it requires an understanding of factors influencing modern safety management in the Swedish mining industry in order to anticipate and manage these influences successfully. With these understandings, we will be better positioned to identify and address the opportunities for and challenges with safety management within mining organisations and between clients and contractors.

1.1 Purpose and research questions

The purpose of this thesis is thus to *explore the characteristics of safety management in the Swedish mining industry found in different interpretations and experiences of management practices and strategies*. The goal of this is to *support more informed approaches to challenges and opportunities with safety development*. I have limited the scope of this thesis to the Swedish mining industry for the sake of examining a more coherent cultural, societal and regulatory context. I consider this a novel subject to study due to the absence of studies exploring it in the Swedish industry despite its potential value for meeting future challenges regarding work environment in mining workplaces.

Three research questions were established in order to better guide the process of exploring safety management strategies and practices from different perspectives:

- 1. How is the development of safety management discussed by safety professionals and managers in the Swedish mining industry?*
- 2. What characterises safety management policies and strategies in the Swedish mining industry?*
- 3. How do mining company and contractor employees in the Swedish mining industry experience and interpret safety management in practice?*

The first question pertains to the perspectives of leaders of Swedish mining organisations and operations. The second is used to supplement these perspectives by examining stated and established safety management policies and guidelines. These offer insight into existing attitudes and approaches to safety management demonstrated by the leaders of safety management in the Swedish mining industry. Solely relying on reviews of strategies and documented approaches to safety management does not allow for a comprehensive understanding of how safety management in mining is experienced, however. The third research question thus focuses on analyses of the “practical perspective”—the perspectives of the people whose work is directly affected by strategies and practices.

2 Context

This chapter describes the context within which this thesis is situated. It describes the Swedish mining industry that I have focused the thesis on, including the people and roles active in the industry, and a summary of how safety in mining has been and is depicted by organisations and in society at large.

2.1 Swedish mining work

Mining as a method of natural resource acquisition is an essential aspect of almost all societies of today. Most if not all industries currently operating rely in some form on natural resources extracted through mining. In the pursuit of ore and mineral resources, the Swedish mining industry consists of both underground and above-ground mining operations which are primarily located in the northern part of the country. Sweden stands as the largest iron ore producer in the EU according to the Geological Survey of Sweden (SGU, 2020). While the number of active mines has dropped from around 250 mines in the 1900's to 12 mines today, the total production of minerals has increased significantly, producing 87.9 million tonnes of ore in 2020. The annual revenue for the industry in 2020 reached 49 billion SEK, or approximately \$5.24 billion. The majority of Swedish mines are located in the northern part of the country and excavate iron ore, base metals and gold, while mines located in the south mostly consist of base metal mines. Much of the work in these mines involves operating heavy vehicles and machinery for blasting, loading, and transporting the excavated rock and ores.

While there are similarities in the nature of the work in both types of mines, underground mining involves very different environmental conditions and workplace risks compared to above-ground operations. Further variation can be caused by differences in the surrounding environment, the characteristics of the rock and minerals being excavated, the presence of different organisations operating in the mines, and site-specific management strategies. As such, each individual mine often requires

unique safety management methodologies and practices, tailored to suit the needs and circumstances of its personnel and workplaces.

According to the Mining Inspectorate of Sweden (2023), the majority of mines operating in the Swedish industry are owned by two larger companies, with one owning three mines and the other five. The remaining four mines are owned by smaller mining companies. While these companies all employ their own personnel for much of the work, a relatively significant portion of mining work in Sweden is done by contractors (Liljenstolpe et al., 2023). This can range anywhere from drilling work, vehicle operation, safety inspections, or maintenance depending on the needs and strategies of the employers who own the mining workplace. This adds further complexity to the subject of safety cultures in the Swedish mining industry, as the organisational cultures of these contractors must adapt to accommodate their clients.

According to the Swedish Association for Mines, Minerals and Metal Producers (SveMin, 2021b), accident rates in the Swedish mining industry have significantly declined over the last 30 years. The number of injuries causing an absence has reduced from 51.3 in 1981 to 6.0 in 2020 per one million worked hours, while the amount of fatal accidents has dropped from 1.1 per one million hours in the 1950s, to 0.06 in 2009 according to Lööw and Nygren (2019). Similar trends can be seen in other countries as well. For example, the estimated loss of employee hours due to injuries in United States metal, non-metal, stone, sand and gravel mining has according to the U.S. Department of Labor (2021) gone from 139 million hours lost in 1993 to 25 million hours in 2020. Another example is the Australian mining industry, where the number of fatal injuries per 1000 employees has dropped from 0.25 in 1997–1998 to 0.015 in 2019–2020 as reported by the Government of Western Australia (2021). In Sweden, this decrease has according to Lööw and Nygren (2019) coincided with the increased focus on organisational safety measures and strategies, otherwise called safety initiatives.

Swedish work environment legislation regarding health and safety in mining work in Sweden is primarily managed by the Swedish Work Environment Authority. They provide provisions to clarify and support the Work Environment Act, a law that prescribes to all employees in Sweden the right to a good work environment (Work Environment Act [SFS], 1977:1160). This act applies to all industries and workplaces in Sweden, including the mining industry. As such, the general guidelines and regulations for good working environments provided by the Swedish Work Environment Authority, such as the Systematic Work Environment Management provisions (Systematic Work Environment Management [AFS], 2001:1), are applicable to all industries as well. Systematic work environment management (SAM) is defined as:

“[...] the work done by an employer to investigate, carry out and follow up activities in such a way that ill-health and accidents at work are prevented and a satisfactory working environment is achieved.” (AFS, 2001:1)

Provisions for specific industries and workplaces are created in cases where issues more specific to a certain type of workplace require managing. For the mining industry, the rock and mining regulation (AFS 2010:1) provides regulations for topics and issues specific to mining workplaces in addition to the generally applicable provisions. The Work Environment Authority advocates for various safety management strategies, including for organisations to develop and support positive safety cultures by prioritising safety on all organisational levels (Swedish Work Environment Authority, 2022). They define safety culture as the shared attitudes, values and assumptions held by managers and employees regarding safety and work environment. Cultivation of positive safety cultures is described to primarily depend on quality management in addition to efforts to adapt technology and the workplace to the needs of their users.

Another provision included in the Work Environment Act (SFS 1991:677) is that employers with five or more employees must appoint and train one or more of them to act as safety representatives, also known as work environment representatives. These representatives are responsible for monitoring the protections from illness and accidents in the workplace and the employer's compliance with other obligations such as SAM. They are granted the rights by this provision to order the suspension of work in cases where it involves immediate danger and cannot be immediately solved by the employer. The law also states that representatives must be included in the planning of additions or alterations to their working environment, equipment, processes or the organisation of work.

In addition to the Work Environment Authority, industry associations such as SveMin (2021a) also provide guidelines for safe mining workplaces. SveMin represents around 50 Swedish mining industry companies and have a significant influence on mining work in Sweden. They provide documents compiling Swedish regulations and laws that may be relevant in mining work beyond the AFS 2010:1 and give recommendations for establishing safe workplaces. Some of these recommendations, such as their guidelines for fire safety in underground work (see, e.g., Svemin, 2016), have been developed through collaborations between the different organizations in the industry association.

2.2 The Swedish miner

According to the Geological Survey of Sweden (SGU, 2023), the Swedish mining industry employed 7,773 people as employees in 2022, with an additional 800 people employed as contractors. The gender distribution between men and women in this field at large was estimated to be 74% and 26% respectively in 2023 (Liljenstolpe et al., 2023). Swedish mining is structured to involve both blue-collar and white-collar work with a range of both low-skilled and high-skilled positions, however the modern industry has shifted towards higher average levels of education compared to its previous iterations (Lööv et al., 2019).

The industry currently encompasses over 200 different professions, encompassing both blue- and white-collar roles. Some examples include blast technicians, machine operators, mechanics, maintenance engineers, process operators, computer technicians, electrical engineers, health and safety coordinators, production managers, and more.

The mining companies in Sweden directly employ people for many of these different roles, however it is not uncommon for practical work tasks such as machine operators and maintenance tasks in mining workplaces to be delegated to contractor companies. The scope of contractor work, subcontractor work and indirect employment in the industry is difficult to determine due to a lack of comprehensive, consistent and recent data. While the Geological Survey of Sweden accounted for 800 people employed as contractors in the Swedish mining industry, other sources have come to different estimations. The union IF Metall (2015) estimated that the industry employed a total of 10,000 people in the early 2000's, of which about 6,000 were direct employees and the remaining 4,000 were contractors and subcontractors. With employment in mining rising in the years since then (SGU, 2023), it is unclear where the number of (sub)contractors in the industry lies today. Analyses of the proportion of work performed by contractors in the Swedish mining industry varies in a similar manner depending on the time period and source. While SveMin estimated in 2010 that 14% of mining industry working hours in 2010 were performed by contractors, other sources later estimate the numbers to be much higher, possibly as high as 40-50% (IF Metall, 2015; Nygren, 2018). A lack of exact statistics notwithstanding, the Swedish mining industry employs a significant amount of contracting and subcontracting for many different work tasks. As such, a description or analysis of Swedish miners must thus include the employment and working conditions of the industry's contractors.

2.3 The depiction of safety in a broader Swedish mining industry context

At this point, it has been clearly demonstrated that safety is a very important organisational subject in Sweden. What was historically seen as heavy, dirty and dangerous work done by hand around the 1950's would according to Abrahamsson and Johansson (2006) see several improvements over the years. Examples include several heavier or dangerous work tasks becoming automated or remote controlled, vehicles providing more protection to the workers, and general working environment improvements being introduced, such as better ventilation. While it's hard to say whether these improvements were more motivated by economic factors rather than safety-related reasons, the fact is that mining work did develop to become safer in the sense that fewer accidents and incidents occurred.

Historically, wider adoption of the concept 'Safety first' in Swedish industries began around the end of the 1920's, when worker protection trends from America started seeing wide use (Sund, 1993). Today, the strategy of "Safety first" can be found to some degree in most industries of Sweden, especially in the mining industry field. The goal of holding the safety of people and equipment as a highest priority is a part of most major mining-related company in Sweden. They communicate this goal through descriptions of their values and priorities on the companies' webpages and in their policy documents. One example includes Boliden (2020) saying they hold safety in the highest priority both in regard to working environments and their impact on outer environments, that everyone working should be able to return home without their health being affected by their work. Another example is how Zinkgruvan Mining (2020) claims that safety is first on their agenda; that their goal is to improve awareness of risks and accidents, change attitudes, and work towards the final goal of zero accidents.

One notable example is the company LKAB naming their safety program 'Säkerheten först' in 2006, which directly translates to 'Safety first' (LKAB, 2019a). Proponents of this concept promote proactive safety management by developing positive safety cultures throughout all levels of an organisation (Andersson, 2012). Since the first implementation of 'Safety First' at LKAB, similar notions and strategies have propagated and become commonplace amongst organisations within the Swedish mining industry (Löow & Nygren, 2019).

3 Theoretical framework

The theoretical framework developed for this thesis is used to facilitate my analyses of different perspectives on mining industry safety management and to evaluate potential opportunities and challenges with the explored approaches. In my research's empirical exploration of Swedish mining organisations, various organisational theories have been included to better understand and analyse the themes explored in the papers appended to this thesis. I highlight different conceptualisations of and approaches to safety in order to better understand the goals which the mining industry's safety management efforts are intended to fulfil. Together with a similar review of some of the methodologies involved in such efforts, more informed analyses can be made regarding the perspectives on safety management found in the Swedish mining industry. Finally, I complete this framework with theories on organisational culture and boundaries to explore factors which influence decisions made and assumptions held regarding safety and how it is approached.

3.1 Prior safety management research

Before delving into my theoretical framework, it is important to contextualise this thesis within the mining safety research field. Safety management efforts are predominantly focused on strategies and practices for mitigating occupational injuries, illnesses and losses (Haas & Yorio, 2016). To this end, many studies in the mining research field have focused on how to develop, evaluate or implement various technological and practical solutions to safety issues. This could for example include models for predicting blast vibrations (Qiu et al., 2022), or investigating the use of new sensor technology (Duarte et al., 2022). The technological and practical solutions are complemented by a wide range of research incorporating organisational factors such as policies, practices and safety culture as methods for safety management and development. According to Lööw and Nygren (2019), companies in the Swedish mining industry began focusing on organisational factors for safety development in the early 2000s.

While organisational factors have been touched upon in earlier mining industry research (see, e.g., Trist & Bamforth, 1951), studies exploring organisational safety measures became more common around the same time period as the Swedish mining industry (see, e.g., Sundström & Nygren, 2023b). Common factors to explore include subjects such as safety culture development, communication, knowledge development, leadership and empowerment in safety management contexts (Sundström & Nygren, 2023a). In doing so, researchers have sought to better understand potential causes for accidents, create models for workplaces with better safety outcomes, and to identify methods for mitigating or preventing future incidents. Examples include Laurence (2005) promoting regulatory frameworks focusing on safety cultures and Komljenovic et al. (2017) identifying how certain aspects of organisations may represent risks for leadership efforts. The exploration of organisational factors and their role in safety in mining has continued to be developed and adapt alongside the development of new technologies and strategies for safety development.

Mining safety research is further characterised by a focus on exploring the concept of safety and its management from a top-down perspective. Studies in this research field have included personnel at various levels of organisational hierarchies as study participants, from contractor employees to safety management specialists. When researchers establish their aims, angles of approach and their conclusions, however, they predominantly apply organisational and theoretical methods and conceptualisations. Examples include studies evaluating working environments through surveys for safety experts (Wyganowska & Tobór-Osadnik, 2018) and interpreting unsafe behaviours as a sign of ineffective regulations (Wang et al., 2019). Studies that have analysed mining industry safety management based on the experiences and understandings of more practical perspectives (see, e.g., Bahn, 2012) are much more uncommon. As a result, safety management has largely been explored within the research field with comparatively lacking consideration for the conditions of practical roles.

3.2 Conceptualisations of safety

Safety management is a complex subject to discuss, in part due to the multitude of conceptualisations regarding its characteristics and their importance. Definitions of safety management as a concept can vary between individuals, groups and organisations, which will affect their decisions and reactions to safety. While each approach to safety improvement may share common characteristics based on adhering to regulations or industry standards, the key differences lie in their areas of focus. One approach may seek to improve safety performance through the delegation of responsibility and empowerment (Nygren & Sundström, n.d.), another through addressing psychosocial safety climates (Yu & Li, 2020), while a third may prioritise the promotion of safety-positive behaviours and attitudes (Wu et al., 2017). These areas of focus are not necessarily exclusive to one another, but different approaches typically prioritise some aspects differently from others.

In order for me to present my analyses regarding safety management strategies and practices, it is important at this point to discuss what ‘safety’ and ‘the management of safety’ can entail. ‘Safety’ is a concept that has been given many different definitions in research fields by various authors. Some consider safety from a perspective focused on the accident and injury rates of workplaces, where a safe workplace provides protections from risks of harm, both to people and equipment, in order to prevent such accidents (see, e.g. Osborne & Zairi, 1997; Aldrich, 1997; Beus et al., 2016). Safety is often linked with the concept of ‘health’ in mining industry contexts, where ‘safety’ is used to refer to immediate dangers and harms, such as a tunnel collapse injuring a person, and ‘health’ refers to more long-term effects, such as lung damage from inhaling dust (Saleh and Cummings, 2011, as cited by Lööw et al., 2019).

In addition to these pragmatic perspectives on safety, there are other interpretations that incorporate organisational and social aspects. Safety is defined not just as protection from harm; a safe workplace will also strive to make you *feel* safe and will be made up of people who understand the importance of safety (Whiteoak & Mohamed, 2016). These interpretations of safety are not exclusive to one another and are prioritised to varying degrees depending on the context.

