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Framework Factors with Critical Influence on Safety, Health and Environment in the Mining Industry

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Thesis for the degree of Philosophiae Doctor
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Preface

The work presented in this Ph.D. thesis was carried out at the Department of Geology and Mineral Resources Engineering at the Norwegian University of Science and Technology. The decision of applying for a position as a research fellow on the topic "*Framework Factors with Critical influence on Safety, Health and Environment in the Mining Industry*" arose from experiences gained within the Norwegian mining industry, and also from a wish of contributing positively to the development of the safety, health and environmental activities in the mining industry.

During nearly twenty years of practice within the Norwegian mining industry, I have faced considerable changes in the approach to safety, health and environment, from safety being the main topic during the 1970's to the introduction of a 'goal oriented' safety regime represented by the 'Internal Control Regulation' in 1992 and the concept safety, health and environment. Afterwards the enterprises were responsible for implementing systematic safety, health and environmental activities. I have also experienced at least four events of which the outcomes for myself could easily have become either very serious or fatal. As a plant manager I have experienced some of 'my' employees being more or less seriously injured, but luckily none of the injuries

were fatal. In addition, I have become aware of numerous events that could easily have caused accidents. Several of those events were revealed through discussions with employees during routine, supervisory inspections within the plant and especially after periods of office bound work to provide required enterprise reports, budgeting activities etc., and hence providing less management focus and pressure related to safety issues and activities. Finally, I have experienced three discharges of pollutants, of which two involved interrogation by the police and a third event (a near accident) that could easily have developed to be a major accident due to the probable extent of pollution and use of resources in subsequent reclamation activities and total costs involved.

From the perspective of a plant manager in a small or medium enterprise, the main challenges of the responsibility related to systematic safety, health and environmental activities lies in finding the time to do all necessary tasks related to operational responsibilities and further to ensure work environment and environmental rule compliance, a safe physical work environment, extensive dialogue and communication with the regulatory authorities, communication with employees to motivate, ensure a satisfactory psychosocial work environment, provide sufficient competency, ensure employees' participation and commitment, maintain overall commitment to enterprise goals concerning safety, environmental emissions, production efficiency and enterprise economy. Certainly, in balancing all these tasks and responsibilities, conflicts appear and also frustrations in relation to the question of how to manage all the tasks and responsibilities within the resource framework of a small sized enterprise; and at the same time keeping focus on decreasing the present risks of accidents and illnesses.

What, then, were the causes of the accidents and near accidents described above? With regard to my experiences regarding accidents, none of the minor accidents were analysed properly. As far as I recall, most of them were allocated to 'stupid acts' or 'the persons own fault', although underlying causes of other kinds were discussed in some of the cases. Clearly all the above described activities and responsibilities involved decision making at various organisational levels. I cannot point to one single decision being made, that ended with an accident causing injury or injuries, but of course I cannot exclude previous decisions, decisions and chains of decisions as part of causal

history either. Probably decisions 'not being made' may have contributed to the accidents too. However, the decision-making processes in connection to the previously described events were not followed in detail, for instance as part of a formal accident investigation.

The poem following on page vii represents an unfortunate flash of hindsight that appears from the outcome of decisions and actions not being made. Do not forget that a decision 'consciously not being made' is also a decision being made! But more important thus, it may also serve as a reminder of the fact that each and everyone of us possesses the potential of contributing positively to reduce the work environment and environmental risks, by showing commitment to work environment and environmental safety, by acting proactively in accordance with our commitment and by influencing other peoples' commitment to safety and their actions towards proactive behaviour.

My doctoral thesis would never become a reality without the contributions made by many people. They are recognised in the Acknowledgement section of the thesis. I hereby offer them all my sincere thanks.

Hans Tore Mikkelsen
Trondheim, Norway 2012

“I CHOSE TO LOOK THE OTHER WAY”

By Charlie Mearns, Safety Director Santa Fe Drilling

I could have saved a life that day,
But I chose to look the other way

It wasn't that I didn't care,
I had the time, and I was there

But I didn't want to seem a fool,
Or argue over a safety rule

I knew he'd done the job before,
If I called it wrong, he might get sore

The chances didn't seem that bad,
I've done the same, he knew I had

So I shook my head and walked on by.
He knew the risks as well as I

He took the chance, I closed an eye,
And with that act, I let him die

I could have saved a life that day,
But I chose to look the other way

Now every time I see his wife,
I'll know I should have saved his life

That guilt is something I must bear,
But it isn't something you need share

If you see a risk that others take,
That puts their health or life at stake

The question asked, or thing you say,
Could help them live another day

If you see a risk and walk away,
Then hope you never have to say,

I could have saved a life that day,
But I chose to look the other way.

Acknowledgement

My thanks on this project go to many people over many years. Friends, colleagues at the Department of Geology and Mineral Resources Engineering at the Norwegian University of Science and Technology have contributed in various ways.

First I would like to thank my supervisor Tom Myran. I will also thank my co-supervisor Steinar Ellefmo; and Rolf Arne Kleiv and Maria Thornhill for their valuable contributions in term of advice during this project.

Secondly I would like to thank the Department of Geology and Mineral Resources Engineering. This study would not have been possible without the financial support. I would like to thank the Professors Terje Malvik and Mai Britt Mørk as the succeeding heads of the Department for finding financial resources and solutions.

Next I would like to thank the enterprises and their representatives for responding to the surveys. Without their contributions, there would have been limited results to present. The names of the enterprises responding to the FC-survey are listed in appendix 2.

Finally I would like to thank my dear family and friends, who have supported and encouraged me during the doctoral project.

To all, my sincere thanks!

Hans Tore Mikkelsen

Abstract

For the years 2000-2010, both the fatal and non-fatal injuries in the Norwegian mining industry show decreasing trends. However, the observed levels are high compared with other Norwegian business sectors, and also international mining industry fatal and non-fatal levels. The Norwegian mining industry contributes with 0.4 % of the annual gross national product, employs about 0.2 % of the Norwegian workforce and 2.2 % of the fatal injuries. In 2007, the non-fatal injuries comprised 0.5 %.

The objectives of this study were to identify relevant framework factors and next framework factors of critical importance for the safety, health and environment, both in general and in relation to the mining industry; and finally to identify differences in factor importance apprehensions between various sectors of the Norwegian mining industry.

Here the framework concept describes the structure of the safety, health and environmental situation. Within the framework concept, *framework factors* are defined as factors that influence the safety, health and environment. Similarly *critical framework factors* are defined as influencing factors that are identified as being of very

high importance with respect to their influences on the safety, health and environment. For both framework factors and critical framework factors the influences are indirect and may range from negative to positive impacts. Negative impacts are increased risks of accidents, risks of occupational health illnesses and exposures causing fatal and non-fatal injuries, while positive impacts are reduced or eliminated risks of such impacts.

In this study eighteen possible framework factors were examined with respect to their importance for the SHE situation. Based on survey feedback, no framework factor was considered critical in average. However, individual responses still consider factors such as legislation, management, SHE-system, reputation, society acceptance, mineralogy, risk, protection equipment, environment and economy factors' importance as critical.

The main conclusion is that organisational factors such as *management*, *culture*, *system* and *competence*, and the *management* factor in particular, are very important framework factors with regard to influencing the safety, health and environment and the possibilities of keeping the risks of occupational accidents and illnesses under control. With regard to the *management* factor, a 'commitment to safety' is regarded highly important and considered of critical importance. Management commitment to safety is considered very important in creating and maintaining the organisation's safety culture. Findings from literature concerning safety management including experiences from accident investigations and the feedback from the mining enterprises through the FC-survey form the basis for this conclusion. In general, a continuous managerial pressure is necessary to maintain a good safety culture within organisations.

Other factors of very high importance are the examined *legislation*, *risk* and *communication* factors. Some of the respondents were critical to the extent and complexity of the legal framework related to safety, health and environmental issues, others were critical to the equality in law enforcement practice performed by local regulatory authorities.

With regard to risks of health impacts connected to the inherent framework such as deposit mineralogy, inherent gases and gases from mining operations, the emphasis was here put on the content of quartz and fibre minerals including asbestos minerals. According to FC-survey responses, the deposit content of quartz and fibre minerals varies from traces to high contents among the respondents. The importance of the 'Quartz agreement' were not acknowledged at the time of the survey, but is expected to grow in importance. A requirement of assessing risks is a central part of the legal SHE framework. Therefore the status of implementing risk analysis techniques was examined. Various risk analysis techniques are implemented to a high degree in relation to work environment and to a lower degree in relation to environmental issues.

The survey results indicate differences between the mining industry sectors being examined. The sample representing production of dimensional stones producers, separate distinctly with respect to factor importance apprehension from the samples representing industrial minerals, ores and coal mining on one side and the mines producing aggregates, gravels and sands on the other side. Also for the two latter samples, distinct differences are observed. Here the producers of aggregates, gravels and sands seem to consider most factors to be of very high importance, while the producers of industrial minerals, ores and coals show more differences in factor importance apprehension. Generally a large disagreement with respect to factor importance is observed for enterprises with a size of less than 50 man-labour years and production volumes less than one million tonnes.

Based on public statistics from 2010, the average Norwegian mining industry enterprise size was 6.9 man-labour years per enterprise. The size of enterprises comprised by this study varies from 3 to 400 man-labour years, of which the majority of enterprises' employ less than 50 people. In contrast to other safety research programmes which are connected to large organisations, this study comprised mainly small and medium sized enterprises. To deal with risks of occupational accidents and illnesses and in comparison with large enterprises, the small enterprises possess more limited resources with regard to human resources and competencies at site. However, small organisations should be more transparent with regard identifying and preventing losses from such risks.

With reference to the observed overall factor high importance observations for enterprises producing aggregates, gravels and sand, most of the enterprises are small and medium sized. The consequently high scores may indicate a priority problem related to balancing the human resources and requirements to production efficiency, health, safety and environmental performance, legal compliance etc.

This study of framework factors represents the perspectives of safety officers in medium and large enterprises or group of enterprises and chief executive officers in small and medium enterprises. Other perspectives represented by the organisations' base level, authorities and other stakeholders may be quite different.

Sammendrag

Både frekvensen av skader og skader med dødsfall for norsk bergindustri viser en nedadgående trend i årene 2000-2010. Observerte nivå er likevel høye i forhold til nivå observert i andre norske bransjesektorer men også internasjonal gruveindustri. Norsk bergindustri bidrar med 0,4 % av brutto nasjonalprodukt, sysselsetter omkring 0,2 % av den norske arbeidsstokken og 2,2 % av arbeidsulykkene med dødsfall som resultat. I 2007 utgjorde skadetallene for øvrig omkring 0,5 %.

Hensikten med denne studien var å identifisere kritiske rammevilkår for helse, miljø og sikkerhet både generelt og i relasjon til bergindustri samt kartlegge forskjeller i oppfatning av rammevilkår mellom ulike sektorer av norsk bergindustri.

Rammevilkårskonseptet definerer strukturen med hensyn til helse, miljø og sikkerhet. Innenfor dette konseptet, er *rammevilkår* definert som faktorer med indirekte innflytelse på helse, miljø og sikkerhetsarbeidet, mens *kritiske rammevilkår* på tilsvarende måte er definert som faktorer med indirekte innflytelse på helse, miljø og sikkerhetsarbeidet men hvor faktorene er særlig viktig med tanke på virkningen av endringer i

rammebetingelser. Innflytelsen kan være både negativ og positiv. Eksempler på negativ innflytelse er økt risiko for arbeidsulykker med skader og yrkessykdommer som følge av arbeidsulykker og arbeidseksponering. Positiv innflytelse er redusert risiko for nevnte arbeidsulykker og yrkessykdommer.

I denne studien ble totalt atten faktorer undersøkt med tanke på hvor viktig de er for helse, miljø og sikkerhetsarbeidet. Med bakgrunn i tilbakemeldingene fra spørreundersøkelsen om rammevilkår, var det ingen av de undersøkte rammevilkårsfaktorene som fikk gjennomsnittsscore 6 – tilsvarende 'kritisk viktig'. Imidlertid må det nevnes at individuelle respondenter vurderer faktorer som lovverk, ledelse, HMS-system, omdømme, sosial aksept, mineralogi, risiko, verneutstyr, ytre miljø og økonomi som kritiske rammevilkår med hensyn til helse, miljø og sikkerhet.

Hovedkonklusjonen er at organisatoriske faktorer som *ledelse*, *sikkerhetskultur*, *HMS-system* og *kompetanse*, og i særlig grad faktoren ledelse med vekt på ledelsesfunksjonen er svært viktige rammevilkår med tanke på virkning i forhold til helse, miljø og sikkerhetsarbeidet og derved mulighetene for å holde risikoen for arbeidsulykker og yrkesskader under kontroll. Med tanke på faktoren *ledelse* er 'ledelsens forpliktelse til å ivareta sikkerhet' ansett å være svært viktig og av kritisk betydning. Ledelsens forpliktelse til å ivareta sikkerhet er ansett å være svært viktig med tanke på dannelsen og vedlikeholdet av en god sikkerhetskultur. Publisert forskning vedrørende sikkerhetsledelse og erfaringer fra ulykkeskommisjoner samt tilbakemeldinger mottatt fra norsk bergindustri via spørreundersøkelsen om rammevilkår utgjør basis for denne konklusjonen. Generelt er kontinuerlig oppfølging og press fra ledelsen ansett å være nødvendig for å opprettholde en god sikkerhetskultur.

Bergindustrien anser også faktorene lovverk, risiko og kommunikasjon som svært viktige faktorer. Noen av respondentene var kritiske i forhold til omfang og kompleksitet i lovverk relatert helse, miljø og sikkerhet. Andre respondenter markerte kritisk holdning til lovpraksis utført av lokale myndigheter. Kritikken går på variasjoner i lovpraksis i ulike regioner av landet.

Naturlige risikofaktorer tilknyttet bergverksdrift er knyttet opp mot forekomstens mineralogi, naturlige gasser og gasser utskilt under ordinær gruvedrift osv. Risikoen for yrkessykdommer eller helseeffekter som følge av disse eksponeringene vil avhenge av eksponeringsnivå. Her ble eksponering i tilknytning til respirable partikler fra kvarts, fibermineraler og asbestmineraler vektlagt. Respondentene rapporterer varierende innhold av kvarts og fibermineraler i tilknytning til sine forekomster. Betydningen av kvartsavtalen som rammevilkår er forventet å øke, men den var relativt ny og lite kjent på tidspunktet for spørreskjemaundersøkelsen, Krav til gjennomføring av risikovurderinger står sentralt i lovverk for helse, miljø og sikkerhet. Deltakerne i undersøkelsen rapporterer at de i stor grad gjennomfører ulike typer risikoanalyser i forhold til arbeidsmiljø og i noen mindre grad i forhold til ytre miljøforhold.

Undersøkelsen indikerer forskjeller mellom de tre undersøkte sektorene av norsk bergindustri. Steinprodusentene skiller seg tydelig fra produsentene av industrimineraler, malmer og kull, og produsenter av pukk, grus og sand gjennom syn på hvor viktig de ulike faktorene er. Nivået med hensyn til score hos førstnevnte gruppe ligger lavere enn de to andre. Tilsvarende forskjeller kan også observeres mellom de to sistnevnte gruppene også. Produsentene av pukk, grus og sand gir score tilsvarende svært viktig til nesten samtlige undersøkte faktorer mens produsentene av industrimineraler, malmer og kull differensierer mer mellom ulike faktorer. I tillegg kan man observere større variasjoner i syn på hvor viktig de ulike faktorene er for bedrifter med færre enn 50 årsverk og produksjonsnivå under en million tonn.

Norske bergindustribedrifter sysselsatte i gjennomsnitt tilsvarende 6,9 årsverk pr. bedrift i 2010, mens bedriftene omfattet av denne studien sysselsatte tilsvarende 3-400 årsverk pr. bedrift eller konsern, mens majoriteten av bedriftenes sysselsetting tilsvarer mindre enn 50 ansatte og produksjonsvolum mindre enn en million tonn. Til forskjell fra andre forskningsprosjekter vedrørende helse, miljø, sikkerhet og risiko i tilknytning til storulykker og ulykker, gir denne undersøkelsen kunnskap om tilsvarende forhold i hovedsakelig små og mellomstore bedrifter. For å håndtere helse, miljø og sikkerhetsspørsmål og aktiviteter, innehar gjerne disse bedriftene mer begrensede ressurser med tanke på mannskapsstørrelse og kompetanse sammenliknet med store

bedrifter. På den andre siden er små organisasjoner mer gjennomsiktige i forhold til beslutningstaking i relasjon til risikohåndtering. Dette er imidlertid å anse som en fordel i så måte.

Utvalget tilhørende produsenter av pukk, grus og sand ga i gjennomsnitt høy score for nesten samtlige faktorer. De fleste av disse bedriftene er små eller mellomstore bedrifter. Det konsekvente høye nivået på score kan indikere et prioriteringsproblem tilknyttet balansen mellom forvaltning av menneskelige ressurser og krav til produksjonseffektivitet, systematikk i helse, miljø og sikkerhetsarbeidet, overholdelse av lovverk osv.

Spørreskjemaundersøkelsen vedrørende rammevilkår representerer et perspektiv sett fra HMS-ledere i mellomstore og store bedrifter samt daglige ledere i små og mellomstore bedrifter. Andre perspektiv representert av andre nivå i organisasjonene, myndighetene og andre interesseparter er ikke ivaretatt og kan derfor variere fra de syn på rammevilkår som er presentert i denne studien.

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List of acronyms

ACGIH:	The American Conference of Governmental Industrial Hygienists
AD:	Ministry of Labour (from 1.1.2010)
AID:	Ministry of Labour and Inclusion (01.01.2006–31.12.2009), see AD
CEO:	Chief executive officer
DAT:	The Norwegian Labour Inspection Authority
FC:	Framework conditions. Translation of 'rammebetingelse' in English
HAZOP:	Hazard and operability study
HES:	Health, environment and safety
HMS:	Safety health and environment (concept in Norwegian)
HRO	High reliability organisations
HSE:	Health, safety and environment
IMA-Europe:	Industrial Minerals Association Europe
JSA:	Job Safety Analysis
ILO:	The International Labour Organization
NEPSI:	European Network for Silica
NGU:	Geological Survey Norway
NIMBY:	Not in my backyard
NORSOK:	Norsk Sokkels Konkurranseposisjon
NOU:	Official Norwegian Reports
OHS:	Occupational health and safety
PDSA:	Strategy for improvement work (*Plan*, *Do*, *Study* and *Act*)
PM:	Particulate matter
ROS:	Risk and vulnerability
SCOEL:	Scientific Committee on Occupational Exposure Limits
SEM:	Safety Element Method
SHE:	Safety, health and environment
SN:	Standard Norway
TLV:	Threshold Limit Value (concentration value connected to exposure)
UN:	United Nations

1. Introduction

Worldwide industrial production delivers a wide range of products required by society. It makes a foundation for social development by providing income for workers, suppliers, communities, nations, international trading etc. Unfortunately, not all contributions are positive. The International Labour Organization (ILO)[1] describes some of the negative outcomes from work-related activities as follows:

> "*Every day, 6,300 people die as a result of occupational accidents or work-related diseases – more than 2.3 million deaths per year. Over 337 million accidents occur on the job annually; many of these resulting in extended absences from work.*
>
> *The human cost of this daily adversity is vast and the economic burden of poor occupational safety and health practices is estimated at 4 per cent of global Gross Domestic Product each year.*
>
> *The safety and health conditions at work are very different between countries, economic sectors and social groups. Deaths and injuries take a particularly heavy toll in developing countries, where a large part of the population is engaged in hazardous activities, such as agriculture, fishing and mining...* " (ILO, n.d.)

The ILO calls attention to several important issues such as occupational risks resulting in accidents and work related diseases, human and economic costs of poor occupational

[1]The ILO was created in 1919. It became the first specialized agency of the United Nations (UN) in 1946. The main aims are "*...to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue on work-related issues*" (ILO "n.d.")

safety and health practices. Large differences between the western world and the developing countries are observed and mining together with agriculture and fishing are classified as hazardous activities. Global estimates based on compiled data from 175 countries in eight regions were made by Hämäläinen. Takala and Sarela (2006) . Their estimates show that accidents causing more than three days of absence happen more frequently than reported and the proportion of occupational accidents reported to the ILO is 3.9 % of the estimated accidents. Estimates showing decreasing trends in the Western countries, are attributed to managerial aspects of risk prevention reflected in laws and regulations, technical hardware measures (barriers), automation removing interference between man and direct process flows by Swuste (2008). In addition a pattern of employment change in the Western countries by less people working in hazardous sectors as fishing, agriculture, mining, steel mills, ship building etc. has contributed to this development. To an increasingly degree these sectors have been exported to other parts of the world (Swuste, 2008).

1.1 The framework concept

Commonly human, organisational, technical and environmental factors are examined in order to first find the causes of occupational accidents and illnesses and next to implement actions to reduce the risks of such events (Smith and Sainfort 1989; Smith et al. 2003). Here, an attempt to approach the underlying causes of occupational accidents and illnesses are related to an examination of the framework of the SHE situation and also important or critical framework factors with indirect influences on the risk of occupational accidents, illnesses and the SHE situation in general.

Sometimes the framework concept is used to describe the structure of something definite, in other cases something abstract. In many respects a framework is supportive such as a skeleton or scaffold, while in other respects it describes and defines a definite set of boundaries. Framework factors that define boundaries are commonly restrictive of nature and concepts that fit the restrictive nature such as *constraints*, *external conditions* or *public safety framework* are used. One may for instance speak about the legal

framework comprised by SHE related legislation; economic framework influenced by economic related legislation, resource and product qualities, market factors, costs, investments etc.; organisational framework; environmental framework etc. To emphasise the supportive function prior to the restrictive content of the framework concept and also avoiding an attitude that the framework of the SHE situation are 'given and cannot be changed', the more neutral influencing *framework factors* concept is used in the description of the survey results in chapter 4.

The practical research work described in this thesis is related to the Norwegian mining industry and a study of framework factors with influence on general SHE situation and on the risk of occupational accidents and illnesses in the Norwegian mining industry. The Norwegian mining industry is comprised of underground mines, quarries, mineral dressing plants, lime kilns etc. As statistics presented in chapter 2 will show, the Norwegian mining industry does not stand out from similar industries in other parts of the world. It is characterised by high rates of fatalities and injuries compared to other business sectors. The research also comprises literature studies with the aim of providing a theoretical basis for discussing framework factors that influence the SHE situation and the risk of occupational accidents and illnesses. The objectives are further elaborated in chapter 1.2.

Most studies within risk management seem to be made within large organisations. The originality of this study is first that the research is made in cooperation with mostly small or medium sized enterprises and next, that it tries to add a 'measure of the importance' of various framework factors with influence on the risk of occupational accident, illnesses and the SHE situation in general.

1.2 Objectives

The aim of this thesis is to identify framework factors with possible critical influences on the risk of occupational accidents, illnesses and the SHE situation of the mining industry in general. Here the characteristic 'critical' is connected to factor importance.

Although both work environment and environmental risks are considered, the emphasis is related to the work environment. First, influencing factors are identified by reviewing scientific and other literature sources and next by performing a survey among enterprises belonging to the Norwegian mining industry. Finally a discussion of factor importance or critical importance with respect to influences on the above mentioned risks.

In the framework context of the SHE situation, the objectives of this research are summarized in the following questions:

1. Which framework factors are relevant for the SHE situation, both generally and more specifically in relation to the Norwegian mining industry?
2. Which influencing factors are of critical importance for SHE situation, both generally and more specifically in relation to the Norwegian mining industry?
3. What are the differences in the apprehension of framework factor importance between the different sectors of the Norwegian mining industry?

1.3. Scope

The concepts safety, health and environment (SHE) indicate a multidisciplinary character. Occupational safety, health and environment as a concept has its roots within disciplines such as engineering, toxicology, epidemiology, medicine, sociology, psychology, economics etc. To deal with the interacting factors of people, technology, organisation of work activities, work environment or environmental issues, knowledge from various sources or disciplines is required.

When discussing matters concerning safety, health and the environment, the abbreviation 'HMS' is used in Norwegian. In English terminology various abbreviations are used, such as HSE, SHE, OHS etc. From here on, the abbreviation SHE will be used to denote the concepts safety, health and environment. Essentially it indicates that work environment and environmental issues are included. The work environment includes

physical, chemical, psychosocial factors etc. while environmental includes physical, chemical and other factors that influence air, soil and recipients (streams, rivers, lakes, sea etc.), climate etc. Due to the broadness of the complete SHE concept, delimitations are required. Here the main emphasis will be put on framework factors that influence the work environment. However relevant environmental issues may be included, because environmental issues were part of the research programme. Accidents and risks connected to for instance terror actions will not be considered. Further delimitations are made by excluding psychosocial factors.

1.4. Outline of the thesis

The thesis is organised as a monograph, containing the following chapters:

1. Introduction

   A general introduction and definition of the objectives and scope is presented.

2. Background

   In this chapter a review of issues related to the SHE situation, general terminology connected to the SHE situation, accidents, hazards, risk assessment and framework factors are presented.

3. Methodology

   Here, methods for collecting and evaluating framework factors data are presented.

4. Results

   The results the FC-survey are presented.

5. Discussions
6. Conclusions and recommendations
7. References
8. Appendices

2. Background

Frequently public debates concerning the general framework in connection to various businesses appear. The general impression is that most of the discussions are related to economic issues. In mass media, debaters' statements such as "*Our industrial business sector is in urgent need of a better framework*" are common and they usually are expressed with reference to conditions or framework factors that are considered especially important. In some situations, the discussed factors may influence the SHE-activities in general or particularly the risk of occupational accidents or illnesses. Individuals participating in debates may represent the authorities, research environments, enterprises etc.

Initial literature searches related to the framework concept gave the impression of sparsely available information. However, fragmented information about factors considered to be part of the framework concept exists in scientific, while literature discussing the overall framework concept in relation to SHE seemed sparse at the time of designing the FC-survey described in chapter 3. However, it is unlikely that anyone will challenge a statement that laws and regulations are part of the legal framework concerning health, safety and environment, but a statement concerning the importance of the individual laws and regulations invite to discussion.

Lately the framework concept is put in focus in Norwegian work environment and workers safety research, for instance within the petroleum sector by Førland (2003), Rosness, Blakstad & Forseth (2009) and Rosness, Forseth & Wærø (2010) in relation to major accident and occupational illnesses risks, while this thesis focuses on the framework concept related to the SHE situation and risks connected to the mining industry. Works by Rosness et al. (2009) and Rosness et al. (2010) are referred to in detail in subsequent chapters.

The subsequent chapters present shortly the legal framework, a snapshot to Norwegian work life, mining industry hazards and SHE performances and finally a theoretical approach to the SHE situation and its framework.

2.1 The legal framework of the SHE situation

Kjellén (1998) uses the 'framework conditions' concept to cover what is described as the framework concept and its accompanying framework factors in chapter 1.1. He focuses on how changes in competitiveness within the economic framework and legislative changes within the legal framework influenced on the petroleum industry's internal safety management work processes and the implementation of risk analysis techniques. In this context a NORSOK initiative aimed to improve the competitiveness of the petroleum industry while new legislation represented a change from detailed prescriptive SHE requirements to goal oriented requirements and requirements concerning the industry's implementation of risk analysis in the decision making processes. The change to goal oriented requirements represents a paradigm shift that involves a strengthening of the responsibilities for performing safety management allocated to the enterprises and those who are responsible for the enterprises.

The present general legal framework concerning SHE comprises more than 50 acts and regulations. Within these acts and regulations, numerous rules are described. When referring to the 'mining industry' and 'industries producing glass, cement etc.' and with Regelhjelp (2007A, 2007B) as the source, the legal framework regulating SHE

activities in those two mining industry sectors counts close to 50 acts (laws) and regulations in total. The latest development is that the Ministry of labour plans to replace 47 regulations sanctioned by the Working Environment Act with 6 new regulations from January 1st 2013. The regulators objective is to improve the structure and availability of the legal framework (Regelhjelp, 2011).

Within the present legal framework the objective of the *Working Environment Act* is to ensure a healthy and meaningful working environment that provides full safety from harmful influences. The *Working Environment Act*, with exceptions noted in the text, applies for undertakings that engage employees (DAT, 2007, AID, 2005). Despite the legal requirements of a working environment that provides full safety from harmful influences, implementation of technological solutions, barriers to reduce the exposure of humans to hazardous equipment or environment, non-conformance recording with focus on deviations from prescribed legal rules or other rules incorporated in internal company procedures or instructions, focus on human errors and behaviour, risk assessments that shall protect workers and training programmes; accidents are still happening. As the subsequent chapters will demonstrate, the moment of fulfilment of the above described Working Environment Act objective seems to be far away.

2.2 Norwegian work life and SHE performances - a snapshot

The objective of performing occupational SHE activities is to avoid accidents causing injuries or fatalities, health impacts from exposure to gases, dust etc., environmental pollution impacts (oil spills, heavy metals pollution etc.), improved working conditions etc. However, public Norwegian statistics show that a total of 17 686 occupational injuries, 42 fatalities and 2 382 occupational illnesses were recorded in 2009. In total about 34 % of the injuries, 45 % of the fatalities and 56 % of the illnesses were recorded within the industrial and construction sectors (DAT, n.d.). Further details concerning the mining industry is presented in chapter 2.3.

2.3 The mining industry

2.3.1 General description

In 2010, the Norwegian mining industry consisted of 790 enterprises with about 5 500 man-labour years distributed at 1190 production sites. They produced about 85 million tons. The production and export values[2] were about 1 349 million € and 824 million € respectively (Neeb et al., 2011). Estimates made from these numbers correspond to 0.2 % of the total Norwegian workforce and about 0.4 % of the annual gross national product[3] (SSB, n.d.-a, SSB, n.d.-b, SSB, n.d.-c). Future increasing needs for mineralogical resources in the world market are promising for mining industry development. Planning for new mining activities and reopening of old metallic deposits has been initiated at the Nussir copper and the Engebøfjellet titanium oxide ores.

The Norwegian mining industry is commonly separated into three business sectors. The first sector comprises mines producing industrial mineral products, metal concentrates from ores, coal etc., the second sector produces dimensional stones such as roof slates, benchplates, headstones etc. while the third sector produces aggregates, gravels and sands. Excavating usually takes place in quarries or underground mines, but some deposits are alluvial deposits of origin. The complexity of the belonging production lines may vary a lot, depending on the type of deposit and products. The simpler production lines consist of mainly crushers, sieves and conveyors for transportation while the complex ones can be compared to those found in chemical industry. For others the complexity is something in between. Dimensional stones production lines are comparable to manufacturing lines.

[2]Estimated production and export values are based on the 2010 average foreign exchange quotation of 8.0083 NOK/€ (DnB "n.d.").

[3]In 2010, the total Norwegian workforce counted about 2.5 million people, and the Norwegian annual gross national product value was estimated to NOK 2 523 billions corresponding to € 315 billions (DAT "n.d."; SSB "n.d.-A"; SSB "n.d.-B"; SSB "n.d.-C").

2.3.2 Mining industry hazards

In general, mining activities are considered hazardous (Alteren 1999; Devine, Muller and Carter 2008; Perrow 1999; Myran 2004). To a large degree mining industry hazards may be similar to hazards found in other industries, for instance the use of hazardous equipment and work tools, exposure to chemicals, oils etc. while other hazards are unique and related to mining and tunnelling activities only, such as block falls due to high rock stress, tectonic weakness zones in the rock, exposure to respirable particles, gases from blasting and diesel oil etc. In Norway the problem of high concentrations of blasting gases is a larger problem in tunnelling compared to underground mines. In underground mines, blasting is commonly done at the end of the evening shift and the blasting gases are ventilated out during the night while no one is working in the mine. In tunnelling, the workers seldom wait for a complete ventilation and removal of blasting gases, leaving satisfactory low concentrations in the work area before entering. Frequent reports of people passing the gas plug during transport to the working area exist, most probably due to efficiency pressure induced by terms of contracts etc. The problem of exposure to gases from diesel oil and high concentrations of mineral dusts is common in underground mining as well as in tunnelling.

Perrow (1999:244) refers to findings and experience from the United States and concludes that "*Subsurface mining ... is clearly a dangerous occupation*". Based on causal analyses of accidents, he further states that "*The mine, as a system, is rarely visited by system accident, as far as my search efforts indicate*". According to Perrow, system accidents happen in complex systems with tight couplings such as nuclear power plants, chemical production plants etc. Further he discusses earth bound systems such as mines and dams and conclude that "*Accidents in both systems could readily be reduced; the fatal combination of complexity and tight coupling is not present*" (Perrow, 1999:232). Details about this perspective on system accidents are elaborated in chapter 2.7.2 describing the 'normal accidents' theory. With reference to the previous statement about the lack of complexity and tight coupling in mining in combination with the subsequent statement that accidents can therefore readily be reduced, everything seems rather simple. However, statistical data previously referred to and statistical data

compiled from the Norwegian and international mining industry presented in chapter 2.3.4, indicate another reality. The statistics show that we are far away from an aim of totally preventing accidents, health illnesses, injuries and fatalities in the mining industry, as in other industries.

One may ask whether accident prevention in the mining industry is as simple as expressed by Perrow (1999). Natural questions to ask would be: Why are the accidents still happening and why not at much lower rates of fatalities, injuries and occupational illnesses than that being observed? Is there something wrong with the safety management or our commitment to perform safety activities? Are we pulling the wrong strings, i.e. pursuing non-important influencing framework factors, in our present safety activities? Is it possible to make changes to the present framework to stimulate better preventive actions?

2.3.3 Work environment and accidents in Norwegian mining

Typical mining activities are drilling, blasting, loading, transportation, crushing, sieving, milling, various mineral extraction techniques, maintenance operations etc. All the described operations may involve safety risks and risks of injuries and fatalities for the workers involved in these activities. In the work environment, they may also be exposed to respirable crystalline mineral particles (dust), gases or other substances that may cause health impacts and health illnesses. Mineral production may also cause environmental impacts. Impacts may come from emissions of noise, vibrations, emission of mineral particles to air, discharges of particles or other substances to soil, streams, rivers, lakes, sea, etc. Other substances are chemicals, oil, heavy metals etc.