‘The management of safety’ is a similarly flexible term, but it generally encompasses management efforts to reduce accident rates, mitigate risks and harm to personnel, and reducing absenteeism (Osborne & Zairi, 1997). While safety management strategies and practices can contribute to reducing accident rates, some authors like Reason (1997) believes it may be impossible to completely eliminate the risk of accidents. Due to largely unavoidable factors such as human errors or truly unexpected equipment failures, industrial workplaces will inevitably suffer some form of deviation from standard operations regardless of how ‘safe’ they are considered to be. The goal of safety management could thus be described as improving a workplace’s resistance to the consequences of accidents and hazards, and in ensuring those consequences do not cause harm to the people involved. These definitions liken my own interpretations of ‘safety’ and ‘safety management’ which I have applied in my research. I approach safety on both a physical and psychological level, with safety management thus entailing the efforts to create workplaces where people are protected from harm and *feel* safe. While accident and incident rates offer a valuable reactive indicator of safety issues in an organisation or a workplace is, I believe it vital to also approach safety through proactive, qualitative assessments and measures. This conceptualisation is shared by others in the Swedish mining industry as proactive measures of safety management have seen more development over time (Löow & Nygren, 2019).

When analysing how ‘safety’ is conceptualised, it is important to specifically examine how safety is *measured*. The methods and practices applied in an organisation’s safety management systems can according to Vinodkumar and Bhasi (2010) serve as indicators of characteristics such as its safety culture, its safety performance and its people’s commitment to safety. Safety culture and its relevance to mining industry safety management will be explored further in a later subchapter, but one summary by Antonsen (2009) describes it as a set of shared, safety-related attitudes, values or assumptions. As is explained by Bisbey et al. (2021), the assumptions of a group or organisation can serve as the foundations for their members’ safety-related behaviours. The term ‘safety performance’, meanwhile, can be used to refer to two different concepts according to Christian et al. (2009). The first is as a metric for safety-related behaviours, with high-performing workplaces consisting of people following rules and policies in addition to participating in safety management practices. The second is to use safety performance in reference to an organisational metric for safety outcomes such as incident rates or the number of accidents per worked hours. In this sense, the former interpretation assesses the level of safety by proactively analysing safety-related behaviours while the latter is reactive to the outcomes of those behaviours.

While there are several different metrics for measuring safety that are applied by safety practitioners, the most prevalent in both theoretical and practical contexts are accident frequency rates. Accident rates are, as stated by Christian et al. (2009), often used in reference to safety performance, with the number of accidents across a number of hours worked being common variables used in industrial contexts (see, e.g., European Statistical Office, 2022). High accident rates work well as indicators of unsafe workplaces, organisations or industries, highlighting the need for improvement and new management efforts (Oswald, 2020).

In some safety-related contexts and research, this logic is inverted, implying that low accident rates are indicative of workplaces or organisations being safe (see, e.g., Bentley & Haslam, 2001). Beus et al. (2016) effectively describe the flaws of this understanding by emphasising how a lack of accidents in a workplace may simply be a temporary reprieve. In other cases, unnoticed hazards may be accumulating over time until a breaking point is reached, and an accident occurs, such as when supporting structures such as gratings are left to slowly degrade.

In presenting these distinct conceptualisations of safety and approaches to its management, some of the challenges with safety development are made clear. It is not difficult to imagine the conflicts that may arise based on differences in expectations and norms regarding safety between different groups and individuals. One group may prioritise more immediate initiatives to secure physical workspaces over other strategies while another may consider long-term efforts to improve people's risk perceptions to be more important. Without an understanding of and strategies for addressing such differences, safety management efforts may risk contributing to further friction between groups with different expectations and needs.

3.3 The management and development of safety

Having established some of the more prominent ways safety can be conceptualised, it is also valuable to examine how safety practitioners gravitate towards certain methods and approaches to safety development based on those interpretations. As was shown by Lööw and Nygren (2019), safety management efforts—specifically in the Swedish mining industry—have seen several significant developments in terms of methodology and practice since the 1980's. New technologies are consistently being developed to address hazards and risks, and various organisational measures have been explored to manage aspects like psychosocial work environments. Much of safety management literature thus focuses on highlighting the many different tools available to practitioners of safety management in modern industrial contexts and how they could best be utilised.

An example is the author Reason (1997), who considers workplace hazards in industrial contexts as something inevitable; regardless of the safety measures and policies that have been implemented, unforeseen accidents may still occur. Whether because of human errors or external, uncontrollable factors, organisations must thus be prepared to manage hazards and risks by implementing suitable systems and strategies. The methods for safety management recommended by Reason thus include several proactive measures and strategies. Such measures are described by Oswald et al. (2018) and Lingard et al. (2017) as potential proactive or 'leading' indicators of safety performance, i.e., features that can contribute to preventing unwanted safety outcomes in the future. Reactive or 'lagging' safety indicators such as measuring lost-time injury frequencies (LTIF) are useful in many contexts, including for identifying areas of improvement (Nowrouzi-Kia et al., 2018) and in highlighting historical safety management developments (Löow & Nygren, 2019). However, focusing too much on reducing LTIF as a safety goal could potentially impede an organisation's work to address challenges that are difficult to discern through such metrics, psychosocial work environments being one example. Organisations must be able to learn from past incidents while also being aware of latent conditions that could contribute to future accidents.

A common characteristic of most modern safety management theories is that they are primarily consider safety from a top-down perspective, i.e., as an issue that can only be solved through management efforts and strategies. Many approaches to safety management in both theoretical and industrial contexts thus emphasise leadership in some way. Strategies for improving safety through leadership vary from leaders focusing on building trust and demonstrating commitment to safety (see, e.g., Ajith et al., 2020; Balogun et al., 2020) to addressing psychosocial stress factors (see, e.g., Yu & Li, 2020; Zhu et al., 2020). With this subject's ubiquitousness in safety management contexts, approaches to leadership and their influences on strategies and management decisions are nuanced.

Trust is an aspect of leadership commonly linked to success with safety development, with focusing primarily being on how leaders can develop and maintain trust in their management efforts (see, e.g., Gunningham & Sinclair, 2014; Parker et al., 2017, p. 201). The benefits of building trust in safety management partially lies with the potential to mitigate resistance to the changes that occur when addressing safety issues (Doeze Jager et al., 2022). Furthermore, mutual trust across hierarchical levels is considered to facilitate effective communication in organisational contexts (Törner, 2011). Various methods can be pursued in order to foster trust with varying success depending on the psychological and organisational cultures and climates within the organisational context in question. This can for example involve personnel following and engaging with safety policies provided that management has addressed their concerns regarding important risks and hazards.

A leadership approach closely related to trust is to focus on empowerment by delegating more authority and responsibility to personnel at lower hierarchical levels. Empowerment can be succinctly described as a process by leaders to allow and provide employees with more control over their work (Monica, 2019; Rothman et al., 2019). Examples of this can include delegating responsibilities to and implementing training for employees, supervisors and managers to participate in the management of safety issues and their work environment. According to Monica (2019), in addition to building trust, the proposed benefits of empowerment also include improving morale and productivity by creating a more engaged and informed workforce. Empowerment is a well-established practice in industrial contexts, with Swedish work environment regulations requiring all employers to incorporate it in their safety management processes in order to ensure health and safety management is incorporated in the daily work (see AFS 2001:1, Provisions for Systematic Work Environment Work).

While these examples are not exhaustive depictions of their related methodologies, they serve to describe the more common approaches to safety management found in Swedish mining industry contexts. The relative scarcity of safety management methods approaching the subject from a bottom-up perspective, i.e., by developing safety practices with lower-level employees, highlights a relatively untapped resource in this field. Empowerment of lower organisational roles in safety responsibilities is an interesting option for accessing other perspectives on safety management, but its efficacy as a method must be further evaluated.

3.4 The role of culture in safety management

In any organisation, there are many different factors that can influence people's decisions and interpretations of occupational safety. A prominent factor in both theoretical and practical contexts is that of safety cultures, which has significantly influenced this thesis' studies. Safety cultures are promoted and discussed in theoretical contexts by the safety research field (see, e.g., Guldenmund, 2000), and in practical contexts by organisational strategies and work environment regulations (see, e.g., Boliden, 2016; LKAB, 2019; Swedish Work Environment Authority, 2022).

Before approaching safety culture theories, however, I believe it important to also address theories regarding the overarching culture shared by individuals, groups and collectives within organisational contexts, i.e., organisational cultures. Safety culture theory is, in essence, an offshoot of general theory regarding organisational cultures, and shares many foundational characteristics and functions. As such, examining general theories regarding organisational culture can allow for a better understanding of foundational characteristics of safety culture, which facilitates my analyses on how the mining industry address them.

The term ‘culture’ can be used in reference to a wide array of concepts, including social patterns, the treatment of others, relationships between hierarchical levels, or informal rules and procedures (Schulman, 2020). Organisational culture is used in similarly nuanced ways; sometimes referring to beliefs, sometimes to symbolism, and other times to values and norms. Alvesson (2015) defines organisational culture as a concept encompassing people’s relations to symbolism; the effects on people’s experiences and ideas linked to the groups they’re part of; and its properties as a system providing us with shared guidelines, values and assumptions. Furthermore, organisational culture can serve to explain various approaches, processes, institutions, and how objects, actions or statements are interpreted.

Culture is thus considered essential for understanding several different aspects of an organisation, including the behaviours, values and assumptions within or between social units. By better understanding the impetus behind how people and groups think, interpret and act, it becomes easier to respond and adapt to such factors. The influences of culture on an organisation’s safety management practices relate to how people’s assumptions and attitudes toward safety, and to the decisions behind safety strategies and initiatives. Another prominent expert—Schein (2017)—focuses on the developmental nature of culture in their definition of the concept, stating that:

“The culture of a group can be defined as the accumulated shared learning of that group as it solves its problems of external adaptation and internal integration; which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, feel and behave in relation to those problems. This accumulated learning is a pattern or system of beliefs, values, and behavioural norms that come to be taken for granted as basic assumptions and eventually drop out of awareness.” (Schein, 2017, pg. 6)

This definition was created to summarise and, in a sense, combine 12 different existing definitions of culture that Schein had encountered, further highlighting the potential variability of how the concept can be interpreted. According to Schein (2017), leadership is involved at all stages of cultural development. When new groups, organisations and movements are created, they are determined in large part by their leaders. It is they who decide what aspects of the group to develop and how, and as such, they influence the new culture that the group embodies. However, once the organisation has established aspects like basic assumptions, shared values and norms, the leaders' roles shift to instead work to maintain and consolidate the now existing culture. At this point, the organisational culture determines which types of leadership that are accepted and desired in the organisation and its groups (Schein, 2017).

This interpretation approaches an important aspect of cultures which I want to clarify my stance on, namely that of subcultures. Alvesson (2015) considers it idealistic to assume that organisational cultures are controlled through the ideas, notions and values communicated by an organisation's top leaders. They criticise such normative assumptions on cultural influence and instead argues that organisations also contain complementary or contrasting perspectives that are emphasised by different work contexts and daily routines. Roles at higher hierarchical positions may for example place ecological sustainability at a higher priority than employees who instead focus on how to best avoid accidents in their daily practical work. Further sources of cultural differentiation can include macro-cultural factors such as class, gender, profession and ethnicity. Through such connections, a group within an organisation can independently import ideas and values which may contradict management goals and efforts (Alvesson, 2015). While subcultures may share certain values owing to a shared organisational culture, they can significantly influence the reception of management strategies amongst different groups and affect their outcomes if not properly accounted for.

3.5 Strengths and limits of safety culture conceptualisations

Safety culture is, similar to organisational cultures, a concept with many definitions. One of the most notable early uses of the term was in a nuclear powerplant safety report in 1986 (Guldenmund, 2000; Le Coze, 2019), where it was used to highlight factors other than technical properties that had contributed to an accident. Since then, various other interpretations have emerged (Guldenmund, 2010). Some perspectives consider safety culture to be an attribute or quality possessed by ‘safe’ organisations and groups (Edwards et al., 2013), or that organisations that do not strictly prioritise safety either possess a lesser version of or completely lacks a safety culture (Hopkins, 2006; Reason, 1997). Meanwhile, some authors from more practical contexts, such as Tripathy (2020) in their book on health and disaster management for mine safety engineers, claim that safety culture represents the way safety is seen, understood, valued and formulated in a group or organisation when not actively influenced. It is seen as an aspect of the overarching organisational culture and is considered vitally important for the effectiveness of the organisation’s safety management and its safety outcomes.

While unique, these more modern approaches are similar to the older conceptualisations in that safety culture is considered to be something organisations must strive for in order to become safer. They offer safety practitioners in the mining industry with practical guidelines and objectives to implement and develop through their organisations’ safety management efforts. There are other authors in the safety culture research field who are more critical to these approaches, however, or who focus on entirely different aspects of an organisation. Bisbey et al. (2021) argues, based largely on Guldenmund’s (2000) theories, that such practical approaches generally neglect to study the characteristics of safety cultures in favour of focusing on and interpreting their results. A mining organisation might for example be diagnosed as possessing a good or poor safety culture based on their accident rates and management policies, yet less attention is paid to understanding the underlying assumptions and values that could have

contributed to those outcomes. Guldenmund (2000) defines safety culture as consisting of the aspects of an organisational culture that influences attitudes and behaviours relating to risks. It is described as a construct with three layers: subconscious assumptions regarding safety at its core, espoused values as the middle layer, and an outer layer expressed through artefacts such as behavioural norms and statements.

Richter and Koch (2004) focus on similar aspects in their definition, where safety culture refers to:

“...the shared and learned meanings, experiences and interpretations of work and safety – expressed partially symbolically – which guides peoples’ actions towards risks, accidents and prevention.” (Richter & Koch, 2006, pg. 3(705))

In an attempt to consolidate and better understand these many definitions and applications of the safety culture concept, some authors have taken to categorising the various approaches. One example is how Guldenmund (2010) describes three different categories—academic, analytical and pragmatic approaches to safety culture. The first focuses on describing and understanding safety cultures by primarily focusing on an organisation’s past. An analytical approach instead seeks to evaluate the current state of an organisation and its culture by examining manifestations of culture such as behaviours, norms and perspectives. Lastly, pragmatic approaches focus on how an organisation’s structure, culture and its processes serve as the foundations for its safety performance and safety-related behaviours. These three factors are considered to be interdependent, meaning that safety cultures are considered changeable by changing an organisation’s management structures and implementing new processes for management.

Another example of authors seeking to categorise approaches to safety culture is the review of safety culture conceptualisations by Edwards, Davey and Armstrong (2013). These authors explore approaches to safety culture focusing on how it is interpreted and understood as a concept, and how safety culture development changes as a result.

Edwards et al. establishes three categories of conceptualisations—normative, anthropological and pragmatic—and while few groups, organisations or studies exclusively follow one interpretation, one is usually more predominant than the others. Approaches utilising normative conceptualisations of safety culture are ones where people and organisations strive for the measurably ‘best’ culture where safety goals have been achieved and accidents are avoided.

‘Normative’ in this case is used to refer to how cultures are analysed and influenced by addressing norms and standards. Safety culture is considered a substance that is possible to create and uphold through intentional actions, for example through the implementation of suitable policies and procedures promoting safety. The quality of an organisation’s safety culture determines the level of safety performance they can achieve, and those with lower incident and accident rates are considered must thus have ‘stronger’ safety cultures.

An example of this perspective can be found in Tripathy's (2020) descriptions of processes for building positive safety cultures in their books aimed at safety practitioners. In order for an organisation to achieve an effective safety culture, they consider implementing proper management practices to be necessary. This would involve both policy-focused processes such as safety mission statements or disciplinary programs, and management-focused processes focusing on involvement, responsiveness and training from leaders. Two important characteristics of this conceptualisation are highlighted by Edwards et al.'s (2013) descriptions. Firstly, safety cultures are primarily considered from a hierarchical top-down perspective due to cultural change requiring the implementations of, e.g., new safety policies or strategies. In the pursuit of the ‘best’ qualities of a culture, contributions from lower hierarchical levels such as employees or contractors are much more rarely explored. Secondly, as a consequence of the first characteristic, normative approaches often prioritise the organisational aspects that management can alter such as processes and policies. while largely overlooking deeper values and influences.

Edward et al.'s (2013) other categories of safety culture conceptualisation, namely the anthropological and pragmatic ones, are depicted as more nuanced approaches than normative interpretations. In the former, safety culture is considered to be represented by the shared attitudes, values and assumptions relating to safety within a group. Anthropological interpretations of culture are less prescriptive, focusing on understanding current values and assumptions rather than seeking to change and shape them to achieve certain predetermined standards of "good cultural values". Meanwhile, pragmatic safety culture approaches consider the shared practices and other cognitive causes which contribute to safety outcomes and behaviours relating to safety.

A notable difference with these conceptualisations is that they highlight both positive and negative qualities as characteristics of a safety culture. A certain group may for example be very accepting of new colleagues while also sharing a reluctance to collaborate with other departments within their organisation. In contrast, normative interpretations often focus on the idea that safety culture is a substance obtained by implementing the right policies and solutions. As such, underlying psychological factors that can influence the outcomes of those solutions, i.e., attitudes, behaviours and shared practices, may not be sufficiently accounted for. Different ways of interpreting and approaching safety culture will naturally have different strengths and weaknesses with how they address different issues. Edwards et al. (2013) addressed this by recommending a synthesised approach applying different conceptualisations of culture depending on the organisational factors being managed. Considering the subdivided nature of cultures within organisations as described by Alvesson (2015), this highlights the importance of understanding the various cultural assumptions and values regarding safety that can exist within different groups.

3.6 The boundaries surrounding safety management

Mining industry organisations can be complex structures with multiple levels of roles, responsibilities and actors involved. This is further emphasised by the general tendency of modern mining industries—the Swedish mining industry included—to employ a proportionally significant amount of contractors (see, e.g., Liljenstolpe et al., 2023). As such, it is important for discussions on the management of safety in such an organisation to take the influence of organisational boundaries on into account. Organisational boundaries have been described as separations that define the limits and scope of interactions between both physical and abstract facets of an organisation, including between people, hierarchies, departments and cultures (Heracleous, 2004; Hernes & Paulsen, 2003; Jæger & Pedersen, 2020). Depending on their scope and orientation, boundaries can have both beneficial and detrimental effects on the flow of information, resources and authority within and between organisations. Clear boundaries can for example provide structure and stability to the management of different groups and departments of an organisation, allowing for more organised resource management and efficient decision-making processes (Weil, 2014). Social relations and workplace cultures can be similarly influenced, with separations between groups potentially having positive effects on the growth of internal cohesiveness or shared identities and values. However, by also limiting potential interactions between separated groups, strong boundaries can impede collaborations and the sharing of information by indirectly encouraging group insularity. Boundaries also have the potential to complicate relations within hierarchies and foster discourse between groups (Jæger & Pedersen, 2020).

It is important to emphasise that, while the structures of workplaces and hierarchies within organisations may be the most visible, they are not the only forms of organisational boundaries. As described by Hernes (2004), boundaries within organisations can also be based on mental and social factors such as distinctions of identities, values, norms and underlying assumptions. Older, more experienced employees may for example prefer

to socialise amongst themselves instead of with their younger colleagues, and people of certain ethnicities may face various forms of discrimination based on preconceived prejudices. In addition to affecting social relations, the more social facets of organisational boundaries can also influence the conditions for safety management (Pilbeam, 2024). Language barriers can complicate the dissemination of safety instructions, and differences in assumptions regarding how risks should be approached can lead to confusion and accidents. In order to understand and address organisational boundaries, Hernes (2004) highlights three important aspects to analyse: the extent to which boundaries regulate internal interactions, how they distinguish between external and internal contexts, and how they regulate movement between the two. With social boundaries, this could entail assessing the nature and scope of the social bonds between people, how a group distinguishes themselves from others, and potential criteria for being accepted within that group.

The impact and development of organisational boundaries is determined not only by the internal attributes and contexts of the organisation, e.g., the enforcement of hierarchies or social distinctions, but also by external influences, i.e., industry standards and legal frameworks. An example of the former in relation to safety management is the bureaucratisation of safety, e.g., an increased focus on standardised safety practices and specialisation of safety responsibilities (Dekker, 2014).

While this may bring benefits such as reductions of accident rates and deviations in practices, bureaucratisation can also encourage suppressing incidents and injuries to keep accident rates low. Furthermore, by relying too much on standardised approaches to safety evaluations and measures, people's ability to predict and manage unexpected events might degrade.

Mining workplaces in Sweden are replete with organisational boundaries due to the number of different processes involved such as extraction, refinement and maintenance (SGU, 2022). This is further emphasised by the various organisational cultures, employment conditions and power relations introduced by the use of contractors and subcontractors (Pilbeam, 2024). Managing these boundaries can be complicated and may require involving boundary spanners or the use of boundary objects in order to bridge potential gaps between disparate groups. Boundary spanners are described by Jæger and Pedersen (2020) as individuals or groups with connections and knowledge that overlaps between different groups and contexts separated by organisational boundaries.

A prominent example in safety management contexts are occupational health and safety professionals. According to Nord Nilsson and Vånje (2018) they can act as mediators between different parts of an organisation, for example during technological or workplace changes, to ensure that the work environment perspective is accounted for. In addition, this could include the role of safety representatives; employees responsible for organising their department's safety feedback and raise workers' safety concerns with management (see, e.g., Work Environment Act, 2015). Boundary objects, meanwhile, are physical or symbolic objects that similarly enable connections and shared understanding across boundaries by creating spaces and opportunities for disparate roles and groups to interact (Jæger & Pedersen, 2020). Common examples in mining industry contexts include shared spaces such as cafeterias or changing rooms, and organisation-wide internal networks and risk reporting systems. In the context of mining industry operations, these boundary-crossing elements are vital for communication and the coordination of safety management efforts within and between organisations.

4 Methodology

In this chapter I will endeavour to detail the methodology I have applied and followed in my research and in producing this thesis. Since the start of my PhD studies in December of 2019, I have participated in different research projects that studied the Swedish mining industry. While each project had separate aims and goals, I was able to utilise the data gathered and analyses made during those projects in my own research as well. The empirical methods utilised during my research include two sets of semi-structured interviews, including a total of 26 participants, and three sets of document studies, utilising a total of at least 74 documents. Analysis of the data collected with these methods followed a thematic analysis methodology throughout my entire research process. The timeline for my methodology and project participation during my PhD studies is described in table 1.

Table 1: Timeline of project participation and methodology

	2019	2020	2021	2022	2023	2024
Project participation	-	<i>STRIM SAFE</i>		<i>ISSMW</i>	<i>Attract</i>	
Methodology - Data collection	-	First interview study		<i>ISSMW</i> document study	Second interview study	
		First <i>STRIM SAFE</i> document study			Second <i>STRIM SAFE</i> document study	

4.1 Projects

During my time as a PhD student in the division for Human Work Science at Luleå University of Technology, I have participated in multiple projects. Each project has focused on or related to aspects of occupational safety in the mining industry and have served as the primary sources of data for my own research.

The first project, *STRIM SAFE*, was part of a strategic innovation program for the Swedish mining and metal producing industry, which was funded by Vinnova, Formas and the Swedish Energy Agency. The project was established in collaboration with six Swedish mining companies and an industry committee participating as project partners. The project focused on exploring the Swedish mining industry in order to study proactive indicators for safety by way of analysing organisational safety measures and initiatives utilised by the participating companies that highlighted the quality and effectiveness of their safety practices. Before I joined the project in late 2019, preliminary studies of each company's organisational safety management were performed in order to highlight notable initiatives. Two different safety initiatives from each company were chosen to be studied through document analysis and interviews with personnel in safety-related roles. My contributions to this project included the planning and execution of the interview studies, the process of which has been detailed in section 4.2, and the writing of texts for two of the project's reports. For my thesis, this project contributed not only with the opportunity to explore the perspectives of safety initiative experts, but also influenced the decision to focus my research on examining safety management in the Swedish mining industry.

The second project that significantly contributed to my data collection and analysis was the project *Attract – Road map for attractive, inclusive and safe mine work*, within the Swedish Mining Innovation program funded by Vinnova, Formas and the Swedish Energy Agency. The project was done in collaboration with several mining companies from the Swedish mining industry, including both mining employers and contractors. The goal of the project was to create better conditions for an attractive, inclusive and safe mine work by creating new knowledge about the interplay between digitalisation, skills, safety and gender.

The project was separated into four work packages, with my work primarily focusing on the third package titled *GenSafe*. This package focused on studying the perspectives on safety, equality and workplace cultures in a Swedish mine in order to analyse the conditions in today's workplace cultures to develop attractive, safe and inclusive mining workplaces. The studies in this work package focused on the workplace cultures, practices and policies of companies operating in a specific open-pit mine in Sweden owned and managed by one of the participating mining companies.

In addition to these larger, more extensive projects, my thesis has also been influenced in varying degrees by a smaller project in terms of my own involvement and its contribution to my research. I participated in the project *Israeli Safety standard for working in mines - Pre-standardization*, which will be abbreviated here as *ISSWM*, late in the year of 2021. This project was managed by the Ruhr-University-Bochum in collaboration with the Standard Institute of Israel, with Luleå University of Technology (LTU) acting as subcontractors. The project's main goal was to develop new Israeli safety standards for working in mines. Our contribution at the Human Work Science division at LTU involved studying different countries' national mining safety standards as reference points. My personal contribution to this project consisted of a document study of Sweden's regulatory framework for working environments in mining workplaces. To my thesis, this provided a contextualisation of the Swedish mining industry's regulatory framework for its organisations' safety management strategies and practices.

4.2 Gathering of data: Interviews

As the primary method of empirical data collection for my research, I performed a total of 26 interviews with participants of varying organisational positions from different Swedish mining companies. Interviews as a method are commonly used in qualitative research. They are suited for approaching specific target groups, evaluating measures and services, personal and general interpretations and perspectives of different subjects, as well as studying subjective experiences, interpretations and behaviours (Flick, 2014; Ryan et al., 2009). As I sought to study experiences of mining industry safety management strategies and practices, the philosophies behind them and the results from different perspectives, this method suited my purposes very well.

The first 12 interviews took place in 2020 as part of the *STRIM SAFE* project while the remaining 14 interviews were held in 2022 as part of the *Attract* project. Similar to how Flick (2014) describes semi-structured interviews, my interviews followed sets of prepared, open-ended questions that served to guide the conversation and discussion. Follow-up questions or clarifying questions were asked when relevant in order to better explore and elaborate the participants' unique experiences and perspectives. This interview model, while offering greater flexibility than the more structured methods only focusing on predetermined questions, also helps ensure every relevant subject is approached better than completely unstructured interviews. The length of the interviews varied, with most taking between 40 and 75 minutes to complete while a few interviews took approximately 120 minutes. The participants were notified ahead of time the subjects we were going to cover and were informed at the start of the interview of how many interviewers that would be present and their rights to refuse any question or to cancel at any time. The audio of each interview was recorded with the consent of the participant and was utilised only to support the transcriptions of the interviews.

The majority of my interviews were conducted one-on-one, with the participant and I being the only people in the room or on the video call for the duration of the interview. According to Råheim et al. (2016), it is commonly believed that power during interviews is generally held by the researcher and not the participant. While an interview is reliant on and controlled by the participant's willingness to participate, the researcher possesses greater knowledge of the subject being studied, how it is being studied and control how the empirical findings are interpreted. I sought to mitigate this impression during my interviews by striving to bringing a relaxed, attentive and interested attitude to help make the participants more comfortable in our conversations. My goal was to treat the interview participants as experts on their work and workplaces based on their experiences and perspectives in order to raise their position in our interactions.

Five of the interviews were performed together with other research colleagues and project members. While I never performed any interview with more than one other colleague present, the interviewee being outnumbered may have impacted the results of those conversations. Since discussions on personal experiences could become more difficult for them with multiple interviewers, I tried to account for this fact when analysing these interviews. For some of these interviews, however, the participants consisted of project partners with whom us interviewers were already familiar with through previous meetings and interactions, which helped create a more relaxed conversational atmosphere. Furthermore, having two interviewers enabled more dynamic conversations where we could focus on different subjects and support each other with follow-up questions, while also allowing for moments where one of us took detailed notes while the other focused on the questions. Finally, similar to what Velardo and Elliott (2021) claim, it allowed for richer reflections together with my colleagues by discussing important subjects and their connections with them which proved useful in confirming the relevance of the findings both to the goals of the projects and to my own research.

Another potentially influencing factors of the interviews were the locations of where the in-person interviews took place. Due to the circumstances of planning these interviews with the participating companies, the locales they took place in were determined by the company representatives. While the interviews with participants from contractor companies could be performed in their own offices, offering a sense of familiarity, the interviews with the participants from the employer organisation had to take place in the mine's central offices. These were stated by some of the participants to be somewhat unfamiliar environments that they had rarely visited, while others used the locales as examples to point out differences and flaws with their own locales. Based on my impressions of the discussion we held, I believe I managed to distinguish myself sufficiently as an outside observer for them to not associate me as a representative of the employer organisation. However, the environs may have influenced their comfortability with discussing or criticising certain aspects of the workplace and its culture, which had to be accounted for.

As for the *STRIM SAFE* project interviews, of the 12 interviews, only two were done in-person, with the remaining 10 taking place through virtual channels due to the onset of the Covid-19 pandemic forcing most if not all interactions to use virtual means. The in-person interviews of this set both took place in neutral locales not directly associated with either their employer or the university and were thus assumed to not significantly affect the interview participants. While it is difficult to assess the exact consequences of the sudden transition from in-person meetings had on the virtual interviews, my impression is that the unfamiliarity with this setting caused some difficulties that delayed or affected some of the interviews. Some technical examples include problems with setting up the interviews creating delays and some issues with low audio quality which made the transcription process more difficult. Regardless, the virtual interviews progressed well once these initial complications were cleared, and the transcriptions were not significantly hindered by the audio issues.

As previously mentioned, the first 12 interviews I performed were part of a project called *STRIM SAFE*, with the subjects of focus being different safety initiatives from four Swedish mining companies participating in this project. While the project had initially included six participating companies, only four were available to participate in these interviews. These companies included both direct employers and contractor organisations, providing more nuanced perspectives in that sense. The interviewees included people from a variety of roles related to the management of safety such as safety representatives, health and safety managers, safety coordinators and section heads. While some of these interviews provided practical examples of how such initiatives had been applied, the focus was on the participants' perspectives of what the intended purposes with, philosophies behind and desired results from the safety initiatives were. Referring to these aspects of the companies' strategies for safety management, I categorised these interviews as *strategic perspectives*.

14 additional interviews were performed as part of the project called *Attract* where the subjects of focus were the participants' perspectives on workplace culture, equality and safety in a specific Swedish mining operation. These participants included truck drivers, loaders, maintenance workers, shift leads, safety representatives and production managers working at different workplaces in an open pit mine. Similar to the previous set of interviews, the participants included people from both the client organisation—the employer—and from contractors employed at the mine, providing additional nuance.