At the assignment of the Ministry of Transport and Communications, Jersin (2003) investigated and reported Norwegian major accidents occurring during the period 1970-2001. A total of 103 accidents were classified as major accidents[4]. In total 1 174 people

[4]Major accidents criteria: i) ≥ 5 persons being killed, ii) material damage values are estimated to ≥ NOK 30 million (≥ € 3.7 million) or iii) large environmental impacts involved such as heavy and expensive remediation cost, large quantities of killed living organisms or serious long term effect.

were killed in these accidents. The majority of the recorded accidents and fatalities occurred in the transport sector (aeronautical, maritime, railways and road traffic), while the remaining accidents and fatalities occurred in the petroleum industry, industrial sector and other sectors. One of the accidents reported is connected to a pollution event that was caused by a mining company.

Examples of publicly known accidents within the Norwegian mining industry that can be classified either as major accidents or potential major accidents according to the criteria used by Jersin (2003) are presented in table 1. Short descriptions for all accidents except the Svea North mine fire are given in the subsequent paragraphs.

Table 1: Mining industry major and potential major accidents

Year	Accident examples from the Norwegian mining industry
1962	The Kings Bay Coal Mine accident involved a combined methane gas and coal dust explosion where 21 mine workers died.
2001	Discharge of 780 m^3 waste oil to sea from a tank farm. Remediation actions performed afterwards.
2005	The Svea North Coal Mine. The accident occurred during ordinary operations One coal miner died in the accident. In total twelve miners were directly involved in the accident.
2005	A fire occurred in the Svea North coal mine. It started in connection to pipeline welding work. Due to smoke exposure, two persons were transported to hospital. No fatalities involved. Mine closure and eight months of production volume losses.
2011	The Rana Mine. Concentrator explosion and fire. No serious personnel damage, but two persons were checked for smoke damage. Material damages and major production volume losses (200 000 tons of hematite concentrate).

In November 5th 1962 a combined gas and coal dust explosion happened in the Kings Bay mines at Svalbard. In this accident 21 miners died. A commission of inquiry was established to evaluate the causes of the accident. In their report the commission criticised the mining company administration, company board and the Norwegian Labour Inspection Authority. The Government's handling of the situation was criticised and followed by a motion for a vote of no confidence in Parliament. The vote of no confidence was approved by 76 against 74 votes, and the Government resigned (NRK, 2002, NOU, 2009, Caplex, n.d.).

In the environmental pollution accident referred by Jersin (2003), about 750 tons of waste oil was discharged to sea (Government, n.d.). Initially the oil discharge was caught by a box dam surrounding the tank farm. At the time of the accident, a valve for draining water from the box dam to the sea was open, allowing the oil to flow directly to the sea. Neither direct costs (remediation etc.) nor indirect costs are known.

July 3rd 2005 the Svea North coal mine accident at Svalbard produced one fatality. The accident occurred when braking through from a new to an old part of the mine. Methane gas accumulated in the old mine area, moved into the stope where twelve miners were working at the time. Methane gas with a specific density lower than oxygen replaced the oxygen at the upper level of the stope. All twelve miners fainted due to lack of oxygen in the breathing area. Due to the higher oxygen concentrations at the lower level of the stope, some of the unconscious miners woke up. They were able to move themselves to a safe area. A rescue operation was initiated. All the miners except one recovered. The latter died in the accident. This accident could potentially have caused the death of twelve miners. The accident investigation revealed major weaknesses and failures in safety routines prior to the break through. The mining company accepted a penalty of NOK 10 million corresponding to about € 1.2 million (Lofotposten, 2006). Due to negligent actions prior to the accident, a production engineer was found guilty in court. He received a suspended sentence of 90 days in prison and a penalty of NOK 30 000 corresponding to about € 3 750 (HegnarOnline, 2007).

In February 4th 2011 a hydraulics tank placed in the concentrator of the Rana Mine ore dressing plant exploded. The explosion was followed by a fire. No people were seriously injured, but there were damages to buildings and process equipment. The lost production volume during six weeks of downtime were about 200 000 tons of hematite concentrate (RanaBlad, 2011A, 2011B). In this case neither the direct nor the hidden costs are publicly known.

2.3.4 SHE performance in mining

Annual mortality rates of occupational accidents are considered an indicator of the effectiveness of safety management systems (Swuste, 2008). His conclusion is based on

global estimates of occupational accidents with fatal and non-fatal outcomes for 175 countries reported by Hämäläinen, Takala and Saarela (2006). The ILO[1] reports annual fatalities and non-fatal injury rates globally. To be able to compare the results per country, the fatality and non-fatal injury rates are scaled against 100 000 workers (Hämäläinen et al., 2006, ILO, n.d.). It is also common to use working hours in the frequency estimates. For fatal accident rates (FAR) 10^8 working hours are commonly used to estimate FAR values, while for lost time injury (LTI) and severity frequency rates 10^6 working hours are used (Beggerud, 2006). Sickness absence ratios are commonly considered an indicator for the enterprises climate concerning cooperation (NorskIndustri, n.d.-b). Sickness absence ratio numbers will also reflect ordinary workers health problems such as non-occupational injuries (causing absence), flues, colds etc.

The Norwegian Labour Inspection Authority compiles the Norwegian occupational fatality and non-fatal injury numbers. Their annual statistics are compiled and reported according to business sector results. International statistics are compiled and reported by ILO (n.d.). In table 2, figure 1 and figure 2 the rates of fatal injuries in the Norwegian mining industry, other Norwegian business sectors and international mining industry are presented. Similarly the non-fatal injuries are presented in table 3, figure 3 and figure 4. The share of fatal and non-fatal injuries vs. total Norwegian results is presented in table 2 and table 3. The Norwegian fatal and nonfatal injuries show decreasing trends, see figure 1 and figure 3. The Norwegian Labour Inspection Authority (DAT)[5] experiences time lags of 1-1.5 years in the reporting of injuries. Biases may also be connected to detained occupational fatality, injury or illness reports (DAT, n.d.).

[5] Occupational fatalities and serious injuries are reported by the enterprises to the Norwegian Labour Inspection Authority (DAT). DAT compile the data. To reveal fatal injuries, DAT also monitors other sources and fatal injuries not being reported by the enterprises are next subject to follow-ups by DAT. Occupational injuries that give the right to economic compensations are reported to The Norwegian Labour and Welfare Service (NAV) by the enterprises. Occupational illnesses are diagnosed and reported by medical and general doctors (DAT "n.d.").

Table 2: Fatal injuries in Norwegian and international mining industry

Norway sectors[6A)]		**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Norwegian totals	Injuries per 100 000 workers	2.5	1.6	1.7	2.1	1.7	2.1	1.3	1.6	2.0	1.7	1.8
Agriculture, hunting and forestry		22.1	12.5	7.2	20.9	17.5	25	6.0	7.1	21.4	12.1	12.7
Fishing		23.1	-	-	-	-	23.6	-	20.9	20.4		
Manufacturing		3.4	3.1	2.8	2.1	0.8	2.0	2.0	2.9	3.5	3.2	2.5
Construction		4.1	5.2	5.0	5.5	5.1	4.6	4.4	4.9	3.7	6.1	5.0
Mining industry		50.0	25.0	0	66.7	100.0	50.0	0	25.0	20.8[6B)]	0[6B)]	18.0[6B)]
Mining industry vs. Norwegian totals	%	3.5	2.7	0	4.0	7.9	4.2	0	2.6	2.0	0	2.2
International mining industry[6 A)]		**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Argentina	Injuries per 100 000 workers	33,1	-	41,8	41,4	60,1	37,9	23,9	26,8	-	-	-
Australia		17,0	21,2	11,8	15,7	6,6	4,0	10,6	4,7	5,0	-	-
Canada		20,1	23.0	17.0	14,1	16,4	10,7	14,7	7,8	14,1	-	-
Finland		0	0	28,6	47,6	0	43,5	0	0	-	-	-
Norway		50.0	25.0	0	66.7	100.0	50.0	0	25.0	20.8[6B)]	0[6B)]	18.0[6B)]
Sweden		0	13,8	14.0	0	0	0	13,3	12,8	25.0	-	-

[6] A) Norwegian statistics are compiled by the Norwegian Labour Inspection Authority, while international statistics are compiled by the International Labour Organization (DAT n.d.; ILO n.d.). B) Fatal injuries that occur in Russian mining at Svalbard and in energy raw materials recovery are subtracted from the total mining industry fatal injuries. Next employment numbers reported by Neeb et al. (2011) were used to estimate fatal injury rates for the period 2008-2010.

Table 3: Non-fatal injuries in Norwegian and international mining industry

Norway sectors[7A)]		**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Norwegian totals	Injuries per 100 000 workers	1400	1260	1179	1047	993	899	780	781	662
Agriculture, hunting and forestry		584	553	478	455	444	422	357	336	383
Fishing		1895	1910	1794	1427	1702	2032	1323	1273	1676
Manufacturing		2823	2608	2290	1986	1828	1639	1404	1451	1304
Construction		2454	2172	1928	1765	1676	1537	1280	1263	1121
Mining industry[7]		3650	4150	3800	3300	3400	2225	2225	2775	369[7B)]
Mining industry vs. Norwegian totals	%	0,46	0,54	0,53	0,39	0,42	0,45	0,39	0,52	-
International mining industry[7A)]		**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Argentina	Injuries per 100 000 workers	7665	-	5690	6580	7190	7300	7320	8080	-
Australia		2630	2480	2500	2210	2120	2000	1540	1620	1550
Canada		2021	1767	1588	1544	1382	1289	1132	1067	987
Finland		5088	6667	4829	3333	3405	3261	3064	3800	-
Norway[7]		3650	4150	3800	3300	3400	2225	2225	2775	369[7B)]
Sweden		2887	2850	2590	2219	1746	1923	2003	1744	1590

[7] A) Norwegian statistics are compiled by the Norwegian Labour Inspection Authority (DAT n.d.). International statistics are compiled by the International Labour Organization (ILO n.d.). B) Norwegian mining industry non-fatal and fatal injuries include Russian mining industry injuries at Svalbard. From 2008 the statistics also include recovery of energy raw materials. Prior to 2008 mining and energy raw materials recovery were reported separately.

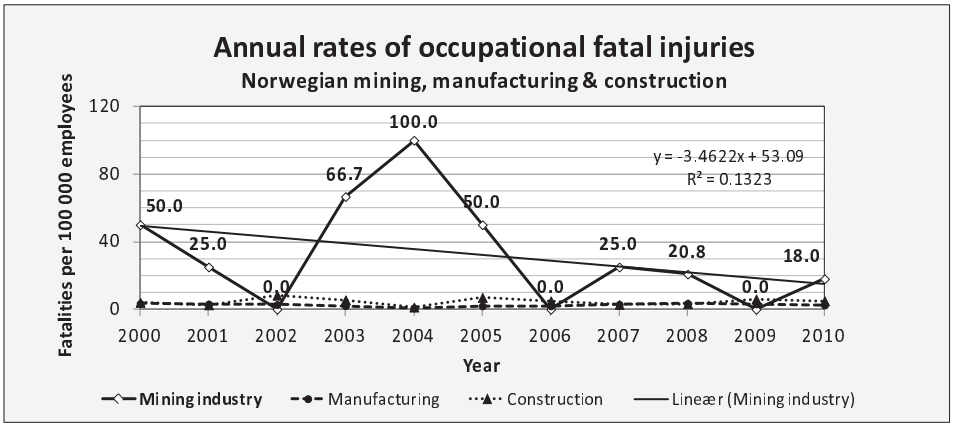


Figure 1: Annual rates of fatal injuries – Norwegian business sectors

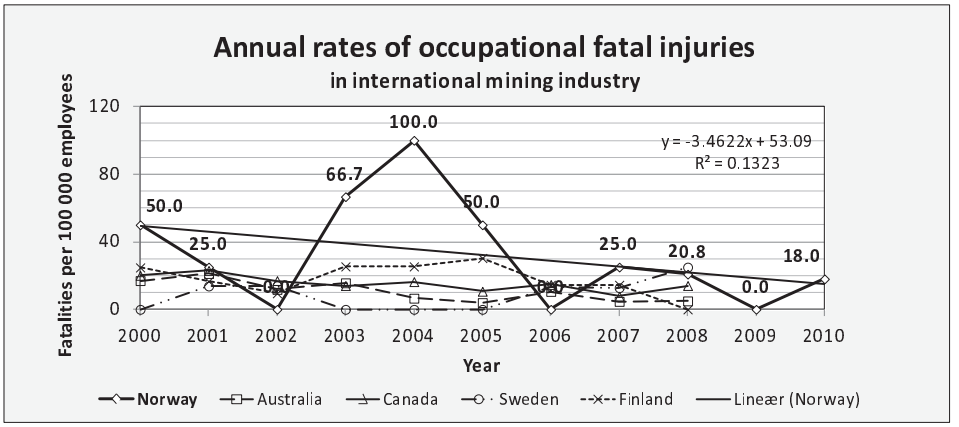


Figure 2: Annual rates of fatal injuries – international mining industry

Table 4 presents the distribution of occupational related illnesses for selected Norwegian business sectors for the period 2005-2010. In table 5 the distributions of selected medical diagnoses are presented. Unfortunately the distribution per business sector is not available in the public statistics.

Table 4: Norwegian occupational illnesses

Country	2005	2006	2007	2008	2009	2010
Total number of illnesses	2757	3051	2879	2684	2382	2740
Agriculture, hunting and forestry and fishing (in percentage)	2,4	2,6	1,7	1,9	2,0	2,4
Mining industry[4] (in percentage)	2,6	2,4	2,0	2,8	4,0	4,1
Manufacturing (in percentage)	34,7	37,3	35,8	35,2	27,6	34,2
Construction (in percentage)	14,1	17,8	18,0	17,3	17,1	20,3

Table 5: Norwegian occupational illnesses per medical diagnose

Country	2005	2006	2007	2008	2009	2010
Total number of illnesses	2757	3051	2879	2684	2382	2740
Noise damages (in percentage)	56,0	63,5	63,9	60,4	55,0	63,5
Respiratory system illnesses (in percentage)	11,9	14,2	11,9	11,0	9,0	9,2
Illnesses causing musculoskeletal problems and illnesses in the connective tissue (in percentage)	7,6	6,8	4,1	3,9	6,1	6,9
Illnesses in skin and corium (in percentage)	8,6	7,7	6,6	5,8	5,5	4,6

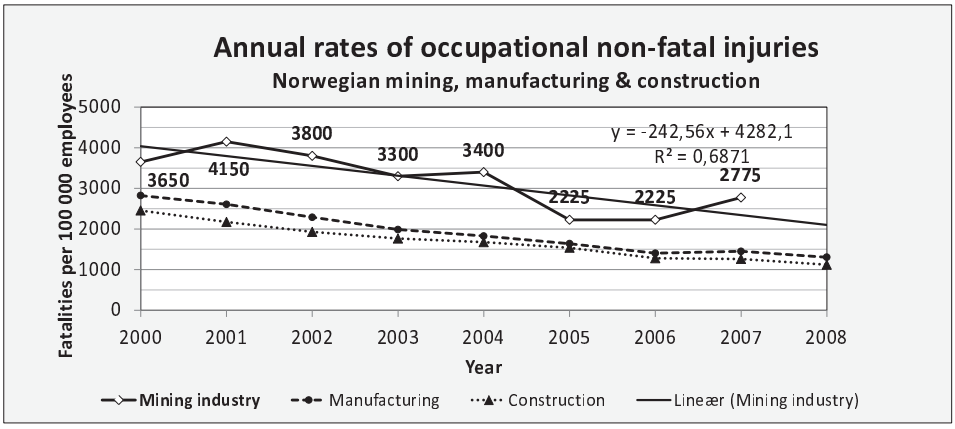


Figure 3: Annual rates of non-fatal injuries – Norwegian business sectors

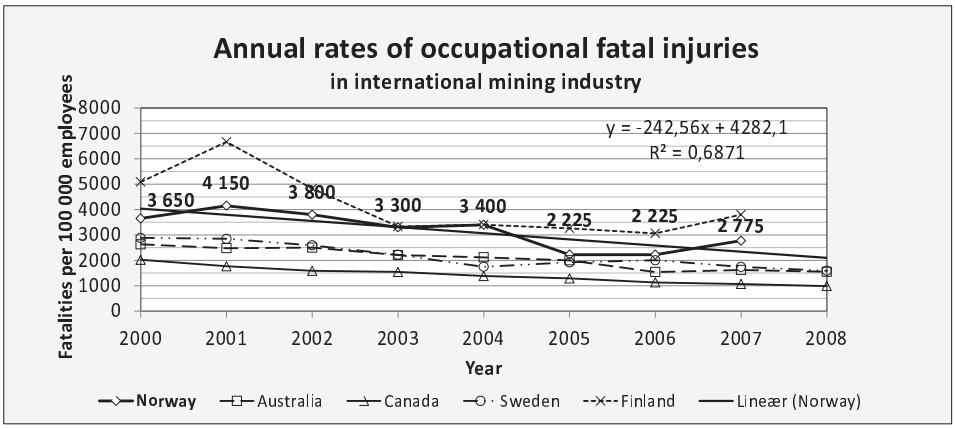


Figure 4: Annual rates of fatal injuries – international mining industry

2.4 Safety, health and environment

For practitioners, the multidisciplinary nature of occupational safety, health and environment (SHE) require specialised knowledge obtained within various fields such as engineering, toxicology, epidemiology, medicine, sociology, psychology, economics etc. (Smith, Karsh, Carayon and Convey 2003). In research related to SHE, this multidisciplinary nature must be considered and the approach to research in risk management as an example, must be cross-disciplinary (Rasmussen, 1997).