From this selection of roles and subject focus, I was better able to explore the perspectives of the recipients of safety management, i.e., the people whose daily work was affected by the designs of strategies and practices. This was in order to better study people's more operative and practical interactions with safety management. These interviews were categorised as *practical perspectives*; portrayals of opportunities, challenges and effects related to safety management from perspectives closer to the affected work. While some of these interviews included people in similar roles as the strategic studies, the difference in approach offered satisfactory levels of nuance. A list of the roles of the interview participants from both categories can be found in table 2. I consider it important to have explored these different types of perspectives in order to achieve a nuanced understanding of approaches to safety management in the Swedish mining industry. The study of strategic perspectives can provide an understanding of the formal practices and initiatives that Swedish mining organisations and their managers strive to implement, and their methods for doing so. Meanwhile, studying practical perspectives can complement such an understanding by exploring how such practices might be interpreted and received in practice.

Table 2: List of interview participants and their occupations categorised by interview focus.

Interviews	Participants			
<i>Strategic perspectives</i> – 12 interviews	HSEQ-specialist	Head of health and safety	EHS manager	Applications manager
	Work environment developer	EHS manager	Safety representative	Supervisor
	Fire safety representative	Head safety representative	Section head	Work environment coordinator
<i>Practical perspectives</i> – 14 interviews	Quality, environment and work coordinator (Contractor)	Supervisor (Contractor)	Production manager (Contractor)	Dispatcher (Contractor)
	Truck driver (Contractor)	Economic administrator/ Supervisor (Contractor)	Supervisor (Contractor)	
	Lubrication technician	Systems technician	Human Resources	Production supervisor/Safety representative
	Production manager/Safety representative	Explosives technician	Draftsman and planner	

As the interviews focusing on strategic perspectives approached different safety initiatives in multiple organisations, I created interview guides and adapted them to each of the participating companies supported by feedback from colleagues in the *STRIM SAFE* project (see appendix of Paper 2). These questions were written firstly to explore the participants' understandings and experiences of the organisational safety measures and initiatives being studied in their organisation. This provided knowledge of how the safety initiatives were applied in addition to the distribution of responsibilities and information within the organisations.

Secondly, these questions were designed to elicit responses regarding the quality of these safety measures to identify aspects of these safety measures that were considered successful and why, and which aspects that could still be improved. While I broached the same subjects in each interview with participants from the same organisation, the angle and depth of those approaches varied based on the knowledge and experiences of each person. The interviews focusing on practical perspectives were all based on one collective interview guide with both pre-planned and spontaneous follow-up questions. While this occasionally resulted in me asking participants about a subject they were not experienced in, their answers were still useful for understanding the scopes of the safety measures, knowledge sharing, and indications of social relations. The interview guides of both projects were developed in collaboration with colleagues from each project, specifically the colleagues who participated in a few of my interviews. Their feedback and perspectives helped create interview guides with questions that would satisfy both the interests of the projects and those of my own research. Furthermore, as each interview was performed with a semi-structured design, I could easily complement the interviews with any additional questions that might not have made it into the interview guide.

After each set of interviews, the audio recordings were transcribed in order to adapt the data into a more conveniently analysable form. While these transcripts were not written entirely in verbatim, I included significant pauses, linguistic expressions and such in order to allow for potential inferences. For the sake of the interview participants' integrity, all mentions of names and genders of the participants and their colleagues were anonymised. Each participant was instead referred to by their occupational role in their organisation. Once the material had been transcribed, each interview participant was contacted and were offered to review the transcriptions of the interview they participated in. This was done to provide the opportunity for them to correct statements and comments that they considered to be inaccurate, in addition to providing transparency of the material my own and the projects' analyses would be based upon.

4.3 Gathering of data: Document studies

Document analyses were utilised in my research in order to provide corroborative data regarding the safety management strategies and practices I studied in Swedish mining organisations. According to Bowen (2009), document studies serve as a useful method for triangulating data during qualitative research. The method is described by these authors as being particularly suited for data triangulation, i.e., validations of empirical findings through the comparison of different data sets. This aspect was particularly relevant during my research in my efforts to create a nuanced depiction of how safety management is approached and influenced in the Swedish mining industry. The data management program NVivo 12, a program for qualitative data analysis, was utilised in all but my first document study in order to organise and more easily analyse the material. Coding and categorisation were used to highlight and compare important and interesting statements regarding safety management practices.

Document studies were utilised during the *STRIM SAFE* project's initial stages in order to identify important safety initiatives and management strategies. This review included documents from the four Swedish mining companies who participated in the interviews, focusing on three broad topics: company-specific safety policies and safety strategies; compilations of descriptive statistics concerning accidents and leading safety indicators; and company-specific surveys, reports and other documents focusing on the work environment in general and workplace safety in particular. In order to complement and validate the practical details regarding the studied safety initiatives and strategies provided by this project's interview participants, I conducted a review of this existing material and of publicly available documentation from the participating companies. This was to ensure that I could provide accurate descriptions of the safety initiatives and strategies we had studied for the project. For my own research, it also helped infer which aspects of the initiatives the participants found to be important or not based on how they were described, and which aspects were emphasised or omitted.

Due to the relatively informal nature of this document study, the number of unique documents and webpages utilised were not recorded. This initial document study was later complemented by another study utilising 66 documents from all six Swedish mining companies who participated in the project. Instead of validating interview statements, the second study provided more formal and generalised strategic perspectives on safety management strategies that could be contrasted with interpretations from the interview studies. The documents included statistical reports, safety policies and guidelines. They provided insight into the frameworks for these strategies, the language used to communicate the organisation's goals, and prioritised methods and aspects of safety management from the organisations' perspective. NVivo 12 was used here to highlight statements which served to depict these frameworks and to organise the documentation.

According to Flick (2014), it is important in document studies to analyse the purposes behind the documentation's creation and sharing. In the initial review I performed during my time in the *STRIM SAFE* project, the primary type of documents used were openly accessible policies, newsletters and descriptions of safety strategies. This was intentional communication from the organisations seeking to describe their safety management strategies and practices based on their intended functions to support the company's desired image, e.g., to be seen as safety conscious. The documentation in this project's second study included less readily accessible material that was primarily directed either to their internal organisation or to their contractors, and focused on the more practical management of safety through policy documentation or reports. The governing documents of an organisation primarily represent the industry's leaders and management responsible for developing and implementing the organisation's safety strategies and initiatives. As such, these document studies almost exclusively served to explore strategic perspectives of safety management in the industry.

Documentation from the perspectives of employees and recipients of safety management strategies are much less prevalent. While actors such as industry associations and unions seek to offer people in practical roles with information regarding subjects such as their rights and options regarding safe work, they do not necessarily offer practical perspectives on these subjects. As such, while document studies serve as excellent opportunities to further examine the previously mentioned *strategic perspectives* of safety management, they are not as easily utilised to represent the *practical perspectives* in those organisations and their workplaces.

While not directly related to my work with the two perspectives, I performed another document study to establish an overview of the regulatory context that the Swedish mining industry operates in. This was done during the *ISSWM* project, focusing on Swedish mining regulation and laws relating to workplace safety. This included the Swedish Work Environment Authority's provisions for systematic work environment management (AFS 2001:01) and regulations on rock and mining work (AFS 2010:1). In addition, material from industry associations such as SveMin (2021a) were also examined, including their fire safety guidelines (SveMin, 2016, p. 201) and checklists for entrepreneur work environment evaluations (SveMin, 2019). In total, eight governing, regulatory or guiding documents were studied in the Swedish context. These documents were imported into NVivo 12, where their contents were coded and categorised according to their focus areas in regard to safety. Examples of categorisations include if they focused on specific work tasks and roles, whether the regulations required physical equipment or management approaches, or if certain training was necessary.

Additional tertiary document studies were performed during the writing of this thesis, including brief reviews of the Swedish mining industry unions and industry associations. These studies were smaller in scope and did not necessarily follow the methodology of the previously described studies as strictly. Instead, their purpose was to supplement my personal knowledge regarding perspectives on safety and safety management, and to provide

suggestions for questions and subjects to explore in my data collection. While this did not provide concrete empirical data, this still fulfilled some of the functions of document studies by strengthening the contextual framework for my research (Bowen, 2009).

4.4 Analysis: Themes and framework

For the analysis of data in my research, the primary method has been thematic analyses following the methodology described by Braun and Clarke (2006). As a method for identifying and analysing patterns within data sets, I deemed it suitable for studying prevalent and recurring themes in experiences and descriptions of safety management practices and strategies. When creating themes, I have focused on examining the participants' experiences and interpretations of safety management strategies and practices. My approach to thematic analysis has involved both inductive and deductive aspects, as described by Säfsten and Gustavsson (2019) and Braun and Clarke (2006). The inductive nature of my analysis involved identifying and creating themes based not on existing theoretical frameworks, but on the data itself and my own preexisting knowledge. The understanding of safety management in the Swedish mining industry I developed was based on my inferences of underlying factors in the participants' descriptions of important methods, reactions to safety practices, and from the comparisons between different perspectives. In these analyses, I focused primarily on identifying latent themes by examining the participants' underlying ideas and assumptions regarding safety practices, strategies and their workplaces (Braun & Clarke, 2006). In addition to being well-suited for analysing safety management factors related to organisational culture, it also allowed me to address potential differences in interpretations of terminology. Concepts such as safety or culture can have many different definitions and interpretations varying between individuals, making latent analysis important for examining comparable aspects from different perspectives.

For the more theoretical or deductive aspects of my studies, I approached some data sets with specific research questions in mind, for example to examine how proactive indicators of safety are discussed in policy documentation. These analyses were part of my reviews of Swedish mining organisations' safety policy documentation and in examining the mining safety research field. Through more semantic thematic analysis focusing on explicit statements regarding safety management in the mining industry field, I sought to describe the context they created within which the experiences and meanings of individuals and groups were situated. With both inductive and deductive aspects involved, my general approach to thematic analysis can be described as abductive, comparing and contrasting the empirical results with a theoretical framework on the management of organisations and safety (Thompson, 2022). These comparisons between experiences, interpretations and context have illustrated different characteristics, opportunities and challenges with the safety management strategies and practices of Sweden's mining industry organisations.

My process of utilising this method has been similar to the step-by-step summary provided by Braun and Clarke (2006). Whether I was analysing transcribed interviews, reviewed literature or policy documentation, the process began with familiarising myself with the data by reading, re-reading and taking initial notes. This was followed by coding sentences, statements and claims from the material and collating potential themes to be reviewed and compiled. The process of coding and categorising was managed using NVivo 12. The codes and themes identified within the data were cross-referenced and compared in order to identify similarities and differences in the statements regarding the safety management systems and practices of that organisation. The goal was not to quantitatively identify the most commonly mentioned subjects in the mining industry field and more on reading into the statements surrounding different organisational aspects in order to interpret the characteristics of organisational cultures. The analyses and following discussions thus focused on the implications of the statements and the circumstances surrounding the presence of such subjects rather than

attempting to draw generalising conclusions based on quantitative evaluations. During certain points of my research, I have deviated in some ways from this suggested methodology of thematic analysis, however the overarching structure of phases has remained the same. One examples has been to include themes with some degree of overlap between one another, which is something Braun and Clarke (2006) recommends avoiding. In these cases, I considered the overlapping aspects of those themes to be of interest for the concluding analyses and thus chose to retain them. Another was my choice to include quantitative analyses of the occurrence of themes as complementary to the general qualitative approach.

4.5 Reflections on methodology and subjectivities

Approaches to strategic and practical perspectives

As previously mentioned, the interviews performed as part of the *STRIM SAFE* project were done in collaboration with different companies from the Swedish mining industry. Due to their direct involvement, the interviews and resulting reports in this project were designed to focus on neutral or positive features of the studied safety initiatives. In order to balance this requirement of the project with my own research aims, I designed the interview guides to facilitate some discussions regarding potential areas of improvement in each of the organisational safety measures that were being studied. Furthermore, I endeavoured to cover potential negative aspects through follow-up questions in order to provide some nuance for my personal research notes. This positive focus coupled with the lack of employee perspectives of this study served as motivation for me to explore these interviews, and the document studies for their comparable views, as *strategic perspectives*. The descriptions of safety management strategies and practices were interpreted not as objective depictions of reality but as examples of how the organisations and management intend to or wish for them to work.

Following this, I approached the perspectives of employees, supervisors and contractors whose work was more directly affected by safety management practices and strategies. I defined these interviews as explorations of *practical perspectives*, in part to emphasise their contrasting relation to the changes brought by safety management strategies. Together, this offered an opportunity to compare the two perspectives' experiences and interpretations of safety management and identify the different opportunities and challenges they highlighted. Issues of power in these interviews has been approached earlier in section 4.2, and the participants may have experienced a certain degree of discomfort from me asking questions regarding their workplaces or having to perform the interviews in their senior management's offices. The introductory questions regarding familiar topics such as work tasks and the length of the interviews may have helped mitigate potential apprehensions, however, as I experienced the conversations becoming noticeably more relaxed as they went on.

Qualitative research

In my research, perhaps somewhat in contrast to my educational background in the more pragmatic field of Industrial Design Engineering, I have taken a primarily qualitative approach to studying the Swedish mining industry rather than a quantitative one. Certain aspects of my work have had quantitative characteristics, such as quantifying the occurrence of themes in my literature review described in Paper 1, but they have never been the primary focus of my studies. Qualitative studies are relatively common in international safety-related mining industry research (Noraishah Ismail et al., 2021). This extends to the Swedish mining industry to an extent, where qualitative studies have been applied to examine safety (see, e.g., Abrahamsson et al., 2014; Lööv & Nygren, 2019; Nygren, 2018). However, more conventional methods in the research field seem to include finding objective generalisations and utilising methods that can achieve that through quantitative measurements (Sundström & Nygren, 2023b). Furthermore, few qualitative studies, including those from the Swedish context, have examined challenges and opportunities

with safety management from the perspectives of both higher and lower hierarchical levels of mining organisations. As such, my choice to qualitatively study the characteristics of safety management in Swedish mining from varied perspectives and experiences offers a novel approach to the subject and context.

During my time working on this thesis, opportunities to approach the practical perspectives of the recipients of safety management practices directly were not as numerous as for the strategic perspectives. Safety policy documentation, reports, accident rate statistics and other more readily available data almost exclusively the perspectives of the mining companies and their health and safety departments or managers. Furthermore, my project participation has offered me the opportunity to study multiple different cases of mining organisations' safety management efforts from strategic perspectives, but only one case for studying practical experiences. It could be argued that the different unions in the industry provide perspectives on safety management more aligned with its members, such as information on rights and responsibilities for safe workplaces, and should thus have been explored further. I do however believe that proper explorations of practical perspectives require more direct empirical methods such as surveys, observations or interviews. While a document study on unions in the mining industry could be an interesting supplementary study, I do not consider it essential for the scope of this thesis. Opportunities for direct empirical studies with practical perspectives were unfortunately not as readily available during my period of research, which is why I've had to base my qualitative analyses of practical perspectives primarily on one interview study focused on the context of one specific mining operation.

The fact I was able to interview both direct employees and contractors allowed me to better analyse different organisations and power relations. However, this does create an uncertain situation for me where I've explored the strategic perspectives from a multiple-case context, i.e., several different mining organisations, but have contrasted this with practical perspectives from a single-case context, i.e., employees from one and the same mining operation. It is my belief that I have managed to identify experiences and perspectives from this single context that can be analysed in relation to the mining industry field as a whole. Akin to the theory of analytical generalisation as described by Yin (2018), the practical experiences and impressions from this single-case context were applicable in identifying relevant theories regarding influences on safety management that could be transferred and contrasted with the strategic perspectives from the other contexts. For example, analysing contractor perspectives of safety policies can indicate to the relevance and influence of organisational boundary theory, which in turn can be contrasted with the strategic perspectives' approaches to implementation and dissemination of similar policies. I do acknowledge, however, that further practical perspective studies would have been beneficial to better ensure that I avoid conflating the experiences of general mining industry safety management with one organisation's policies and strategies.

4.6 Personal subjectivities as a researcher

As is the case with many qualitative analysis methods based on Flick's (2014) descriptions, the conclusions drawn from my analyses are based on subjective interpretations. This is relevant both in relation to my own interpretations of the data, but also the data itself being based on the interview participants' subjective understandings and views of the investigated safety measures and strategies. While I'd argue that the interview participants' subjectivity can more easily be identified and accounted for by interviewing people in different positions with the same initial questions, I still had to consider my own personal biases and subjectivity.

Peshkin (1988) mentions that many researchers at the time would claim that subjectivity was always present in research but would rarely address or identify that subjectivity properly. Because of that, I have followed some of their recommendations and have taken time during my analysis work to consider my own subjectivities, how they are formed and how they might affect my analyses.

My research has been influenced by various factors separate from the projects that I have worked in during my time as a PhD student. This includes odd visits to mines during courses, conversations with colleagues and others in the research field, and readings of news articles. These occasions offered various different depictions of the Swedish mining industry. Supervised mine visits would focus on improvements and future development while news articles would describe land disputes between mining companies and natives. These minor influences have not been described in great detail and have not been relied on as sources of data for my studies. They have, however, still contributed to my overarching understanding and perspective of the mining industry, and of the circumstances surrounding occupational health and safety in the field. I thus thought it prudent to at least mention their contributions to the position of my research.

During my previous experiences with studying working environments, safety and workplace development in my educational background, I encountered several theories relating to the involvement of the employees and their perspectives. Specifically, my understanding is that the people on management levels and those on the employee level of an organisation can have very different opinions and interpretations of organisational measures and changes. As such, I will admit that I have focused more on the perspectives of lower levels in previous studies on attitudes and understandings between organisational levels. Furthermore, my analyses of the Swedish mining industry's approaches to safety management were to some extent affected by my subjectivities from my previous experiences with mining-related research.

Due to my relative familiarity with the Swedish mining industry and the organisations in it from a previous project I participated in before becoming a PhD student, I approached my research with predetermined notions and understandings of the organisations that I was interviewing and analysing. This included general knowledge of the current states of these organisations, which affected how I approached and analysed their safety measures and strategies. As an example, when interviewing people from and studying larger, more established mining companies, I had higher expectations for the quality of their health and safety management strategies, initiatives and safety cultures. Meanwhile, I began my studies of smaller organisations such as contractors with a different, perhaps more lenient outlook on and expectations of the methods used to work with safety initiatives and cultures. I do believe that setting such expectations is necessary to a degree. Expecting a smaller company to have a safety strategy that is as comprehensive and advanced as a larger, more established company and not accounting for that factor would be naïve. This does not mean, however, that attitudes to and planning of the management of safety cannot be criticised, only that comparisons must account for this nuance. Having my peers and supervisors with more experience with qualitative analysis and mining industry research review my analyses was one of the primary measures I took to address my own subjectivities. In addition, the nature of studying multiple approaches to safety management strategies practices helped with understanding the different perspectives and the grounds for their positions, which helped balance my predispositions.

4.7 Ethical considerations

One of the primary ethical considerations in research methodology according to Mustajoki and Mustajoki (2017) is the inclusion of humans as research subjects, which was essential for my research. They argue that securing the participants' autonomy and privacy are foundational in discussions of research ethics in general.

A fundamental aspect of involving humans in research is informed consent, i.e., ensuring that each participant is aware of what the study is about, how to terminate their involvement, and how and where the results will be made available, allowing them to make informed decisions on whether to participate (Shamoo & Resnik, 2015). Several steps were taken in order for me to provide my interview participants with the autonomy, privacy and security necessary to uphold these ethical standards. Each interview participant was, as mentioned in section 4.2, informed of their rights at the start of each interview. This included their right to withdraw from or cancel the interview at any time, that they and any statements made would remain anonymous, and that any recorded material or notes would not be accessible to anyone other than the researchers involved in each project. Furthermore, each participant was informed of the purposes of the studies ahead of time and at the start of their interviews. After the interviews, they were offered the opportunity to review and comment on the transcriptions of our conversations and the resulting reports based on this data.

An important ethical aspect of the interview data that I had to keep in mind during my analyses were the circumstances behind its collection. In order to best explore strategic and practical perspectives of safety management in Swedish mining, I have required access both to people with expert knowledge and experience with implementing and managing safety strategies, and to people with experiences of work governed by these strategies and policies.

The participants in the strategic perspective interviews were in large part chosen and invited based on their expected knowledge and experience with the safety measures and initiatives that were being studied in the project. Almost all participants from this set were directly contacted by myself and my project partner, however several of them were invited based on recommendations from the *STRIM SAFE* project's company contacts. While this provided access to a wider range of participants and experiences, I have considered the potential ethical question of their inclusion, in part due to the potential for conflict of interest.

It is possible that their decision to participate was influenced in some way, whether intentionally or not, through encouragement or demands from the contacts, who were all in positions of relative power in their organisations. This could have affected the responses they gave and the level of detail and criticism they felt comfortable with providing, whether by pressuring to avoid discrediting the organisations or by influencing their assumptions about my role and purpose as a researcher. This was relevant for the practical perspective interviews as well, as their participation required our industry contacts and partners to provide the project group with contact information. It would have been much more difficult to reach these participants without the efforts of our industry contacts and project partners given the complexity of their scheduling and availability. They were often positioned lower in the organisational hierarchy from our contacts, which could have made them more vulnerable to being influenced.

However, based on my subjective observations and experiences of the interviews, most of the interview participants seemed willing if not eager to share their thoughts and would openly provide criticism to different aspects of their work, safety management practices or their workplace cultures. While there were no clear indications of the participants being pressured to participate or to avoid certain statements, the possibility of such influence had to be accounted for, including the aforementioned efforts to obtain the participants' informed consent.

Any sensitive information such as interview data or contact information was kept confidential and available only to myself and the researchers involved in the relevant projects. All recordings and transcriptions have been kept separate on secure storage servers managed by the Luleå University of Technology. The virtual meeting programs used during the interviews included both Zoom and Microsoft Teams. While these programs recorded both video and audio data from the meetings, the video portions were removed and only the audio was utilised for transcription purposes. None of the participants felt it necessary to cancel their interviews or to withdraw their consent. Based on these efforts, I consider my research to have upheld the guidelines and regulations for ethical research as established by the Swedish Research Council (2017).

5 Summary of appended papers

This chapter provides a summary of the papers appended to this thesis. This includes a general overview of the background, purpose, methods and conclusions of each paper, in addition to a description aiming to clarify how each of the appended papers have contributed to the themes and statements in this thesis. Furthermore, this chapter includes highlights of my own and my colleagues' roles in these papers.

5.1 Paper 1: Review of the mining safety research field

Understanding the mining safety research field: Exploring organisational safety measures and programs in international research

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As mining workplaces come with several dangers and risks inherent to the environment and the nature of the work, safety is considered an important cornerstone of the mining research field. With researchers applying a wide variety of methods and perspectives with the purpose of improving safety performances in mines, we identified an opportunity to review the subjects that were in focus and identify gaps that were being left unexplored. The purpose of my first paper was thus to investigate perspectives on safety development that had been highlighted in the mining industry research field. The goal of such an overview was to provide grounds for analysing the methods for safety management practices that were being promoted in mining industry research, and to identify potential gaps in the field. The analysis in this paper was facilitated by a two-stage literature review consisting of a thematic analysis of 54 research articles focusing on organisational safety measures in international mining industries. From reviewing these articles using thematic analysis, we concluded that the safety management practices recommended in mining-related research, while varying greatly in approaches and methodologies, promote similar organisational subjects and themes.

Ten organisational themes were identified as being prominently featured in safety-focused research aimed at mining workplaces, the most common of these being the development of safety cultures, training and knowledge development, and leadership. Other themes included the promotion of safe behaviours and attitudes; communication; ownership and accountability; risk and safety management; regulations, rules and laws; social relations; and systematic technological development. While the studies often had an apparent focus on one or a few of these themes in the organisational safety measures they presented, it was common to see some aspects overlapping between different solutions. Behaviours and attitudes were for example a common goal of many safety measures; however, they proposed different methods for promoting such behaviours.

Through analysis of the review literature, tendencies of and gaps in mining industry safety research could be inferred. It was noted that the mining industries of China, the United States and Australia were more commonly represented in the research field than any other nation. As nations' societal cultures have been theorised to affect the cultures of its organisations and industries, the potential influence that this abundant representation may have on safety practices and research can be a subject of interest for future research. Other research gaps of note that were highlighted by this literature review included opportunities to review recent safety management practices from a socio-technological perspective, to study the underlying conditions for the dissemination of safety management practices in mining industry fields through the lens of institutionalism, and to further explore safety culture in mining from different perspectives other than the currently prevalent normative conceptualisation.

To this thesis, Paper 1 contributes with an overview of the mining industry safety research field, providing an understanding of the most common themes and focus areas of safety practices in mining research. It provides context for the theoretical background behind current mining industry safety management and highlights the current prevalence of normative conceptualisations of safety culture in mining industry research.

5.2 Paper 2: Interview study of strategic perspectives on safety management strategies and practices

Safety practices in the Swedish mining and mineral industry: Examples from four organisations

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Along with technological developments and new regulations, the reduction in accident frequency rates in the Swedish mining industry has been attributed to new organisational strategies and focus areas. One notable reoccurring subject is the development of safety cultures, i.e., the cultural factors that will have an impact on how safety is managed at different levels of an organisation. With Paper 2, my purpose was to study strategies and structures of work that have been implemented and utilised in the industry for the purposes of safety improvement and identify aspects that experts on such initiatives considered to be important. The goal of this was to explore the subject of safety culture development in the Swedish mining industry by way of analysing the potential influence on and from safety cultures in decisions of safety management. The primary method of data collection for this paper was a series of semi-structured interviews, where people from four participating companies from the Swedish mining industry were interviewed regarding the safety initiatives of their company in a total of 12 interviews. 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. The resulting interview data was analysed using a thematic analysis methodology, providing a list of themes describing each safety initiative. By interviewing experts from different mining organisations on safety initiatives developed and applied in their respective companies, we were able to study examples of how companies in the Swedish mining industry approach safety culture development.

Common themes of these approaches include safety-supporting organisational structures and systems, safety leadership, support for providing and receiving feedback, fostering attitudes and commitment to safety, communication between and within organisational levels, and knowledge development. A list of each safety initiative investigated in this study and a summary of relevant themes is presented in table 3.

Table 3: List of investigated safety initiatives and summary of themes.

Company	Safety initiative	Summary of themes
<i>Company A</i>	Development of organisational structure and culture	<i>Work environment quality, feedback and discussion, control and responsibility, organisational structures and processes.</i>
	Operational safety system	<i>Safety leadership quality, training and knowledge development, promoting safety attitudes.</i>
<i>Company B</i>	Organisational safety management program	<i>Knowledge development, cross-workplace communication, promoting attitudes to feedback and safety.</i>
	Implementation and application of digital positioning system	<i>Communication, transparency, demonstrable results.</i>
<i>Company C</i>	Improvement of risk reporting practices	<i>Safety leadership quality, training, commitment to safety.</i>
	Environment, health and safety management practices	<i>Safety leadership goals, intra-organisational communication, safety prioritisation.</i>
<i>Company D</i>	Fire safety management	<i>Cross-industry collaboration, leadership engagement and commitment, risk knowledge development.</i>
	Development of accident investigation processes	<i>Promoting safety attitudes, system usability and transparency.</i>

Based on the participants' descriptions of safety initiatives and strategies, safety culture development in the Swedish mining industry is commonly approached through a focus on policies, procedures and structures of organisations in order to affect people's behaviours and attitudes to safety-related issues. While these findings are not indicative of an absence of initiatives and strategies highlighting shared values or informal practices, pragmatic and normative approaches to culture development were the most prominent ones. Furthermore, while each company promoted employee feedback to and participation in established safety practices, employee involvement in proactive safety development, such as the implementation of safety initiatives, was more uncommon. The employees' 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.

This paper attempts to examine how safety management professionals in Swedish mining industry organisations directly or indirectly approach safety culture development by way of safety management practices and initiatives. The thematic analysis of safety initiatives contributes to the context necessary to understand the strategic perspectives on safety cultures.

5.3 Paper 3: Document study of safety management practices

A framework for safety performance indicators: The case of the Swedish mining industry

Nygren, M., Sundström, E.

As previously mentioned, the recent reduction of accident frequency rates in the Swedish mining industry has coincided with a large number of initiatives intended to reduce accident rates and improve safety in general having been introduced by companies in the industry. With an influx of new safety practices, particularly of those more proactive in nature, new methods and tools to measure safety performance within these companies have been explored. As there have been few studies studying proactive safety initiatives in the Swedish mining industry, Paper 3 aimed to explore their characteristics and potential roles in the industry's indicators of safety performance. These proactive safety measures can often be found in mining organisations' policy documentation and written guidelines as part of their broader safety management system. As such, 66 documents describing the policies for safety development, internal reports and communiqués highlighting safety practices of six different Swedish mining companies were studied and thematically analysed.

Four categories of prioritised safety practices were highlighted from the studied documentation, including safety management systems, safety leadership, safety education and worker safety engagement. Measurements of these categories in a company can be used to proactively determine a basic level of safety performance, however they do not indicate as to the quality of safety practices and efforts. Three common denominators of social dimensions deemed necessary for upholding that quality were highlighted by the company documentations: communication and collaboration, empowerment and responsibility, and inclusion. By permeating the processes of safety practice and safety indicator development with social dimensions, stability and value can be added to the practices while allowing for more accurate assessments of safety performance through the addition of additional measurable qualities.

In order to illustrate this relationship between prioritised safety practices, safety indicators and social dimensions, a framework was developed (see figure 1).

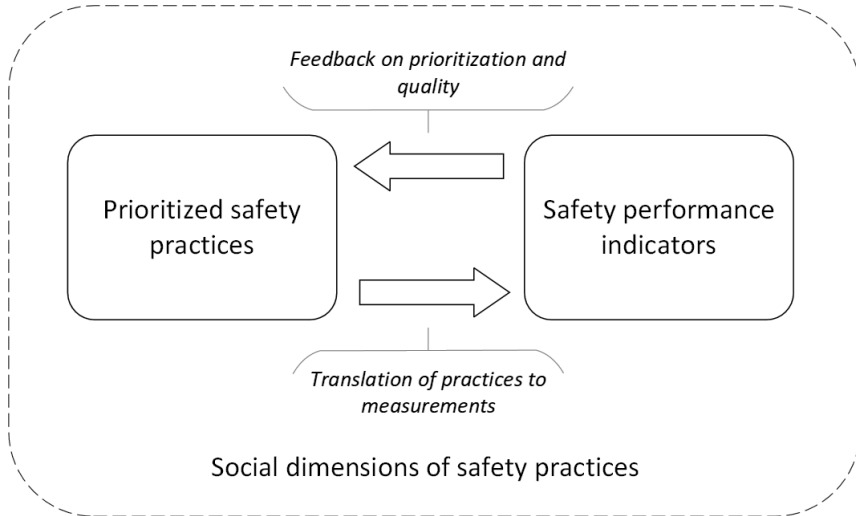


Figure 1: Framework for safety performance indicators (Nygren & Sundström, n.d.)

Paper 3 contributes to this thesis with an analysis of the characteristics of safety management policies and guidelines of organisations within the Swedish mining industry. This complements the strategic perspective interviews and facilitates a greater understanding of their approaches to safety management and safety cultures. Furthermore, it provides grounds for discussing the value of further deliberate inclusion of social dimensions in safety management practices.

5.4 Paper 4: Interview study of practical perspectives of safety management strategies and practices

Workers' perspectives and experiences in mining industry safety management

Sundström, E.