An example of considering this multidisciplinary nature can be found in the determination of threshold limit values (TLV)[8]. These values regulate the exposure to airborne concentrations of pollutions in the working environment. Examples of such pollutions are nitrogen dioxide from blasting and diesel oil, and particulate matter (PM). The determination of TLV's is based on medical, technical and economical evaluations (DAT, 2009). TLV evaluations are based on recommendations stemming from research

[8]TLV's represent conditions with respect to airborne concentrations of chemical substances under which it is believed that nearly all workers may be repeatedly exposed, day after day over a working lifetime without adverse health effects. TLV's are developed to protect workers who are normal, healthy adults TLV's are not standards. They are guidelines designed for use by industrial hygienists in making decisions regarding safe levels of exposure to various chemical substances and physical agents found in the workplace (ACGIH, 2008).

within the fields mentioned, for instance recommendations given by the Scientific Committee on Occupational Exposure Limits (SCOEL). One definite example is the recommendations for reducing the present TLV value for respirable quartz dust from 0.1 to 0.05 mg/m^3 presented by SCOEL (2002).

Exposure to a definite concentration of respirable dust from minerals that are considered inert causes no harm or virtually no harm, while the same concentrations of minerals such as quartz (crystalline), asbestos, coal etc. is known to cause pneumoconiosis[9]. In addition, asbestos and crystalline quartz are considered carcinogenic (Mossman & Churg 1998; Hetland, Namork, Schwarze & Aase 2000; SCOEL 2002; Proctor, Huges and Hathaway 2004). The risk of health impact from particulate matter depends on exposure levels (concentrations, time of exposure); the properties of the mineral particles, including particle sizes and toxicity; and the relationship between dose and the individual response of the person(s) being exposed (Proctor, Huges and Hathaway 2004). Geological processes (metamorphism associated with regional or local tectonic events, metasomatism etc.) may have altered the original composition of the deposit or the side rock, resulting in contents of minerals known to be harmful for human beings such as quartz, asbestos minerals, talc etc. (Monroe and Wicander, 1994). In daily follow-ups threshold limit values (TLV's) are commonly used in the evaluation of risks of health impacts from various substances and chemicals. In Norway TLV's are administrated by the Norwegian Labour Inspection Authority as guidelines to exposure (DAT, 2009). A new regulation made operative from January 1st, 2013, replaces the guideline (AD, 2011). For practitioners within the SHE field in mining, general toxicology and more specific knowledge of minerals' health hazards, concentration levels, the means to protect against respirable dust and the technical solutions to reduce or eliminate particle emissions must be known.

[9]Pneumoconiosis may results from exposure to respirable mineral particles over a period of time depending on the exposure level. It is a lung disease where the formation of scar tissue or fibrosis in the lungs, reduces the ability to extract oxygen from the air. Various names are used depending on the type of mineral that are causing the disease, for instance silicosis (from quartz), "black lungs" (from coal) etc. (Intelihealth 2010; EncyclopediaBrittanica "n.d.").

The *risk* concept, being introduced above, is connected to the two dimensions, *the probability* of an undesired event, and the outcome or *the consequence* of this event. Usually, we are talking about future events and therefore the two dimensions are connected to some level of uncertainty. In general the consequences are separated in impacts or harm to persons (including fatalities), environmental impacts and impacts or damages to materials, economic losses etc. Risks can be related to one single event or an activity that may result in multiple undesired events as in the example of exposure to particulate matter. The risk of an event is generally defined as *the product of the probability and the consequence of an incident*. Alternatively *the product of the frequency and the consequence of an incident* is used (Harms-Ringdahl, 2001, Rausand and Øien, 2004).

A large spectrum of methodologies for assessing risks, such as the fault tree method, energy analysis, HAZOP, job safety analysis (JSA), risk and vulnerability assessments (ROS), is available (Harms-Ringdahl, 2001, Rausand and Øien, 2004). Detailed requirements and guidelines are described in international standards (SN, 2006, SN, 2008) and in literature (Ale et al. 2008; Harms-Ringdahl 2001; Tweeddale 1992). Applications and experiences from implementing risk assessments techniques are also described in literature (Kjellén, 1998, Joy, 2004).

As illustrated in figure 5, Rasmussen (1997) divides individual accidents into three categories according to their frequency and magnitude of loss. The frequency is in inverse ratio to the magnitude of loss from an accident. The three categories are: 1) frequent small scale accidents with low losses, 2) major accidents with lower frequency and medium losses and 3) large scale accidents with very low frequency but substantial losses.

Nuclear power plant melt-downs, chemical plant runaway reactions are examples of the third group of accidents. The potential damages from such accidents are large and they may have substantial impact on future generations (Rasmussen, 1997, Perrow, 1999). Fortunately, the frequency of such accidents is very low, but according to Perrow they will sooner or later happen. An acceptable mean-time between accidents cannot be

established by empirical evidence and consequently the design and operation must be based on reliable predictive models of accident processes and probability of occurrence. Probabilistic risk analysis has been developed and system design is based on the application of several, functionally independent protective systems (Rasmussen, 1997).

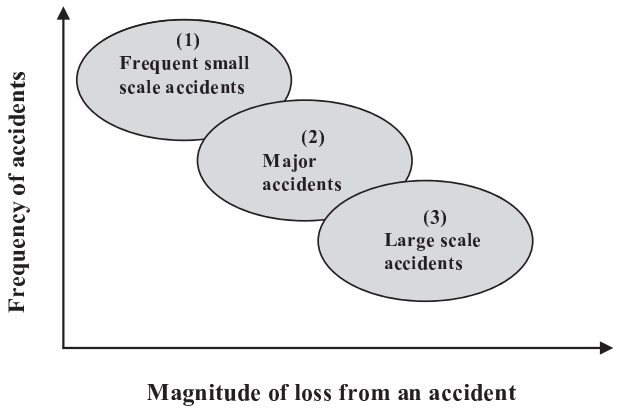


Figure 5: Accident types based on Rasmussen (1997).

Examples of category 3 accidents are the Three Mile Island accident in 1979, the Tsjernobyl accident in 1986 and the recent accidents in Japan in 2011 that were caused by a tsunami.

Examples of the second category of accidents includes aircraft crashes, ferry accidents, train crashes etc. Here safety control is focused on controlling reasonably well defined hazard sources and accident processes. Usually several redundant defences are implemented as part of the control system (Rasmussen, 1997).

The most frequent occupational accidents are found within the first category accidents and often the consequences are relatively low (Rasmussen, 1997). The hazards are related to a large number of work processes, use of hazardous equipment or exposure to

hazardous environments such as hazards previously described in chapter 2.3.2 in the case of mining and tunnelling. The level of safety can be measured by the number of fatalities or lost-time injuries (LTI's) being observed. The average level of safety is typically controlled by empirical studies of the outcomes from past accidents (Rasmussen, 1997).

Rasmussen (1994) refer to analysis of accidents that conclude that some 80 % of the cases are caused by human errors but argues for the ambiguity of the notion 'human error'. The ambiguity is connected to acts causing an accident, which rules that are applied, accident precursors identified in the subsequent accident investigations etc. Similar results from accident investigations performed in underground mining in the United States are recorded, first in a Texas limestone quarry, then two accidents occurring in a quarry mine accident in Georgia and finally in a New York shale rock pit Perrow (1999:246-249). Although assigned to errors caused by the victims in the initial investigation reports, Perrow argues that they were forced error accidents occurring i) due to poor work design, ii) fear of job loss due to not performing risky tasks and iii) relying on advice to work safely in unsupported areas. Most workplace accidents are simple. These accidents seldom result in serious injuries and thorough investigations. In cases actually being subject to accident investigation, the investigation is usually brief. As the end result such accident investigations frequently conclude that it was the victims fault (human error) or just an unfortunate situation that could not be helped (Jørgensen, 2011).Applying tools and techniques for investigating simple accidents may therefore reveal more complex causes than first concluded (Jørgensen, 2011, Sklet, 2004). The tool described by Jørgensen (2011) includes a phase of mapping accident facts followed by an analysis and a preventive phase. A central part of the analysis phase is making a cause-effect tree. Positive effects from applying the systematic investigation tool are improved understanding of accident causes, improved risk perception and accident prevention (Jørgensen, 2011).

2.5 The framework concept in literature

Searches within scientific databases[10] reveal sparse information about the *framework* concept related to the SHE situation. In English scientific literature several concepts such as *constraints*, *external conditions*, *context*, *environmental stressors*, *external stressors*, *contingencies*, *influencing factors* and *framework conditions* are commonly used as a denotation of factors that can be considered a part of the *framework* concept. The framework concept was described in chapter 1.1.

A model for conceptualising job design and job stress based on the balance among job elements was proposed by Smith and Saintfort (1989). Their model consists of four factors including the human, technological, organisational, environmental factors and tasks. Figure 6 is based on their model. Here the person exposed to risks is added to the centre of model. The objective of the model is to integrate social psychological theories of job design with job stress concepts by addressing how organisation and job design can influence workers health. Further it defines how job design can improve the situation by balancing work environment factors (indicated by arrows) that contribute to stress.

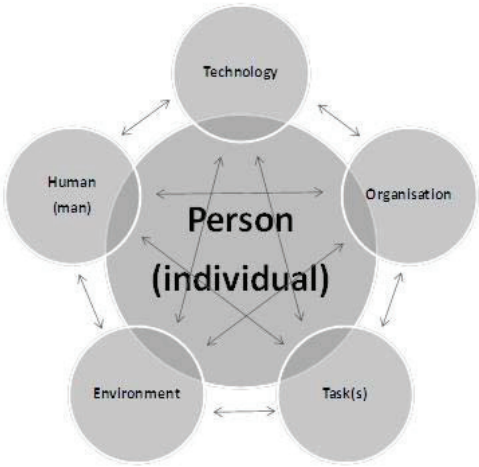


Figure 6: Model for conceptualising various elements of a work system.

[10] BIBSYS (Norwegian), ISI Web of Science and ABI Inform (ProQuest)

Smith et al. (2003) elaborates this model further. In their discussion on how to keep occupational safety and health hazards under control, they emphasise *knowledge*, *knowledgeable employees*, *resources*, *legislation*, *organisational safety climate*, *management commitment* and *safety programs* as key issues.

Initially Rasmussen (1997) presents the socio-technical system involved in controlling safety, including external and internal factors influencing this system. Figure 7 shows a simplified version of the socio-technical system. In this system, the distance to occupational hazard sources increases from the operational level towards the society and the regulators level. Factors influencing the system are named environmental stressors.

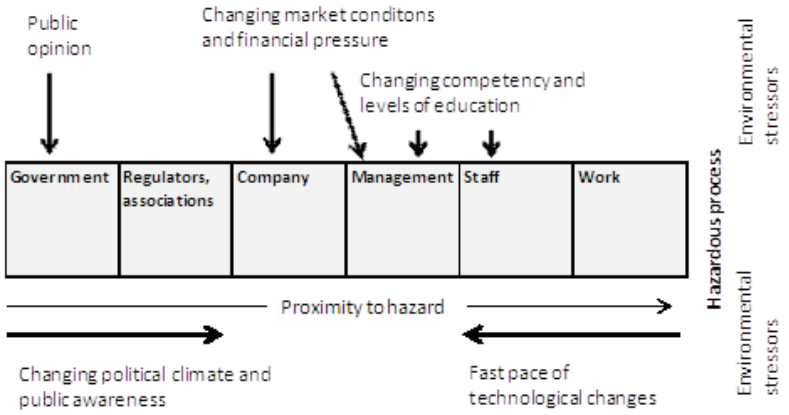


Figure 7: The Socio-technical system involved in risk management based on Rasmussen (1997).

In a stable society, a classic prescriptive command-and-control approach may be effective. It involves a top-down control of activities and their safety as subsequently described. Society seeks to control safety through the legal system. At the regulatory authorities and associations', workers' union level etc., the legislation is interpreted and implemented in rules to control activities in work places and for employees. To make the rules operational they are interpreted in the context of a particular enterprise by considering the local conditions and processes. At the base level close to hazards, we

find the engineering disciplines and the employees involved in process and procedure designs and operations. In relation to a dynamic society, Rasmussen (1997) discusses modelling problems involved in risk management. Here the pace of 'technological changes and public awareness' is quite fast compared with the speed of approving new legal rules, leaving an expanding time gap between legal rule needs and the general development in technology etc. Furthermore enterprises must relate to an aggressive and competitive environment where the decision makers will focus on short term financial and survival criteria rather than long term criteria concerning, welfare, safety and environmental impact. Such properties must be considered in system modelling approaches (Rasmussen, 1997).

Next, Rasmussen (1997) discusses accidents causation, modelling by structural decomposition, modelling by functional abstraction and migration toward performance boundaries, control of system performance and an identification of present constraints and safe boundaries. Finally he reviews trends in the paradigms of human sciences in his 'models of behaviour shaping features & criteria'. Here three perspectives in relation to accident research, occupational safety research, management organisation theories and decision research are described. The first perspective is of behavioural control by normative instruction and punishment, the next on removing causes and errors and the last perspective is by shaping conditions of adaption.

Rasmussen (1997) refers to external stressors such as political climate & public awareness, market conditions, financial pressure, competency (cross-disciplinary), educational levels and technological changes. Other influencing framework factors are rules and instructions, work load, conflicting goals, safety culture, decision network, work conditions, available information, capability and competence and decision makers' commitment to safety. He also refers to timing, administrative, functional and safety related constraints. Within a framework concept these factors would be considered framework factors.

Other studies focus on single factors or groups of connected factors that influences on work environment or environmental risks. These factors can be characterised as

framework factors. Perrow (1999) lists factors such as *system characteristics*, *organisation and management*, and explicit constraints such as *procedures*, *skills*, *quality control*, *regulations and rules*, *training*, *technology* and *externalities*. In relation to mining activities, he emphasises *inherently dangerous operations*, *environmental failures* and *difficult communication* as influencing factors. Hopkins (1999) discusses *economy* in the context of economic benefits from improving safety activities and economic pressure at the sacrifice of safety. Related to accident investigations in small enterprises Jørgensen (2011) refers to *regulations*, *risk perception*, *communication* and *competence/skills* as influencing factors. Swuste (2008) discusses the possible causes of observed decline in occupational accidents in the western world. He refers to influencing factors such as *safety management systems*, *legislation*, *employment patterns*, *training*, *ISO standards*, *economic resources*, *accident causal knowledge*, *safety culture* and *efficiency requirements*. A survey performed by Weyman, Clarke and Cox (2003) studied coal miners' attribute with regard to risk-taking at work. Based on cluster analysis on the survey results, they identified three factor constructs. They named the constructs as *time pressure (performance pressure)*, *management commitment* and *confidence in ability to control risks*.

A review of the framework concept related to safety and health in the Norwegian petroleum industry was performed by Rosness, Blakstad and Forseth (2009). Initially they concluded that the *framework* concept seems to be inconsistently used with regard to content and common understanding, next that establishing a consistent definition and common understanding of the concept would be favourable. Next they discussed the overall framework concept; the present use of the concept; individual influencing framework factors and the factors' significance for work environment and major accident risks. Finally they presented a general theoretical basis.

The majority of the reviewed literature, that is presented in the following sub-chapters presents research performed on topics and factors that influence on working environment risks and major accidents risks, not explicitly the *framework* concept. The authors, with one exception, do not define the framework concept.

Rosness et al. defines framework concept as follows (in Norwegian only):

> *«Rammebetingelser er forhold som påvirker de praktiske muligheter en organisasjon, organisasjonsenhet, gruppe eller individ har til å holde storulykkerisiko og arbeidsmiljørisiko under kontroll» (Rosness et al. 2009:45; 2011:63).*

Then, in English, the definition becomes (translation made by this researcher/author):

> *Within the framework concept, framework factors are factors that influence the practical possibilities possessed by an organisation, organisational unit or an individual to keep major accident risks and working environment risks under control.*

In the context of the definition given above, framework factors indirectly influence working environment risks and major accident risks. The indirect influences are related to the possibilities of interaction, resources, incentives etc. for the parties comprised by the given definition. Further, the parties involved possess no effective and immediate control on the framework factors. They can originate from market conditions, through previous decisions, decisions made by another organisation or by another organisational level within the same enterprise. In some cases, the parties involved may work strategically to modify the present framework (Rosness et al. 2009).