The literature review of the mining industry safety research field made it evident that initiatives and strategies for safety development are predominantly explored from a leadership-focused perspective. These strategies focus on the intended purposes of, philosophies behind and desired results of their methods of safety development. The perspectives of the people whose work is more directly affected by safety management practices, however, are left largely unexplored. Contractor perspectives in particular are rarely examined which, coupled with the amount of work being managed by contractors in Swedish mining workplaces, emphasises the importance of such a study. The purpose of Paper 4 was thus to explore the perspectives and experiences of people in the Swedish mining industry to examine the aspects through which they relate to and understand safety management strategies and practices. The goal of this was to create a better understanding of the factors which shaped the conditions for how safety management is understood by its practitioners and participants.

14 semi-structured interviews were performed with employees, supervisors, and managers, including contractors, involved in the daily operational work of an open-pit mine owned by a large mining company in Sweden. The interviews focused on the participants' practical experiences with safety management practices and different aspects such as workplace cultures and inclusion that could affect their work. The data was analysed following both a latent and semantic thematic approach in order to identify aspects which were related to and could influence the participants' experiences with safety.

Three aspects were consistently mentioned and could be inferred as relevant for the participants' safety management experiences: communication, leadership, and workplace culture and social climate. The quality of communication was characterised as perhaps the most important aspect for determining the success of safety management strategies and practices. When safety strategies would fail to stir up engagement, one commonly identified contributor was how information would be lost in the translation between hierarchical levels from management to employees. References to leadership would primarily focus on the trust and engagement which good leaders could create and how it contributed to improving safety management. There were several different interpretations of what a good leader is, with a significant aspect being how well-supported the employees felt in being able to prioritise safety over productivity. A common descriptor of inadequate leadership, however, would be a lack of consistency between promoting and actually prioritising safety over productivity. Whether through encouragements to fulfil quotas by disregarding risks or by not sufficiently involving safety representatives, this would communicate a lack of dedication to safety from the leaders' side.

While formal safety management strategies and practices were primarily described as controlled by the organisation's management, there were examples of important informal practices owned and managed by lower positions. In these contexts, worker-owned safety management efforts could be valued as a greater contributor to workplace safety than formal strategies and practices. Safety training from colleagues could for example be prioritised over knowledge of safety policies due to a greater relevance for the daily work. The last thematic category encompassed the participants' depictions of how the social and cultural aspects of their workplaces influenced the conditions for safety management. The mine's overarching social climate, which was described as friendly and open, was considered an important contributor to engagement in safety management efforts, particularly efforts to ensure their colleagues' safety.

Efforts to coordinate safety practices could be negatively affected in contexts where the workplace cultures of different groups or individuals did not match up well, however. While all participants had a general understanding of the value of safety and the risks inherent to mining workplaces, familiarity with specific safety policies was more uncommon, even amongst certain production managers. More obscure and uncommon policies would instead be sought out when a relevant incident or situation occurred. Many of the challenges with mining workplace safety management were indicated to be further emphasised for the contractors working at the mine. Communication across organisational boundaries was hindered by additional bureaucratic steps, and the temporary nature of their contract work made it more uncertain as to whether the contractor companies' personnel would integrate with their employers' cultures.

Having examined these commonly reoccurring aspects of experiences with safety management strategies and practices, certain factors that determine the conditions for these experiences could be discussed. Firstly, the exploration of varied perspectives highlighted the potential contrasts between how safety management practices are interpreted and experienced by people at different levels of involvement. In cases where assumptions regarding, e.g., the risks that should be prioritised differed between safety specialists and workers, the potential for disagreements and organisational resistance were higher. Another factor of safety management which also contributes to the challenges with conflicting conceptualisations is that of organisational boundaries. The hierarchical and structural frameworks established by the various types of organisational boundaries highlighted in this study can be beneficial for safety management efforts by defining responsibilities. However, many of the challenges to communicate and share safety values and strategies between organisations, workplaces and hierarchical levels can be linked to the same boundaries. Cooperation and communication can be further impacted by social and cultural boundaries, for example when fissures between teams and workplaces are underlined by differences in cultural values.

The contrast in how safety management practices are conceptualised by different perspectives also highlights how the industry's asymmetrical power relations affect these practices. The lack of insight into the strategies for safety management or opportunities to affect them can be detrimental for the development of trust in such efforts. Roles closer to the practical work possess experience and knowledge that could be invaluable for the development of more effective and better received safety strategies. Based on the participants' experiences, an exploration of potential methods for including roles closer to the practical work in safety management processes would be valuable. In the Swedish mining industry, the existing safety representatives' roles to express the employees' perspectives on safety could be a good starting point for such integration.

This paper contributes to the thesis by providing insight into the practical perspectives of workers and contractor personnel on their experiences with safety management practices and culture. They thus offer contrasting interpretations to the strategic perspectives of managers and policies explored in the other papers. This allows me to establish a more nuanced view of safety management and culture in the Swedish mining industry.

6 Safety management in the Swedish mining industry

The purpose of this thesis was to *explore and create an understanding of the characteristics of safety management in the Swedish mining industry*. The goal of this was to study potential opportunities and challenges with safety management found in different interpretations and experiences of management practices and strategies.

In recent years, the Swedish mining industry has, from the perspectives of its employees, managers, the research field, and industry statistics, seen positive developments in terms of perceived improvements to safety performances. Alongside these experiences, accident rates have declined significantly in the last 40 years (Lööv & Nygren, 2019). Furthermore, the industry's safety management strategies have expanded to further engage with organisational aspects alongside continuous technological advancements and regulatory measures. Modern mines are mapped, monitored and managed through new digital systems while employees are trained to improve their risk awareness and attitudes regarding safety. With Sweden's regulations for Systematic Work Environment Management, Swedish mining organisations have been encouraged to develop and incorporate more proactive aspects such as risk assessment, delegation of responsibilities and safety education. These approaches are also being explored in international mining safety research, appearing alongside the already prevalent studies focused on practical solutions in recent years. This includes promoting safety management through safety culture development (see, e.g., Bahn, 2013; Düzgün & Leveson, 2018; Han et al., 2019), training to establish safety-positive behaviours (see, e.g., Es'haghi et al., 2020; Vahedian-Shahroodi et al., 2019), or leaders building positive relations with their workforces (Gunningham & Sinclair, 2014; Willmer, 2017).

Within the mining industry's organisations, this development of safety management has been experienced by employees through noticeable changes to both attitudes and values regarding safety. People employed at different Swedish mining operations have noticed an increased interest in safety initiatives, workers have noted their leaders' tendencies to prioritise safety over production more often, and attitudes have become notably more positive in many workplaces. Organisational policies and strategies have been described as more accommodating of the needs and expertise of the people involved in the actual mining work compared to historical approaches. Safety managers and specialists with strategic perspectives of safety management have noticed and experienced similar changes, for example through an increase in resources allocated to safety management practices. Furthermore, more time and resources had been dedicated to tacit safety, i.e., ensuring that people are not only physically safe but also *feel safe* (Whiteoak & Mohamed, 2016). For workers, production managers and contractor employees with more practical experiences of safety management, its development was denoted in the receptiveness of their colleagues to discuss safety, a perceived heightened awareness of risks and an increased transparency from management on the organisation's safety strategies.

People on all organisational levels depict each other as being more aware and informed of the many different ways safety is expressed, whether it be through safety from physical harm or psychological health. However, while there are many depictions of safety management in Swedish mining that highlight positive characteristics, there are also several contrastingly critical examples focusing on the same aspects. For example, a safety strategy that is treated as vitally important from one perspective may have been completely disregarded by another, or may have been interpreted as a negative contribution to safety from a third.

It is especially important to highlight these contrasts since the categorisations I have utilised throughout this thesis, i.e., describing perspectives and experiences as either ‘strategic’ or ‘practical’, does not make plain the potential nuances in behaviours or values between individual groups. Furthermore, many challenges remain that are grounded in the approaches to safety management that are currently being implemented and practiced within the Swedish mining industry. In order to properly assess the state of safety management in the Swedish mining industry, we must examine how it is affected by the intermingling of different interpretations and approaches to safety.

6.1 Characterising Swedish mining’s safety management

The organisational structure of mining work challenges safety communication

The organisational structures of Swedish mining organisations are complicated, in large part due to the complex hierarchies, wide variety of professions and the many contractors involved in mining operations. Proper management of organisational aspects such as safety can require the coordination and knowledge of diverse and at times disconnected departments, roles and responsibilities. It was thus not surprising that the subject of sharing information and communication was a pervasive theme amongst the depictions of Swedish mining industry safety management identified and analysed in this thesis. Discussed both by individuals with strategic perspectives and people with practical perspectives, communication was highlighted as a contributor to both positive and negative qualities of modern safety management.

The most prominent factor for distinguishing good versus bad communication throughout these people’s experiences was the level of reciprocity. Good communication would be described as involving information and dialogue being shared mutually between involved parties. Examples of bad communication included cases where personnel felt that information or decisions had been imposed on them by their managers or others in higher hierarchical positions. In this sense, communication was

used as a collective term both for cases of one-way transfer or imposition of information, and for back-and-forth discussions. In many cases, the positive qualities were attributed to various management efforts intended to improve safety awareness and knowledge of employees or to provide more transparency for the methods and goals of management safety strategies. These efforts included safety training, work to improve social relations, collaborations between organisations and workplaces, and efforts to disseminate safety management practices and strategies. Equally important were the independent efforts of teams and groups to promote inclusive workplaces, whether they were larger, more coordinated efforts between different subcontractors or smaller efforts such as informal safety training for new employees by their colleagues.

One recurring issue with communication raised throughout my studies was how to inform people of new or changing safety policies, and in how the conditions for safe work may be affected by changes in the workplaces. When exploring strategic perspectives, these discussions often focused on how to manage reactions and potential resistance to changes brought about by safety initiatives. Some leaders and managers in the Swedish mining industry approached this issue by promoting transparency and clear communication on the purposes of these changes, how they would work and why certain methods were chosen. According to Pieterse et al. (2012) a lack of mutual understanding between horizontal or vertical organisational distance—e.g., between different workplaces or different steps of the organisation's hierarchy—can create confusion and fuel resentment between these groups. In turn, this can foster resistance to change amongst these groups represented by issues such as lowered participation in and engagement with new safety strategies. In my studies of Swedish mining, examples of such resistance included certain groups valuing local safety issues above overarching safety management practices, and certain employees not engaging in specific safety policies until a related accident has occurred (see paper 2 and 4).

In comparing strategic depictions with the practical experiences of in-house and contractor employees, the importance of such approaches becomes more apparent. When machine operators and other employees showed a lack of interest in these safety management strategies, they demonstrated detached attitudes in the organisation's overarching safety management efforts. Employees, contractor workers and supervisors are not always informed of why and how safety management changes are being made, which could be a contributor to their hesitancy to engage with and support their implementation. Contractor personnel in particular depicted a perceived inaccessibility of information regarding safety strategies, even in cases where this information was available to their managers. In such cases, it was argued that the quotas and timeframes of daily operations did not provide many opportunities for contractors to ensure their employees could properly explore these safety strategies.

Information regarding the goals and methods of these strategies was commonly made available through means such as internal networks and systems hosted by client organisations. However, these systems were at times depicted as being troublesome to explore, whether due to complicated designs or by not being sufficiently integrated in the daily work. There is also the potential for information to simply not reach all subcontractors, which was an issue highlighted in discussions regarding both safety policies and practical safety issues. Similar to the cases explored by Valluru et al. (2020), this was explained by participants as a lack of compatibility between client, contractor and subcontractor systems, or because of details not related to the daily work having been filtered out for the sake of efficiency. Such issues with coordinating and communicating safety management understandably affect the impetus amongst lower hierarchical levels to engage with the organisation's formal safety strategies. For contractors, this sometimes leads them to focus inward on improving their own safety management strategies independently from their clients' goals. As a result, several different safety management systems could be operating in parallel within the same mining organisation or operation.

It should be stated, however, that some more experienced personnel have noted positive developments in people's attitudes toward safety over time that have coincided with new approaches from their organisations. Discussions on safety and safe behaviours were described as having become more constructive and inclusive over time. The perspectives I have studied depict an evolution of safety management strategies in that they now include more organisational subjects such as safety cultures or the impact of social aspects in addition to their preexisting focus on technological and practical solutions. This would align with the development of safety initiatives depicted by Löow and Nygren (2019), in how new regulations and strategies focusing on organisational measures have been implemented since the early 1990's. According to the participants of my studies, the industry has made great progress in its safety management efforts over the years, and that these improvements are being appreciated by people. Addressing the mismatch between the communicated goals and the outcomes of safety management would be important for building and retaining trust and engagement in strategic safety management from practical perspectives.

A subject that stood out amongst both strategic and practical perspectives was that of how the value of safety is communicated in the industry. In my studies, I found both employees and managers who interpret Swedish mining industry's organisations as enthusiastic in their efforts to prioritise the health and safety of the people and equipment in their workplaces. Safety routines, work environment regulations, ISO certifications, employee safety training and workplace inspections are some of the practices that people found to be indicative of an industry with a strong desire to reduce and avoid accidents and harm. Employees, managers and contractors are asked to 'prioritise safety above all else' by the safety policies and strategies of many of the mining companies operating in Sweden. The conditional nature of this is emphasised, however, by the participants' descriptions of how these prioritisations shift when production is interrupted, and profitability is affected.

Experiences from such situations describe demands to solve whatever problem had interrupted the production process, with an almost resigned acceptance of having to circumvent safety procedures and policies at times. In other examples, interview participants described encouragement from policies and managers to report risks. However, this was contrasted with managers and supervisors often lacking the resources to follow up accident reports as these processes interfered with daily operations. While emergencies and more significant risks faced fewer obstacles in the follow-up procedures of this example, the smaller issues left unaddressed could develop and cause serious injuries over time. Initially, I considered how the general perception of most Swedish mining organisations being safe could exist alongside such examples of discrepancies from the expressed prioritisation of safety. It is possible that accidents requiring such deprioritisations are uncommon enough for the generally well-maintained safety performance to create the impression of well-performing safety management systems. The accidents and incidents that do occur could then make more of an impression due to the contrast from the daily normal. These perceptions could perhaps be compared to the notion of “safe workplaces being accident-free means that accident-free workplaces are safe” as described by Beus et al. (2016). If a person does not encounter or experience a critical accident, the numerous safety policies and practices present in mining workplaces that mitigate or prevent accidents from occurring in the first place can give the impression of a very safety-conscious organisation.

Despite the implementation of national regulations and organisational policies intended to encourage and support the involvement of personnel in safety issues, the Swedish mining industry still faces challenges with addressing disinterest or indifference. Swedish workplaces with five or more employees are, as previously mentioned in chapter 2, required by law to appoint safety representatives—employees educated in safety policies and regulations who serve as representatives of their colleagues in matters of workplace safety (Work Environment Act, 2015).

While the Work Environment Act requires organisations to include them in safety management efforts that affect their workplaces, their participation is not always prioritised in these projects, however. This is best exemplified by the safety representatives who were uninformed of safety inspections and projects being planned in their workplace until just before their involvement is required. Similar to Grill and Nielsen's (2019) study, this seemed to be a case of inadequate planning affecting employee motivations and interest in safety. Experiences such as these contrast with the generally positive statements from some participating employees, safety management leaders and policy documentation.

According to Carayon et al. (2015), the way these conflicts regarding inclusion are resolved can influence people's perceptions of the true value of safety in their workplace and organisation. This can lead to the development of mistrust and indifference in cases where leaders' claims and promises do not align with from the actual decisions being made and their outcomes. Indications of such mistrust could be seen in some participants acknowledging that safety is not always considered a top priority despite statements from management claiming otherwise. I find it understandable for profitability to be a priority; it is a foundational requirement for the continued operation of any mining operation, and people at all levels of the Swedish mining industry are at least to some degree aware of that fact. It being prioritised in organisations that simultaneously seek to communicate the importance of 'safety above all else', however, demonstrates either a need for new approaches or changes to the expectations set by these organisations. Together with the otherwise positive descriptions of safety in mining workplaces given by the same participants, this may be an issue primarily of communication and expectations.

Another challenge with communication relates to finding a channel that employees can *and* want to engage with in order to obtain this information. Information regarding safety management strategies and goals can end up being disregarded or may not reach people at the figurative bottom of an organisation, with reasons varying from a lack of interest to a lack of incentives or opportunities to engage with it. This includes efforts to communicate and promote desirable cultural values and behaviours to people through promotional material or instructional seminars. The subject of the mining industry's approaches to safety cultures is something that will be explored further in a later section, but the role of communication in that context is important and must be understood as well.

While the industry does face challenges with finding effective methods for disseminating information regarding safety goals and ensuring people's involvement in safety matters, their efforts are showing steady progress. Swedish mining organisations are, based on the criteria for safety maturity described by Foster and Hoult (2013), primarily presented as proactive in their safety management, which could serve as an indicator to their development. Empowerment and involvement in safety issues are pervasive subjects discussed amongst safety practitioners throughout the Swedish industry, and it is very rare for modern safety management strategies to settle for achieving legally compliant levels of safety. As previously mentioned, Swedish mining accident statistics have been improving over the years. Furthermore, of the subjects related to safety management that I've approached in my studies, people with both strategic and practical perspectives agreed that the perceived value of safety had improved as well.

Safety leadership caught in conflicts of prioritisation

Based on the accounts of managers and employees from both client companies and contractors, as well as policy documents, I have highlighted how the Swedish mining industry's depiction of safety is nuanced. People have seen improvements in how both physical and psychological safety is managed, and generally believe that the modern mining industry is much safer than before. However, these same people operate with the understanding that safety can only be prioritised when productivity is not at risk. While I have thus far focused on how this might affect people's assumptions regarding safety, this conflict grounded in prioritisation is also related to the conditions for safety leadership. It is thus important to discuss how Swedish mining organisations respond to these conditions, the methods they have applied and the effects of their efforts.

Before approaching the Swedish mining industry's methods for safety leadership, I consider it important to clarify how leadership is discussed in this context. According to Algahtani (2014), 'leadership' is defined in management literature as supervision focusing on aspects such as inspiration, empowerment, long-term goals, and establishing trust and commitment. 'Management', meanwhile, is said to focus more on the practical work with directing, planning for and supporting a group or an individual. It has a closer connection to ensuring the success of daily operations than to the long-term development of those groups. Examples of both interpretations could be found amongst strategic and practical perspectives on safety management when discussing desirable values for supervisors and managers. Good leadership would encompass not just long-term development but is also attributed to a leader's efforts to effectively manage the daily work, with the challenge being to successfully balance the two goals. In other examples, people have mentioned 'leadership' in reference to efforts to lead through inspiration, trust and innovation, while instances of more practical supervision of daily work processes and directing of employees have been labelled as 'management'.

Ultimately, however, these terms are used more interchangeably throughout the Swedish mining industry based on examples from various participants. 'Leadership' has for example been used in reference to the decisions made in creating and implementing strategies encompassing whole workplaces or organisations. This includes the goals of organisation-wide safety programs promoting certain values, or the attitudes to embedding contractors in the employers' organisational cultures and practices. In other cases, 'management' has been used to refer to the strategies and practices applied in pursuit of the leadership goals the workplace or organisation has established. In relation to safety management, the term commonly refers to the programs, initiatives and measures applied as part of strategies or practices aimed at the development of practical and tacit safety. Using these interpretations of the terms, management strategies such as safety meetings between different departments could for example serve as an indication of a leadership goal to encourage cross-role collaborations.

Throughout various accounts of safety management experiences, its systems and processes have been depicted as almost exclusively top-down driven. Employees and lower organisational levels commonly lack agency in safety management processes, with their primary involvement being to provide feedback. These power relations are depicted as practical in safety management literature for the purposes of managing resources such as time and personnel more efficiently (Antonsen, 2009; Coleman & Voronov, 2008). This image is further emphasised by regulations such as the AFS 2001:1, which enforces Swedish organisations to uphold the health and safety of their personnel through investigations and follow-ups.

The Swedish mining industry does however show signs of fissures and separation between formal and informal safety management, which could be attributed to its power relations. Formal safety management efforts in the Swedish mining industry are prominently approached as top-down driven processes. People at lower hierarchical levels of Swedish mining organisations thus generally have fewer opportunities to influence formal

safety management efforts. However, through various forms of organisational resistance, they can retain a degree of informal power. Similar to organisational restraining mechanisms mentioned by Abrahamsson (2002), this resistance manifests as a lack of commitment to or de-prioritisation of the organisation's formal safety development amongst employees. Based on my analyses in paper 4, contractors and their employees experienced a comparative lack of such prerogatives, however. These contractor employees described their employment conditions as comparatively less secure compared to their clients' personnel as they can change drastically during renegotiations. Furthermore, aligning with Weil's (2014) points regarding contractor employment security, there were participants that expressed worries about potentially being entirely replaced by other contractors with a better offer. While required by law to uphold their own systematic work environment management, contractors must also adjust to the demands of their client and their safety management systems. The standards set by different clients can vary significantly which in turn requires adjustments from the contractors' own safety management efforts, as was the case for one participating contractor in paper 2.

One example of how different the conditions for safety management can be between client and contractor personnel is how they can manage the prioritisation of safety over productivity. Swedish mining contractors are, based on the descriptions of my studies' contractor participants, more closely bound by the production quotas established during their hiring processes. Due to the competition between contractors for commissions with a client company, contractors are required to offer greater incentives for the client to choose them. This can lead to contractors taking on greater production quotas in order to claim a competitive advantage (Weil, 2014). With productivity demands rising as a result, they may be more likely to face situations where they feel compelled to bypass safety policies in order to avoid interrupting workflows. Another example is how the inclusion of contractors and their employees in their workplace's safety development is entirely dependent on their clients' policies and norms.

Initiatives to decentralise responsibilities and power have been explored in mining industry organisations with the goal of improving the management of safety. As depicted by the policies and individual experiences explored in *Papers 2, 3 and 4*, this includes Swedish mining organisations, who have explored the empowerment of lower-level managers and supervisors. The safety programs that encourage acceptance of discussions regarding risks and safety issues are one example, where the goal is to create a greater sense of personal responsibility. In addition, some safety strategies explored providing empowered managers with more authority to make final decisions on safety management decisions. Similar to Monica's (2019) proclaimed benefits of employee empowerment, these methods are intended to promote accountability, awareness, and enable more effective decision-making processes by circumventing the bureaucracy of daily safety management. Empowerment efforts are valued as methods for developing trust between hierarchical levels in both theoretical research (see, e.g., Jaroenroy et al., 2024; Kemp, 2013) and amongst mining organisation's leaders (see Gunningham & Sinclair, 2014). Discussions in the Swedish mining industry on using empowerment to solve safety management issues commonly focus on the control and decision-making power these strategies provide. The intended benefits of this style of empowerment are similar to that of what Monica (2019) describes for employee empowerment: to help people to become more involved in, responsible for and better understand safety management. This could be suitable in mining workplaces where practical and strategic perspectives prioritise different types of safety management, i.e., formal or informal safety practices. It would allow for employees and site managers to better apply their practical workplace knowledge in addressing safety issues and potentially learn more of the circumstances behind management decisions.

Empowering lower hierarchical roles in managing issues of safety can offer several benefits in terms of engagement, inclusion and effective safety practice implementation. However, some strategic perspectives in this study have highlighted an issue I feel is important to address regarding how

empowerment affects actual power structures. These select perspectives regard empowerment efforts as a way for more practical roles to take ownership and responsibility of safety management efforts in their workplace. Regardless of any efforts of empowerment, however, the ultimate responsibility for a mining organisation's choice of strategies and approaches to safety remains with its upper management. They determine which safety strategies to implement based on goals such as meeting regulatory requirements, improving occupational health and safety, and avoiding economic losses and, as such, retain the ultimate responsibility for safety. My reason for highlighting this fact relates to situations in the Swedish mining industry where accidents have occurred which have highlighted the complicated nature of liabilities and responsibilities for safety (see, e.g., Hjertström, 2015; Lund, 2014). These challenges are emphasised by the industry's propensity for utilising contractor employment and have served to complicate and hinder safety management efforts (Nygren, 2018). In this context, I maintain that obligations for maintaining safety must remain with an organisation's management in order to ensure that they retain their responsibility for improving health and safety.

Contemporary management of culture leaving important cultural aspects unexplored

Based on policy documentation and the accounts of managers, supervisors and employees, the subject of culture is commonly broached in conjunction with safety management in the Swedish mining industry. Whether or not culture is a directly stated goal, many strategies are implemented in order to promote safety-positive cultural values, norms and behaviours, which are commonly approached as cultural factors in literature (see, e.g., Bisbey et al., 2021). Definitions of culture are nuanced and plentiful in the theoretical fields, enough that several authors have been able to categorise similar yet varied definitions and approaches in different conceptualisations (see, e.g., Cooper, 2000; Edwards et al., 2013; Guldenmund, 2000).

Examining various approaches to safety management in the Swedish mining industry, one can find examples indicative of different interpretations of safety culture. Some safety practices focus on establishing standardised procedures in order to promote safe behaviours, while others attempt to tackle the norms and values of workplaces through communication and training. Safety culture as a concept is also interpreted differently based on organisational levels and formal or informal contexts, with employees often relating it to local norms regarding safety while safety experts focus on their organisation's overarching values. A commonality between most interpretations, however, is that the organisations pursue what they consider to be a "strong" safety culture, and that intentional change efforts contribute to that goal. This mindset is present in several Swedish mining organisations based on their safety management practitioners and safety policy documentations. Coupled with management practices more commonly focusing on safe behaviours rather than underlying beliefs and values, it highlights the normative conceptualisations of safety culture present in mining industry safety management (see Edwards et al., 2013).

While not representative of all interpretations in the Swedish mining field, the prevalence of normative approaches provides an opportunity reflect on their potential implications for safety management. Normative understandings of and approaches to safety culture can contribute to both positive and negative characteristics for the management of safety. By pursuing predetermined safety culture visions, mining organisations are in a better position to evaluate their organisational structures and identify weaknesses that should be address in order to achieve those goals (Edwards et al., 2013). The degree to which these opportunities are taken advantage of varies between organisations, workplaces and groups, however. A relevant weakness of more normative conceptualisations to address is how such approaches do not reliably address beliefs and values as drivers of culture. Swedish mining organisations do introduce goals to propagate safe values as part of their safety management strategies.

Efforts to understand the underlying factors behind behaviours seem to be relatively uncommon, however, especially in contexts involving contractors. Instead, these safety strategies seem to focus on encouraging safe behaviours by changing the conditions for work through, e.g., new policies and directives. Attempting to address behaviours without a full understanding of the potential values and assumptions behind them could contribute to developing resistances to change amongst the organisation's personnel. This could for example hinder safety management efforts and reinforce the hierarchical boundaries highlighted by various employees, managers and contractors. Without incentives to explore the underlying aspects of safety cultures, normative approaches are also described as being less capable of managing subcultures and cultural differentiation (Edwards et al., 2013). In Swedish mining contexts, this is especially relevant with how some client organisations overlook the safety cultures of their contractors. Challenges to coordinate and cooperate with their clients and other contractors are, as expressed by contractor employees and supervisors, examples of consequences for such disregard.

Finally, normative conceptualisations are also described as possibly encouraging an intrinsic disregard of the influences of power relations and imbalances on safety. When focusing on organisational structures and processes as determinants of safety culture, its development is regarded as exclusively controlled by management and leaders in the mining industry field. An example of this from the mining industry include the approaches to safety performance assessments that rarely examine social dynamics, instead focusing on the implementations of safety policies and systems. In these cases, latent factors encouraging the de-prioritisation of safety regulations such as challenging production quotas may go unaddressed.

Another complication for the Swedish mining industry's normative approaches to safety culture development and management relates to the many subcultures present within the industry field. Subcultures with different values and norms existing within organisations is not a novel concept in and of itself (Alvesson, 2015; Rollenhagen et al., 2013). It was a subject both explicitly and implicitly highlighted by the participants of my studies when discussing subjects from behavioural norms to underlying values of the various groupings in the Swedish mining industry. When organisational strategies are implemented, it is important to be aware of the potential influences they may have, and to understand what any potential differentiations are rooted in. A better understanding of latent cultural influences and different groups' shared values could contribute to improving efforts of safety management, especially when approaching from less normative conceptualisations of safety culture.

Highlighting some of the potential challenges inherent to the top-down focused normative culture conceptualisations in safety management makes clear the importance of clarifying the scope of these challenges. Safety cultures are not unilaterally understood and approached in the Swedish mining industry as organisational aspects dictated solely by the structures and systems in place. Both pragmatic and anthropological approaches, which define cultures based on people's shared practices and underlying values respectively (Edwards et al. 2013), can be recognised amongst different management strategies and individual interpretations in the field. An example of the former was given by contractor production managers as they discussed the compatibility of the workplace cultures of various subcontractors based on each group's approach to safety and planning. Meanwhile, several participants reflected in ways akin to anthropological conceptualisations when discussing their work groups' shared values and assumptions regarding safety and its prioritisation. The differences in how these conceptualisations are applied in the Swedish mining industry lies in the normative ones being more common amongst positions of power over safety management implementation.

Furthermore, they seem to be commonly applied separately from each other, i.e., by attempting to change safety cultures through changes in processes without expressly considering underlying values or the differences in shared practices among different groups. As a result, underlying characteristics and values are at greater risk of being misunderstood, which in turn creates more obstacles to the implementation of safety management strategies. Efforts to make more informed decisions regarding safety management and development would thus possibly benefit from better addressing the cultural influences of these aspects collectively.

Having expressed some of the nuances regarding more deliberate approaches to safety culture in the Swedish mining industry, I also want to discuss more latent characteristics which my studies have alluded to. While organisations and individuals may strive to promote and develop desirable cultural values and norms, the actual underlying safety culture can have very different characteristics. Of the subjects discussed so far, the prioritisation and potential *de*-prioritisation of safety exemplifies the most prominent disconnect between intent and outcome. Mining organisations generally seek to encourage safe behaviours by communicating the importance of deliberation and carefulness, yet the simultaneous need to maintain economic sustainability through productivity hampers such efforts. Instead, mining personnel may adopt the assumption that management and leaders will not truly prioritise their health and safety, which can in turn foster distrust (Carayon et al., 2015). If left unmanaged, such impressions could eventually influence the values and assumptions which make up the foundation for an organisation's safety culture.

As was highlighted by the interviews of Paper 4, and by an exploration of the general industry context, Swedish mining work has retained an image and cultural values from its history. The Swedish mining industry's historical image of, dirty, tough and dangerous work has influenced modern workplace cultures long after technological advancements have significantly changed working conditions (Abrahamsson et al., 2014).

Many of the active mining operations in Sweden have operated for several decades, whether continuously or not, which has allowed for the establishment of strong and resistant organisational and workplace cultures. As is described by authors like Alvesson (2015) and Schein (2017), well-established cultural values and assumptions are very difficult and time-consuming to influence and change. However, many of the more experienced interview participants had noticed significant changes to what they interpreted as their organisations and workplaces' safety cultures. This included a greater general acceptance of discussions regarding safety, a better understanding of the organisation's safety strategies and an increased awareness of risks in their workplaces. Despite these developments, the historical image and its potential influence are still important to consider in modern safety management efforts. Changes to work tasks intended to reduce risks could thus for example face additional resistance if they would end up encroaching too much on, e.g., the enduring historical images of mining work being tough and masculine. Organisations within the Swedish mining industry are constantly evolving and developing their methods, strategies and goals with regards to safety. Objections and resistances to these changes that are rooted in past impressions of mining work will continue to emerge, and as such, a more systematic method of analysing and addressing them would be a useful tool for safety practitioners to develop.