2.6 Theoretical basis

Swuste (2008) refers to numerous research reports and articles describing shortcomings in company decision-making processes regarding safety. He also refers to situations where company policies conflict with other company goals concerning safety. In such situations other goals are frequently prioritised at the expense of safety. In this context, major accidents such as the 1984 Bhopal disaster and the 2005 BP refinery disaster in Texas are examples of such shortcomings that have turned the focus of attention concerning occupational hazards towards organisational factors.

With reference to decision-making, contingency theories are commonly used to describe the organisation of a corporation, the leading of an enterprise or decision-making within organisations in general. The main ideas of the contingency approach to organisational

performance are connected to system characteristics, organising, management commitment, approaches to management and types of organisations. Organisations are open systems that need careful management to satisfy and balance the existing internal needs and to adapt to environmental requirements. Due to variations in tasks and the environment being dealt with, no optimum way of organising the company exists. Therefore different approaches to management may be needed to perform the various tasks, even within the same organisation. Management must be concerned with achieving alignments and good fits to their company goals. Different organisational types are needed to adapt to different types of environment (Morgan, 2006).

Based on similar substantiations with respect to significance of organisational issues and decision-making, and finally by including their definition and description of the nature of framework factors, Rosness et al. (2009) conceptualise framework factors related to major accident risks or work environment risks as showed in figure 8.

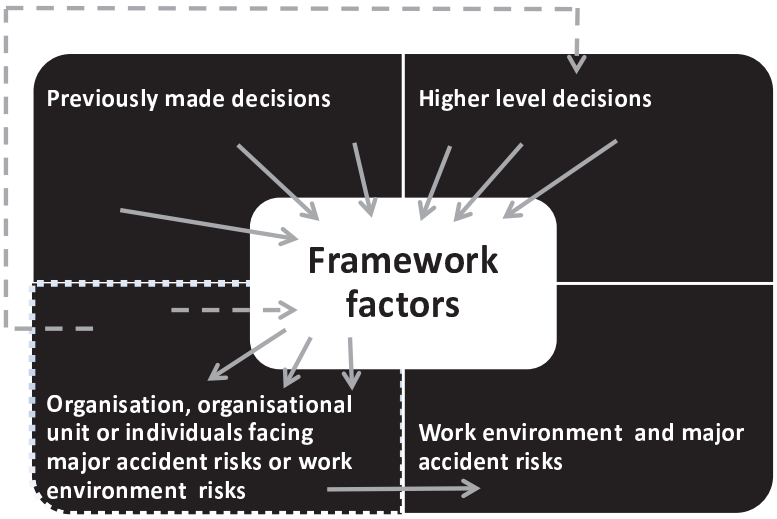


Figure 8: Conceptualising of framework factors, based on Rosness et al. (2009).

In this context the framework factors are always defined in relation to an individual, organisational unit, organisation or body that must relate to the risk of major accidents

or work environment risks. In the model presented in figure 8, the 'Organisations …' rectangle represents an open system being influenced by numerous framework factors. Being an open system is illustrated by the stippled lines, while the arrows indicate influences and the direction of influence. Some of the influences are previously made decisions, other influences are decisions made at a higher organisational level or by bodies superior to the organisations, organisational units or individuals being affected. Other influences are directed from the organisations, organisational units or individuals towards a party with the power to change the present conditions.

Next, a view on framework factors from two different perspectives is presented. The first perspective is of those facing work environment or major accidents risks, while the next perspective is of those with power to influence or change the present framework conditions. Most frequently the perspective of those working closest to the hazard sources is most commonly discussed. By changing viewpoint represented by each of the rectangles in figure 8, a change in perspective with respect to system and decisions level is always possible (Rosness et al. 2009). Figure 7 can be used to illustrate the proximity to the hazards for the parties involved or as function of authority level as illustrated in figure 9.

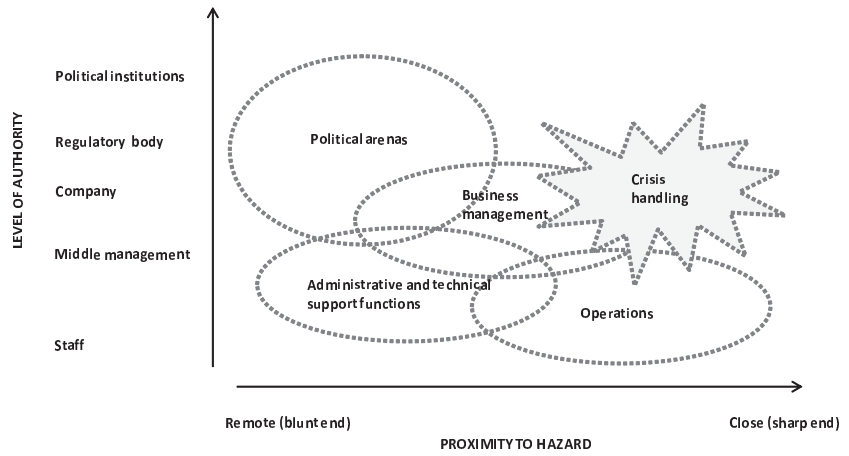


Figure 9: Decision level positions in the context of framework factors (Rosness et al. 2004).

Several problems occur when trying to establish a theoretical basis for understanding the framework concept. A main problem is the reciprocal interactions between the various framework factors, that is every influencing factor affects other factors or is influenced by other factors (Rosness et al. 2009). Another complicating factor is that a definite influencing factor can be related to different disciplines, different fields of research etc. (Rosness, 2009, Rasmussen, 1997, Smith et al., 2003). A third problem is the relation to multilevel systems including parties situated more or less proximate to the hazardous zone (Rosness, 2009), see figure 7 and figure 9.

Rosness et al. (2009) discuss mainly two ways of dealing with problems referred to in the previous paragraph. One solution is the use of general system theories as basis for the describing and understanding the framework concept. System theories are applicable for several levels of analysis and different types of systems as one approach. They claim that models based on system theories are relatively abstract and the results of using system models do not tell more than what could have been deducted from the assumptions being made when establishing the model. Finally system theories implicate an element of control or norms that may lead to one-sided use of actions to control the behaviour of individuals or groups. An alternative solution is the combination of various theories and perspectives. This approach will only catch certain aspects of the reality. One may argue that this approach will result in a fragmented understanding where the different theories do not necessarily overlap. On the other hand, a wide repertoire of theories being available offers better conditions for mutual discussion with the various parties involved.

Rosness et al. (2009) chose to combine various theories and perspectives in their discussion of keeping the risk of major accidents and occupational illnesses under control. In chapter 2.7, this author chose to follow the same approach.

2.7 Safety control and safety management in the context of framework conditions

Different risk management strategies have evolved across different hazard domains and according to the need for cross-disciplinary approach. These strategies also depend on the nature of the hazard sources, as illustrated in figure 5 and briefly described in chapter 2.3. In this context Rasmussen (1997) made a review of research trends within branches of science such as I) decision-making research, II) research related to management and organisational theories, III) occupational safety research and IV) major accident research.

In decision-making research, Rasmussen (1997) concludes that a paradigm shift from A) normative, prescriptive theories and models over B) descriptive models in terms of deviations from norms to C) similar models in terms of actual behaviour can be observed. A main problem is that decisions are not discrete events as observed in laboratory research environments. Decisions are continuously made and therefore difficult to identify as causes of an accident or increased risk of accidents.

Common approaches to safety are:

1. The energy and barriers approach to safety
2. The 'normal accidents' perspective
3. The high reliance organisations approach to safety
4. The information handling approach
5. The resolutions and conflicting goals approach
6. The discourse approach

Each of the perspectives or approaches to safety is briefly described in the following paragraphs. Similarly definite framework factors, factor sensitivity, connections between influencing factors and loss prevention; and definite actions for controlling the risks in the mining industry are referred to.

2.7.1 The energy and barriers approach to safety and loss prevention

Harms-Ringdahl (2001) refers to works made by J. J. Gibson[11] and W. Haddon[12] as the developers of the energy analysis method. The main principle is that accidents are caused by exposure to some kind of hazardous energy. In practice the term 'energy' is interpreted in a wide sense as 'something' that can damage a person, equipment or an entire processing plant in connection with an exposure that exceeds the thresholds for creating damage or injuries. Examples of potential energy objects are persons or objects at height, moving or rotating machine parts, gas pressure, electrical voltage etc. (Harms-Ringdahl, 2001).

The purpose of an energy analysis is to obtain an overview of all harmful energies, assess risks and propose safety measures within the system being analysed (Harms-Ringdahl, 2001).

An important objective of the energy analysis is to either remove or alternatively reduce the risk of damages from the released energies. Haddon (1970) presents ten strategies to prevent losses from accidents:

1. Prevent the generation and build-up of energy (thermal, kinetic, electrical, radiation etc.); e.g. shut down a nuclear power plant
2. Reduce the amount of energy; e.g. reduce speed of vehicles, reduce the amount of explosives being used in blasting etc.
3. Prevent the release of energy; e.g. reduce the speed of trucks, by using shock absorbing mechanisms in anti-falling devices being used to protect workers
4. Modify the rate or spatial distribution of energy releases; e.g. by modifying the distribution of boreholes in blasting (underground mining, quarrying, tunneling)
5. In space or time, separate the possible victims from the energy being released; e.g. the use of sidewalks to separate pedestrian from vehicular traffic, initiate blasting in underground mining at times were people do not work in the mine
6. Separate possible victims from the energy by using physical barriers; e.g. safety heads or protective screens for separating people and engine parts, belt conveyor drives, personal protection equipment (also see item 8) etc.

[11] Title: "Contribution of experimental psychology to the formulation of the problem of safety - a brief for basic research" (published in 1961)
[12] Title: "A note concerning accident theory and research with special reference to motor vehicle accidents" (published in 1963)

7. Modify the contact surface or basic structure; e.g. remove sharp edges, rounding and softening of corners etc.
8. Make the vulnerable target more resistant to damage from energy flows or releases; e.g. use safety helmet, protective footwear, physical training etc.
9. Limit the development of damage; e.g. warning signals, sprinkler systems, first aid and medical care, emergency transport etc.
10. Rehabilitate the victim or victims

It is reasonable to consider factors that influences on the possibilities to implement Haddon's ten principles for loss prevention as part of the framework concept (Rosness et al. 2009). Regarding Haddon's fifth strategy of separating possible victims from the energy both in space or time, the separation in space seem most relevant for the design phase, while separation in time is relevant for both operational and design phases. A separation in time can be made by avoiding certain activities during the operational phases or avoiding definite activities at the same time (Rosness et al. 2009). An example related to implementing the fifth strategy in underground mining, is the initiation of blasting only at times where people do not work in the mine or tunnel. Another example related to the fourth strategy of modifying the rate or spatial distribution of energy releases, is a modification of the borehole distribution in blasting (underground mining, quarrying, tunnelling).

Rosness et al. (2009) concludes that the energy and barriers approach to safety and loss prevention do not deliver a finalized list of influencing framework factors, but it is possible to deduct such factors based on Haddon's loss prevention strategies.

2.7.2 The 'normal accidents' perspective

Perrow (1999) discusses *system accidents*, initially named 'normal accidents', within high-risk technologies. In contrast to component failure accidents which only affect parts, units or subsystems, system accidents involve the unanticipated interaction of multiple failures prior to an accident. Examples of such systems are found within chemical plants, nuclear power plants, aircrafts, space missions etc. Examples of accidents are nuclear power reactor melt downs such as the Three Mile Island accident in 1979, the Tsjernobyl accident in 1986, chemical plant accidents such as the Texas

City accident in 1969, Bhopal in 1984 etc. With reference to figure 5, accidents in chemical plants and reactor melt downs are found within the category 2 or 3 accidents.

Initially Perrow (1999) starts his discussion of accidents by stating that:

> "*As our human technology expands, as our wars multiply and as we invade more and more of nature, we create systems –organizations, and the organization of organizations-that increase the risks for the operators, passengers, innocent bystanders, and for future generations*" (Perrow, 1999:3).

By this statement, the core elements of the theories concerning adaption between organisational structure and the characteristics of technical systems are approached. According to Perrow (1999), systems can be described by the dimensions 'interaction' and 'coupling'. The interactions are either characterised as linear or complex. Here the terms linear and complex describe 'interactions in an expected sequence' and 'interactions in an unexpected sequence' respectively. The latter may not be visible or not immediately comprehensible for the system operators. Couplings are characterised as either tight or loose. For loose couplings there exists slacks and buffers between two items, while for 'tight couplings' there exists no such slacks or buffers. Tight couplings imply that what happens in one item, for instance a disturbance such as a component failure, directly affects what happen in the other item. In systems characterised by high complexity and tight couplings, the effects of human interventions are difficult to predict. Similarly, the diagnosis of irregular conditions is difficult. Interactive complex and tightly coupled systems create considerable challenges for the organisations that are set to control them.

According to Perrow (1999:332), high complexity systems require decentralised control while tightly coupled systems require centralised control by the organisation. For interactive complex and tightly coupled systems, the dilemma between choosing either a decentralised or a centralised controlling strategy is obvious. Perrow (1999) evaluates underground mining as fairly loosely coupled and somewhat more complex than linear. Here a decentralised organisational control seems to meet the challenges both to interaction complexity and the degree of coupling in the system.

In the operative phase and partly in the design phase, it seems reasonable according to Rosness et al. (2009) to consider the technical system characteristics *interaction* and *coupling* as important factors influencing on the risk of accidents and health impacts. In the early design phases the two dimensions can be directly influenced. During an operative phase, it seems reasonable to consider the consistency between the technical system characteristics and the organisation managing the system as a factor influencing the risk of accidents, health impacts and environmental impacts. Other influencing factors mentioned by Perrow (1999) are regulations, training, externalities[13] and safety constraints. In underground mining, he also emphasise the 'inherently dangerous operations', 'environmental failures' and 'difficult communications' as influencing factors involved.

Perrow (1999) gives distinct recommendations on how to control the accident risks:

- ✓ Generally by reducing the interaction complexity and by loosening the coupling 'tightness'.
- ✓ Quality control, operator training, design experience and environmental improve the situation, but is not sufficient for system accidents.
- ✓ For the complex interaction and tight coupling system, centralise with increased tightness of couplings and decentralise with interaction complexity. Provided that none of the strategies outlined above and the catastrophic potential is large, shut down the system.
- ✓ For systems with complex interactions and loose couplings such as mines, decentralisation is recommended.

Rosness et al. (2009) describes the low degree of operationalised system characteristics as the major weakness of Perrow's theory. Hence the degree of 'interactive complexity' and tightness of 'coupling' can be questioned or argued against.

[13]Externalities are explained by Perrow (1999) as the social cost of an activity that is not reflected in the price of the activity. Examples are pollution, injuries, anxieties etc.

2.7.3 The high reliance organisations approach to safety

Theories on high reliability organisations (HRO) were developed from systems where the frequency of serious accidents was low compared with the sources of hazards present. Examples of such systems are aircraft carriers, nuclear submarines, industrialised genetic engineering, air traffic control and nuclear power plants. With reference to chapter 2.4 and figure 5, accidents within these systems usually are classified as category 2 or 3 accidents. Due to the potential damages from accident within these systems, the operational requirements to reliability of the systems are high:

> *"Yet some organizations must not make serious errors because their work is too important and the effects of their failures too disastrous. This is especially true with organizations that operate technologies that are very beneficial, yet costly, and hazardous" (LaPorte and Consilini, 1991).*

To explain low accident frequencies, the early studies of such systems emphasised organisational redundancy[14] and spontaneous redesign of organisations. Organisational redundancy is based on the belief that a system can be more reliable than its individual components. This assumption will require interaction patterns that ensure that several persons do the specified tasks more reliable than one person would be able to do. In organisational redesign e.g. sharing of work, communication lines, decision makings and social conventions etc., organisations change spontaneously during periods with high work load or crises (LaPorte and Consilini, 1991). Weick and Sutcliffe (2007) emphasise that the best HRO organisations know that they have experienced all of the ways that their system can fail and that they have not deducted all possible failure modes. They describe five basic principles of maintaining resilience. Resilience engineering is derived from the HRO theories. In resilience engineering, safety management focuses on achieving success through helping people to deal with complexity under pressure. (Hollnagel, Woods and Leveson 2006).

[14] Lerner (1986) explored redundancy in the contexts of duplication and overlap. Streeter (1992) describes redundancy in organisational systems in terms of two dimensions, forms and roles where the two forms redundant 'parts' and redundant functions are identified. Roles are considered standby or active. Examples of standby redundant parts and functions are reserve backup and extraordinary roles respectively. Examples of active redundant parts and functions are complementary controls and auxiliary services.

Within the HRO theories , factors such as presence of personnel with overlapping responsibilities, qualifications and access to information; physical conditions for interactions in terms of consultations, surveillance and possibilities for actions provided that failures, wrong actions, misjudgements etc. happen; an organisational culture that promote people to seek advice, to perform surveillance connected to critical safety tasks and to act in cases of misjudgements and faulty actions and the spontaneous reconfiguring of organisations at high work load or crises are part of the framework concept (Rosness et al. 2009).

2.7.4 The information handling approach to safety

Here the perspective of handling information refers to the abilities that organisations possess to combine and interpret information (Rosness et al. 2009).

Rosness et al. (2009) refer to the study "Man-Made Disasters" by B. A. Turner in 1978 and by B. A. Turner and N. F. Pidgeon in 1997, showing that despite previous warnings given by individuals within the organisations that experienced accidents, most of the organisations were caught by surprise when the accidents actually happened. In the description of the 1987 Zeebrugge accident[15] as an example, Hopkins (1999) gives an account for management being notified several times by ferry masters about the risks related to proceeding to the sea with open bow doors.

Information being fragmented between organisational units and non-existent connection between fragmented information are probable causes or ambiguous information is interpreted in ways that minimise the observed problems or the organisations' attention is focused on other problems (Rosness et al. 2009). With reference to the Zeebrugge accident, Rasmussen (1997) stresses the interactions of effects from decisions made by several actors placed in different parts of the shipping enterprise and being subject to fragmented information and competitive stress in their normal work context.

[15] Due to open water tight bow doors, the car ferry Herald of Enterprise capsized when leaving the harbour of Zeebrugge in Belgium.

The information handling perspective is discussed in relation to HRO theories by Weick og Sutcliffe (2007). In their introduction to 'resilient performance', a wildland firefighting event at Cerro Grande in 2000 is used as an example of organisations' ability, or lack of ability to manage complex and ambiguous information. They introduce the concept 'mindfulness' to describe an enriched awareness of discriminatory details and hence the organisations' ability to process and interpret ambiguous information in a dynamic environment.

Factors that influence on the organisations' ability to process and interpret ambiguous information are considered framework factors and therefore part of the framework concept (Rosness et al. 2009).

2.7.5 The approach of conflicting goals and decision making

Conflict goals of many kinds are unconsciously handled by people. Here 'conflicting goals' refer to situations where major accidents or work environment risks are balanced against competing considerations or interests (Rosness et al. 2009).

In their analysis of 100 accidents at sea, Wagenaar and Groeneweg (1987) separate between i) situations where risks were taken due to a process of risk evaluation, risks were realised but outweighed by other factors such as economical advantage or efficiency reasons; and ii) situations where the behaviour causing the accidents was not considered hazardous prior to the accidents. Wagenaar and Groeneweg (1987) conclude that the accident are connected to people's lack of risk understanding or risk perception, not a conscious propensity to risk taking. In coal mining, Weyman, Clarke and Cox (2003) identify 'confidence in the ability to deal with risk' as a factor that may increase the probability of risk behaviour.

Rasmussen (1994) refers to the Bhopal, Flixboroug, Zeebrugee and Chernobyl accidents as caused by conflicting goals situations and a migration of organisational behaviour

toward accident under the influences of pressure toward cost-effectiveness rather than caused by independent failures and human errors.

Dealing with conflicting goals and decision making in this context may connected to accidents in various ways. In some cases, one single critical decision seem to be the cause, while in other cases the causes are multitude events and decisions which occur in a coincidental manner that was never foreseen (Wagenaar and Groeneweg, 1987, Rasmussen, 1997, Perrow, 1999, Hollnagel et al., 2006). During normal operations, systematic migrations toward the boundaries of functionally acceptable performance occur as illustrated in figure 10. Such migrations may reduce safety especially when crossing the boundary, resulting in errors or accidents (Rasmussen, 1997). According to Rosness et al. (2009) are constant, well defined limits argued against by Hollnagel in the book "Barriers and Accident Prevention" because they in practice are defined after the accident is a reality.

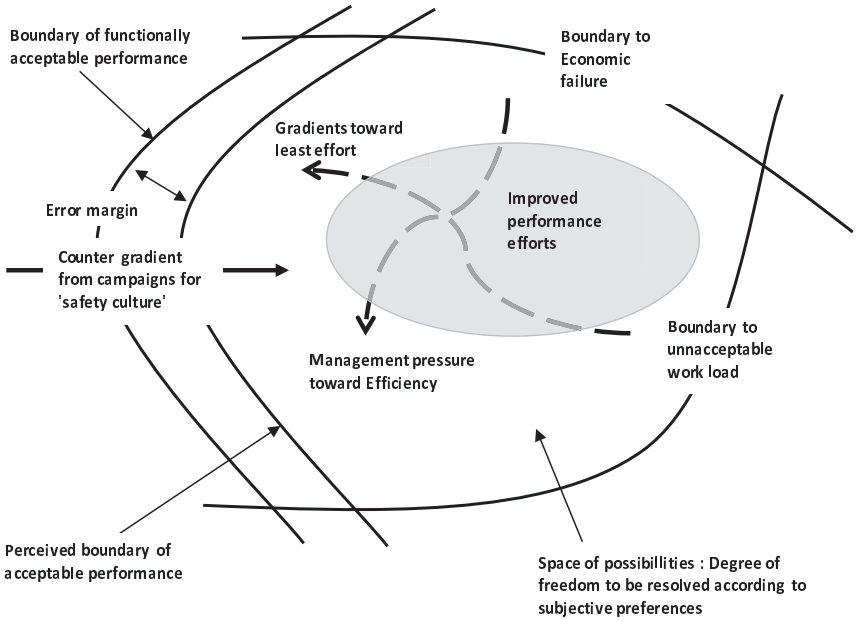


Figure 10: Behaviour – performance boundary model. Based on Rasmussen (1994).

Several papers put focus on the role of goal conflicts or conflicts of interest in relation to safety issues (Swuste, 2008, Rosness et al., 2009, Rosness, 2009, Rasmussen, 1994, Rasmussen, 1997). For most work systems that include risk of occupational accidents, major accidents or health impacts, conflicting goals are common. Within the present framework, such conflicts can be intensified or reduced by changes in framework factors. Thus through the general framework, means to reduce possible conflicts should be considered, for instance through contracts clauses offering incentives in situations of conflicting goals concerning safety versus efficiency. Surveillance of framework factors that influence the situation of conflicting goals seem reasonable (Rosness et al. 2009).

2.7.6 The discourse analysis' approach to safety

Rosness et al. (2009) refers to the book *Oil & Ideology – The Cultural Creation of the American Petroleum Industry* by Olien and Olien (2000). It represents a case study of public discourses affecting policy making in relation to the American petroleum industry, and therefore a basis for understanding and discussing framework changes. Olien and Olien (2000) investigated the history of petroleum industry-related discourse by asking seven questions. In short the questions were about the construction of the industry's identity, participants and their interests and the role of policy. They approached their analysis of the American petroleum industry in three ways, first by working with public discourse to identify and analyse the cultural context as it developed during the time period 1859 to1945. The second approach was to describe the formation and the effect of public discourse directed toward the industry. The third approach was an analysis of the processes of formation of public discourse and policy. Here they assumed "… *the relevance of the 'arena' model of competition for control of public discourse, of media 'framing', of information subsidies by interested parties, and of the operation of media controllers to set public agendas*" (Olien and Olien, 2000:xii).

A variety of published works including popular journalistic accounts, scientific literature, legislative reports, testimony to congressional committees, trade journal articles etc. formed the basis for the analysis. Central parties in the debate and which

arguments they used to advance their interests were identified. Based on these studies, Olien and Olien (2000) recognised five main channels of discourse (rhetorical categories). The channels of discourse were the *operational*, *technical*, *economic*, *political* and *normative or moral* discourse[16].

In their analysis Olien and Olien (2000) illustrates the content and development within the channels of discourse over time. Commonly the various channels of discourse contain contradictory ideas, resulting in the cultural construction of the American petroleum industry at the time period. They also refer to how both positive and negative characteristics are used in an active way within the defined channels of discourse:

> "…there were differing ways of talking about oil, a great many of them were negative and tied the industry to problems such as the abuse of economic power or waste of natural resources. And, as we shall describe, such negative ideas, a staple in discourse, had powerful influence on the impulse to regulate the industry" (Olien and Olien, 2000:xiv).

The socially constructed 'story' about the American petroleum industry resulted from various elements of the channels of discourse that was considered important. Olien and Olien (2000) concludes that the interests and the public views that were considered important within the public discouse frequently resulted in failed policies.

The discourse approach is also relevant for the mining industry. Mining activities are controversial in Norway as it is in other parts of the world (Campbell and Roberts, 2010, Childs, 2008, Kemp et al., 2010, Moffatt and Pless-Mulloli, 2003, Urkidi, 2011, Walton, 2007, Zientara, 2009, Schanche, 2006, Blindheim, 2009).

By implementing discourse analysis, Campbell and Roberts (2010) approached the debate concerning approvals for base metal mining permits in the Upper Midwest of

[16] Operational discourse – what industry actually do. Technical discourse – discussions made within the specialisations of scientists and technologists. Economic discourse – embraces the general subject of economics but also subordinate discourse channels. Political discourse – it is difficult to define precisely, but contain a wide range of contributions. Normative/moral discourse – basically it is the cultural definition of what is right and what is wrong (Olien and Olien, 2000:xiii-xiv)

USA and how this debate affected the outcome of the permit effort by Kennecott and Exxon.

In Kiruna, a small town in the north of Sweden, the community faces major changes caused by an expanding mining industry. The iron ore body is situated below central parts of the town and continued mining may cause that area to collapse due to subsidence. Therefore the Kiruna municipality, under the influence of the mining company LKAB (Luossavarra-Kiirunavaara Aktiebolag) decided to relocate parts of the town. Nilsson (2010) examines the ideological bias that characterises the various opinions in relation to the relocation plans.

In Norway the relevancy of the discourse approach is predominant in relation to environmental issues concerning mining industry wastes disposals, for instance in relation to the establishing of mining industry at the sites Engebø, Nussir, in relation to other future mineral deposit developments and in 'not in my backyard (NIMBY)' type of debates relating to emissions of dust, noise and vibrations from aggregates production (Pelekasi, Menegaki and Damigos 2012; Drew, Langer and Sachs 2002).

At Titania AS the debate about tailings disposal site will rise again prior to filling up the existing tailings disposal at Lundtjern in 2021 and in relation to debating the choice of future solutions (Carstens, 2006). During the 1980's this debate was concentrated about Titania AS tailings disposals at Dyngadjupet in Jøssingfjorden (Schanche, 2006). The environmentalists' influences, with Bellona in front, made the regulatory authorities require that tailings disposals were removed from Jøssingfjorden to Lundetjern on shore waste disposal area in 1994.

In a study of the social dimensions of Australian mining, Solomon, Katz and Lovel (2008) identifies issues that are relevant with respect to the public discourse and future research related to the mining industry framework. These issues identified are social performance, mine site functional roles, industry work and working conditions, indigenous employment and agreement making, women and the mining industry, public participatory processes and community and regional development.

With reference to the perspectives presented by Olien and Olien (2000), Rosness et al. (2009) conclude that the framework concept and accompanying framework factors are not naturally given, instead they are continuously formed by a long list of participants involved in 'battles' about how to understand and interpret the different topics raised in the public discourse. An example of the practical influence from the public discourse is the regulation of the American oil industry as indicated by the above quotation.

2.8 Influencing factors with respect to work environment and accident risks – factor importance

2.8.1 Framework factors

With reference to chapter 2.5, a main problem of establishing a theoretical basis for discussing the framework concept is the reciprocal interactions between framework factors that influence the risk of major accidents and work environment risks (Rosness et al. 2009). Another complicating factor is that definite framework factors are related to different disciplines, fields of research etc. (Rasmussen 1997; Smith et al. 2003; Rosness 2009). The socio-technical model presented by Rasmussen (1997) is a multilevel system including parties situated more or less proximate to the hazardous zone (Rosness, 2009). The apprehension of which factors that is considered framework factors will therefore depend on the system level in question and therefore the various perspectives of those who is discussing the topic, for instance the regulatory authorities, enterprise CEO's, enterprise process operators, researchers or others.

Scientific literature refers to several factors that is considered to influence the level of major accident, accident or work environment risks.
Table 6 compiles framework factors according to which scientist or scientists that identify the factors. Several factors, some of theme expressed by related names, are listed by more than one of the authors. Examples of such factors are legislation, knowledge, competence or competency, safety culture etc.

Table 6: Factors with influence on the risk of occupational accidents and illnesses

Authors	Influencing factors, constraints etc.
Devine, Muller and Carter (2008)	*Management's occupational health & safety (OHS) commitment and involvement, physical work environment factors (hydrogen fluoride, chemicals), staff health & safety perception*
Hollnagel, Woods and Leveson (2006)	*Dynamic systems, system stability, resilience, goal conflicts, for instance production goals and time pressure vs. safety risks*
Hopkins (1999)	*Economic benefits, economic pressure*
Jørgensen (2011)	*Communication, competence/skills, regulations, risk perception*
Kjellén (1998)	*Legislation*
Lawton (1998)	*Situational factors such as staff shortages, supervisory pressure, equipment non-availability, poor conditions and high work load*
Perrow (1999)	*General factors: Externalities, management, organisation, procedures, quality control, regulations, rules, skills, system characteristics, training, technology. Mining specific factors: Inherently dangerous operations, environmental failures, communication (difficult ~)*
Rasmussen (1997)	*Administrative constraints, capability and competence, competency (cross-disciplinary), conflicting goals, cost effectiveness pressure, decision-makers commitment, decision network, educational levels, financial pressure, functional constraints, information (available), management's commitment to safety, market conditions, political climate, public awareness and opinion, rules and instructions, safety culture, safety related constraints, technological changes, timing constraints, work conditions, work load*
Rosness, Blakstad and Forseth (2009)	*Cultural contexts, explicit norms (legislation, regulation, standards, procedures, instructions) ideologies, incentives, interaction conditions, interpretations (framework ~), knowledge, latitude, organising, physical conditions, power, resources, technology, values*
Smith et al. (2003)	*Knowledge, knowledgeable employees, legislation, management commitment, organisational, resources, safety climate, safety programs.*
Swuste (2008)	*Accident knowledge (causal pathways), decision-making processes, economic resources (return on investments), efficiency requirements, employment patterns, hazards recognition, ISO standards, legislation (laws and regulations), organisational complacency (after long accident-free periods) safety culture, safety management systems, training*
Weick and Sutcliffe (2007)	*Precautionary norms, commitment to resilience, organisational modus, mindfulness, mindful practice, routines, normalising the unexpected*
Weyman, Clarke and Cox (2003)	*With reference to coal mining: Confidence in ability to control risks, management commitment, time/performance pressure*

2.8.2 Critical framework factors

In relation to major accidents, Swuste (2008) refers to numerous research reports and articles describing shortcomings in company decision-making processes regarding safety. Next, Swuste (2008) refers to situations were company policies conflict with other company goals such as safety. In such situations other goals are frequently prioritised to the expense of safety.

Swuste (2008) further refers to the components of a safety management system and next with reference to several sources, the limited existent proof of safety management component importance. He concludes that there exist limited empirical evidence that links management and organisational characteristics to safety performance. Poor safety performance seems to lead to "*a persistent focus on human factors, the careless attitude of workers and rule violations*" (Swuste 2008:442). Due to resistance of learning the full lessons from past accidents and critical errors or events remaining latent or misunderstood, training does not give effective learning processes within the organisation (Swuste, 2008). Workers being lazy or showing careless attitude are not the main cause of rule violations. Lawton (1998) describes attitude and rule violations in terms of situational factors:

> *"Situational factors such as staff shortages, supervisory pressure, equipment non-availability, poor conditions and high work load, affect the likelihood of violations by increasing the pressure to violate in order to complete targets and keep to time. In this case, violations result not from a lazy or careless staff but from the well-intentioned loyalty of staff whose priority is to keep the job running" (Lawton, 1998).*

Another aspect of dealing with situational factors is dealing with decision-making processes that involve the balancing of safety versus other company goals as described in 2.7.5 and illustrated in figure 10. The basic principle of this concept is that human behaviour is shaped by objectives and constraints. The works space within which individuals can 'move' freely is bounded by administrative, functional and safety related constraints. To be successful with respect to work performance, the individual(s) in question must adapt to and respect these objectives and constraints. The most likely

result is that human behaviour migrates toward the boundary of what is adapted to be a functionally acceptable performance, for instance an efficiency gradient. Provided that crossing the boundary is an irreversible action, an error or an accident may occur. To counteract in-depth defence strategies are implemented. Provided that violations occur, causing non-visible effects but no accidents, still a reshaping of the initially intended safe boundary happens. Therefore in-depth defence strategies most likely degenerate during time, and especially in situations of cost-effectiveness pressure (Rasmussen, 1997).

Framework factors with possible critical influence on the risks of occupational accidents and illnesses are listed in table 7. A definite measure for importance level related to the various influencing framework factors was not considered in the referred works, and the perceived importanc is therefore context based and qualitative.