Boundaries create focused but disconnected safety management systems and initiatives

Throughout my studies of safety management in papers 2, 3 and 4, a reoccurring theme regarding opportunities and limitations was that of organisational boundaries. People from various strategic and practical positions in mining organisations have described organisational boundaries in manners similar to theoretical definitions, i.e., as indicators of separations between different individuals, groups, departments and organisations (Dumez & Jeunemaitre, 2010; Hernes & Paulsen, 2003; Jæger & Pedersen, 2020).

Swedish mining organisations have distinct internal and external hierarchies which determine safety responsibilities, opportunities for communication and power relations. The larger mining operations are often comprised of several physically separate workplaces with each encompassing different roles and professions. The locales of blue-collar workers may for example be placed underground while white-collar employees work from above-ground offices. Other boundaries are created between groups and individuals with different values and identities based on the images and assumptions of mining as a profession. Whether rooted in racial prejudices, gender-based discrimination, or differing opinions to changes in the industry, such separations make the creation of cohesive cultures and effective collaboration more difficult.

Based on my studies focused on strategic perspectives, the conditions for safety management imposed by organisational boundaries are acknowledged and understood by the Swedish mining industry's safety management practitioners. The safety experts interviewed in paper 2 were for example cognisant of how their strategies could be impeded by boundaries and how approaches could be designed to better utilise the strengths of separate groups. Employees more involved in practical work attributed the positive or negative experiences of interacting with other groups to differences and similarities in values and workplace cultures. The mining safety research field show similar awareness by, e.g., depicting organisational boundaries as obstacles to safety communication for managers to adapt to when implementing safety improvements (see, e.g., Chen & Zorigt, 2013; Laurence, 2005; Zhang et al., 2020). More proactive strategies such as analysing underlying characteristics and potential influences of boundaries seemed less prominent in both the Swedish mining industry and the mining safety research field, however.

The most prominent examples of boundaries interfacing with safety management were highlighted when I explored practical perspectives of a Swedish mining operation in paper 4. Personnel such as machine operators, technicians and production managers gave nuanced examples of how they perceived the many boundaries related to their work and how they affected their experiences of safety. Primarily, they were depicted as hindering communication and coordination between groups sharing workspaces and limiting insight into safety strategies and priorities between different hierarchical levels of an organisation. Discussions regarding contractor personnel at the studied mine were especially informative and made it easier to identify the different types of boundaries influencing perceptions and experiences with safety. Mining contractors are, due to the nature of their contracts and their integration into their client's organisation, often limited in options for interacting with their workplace's safety management. Their offices and workplaces are often physically separated, there are clear structural boundaries between different organisations and hierarchical levels, and they face cultural boundaries between other groups with different values and norms. While these conditions are especially pronounced for contractors, it is also common for direct employees of a client organisation to be similarly limited in their interactions with other stations.

A significant factor for how people interact with and perceive safety management seems to be your occupation, which can be seen when comparing blue-collar and white-collar experiences. As implied by my names for the categorisation of my data, the white-collar roles I approaches, i.e., the safety specialists and higher managers, had more of a strategic, long-term perspectives on safety. Meanwhile, the participants who primarily held blue-collar roles held practical perspectives on safety, focusing on how hazards and risks in the daily work could be avoided or mitigated. As a result, while my studies have shown both groups to be knowledgeable about the safety, the safety strategies and goals they prioritise are naturally different.

While I may have given the impression of boundaries acting only as limiting factors, there are cases where they were depicted as contributing to the quality of safety management efforts. During the interviews explored in paper 4, some study participants emphasised how boundaries between groups allowed for them to better focus on internal safety issues and the unique challenges their work entailed. One example relates to the approaches to safety management in the industry which focus on promoting empowerment and increasing autonomy for local safety issues at lower hierarchical levels. In addition to previously discussed potential benefits of such methods, i.e., improving trust and people's commitment to safety, the support of empowerment can also serve to address and utilise the strengths of organisational boundaries. By reducing the need for top-down decision-making processes in safety management, different workplaces can ensure that important safety issues are being addressed in ways supported by local employees. In other words, individual groups or workplaces can better adapt safety management strategies and practices to their specific needs, provided the organisation's overarching goals are properly communicated.

Safety management efforts conditioned by power and influence

The power structures in Swedish mining are important to consider in order to better understand the conditions for safety management efforts in the industry. With the context gained by exploring how these power structures are depicted and experienced from various perspectives in the industry, we can discuss their consequences for safety management. Most of the safety management practices explored in this thesis have been depicted as management-driven and controlled. A pragmatic argument would be to say that this allows for more effective coordination and management of resources and personnel for safety-related issues. Firstly, it can help reinforce that the ultimate responsibility for safety management remains with an organisation's leadership, as is required by Swedish regulations (Systematic Work Environment Management, 2001).

Secondly, with a wider perspective, safety management practitioners are in a better position to consider wider-reaching implications, such as how a solution can be adapted in order to suit different subcultures in the organisation better. Of course, a downside with a wider perspective is that it may only identify surface-level attributes of a group while missing its underlying values and nuances.

Finally, the detachment from the management of daily work tasks could make it easier to apply a more proactive, long-term perspective on safety management. There are several flaws and challenges with the Swedish mining industry's approaches to safety management that can and will be highlighted in this thesis. As such, I included this section to emphasise that there are beneficial aspects to these modern approaches that are worth highlighting alongside my analyses.

The current power structures may be pragmatic for planning and implementation, and for ensuring work environment regulations and goals are met. However, both the accounts of employees and managers have indicated that imbalanced power can and has been a contributing factor of difficulties with safety-related collaboration across vertical organisational distances. By separating the people developing safety management strategies from the practical work that will be affected, they are less likely to possess a comprehensive understanding of inherent risks and important details. Furthermore, conventional safety management practices still rarely involve relevant employees and lower-level roles. Efforts to provide representation for the employees in safety issues, such as feedback to risk reports or safety representative participation, can still leave much to be desired from their perspectives. Implementing safety policies and practices without opportunities to participate can hamper people's engagement in safety. This was exemplified by safety representatives who at times perceived their inclusion in their managers' safety development projects as a distraction from their own work. As such, they might aggravate the previously described issues with promoting engagement in formal safety management practices.

Furthermore, it can serve to accentuate strong organisational boundaries, which contributes to the development of disparate conceptualisations of safety and its characteristics within organisations.

Power in Swedish mining organisations not only shape the conditions for safety management but also determine which *interpretation* of safety that will be pursued. While generally encompassing protection from physical harm, the notion of ‘safety’ can have very different meanings, as has been demonstrated by the theoretical, strategic and practical perspectives explored in this thesis (see, e.g., Osborne & Zairi, 1997; Whiteoak & Mohamed, 2016). The differences between perspectives in the Swedish mining industry have been highlighted during the studies in papers 2, 3 and 4. The participating health and safety managers and specialists with more strategic perspectives described their work with managing safety by focusing on organisational aspects such as safety cultures, promoting safe behaviours and shaping how people think regarding safety. Conversely, the practical perspectives of operators, supervisors and production managers were more focused on tangible risks and dangers in their workplaces. As demonstrated during the studies of the mining operation in paper 4, the formally established interpretations of safety are not always fully supported by all parties. Individuals and groups with different perspectives on safety can clearly possess different conceptualisations of what “important safety work” means. While lower hierarchical levels may not have the flexibilities to completely disregard the interpretations established by their leaders, they may value their own, more practical safety management more.

These discussions have highlighted several challenges with safety management caused by the restrictions and frameworks established by power structures in the Swedish mining industry. I do not believe it is practical to consider these analyses as arguments for restructuring of the industry’s power relations and structures, however. There is still much room for development and improvement within the current systems to safety management.

Instead, exploring more nuanced perspectives on safety through communication and collaboration between hierarchical levels can serve as opportunities for nuanced perspectives and feedback on safety strategies and goals. Furthermore, while cross-organisational cooperation is not uncommon in Sweden, the integration of contractors has been criticised from several perspectives. One challenge will thus be to allocate sufficient time and resources for collaborations, something that the industry already struggles with in regard to certain aspects of safety management.

Contrasting safety management conceptualisations create opportunities for development

Through the exploration of his thesis has hopefully demonstrated how much that can be learned and gained from approaching the subject of safety from nuanced perspectives. The influence of conceptualisations on safety management conditions was highlighted for me when comparing the perspectives of those who plan safety management and those whose work is affected by their changes. Practical perspectives on safety management can deviate greatly from the strategic perspectives of those in charge of an organisation's safety development. An employee may discern different challenges with the implementation of a safety strategy than what its designer intended, or might have an entirely different interpretation of what 'safety' actually entails. In my studies, some of the safety experts focused more on how to best control the results and effects by establishing policies and regulations or by attempting to encourage desired behaviours and attitudes in employees. They approached safety by way of creating organisational frameworks to provide barriers and resistances to accidents and hazards. In contrast, the interpretations of 'safety' amongst the production managers or machine operators included in my studies were ostensibly, and understandably, more practical. They described developing various shared practices within their teams for, e.g., conducts during radio communication or training of new colleagues as valuable safety management measures.

Contrasting these groups emphasises how important it is to analyse these differing perspectives on safety management in order to more properly evaluate and understand approaches to safety within the Swedish mining industry.

Conceptualisation can be described as the way in which *terms, concepts and actions are interpreted, understood and responded to*. In this thesis, comparisons between various strategic and practical perspectives, both within and between examples from the two categories, have shown clear differences in how the characteristics of safety management are defined and described. These differences are rooted in people's and groups' conceptualisations of safety, and the assumptions and expectations they carry as a result. As an example, both structured, involved strategies and hands-off, delegating approaches from a manager can be seen as signs of a 'good leader'. Similarly, warnings from colleagues regarding risks are in some contexts treated as signs of timidness while being praised in others for their thoughtfulness. Strategic perspectives on safety management in the Swedish mining industry often emphasise bureaucratised, top-down approaches to safety management through policies and safety programs. Safety is but one of many aspects of mining operations that must be balanced in order to sustain a continuous value flow. Meanwhile, individuals working with daily production issues have been shown to be more interested in worker-oriented safety practices while the formal aspects are de-emphasised.

Because of the organisational boundaries and how communication is structured in Swedish mining organisations, many of these conceptualisations rarely interact. While there are efforts being made within organisations to explore new means of communication between organisational levels, many boundaries such as those between workplaces, occupational roles and contractors remain as obstacles. There are several factors that can accentuate the differences between conceptualisations which are important for mining industry safety practitioners to understand, with some being more directly related to safety than others.

One example of such factors is that of historical cultural norms interacting and conflicting with modern values promoted by an organisation's safety programs, strategies and communication. This type of resistance has arisen in mining industry contexts in significant part due to old masculine norms and cultural assumptions being challenged by modern technological developments (Abrahamsson & Johansson, 2021).

I am not the first to approach the subject of shared understanding regarding safety in mining industry contexts. The authors Haas and Yorio (2019) have argued that workers' perceptions of safety and their individual characteristics upon which they are based are important to understand in order to address risk-taking behaviour. By better understanding the individual, managers would be able to adjust their methods in order to positively influence their employees' approaches to health and safety. This approach of safety management—to communicate strategic perspectives of safety to roles with practical experience—was prevalent in the Swedish mining contexts I examined. As previously mentioned, strategic perspectives in mining industry contexts are better positioned to analyse wider-reaching and longer-lasting implications and characteristics of safety management decisions. They can be learned from to develop both theoretical and practical solutions based on a variety of sources, from literature to other mining workplaces. Practical roles can however have a different and comparatively better understanding of the specific conditions, characteristics and challenges inherent to the work.

Throughout my discussions, I have depicted various reactions to and interpretations of the more formal aspects of safety management in the Swedish mining industry. This has included strategic goals and reasonings behind policies and initiatives, and how these are received by various practical perspectives. In examining the experiences of people with more practical perspectives, however, I have also encountered different interpretations of safety and safety management with distinctive values. Amongst participating contractor employees, local supervisors and other blue-collar roles, important safety management efforts were depicted as

including informal methods of addressing internally assessed safety issues. Although they described many of their managers' approaches to safety in positive ways, these employees and supervisors would prefer to rely more on their own skills and knowledge whenever possible. They showed a high awareness of the risks present in their workplaces in addition to an openness to discussions with colleagues regarding important safety practices and goals. In contrast, formal aspects of safety management such as management procedures and organisational strategies were depicted as comparatively less important. While never wholly disregarded, they were not treated with the same enthusiasm and engagement as were those related to the management of safety in the daily work. Some examples, including the late inclusions of safety representatives as described in paper 4, highlighted how such formal practices were at times regarded as distractions from the "actually important" work.

The value of understanding and addressing conceptualisations of safety management lies in ensuring safety practitioners may better adapt their efforts to manage resistance to change, whether from individuals, groups, organisational structures or established norms. Efforts that can contribute to addressing the effects of these nuanced conceptualisations can already be found in today's Swedish mining organisations, such as when site managers are encouraged to develop their formal and informal relations with their employees.

6.2 Conclusions

In this thesis, I have highlighted how approaches to safety management in the Swedish mining industry are characterised by different parties having shared areas of focus but contrasting conceptualisations of safety and its management.

My exploration of approaches to safety management in the Swedish mining industry have shown that people from strategic and practical perspectives both emphasise similar aspects, e.g., communication or safety culture, as important. However, their conceptualisations of these subjects and priorities regarding safety can differ and at times conflict with one another. The common practice of employing contractors in the Swedish mining industry makes these organisations especially susceptible to such conflicts through continuous introduction of isolated groups and norms. Such conflicts contribute to building mistrust and discouraging participation in safety management, which makes important collaborations across hierarchical boundaries more difficult and less effective. Differences in priorities and perspectives are not inherently detrimental to the success of safety management efforts, provided that each party has the necessary resources and support to address the safety issues they consider most important. I believe pursuing a better understanding and awareness of the conditions for each of the groups involved in safety management is important for the continued improvement of safety outcomes in the Swedish mining industry. Modern Swedish mining workplaces already include opportunities and roles where the management of safety is practiced across organisational boundaries. Supporting these opportunities with the time, resources and incentives necessary for more involved safety management collaborations could be one method for bridging the gaps.

The differences in safety conceptualisations and prioritisations can in part be related to how mining organisations and their management of safety is structured. Based on the outcomes of current safety strategies, modern Swedish mining organisations have seen success in addressing safety issues.

However, managing safety across the boundaries between physical workplaces, professional roles, organisations and social groups involves challenges which modern methods have yet to resolve. Examples include difficulties with communication or coordination between different groups causing delays or disruptions of the daily work, or differences in workplace norms and assumptions leading to personal conflicts. Strategies to address these challenges have included methods meant to circumvent these boundaries, such as decentralising safety management through empowerment of lower-level roles.

Furthermore, based on my studies of organisational safety policies and strategies, and on exploration of nuanced perspectives of safety values and norms, the Swedish mining industry's approaches to safety development and culture are predominantly normative and top-down driven. While practical for organising and implementing safety strategies, focusing on safety issues from strategic perspectives complicates efforts to generate engagement in safety management. Paired with its propensity to approach safety from normative understandings of safety culture, the Swedish mining industry's safety management rarely manages to properly account for underlying assumptions and values. This expands the challenges with aligning safety management strategies to the expectations and needs of the people closer to the practical work, which in turn accentuates difficulties with building engagement. I believe the challenges with organisational boundaries and policy-driven, top-down managed safety cultures are similar in that both issues are difficult to address with the current systems of safety management. In order to continue the development of safety in these areas, Swedish mining organisations would benefit from supplementing their current strategies with methods based on new perspectives and conceptualisations. Examples would include more actively analysing the various structural and social boundaries linked to safety strategies, or to explore new methods of safety culture development grounded in different conceptualisations.

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