Table 7: Factors with possible critical influence on the risk of occupational accidents and illnesses

Authors	Factors
Devine, Muller and Carter (2008)	*Management commitment and involvement*
Hollnagel, Woods and Leveson (2006)	*Conflicting goals- production pressures and time pressure vs. safety risks*
Lawton (1998)	*Situational factors such as staff shortages, supervisory pressure, equipment non-availability, poor conditions and high work load*
Perrow (1999)	*Organisation and management vs. systems characteristics (coupling and complexity). Interactions.*
Rasmussen (1997)	*Conflicting goals vs. cost effectiveness pressure, decision-making vs. commitment to safety. Interactions. Management commitment to safety*
Swuste (2008)	*Conflicting goals (safety vs. other company goals). Interactions.*
Weick and Sutcliffe (2007)	*Mindfullness, commitment to resilience*
Weyman, Clarke and Cox (2003)	*Time pressure (representing performance pressure)* *Management commitment (with influences on safety culture/climate)* *Risk perception vs. confidence in ability to control risks*

3. Methodology

The practical research work was performed as a survey. Respondents belonging to the Norwegian mining industry responded to survey questionnaires. This chapter describes the framework of the SHE situation, presents a working definition of framework factors and critical framework factors and finally describes survey questionnaire design, processes of extracting survey samples, data collection and data processing.

3.1 Framework concept vs. influencing framework factors

The research problem was "*Framework factors with critical influence on safety, health and environment in the Norwegian mining industry*". With reference to chapter 2, searches within scientific literature in the early phase of the doctoral project gave sparse information about the framework concept, framework factors and critical framework factors. During the planning of the practical research work, a description and formal definitions allocated to these concepts appeared to be required, but no such definitions resulted from the searches within scientific literature.

As an alternative, a description of the framework concept and working definitions of framework factors and critical framework factors were made prior to the design of the survey questionnaires. The definition was connected to the occupational SHE situation and the risks of accidents and occupational illnesses in the mining industry.

In some cases the framework concept is used to describe the structure that supports something, such as the brick base, wooden or metal framework of a building, an external work platform, a scaffold etc. In other cases the meaning of framework is abstract, such as the fundamental structure of a written work, a set of principles, ideas, concepts, assumptions etc. Examples of the latter meaning are theoretical framework, legal framework, regulatory framework, constitutional framework, the democratic framework of society etc. (MacMillianDictionary, n.d., FreeOnlineDictionary, n.d.).

Also in the abstract sense, a framework is supportive such as a skeleton or scaffold, while in other respects it describes and defines a definite set of boundaries, for instance mathematical or physical model boundaries. Framework factors that define boundaries are commonly restrictive of nature and concepts that fit the restrictive nature such as *constraints*, *external conditions* or *public safety framework* are used. One may for instance speak about the legal framework comprised by SHE related legislation, economic framework influenced by economic related legislation, resource and product qualities, market factors, costs, investments etc., organisational framework, environmental framework etc. Here, to emphasise the supportive function prior to the restrictive function of the framework concept and also avoiding an attitude that the framework of the SHE situation are 'given and cannot be changed', the more neutral *framework factors'* concept was chosen to describe factors influencing the SHE situation in general, risk of occupational accidents or illnesses etc. The working definitions of *framework factors* and *critical framework factors,* presented below, comprised the basis for designing the framework conditions survey (FC-survey).

Then the working definition of the concept '*framework factors*' became:

> *Within the framework concept related to safety, health and environment, framework factors are factors that influence the safety, health and environment situation. The influences can be observed as impacts of negative to positive character. Negative impacts are increased risks of accidents, risks of occupational health illnesses and exposures causing injuries or fatalities, while positive impacts are reduced or eliminated risks of such impacts.*

With reference to the general definition of '*framework factors*' presented above, *critical framework factors* were defined as:

> *Influencing framework factors that show to be of extraordinarily (very high) importance with respect to their influences on the safety, health and environment situation are defined as 'critical framework factors'.*

As for the general definition, the influences can be ranged from negative to positive and with similar impacts as described for the general definition. In the process of defining framework factors, the possibilities of changing the present framework were the background for talking about negative and positive influences.

When working out the framework factors definition, factors that directly influence the SHE situation or the risks of occupational accidents or illnesses were not considered part of the framework factors concept. Directly influencing factors were supposed to be handled immediately by the responsible party (organisation, organisational unit, group or individual) through a choice of actions to reduce the risk level or eliminate the risks completely. Provided that the present organisational culture can be characterised by a consistent practice of reducing or eliminating risks, then this "characteristic" of the organisational culture would be considered an influencing framework factor. Similarly, an opposite standard behaviour of not dealing with direct influencing factors would also be considered an influencing framework factor. The two examples describe what is meant by positive and negative impacts respectively. A practical case could for instance relate to maintenance situations in a crushing and sieving plant for quartzites, where immediate replacement of defect sealing mechanisms, filter bags in dust filters etc. take

place to prevent excessive emissions of quartz particles to the working environment and excessive exposure to hazardous respirable crystalline quartz particles for the workers.

Due to apprehended mining industry sector differences prior to the survey and also the belief that no respondents' consider the framework concept equally, a variation in the apprehension of which influencing framework factors that is part of the framework concept were expected. Similarly differences in the apprehension of influencing factors' importance were expected.

3.2 Surveys

The practical study of influencing factors and their importance was performed in two steps, first a pre-study where the respondents were asked to give a list of framework factors and second the main survey named the FC-survey. In the FC-survey the respondents were asked to respond to a list of individual factors.

The 'framework factors' pre-study

The pre-study of framework factors that influence the SHE situation were part of another survey designed to give feedback on the status of the SHE situation. Respondents were asked the following question:

> *In your opinion, which framework factors do you consider part of the framework concept in relation to SHE activities in your organisation today and in the future? Please give a complementary description.*

Presented as framework factor keywords, the responses were:

> *"Accidents, environment, attitudes, chemical substances, committed employees, discharge permit requirements, dust emissions, economic situation, deposit (mineral composition), greenhouse gas allowances, heavy work operations (physically), injuries, knowledge, law enforcement equality, legislation (coordination, less specified, progressively stricter, overview), legal compliance documentation, maintenance, management (follow-up), mass media (focus, media reports),*

neighbours (complaints, informing, relations), noise emissions, non-conformances/undesired events recording, occupational hygiene mapping (musculoskeletal problems), organisation, procedures and instructions, resources, risk assessments (accidents, ambient environment emissions, dust, noise, quartz), SHE-systems, training, unfair competition and working environment (musculoskeletal problems, turnover)"

The majority of the respondents gave short influencing factors keywords as their response to the question. For related keywords such as acts, regulations, legal rules etc., a common keyword were given. For this example the keyword legislation was chosen. A few respondents gave more complementary information in addition to their factor keywords.

Choice of influencing factors for the main study

Prior to choosing framework factors for the main study, a list of factors was made by the researcher. The researchers' list of factors together with factors compiled from the pre-study results comprised the final list of factors used in the design of the FC-survey questionnaire. Detailed listing of factors and subfactors are given in appendix 1. In the compiling of the factor list, communication appeared as a subfactor in connection to several of the chosen main factors. Therefore communication became a main factor. Unfortunately this choice was made after the survey was initiated. The individual factors are listed below. In addition a short comment is added to each of the factors.

- ✓ Legislation: Regulates various aspects of SHE activities. In addition to general regulations, also separate regulations designed for the mining industry exist.
- ✓ Business sector rules: Rules concerning SHE specified by business sectors or individual enterprises/corporations. Also see the "Quartz agreement".
- ✓ Quartz agreement: The Social Dialogue Agreement on Respirable Crystalline Silica. Signed by European business sector organisations in 2006.
- ✓ Economy: As the foundation of any business activity, economic factors are commonly discussed in relation to framework conditions.

- ✓ Risks (occupational): Most occupational activities involve hazards. Mining activities are considered hazardous, involving risks common to other industries, but also inherent risks that are specific for the mining industry.
- ✓ Mineralogy: Mineral deposits may contain several minerals. Some of the common minerals such as crystalline quartz, asbestos minerals, coal etc. Exposure to respirable dust from these minerals is known to be harmful and may cause serious lung diseases such as pneumoconiosis. Quartz and asbestos minerals are in addition considered carcinogenic.
- ✓ SHE-management (leadership): Managerial responsibilities, organising activities and follow-ups at all levels in the organisation.
- ✓ SHE-system: In Norway a system (internal control) for following up SHE activities including risk assessments are legally required.
- ✓ SHE-competence: Comprised by formal knowledge, skills, training etc. at all levels of the organisation
- ✓ SHE- culture (safety culture/climate): The organisations climate and practice in relation to dealing with safety and the risks of accidents and occupational illnesses.
- ✓ Environment: Includes work environment and environmental issues. Environmental issues were emphasised.
- ✓ Neighbours: Commonly experienced as an external stressor in relation to environmental emissions of particles (dust), noise, vibrations etc.
- ✓ Mass media: The press is commonly named the fourth estate.
- ✓ Reputation: An image of the enterprise or the business sector in the society.
- ✓ Society acceptance: An effect based on the belief or actions of the people comprising the society.
- ✓ SHE-indicators: Indicators expressing SHE performance, for instance lost time injuries, fatality rates etc.
- ✓ Protection equipment: Various safety devices, barriers, personal protection equipment etc.
- ✓ Communication: The process of transferring information from one person, group or organisation to another person, group or organisation (sender/receiver).

Questionnaire design

The design of the FC-survey questionnaire was based on the main framework factors listed above. Main questionnaire items were:

- ✓ The respondents name, position, enterprise products, production volumes and organisational data (working time arrangements, employee turnover, temporary employments)
- ✓ Framework factors - individual response per factor
    a. Factor compliance to the framework concept. Response scale: "Yes", "No", "Do not know/no opinion"
    b. Factor importance within the framework concept. Response scale: "Very low", "Low", "Medium", "High", "Very high" and "critical"
- ✓ A list of supplemental questions
- ✓ Fields for adding supplementary comments and remarks

3.3 Sample extraction

The Norwegian Mining and Quarrying Industries were founded in March 2008, when the three industry associations *The Association of Norwegian Mines (BIL)*, *The Federation of Norwegian Stone Industry (SIL)* and *The Norwegian Aggregates Producers Association (PGL)* merged.

A large proportion of the Norwegian mines, stone and aggregates producers are organized within *the Norwegian Mining and Quarrying Industries*. This organisation is a trade association for enterprises that explore, extract, manage or refine mineralogical resources in Norway or in other ways are connected to the mining industry. In addition their member base contains mining equipment suppliers, consultants and others.

As previously commented in chapter 3.1, a difference in characteristics among the merging associations was expected. Parameters expected to vary were mineralogical content, products, production volumes, number of employees, plant designs and

complexity, plant processes, activities etc. Therefore, a stratified extraction procedure[17] was selected as the basis for sampling. The stratification was based on 1) the characteristics of the merging associations, for instance by placing producers of aggregates, gravels and sands in the AGGREGATES sample etc. and 2) by placing enterprises with double memberships in the most appropriate member data base. Some of the member enterprises were suppliers or consultants. They were removed from the subpopulations prior to extraction. Finally the populations' remaining enterprises were listed alphabetically and numbered prior to sample extraction.

The extraction process gave the following samples:

- ✓ The *MINERALS* sample – extracted from The Association of Norwegian Mines (BIL) population.
- ✓ The *DIMENSIONAL STONES* sample – extracted from The Federation of Norwegian Stone Industry (SIL) population.
- ✓ The *AGGREGATES* sample – extracted from The Norwegian Aggregates Producers Association (PGL) population.
- ✓ The *MINERAL PRODUCTION* sample – comprising enterprises from the *MINERALS*, *DIMENSIONAL STONES* and *AGGREGATES* samples.

The enterprise number comprised the basis for the extraction. The selection of the subsequent enterprises was based on extracting 10 enterprises from each of the populations. The start enterprise was selected randomly. The MINERALS sample consisted of every second enterprise counted from the preselected 'start enterprise' in the corresponding population. The DIMENSIONAL STONES sample consisted of all member enterprises in the corresponding population, while the AGGREGATES sample consisted of every sixth enterprise. To take account of the expected non-responses, additional enterprises were extracted randomly from the remaining enterprises within the population in question.

[17] "*Most populations can be segregated into several mutually exclusive subpopulations, or strata. The process by which the sample is constrained to include elements from each of the segments is called* ***stratified random sampling*** *(Cooper and Schindler 2003).*

Appendix 2 lists the extracted enterprises per sample. The listed enterprises are organised alphabetically. Data processing was made according to the succession in recording enterprise data. Therefore the organising of any sequential respondents' record does not correspond with the listed order of respondents in appendix 2.

During the survey a 'screening question' was added to further remove enterprises that did not fit the sample requirements. One example of enterprise removal was the enterprise 'Scancem International AS'. This enterprise only possesses activities outside Norwegian territory. Another example was 'Hustadkalk AS'. At the time 'Brønnøy Kalk AS' was their only subsidiary company. 'Brønnøy Kalk AS' was extracted separately, thus representing 'Hustadkalk AS'.

3.4 The FC-survey

The respondents were contacted by phone and asked to respond to the survey. The questionnaire form was then sent by e-mail to the respondents and they were given the choice of either filling in the form themselves or by telephone interview. Interviews were performed for about 50 % of the responses. In the latter case, the questionnaire form was sent by e-mail prior at the appointed time of interview. The interview was performed as a structured interview based on the questionnaire form.

Questionnaire forms filled in by the respondents were received by e-mail or facsimile transmission. In the 'interview cases' the questionnaires were filled in by the researcher. The version of the questionnaire that was filled in by the researcher was next returned to the respondent, who was given a deadline for giving corrective feedback prior to compiling and data processing.

3.5 Data processing

Returned questionnaire forms were recorded and compiled. Worksheets designed by the researcher comprised the basis for compiling and processing data. Here the response

data per question per respondent was recorded and statistical results calculated per sample. A unique respondent number, for instance FC15 was allocated for each of the respondents. The response records are presented in appendices 3A-3D.

Next selected survey data was exported to MiniTab[18] for statistical processing, analysis and chart plots. Here the responses were plotted in matrix charts for each of the factors being examined, see figures 14-19. Prior to plotting the score data, enterprise sizes in terms of staff size or production volumes were expected to be important with respect to perceived factor importance and were therefore added to the database reserved for the matrix plots. The influencing factors results are presented in chapter 4 and discussed in chapter 5. Before presenting the factor score distributions, a few comments concerning the score distributions must be provided.

Score distributions - the response spreading model

With reference to the FC-Survey, the respondents were asked to respond to the importance of seventeen influencing factors. The influencing factors importance response[19] was based on a scale ranging from 0 to 6.

The *mean* or expected value of any discrete random variable is obtained by multiplying each of the values x_1, x_2, …, x_n of the random variable X by its corresponding probability $f(x_1)$,$f(x_2)$, …, $f(x_n)$ and summing the products. The mean describes where the probability distribution is centred. Further, the probability distribution is described by the dispersion of observations or the variability. The *variance* of the random variable x is denoted by Var(x) or the symbol σ^2. The positive square root of the variance, σ, is called the *standard deviation* (Walpole, Myers and Myers 1998).

$$\sigma^2=E[(X-\mu)^2]=\Sigma\,(x-\mu)^2\,f(x) \qquad (1)$$

[18] Computer software for performing statistical processing and analysis

[19] Importance score scale: 0="not a framework factor"; 1="very low"; 2="low"; 3="medium"; 4="high"; 5="very high" and 6="critical"

The quantity $x-\mu$ is called the deviation of an observation x from its mean μ. For a set of values that are close to μ, σ^2 will be much smaller compared with a set of values that vary considerably from μ. This is due to the deviations first being squared and next averaged (Walpole, Myers and Myers 1998).

Here the range of scores from 0 to 6 is discrete variables. A model of the standard deviation as a function of the mean values for various distributions of the scores 0 and 6 is presented in figure 12. For a 50-50 % distribution of the two scores, the mean value is 3 while for 100 % of the scores either 0 or 6, the mean value is equal to the score values. The standard deviations corresponding to average scores 0, 3 and 6 are then 0.0, 3.0 and 0.0.

4. Survey results

The FC-survey was designed to reveal information about influencing framework factors and their importance with emphasis on the risks of occupational accidents and illnesses in the Norwegian mining industry. The FC-survey is described in chapter 3.2. Supplemental questions were supposed to give additional information about the factors being examined. Supplemental questions and their responses are listed in appendix 3C)-D). Together the responses to factor importance, supplemental questions and comments in connection to the individual responses, provide new information about to the issue framework conditions in mineral production seen from the perspective of the mining industry. An interesting aspect of this study is that most Norwegian mining industry enterprises are small or medium sized[20] while the dominant research on risks and loss prevention connected to risks of accidents seems to be made within large enterprises and high reliability organisations (HRO). Swuste (2008:449) concludes that most research on managerial impacts on occupational risk prevention comes from large bureaucratic organisations running high-risk technologies, while the vast majority of enterprises worldwide are comprised of small sized enterprises.

[20] Norwegian business activities are comprised mainly by small-and medium sized enterprises. Small and medium enterprises employ less than 100 persons. In 1995 about 96 % of the enterprises employed less than 20 persons (NOU 1996).

In figure 11 the productivity level versus enterprise size is presented, showing that the staff sizes in the majority of the enterprises comprises less than 100 man-labour years. The two respondents with total staff sizes above 100 man-labour years that belong to the AGGREATES and DIMENSIONAL STONES samples represent each several subsidiary enterprises and production plants. Details concerning production volume and staff size data are presented in appendix 3A-3B.

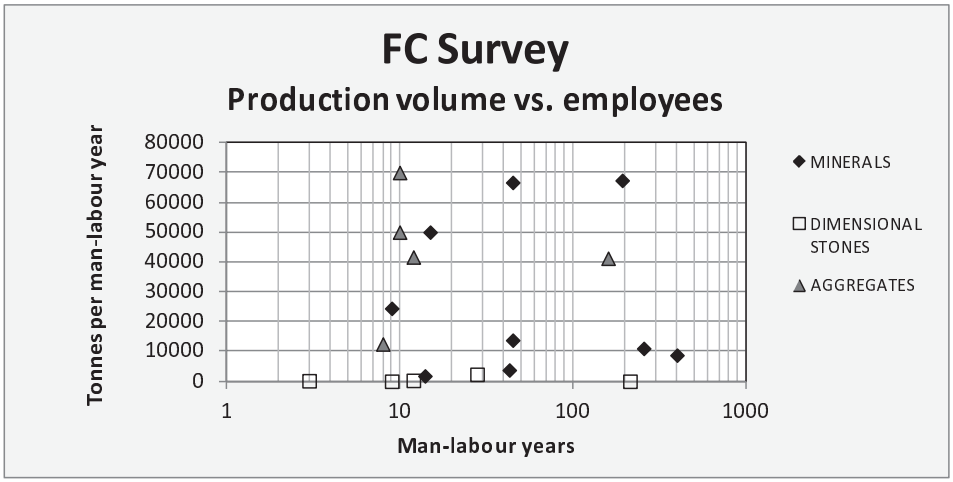


Figure 11: FC-survey productivity levels versus staff size in man-labour years

4.1 Influencing framework factors

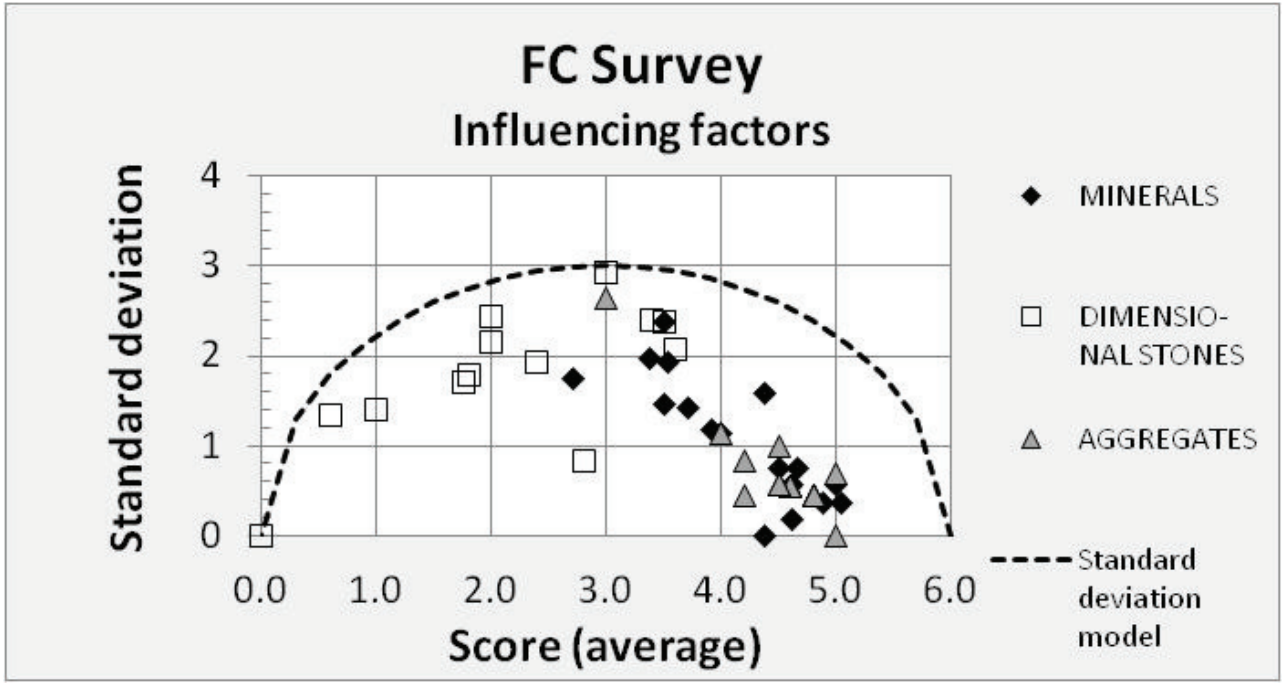
The FC-survey focused on 18 framework factors influencing the SHE situation. The process of choosing factors is described in chapter 3.2 while questionnaire design, extraction of samples and the processing of response data are described in the chapters 3.2-3.5. The examined factors were *Legislation*, *Business sector rules*, the *Quartz agreement*, *Economy*, *Environment*, *Mineralogy*, *Risk*, *SHE-management*, *SHE-system*, *SHE-competence*, *SHE-culture*, *Neighbours*, *Mass media*, *Reputation*, *Society acceptance*, *SHE-indicators*, *Protection equipment* and *Communication*.

4.1.1 The framework factors' average scores and scattering

No factors received the average score 6 that corresponded to *critical* on the response scale, although parts of the MINERALS, DIMENSIONAL STONES and AGGREGATES subsamples have responded that they consider individual influencing factors as *critical*.

Prior to data analysis, all the factors' average scores and corresponding standard deviations were plotted in figure 12. Here data belonging to the MINERALS, DIMENSIONAL STONES and AGGREGATES subsamples are indicated with separate symbols. In figure 12 distinct differences in score clusters for the three subsamples' are observed. The cluster of average scores belonging to the DIMENSIONAL STONES sample is found at the middle and lower score values, while the corresponding cluster of the MINERALS sample is found at the *medium* to *very high* scores. The score cluster for the AGGREGATES sample is found at the *high* to *very high* scores. For the MINERALS AND DIMENSIONAL STONES samples, the factors' score standard deviations vary while for the AGGREGATES sample the standard deviations, with one exception, vary between 0 and 1. A model for analysing the spread of scores based on average scores and the corresponding standard deviations is described in chapter 3.5.

The eighteen framework factors are sorted according to their internal average importance scores in increasing order. The sorting result is presented in table 8. The main observation is that most factors get *high* or *very high* importance score in the MINERALS and AGGREGATES sample while the DIMENSIONAL STONES sample gives lower scores compared with the two other samples. For the MINERALS and AGGREGATES samples, the risk (inherent), legislation and organisational factors such as *SHE-system*, *SHE-management*, *SHE-competence*, *SHE-culture*; and in addition the *communication* and *protection equipment* factors are ranked as the most important influencing factors. Organisational factors such as *SHE-culture*, *SHE-system* and *SHE-competence* also received a high ranking in the DIMENSIONAL STONES sample.



Sample MINERAL PRODUCTION comprised by subsamples MINERALS, DIMENSIONAL STONES and AGGREGATES. Sample size, S=29; number of responses, N=<10, 19> and response rates R=<34 %, 66 %>. Factor importance score scale: 0=No framework factor; 1=Very low; 2=Low; 3=Medium; 4=High; 5=Very high and 6=Critical.

Figure 12: Framework factors standard deviations plotted as a function of the average importance scores

Table 8: Influencing framework factors vs. importance score sorted and listed per sample

MINERALS	Avg. score	SD	Drop-out	DIMENSIONAL STONES	Avg. score	SD	Drop-out	AGGREGATES	Avg. score	SD	Drop-out	MINING INDUSTRY	Avg. score	SD	Drop-out
Risks	5.0	0.4	20.0	Quartz Agreement	5.0	0.0	85.7	Risks	5.0	0.7	58.3	Communication	4.7	0.5	65.5
Legislation	5.0	0.6	10.0	SHE-culture	3.6	2.1	28.6	Protection Equipment	5.0	0.0	58.3	Legislation	4.5	1.4	34.5
SHE-system	4.9	0.4	10.0	SHE-system	3.5	2.4	42.9	Legislation	4.8	0.4	58.3	SHE-system	4.5	1.3	37.9
SHE-management	4.7	0.8	30.0	SHE-competence	3.5	2.4	42.9	Economy	4.8	0.4	58.3	SHE-competence	4.4	1.3	41.4
SHE-competence	4.6	0.2	20.0	Legislation	3.4	2.4	28.6	SHE-management	4.8	0.4	58.3	SHE-culture	4.3	1.2	37.9
SHE-culture	4.6	0.6	20.0	Reputation	3.0	2.9	42.9	Communication	4.8	0.4	58.3	Risks	4.3	1.6	41.4
Communication	4.6	0.5	50.0	Society acceptance	3.0	2.9	42.9	Business Sector Rules	4.6	0.5	58.3	SHE-management	4.1	1.6	41.4
Protection Equipment	4.5	0.8	20.0	Economy	2.8	0.8	28.6	SHE-competence	4.6	0.5	58.3	Protection Equipment	4.1	2.0	41.4
Business Sector Rules	4.4	0.0	20.0	SHE-management	2.4	1.9	28.6	SHE-culture	4.6	0.5	58.3	Reputation	3.9	1.6	41.4
Environment	4.4	1.6	20.0	SHE-indicators	2.0	2.2	42.9	Neighbours	4.6	0.5	58.3	Society acceptance	3.9	1.6	41.4
Society acceptance	4.0	1.2	10.0	Protection Equipment	2.0	2.4	42.9	Reputation	4.6	0.5	58.3	Economy	3.8	1.2	41.4
Reputation	3.9	1.2	20.0	Business Sector Rules	1.8	1.8	28.6	Mineralogy	4.5	0.6	66.7	Business Sector Rules	3.7	1.9	37.9
Economy	3.7	1.4	30.0	Mineralogy	1.8	1.7	42.9	SHE-system	4.5	1.0	58.3	Quartz Agreement	3.5	2.2	65.5
Neighbours	3.5	1.9	30.0	Risks	1.8	1.7	42.9	Society acceptance	4.5	0.6	66.7	Environment	3.4	1.9	37.9
Quartz Agreement	3.5	2.4	50.0	Environment	1.0	1.4	28.6	Environment	4.2	0.4	58.3	SHE-indicators	3.4	1.7	41.4
SHE-indicators	3.5	1.5	20.0	Mass Media	0.6	1.3	28.6	SHE-indicators	4.2	0.8	58.3	Mineralogy	3.3	1.9	41.4
Mineralogy	3.4	2.0	10.0	Neighbours	0.0	0.0	28.6	Mass Media	4.0	1.2	66.7	Neighbours	2.9	2.2	41.4
Mass Media	2.7	1.8	10.0	Communication				Quartz Agreement	3.0	2.6	66.7	Mass Media	2.4	1.9	37.9

The FC-survey importance score scale:
0=No framework factor; 1=Very low; 2=Low; 3=Medium; 4=High; 5=Very high and 6=Critical.

The average score 5 includes the range of 4.5-5.4, the average score 4 includes the range 3.5-4.4 etc. The thick lines and colours indicate the limits between score ranges and the importance score ranges.

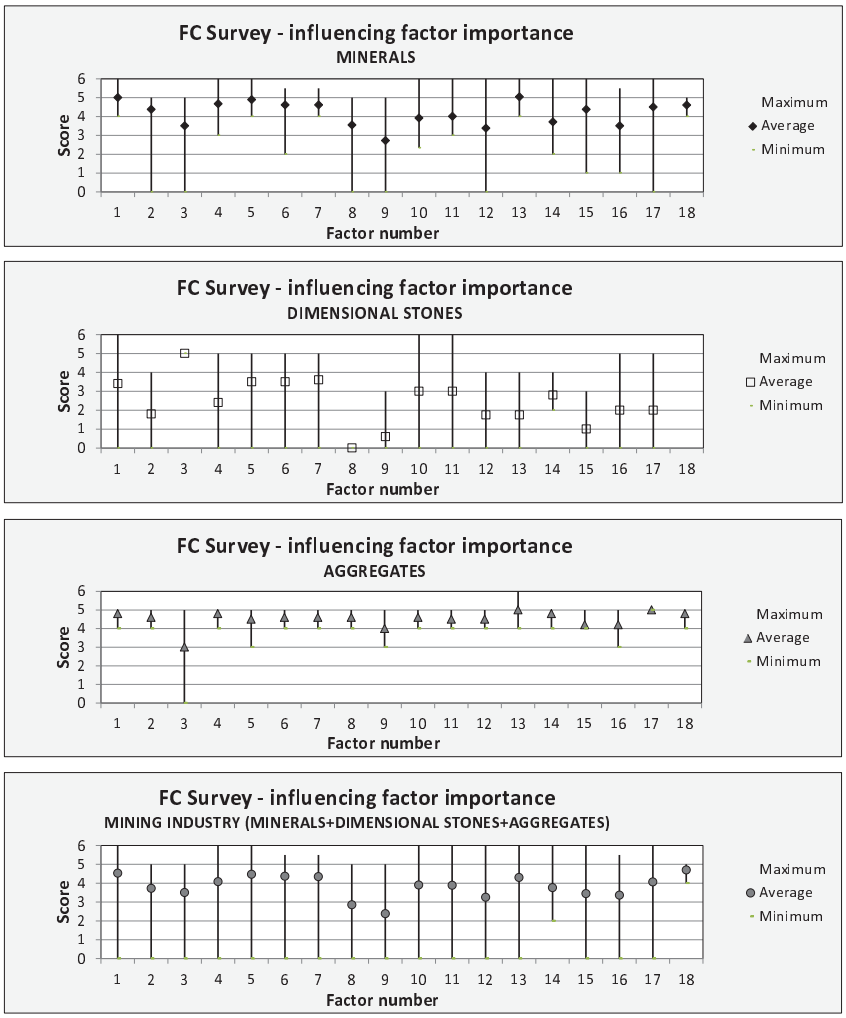
In figure 13, the maximum, average and minimum scores for each of the influencing factors are plotted to illustrate the spread in scores. The plots for the MINERALS, DIMENSIONAL STONES and AGGREGATES samples are organised in a vertical order.

For the MINERALS sample the *Legislation*, *Risk*, *SHE-system*, *SHE-culture* and *Communication* factors show a 2 unit score spread with average scores 4-5, that is correspond to *important* or *very important*. The average score of the *SHE-management* factor is close to 5 but the spread is 3 units. For the other factors the average score is lower and the spread larger than 3 units. The *Business sector rules*, *Quartz agreement*, *Environment*, *Mineralogy*, *Neighbours*, *Mass media* and *Protection equipment* factors show spreads larger than 5 units.

The respondents belonging to the DIMENSIONAL STONES sample were not asked about the *Communication* factor. For fourteen of the seventeen influencing factors being examined, the spread of scores were 3 units or more. The *Quartz* agreement, the *Economy* and the *Neighbours* factors showed less spread in scores. Here the *Quartz agreement* and the *Neighbours* samples show no spread in score values, getting scores 5 and 0 respectively. Score 0 corresponds to *No framework factor* while score 5 corresponds to *very important*. The *Economy* factor got an average score close to 3 corresponding to *medium importance* with a 2 unit spread.

For most of the factors belonging to the AGGREGATES sample, the scores are close to 5 and the spread is 1 unit. Exceptions can be seen for the *Quartz agreement*, the *Risk*, the *SHE-system*, the *Mass media* and the *SHE-indicators* factors. For the *Quartz agreement* factor the spread is 5 units. For the *Risk*, the *SHE-system*, the *Mass media* and the *SHE-indicators* samples the spread is 2 units.

The individual scores per sample are listed in appendix 3B and the individual respondents' comments are listed in appendix 4.



Samples: MINERALS, DIMENSIONAL STONES, AGGREGATES and MINING INDUSTRY (combined) samples. N=29.

Factor importance score scale: 0=No framework factor; 1=Very low; 2=Low; 3=Medium; 4=High; 5=Very high 6=Critical.

Framework factors:

1=Legislation	*2=Business sector rules*	*3=Quartz agreement*	*4= SHE-management*	*5= SHE-system*
6= SHE-Competence		*7= SHE-culture*	*8= Neighbours*	*9= Mass media*
10= Reputation	*11= Society acceptance*	*12= Mineralogy*	*13= Risk*	*14= Economy*
15= Environment		*16=SHE-indicators*	*17=Protection equipment*	
18=Communication				

Figure 13: Plot of framework factors' maximum, average and minimum scores

4.1.2 Rule associated framework factors

In figure 14 the *legislation*, *business sector rules* and *quartz agreement* factors are plotted as a function of a) enterprise size in man-labour years and b) production volume in tons. Table 9 summarises the general comments given by the respondents and comments given to specific questions about legislation impacts and law enforcement equality.

- ✓ Legislation: Independent of enterprise size or production volume, most responses plot in the upper part of the importance score scale that is 4-6 and corresponding to high-very high and critical importance.

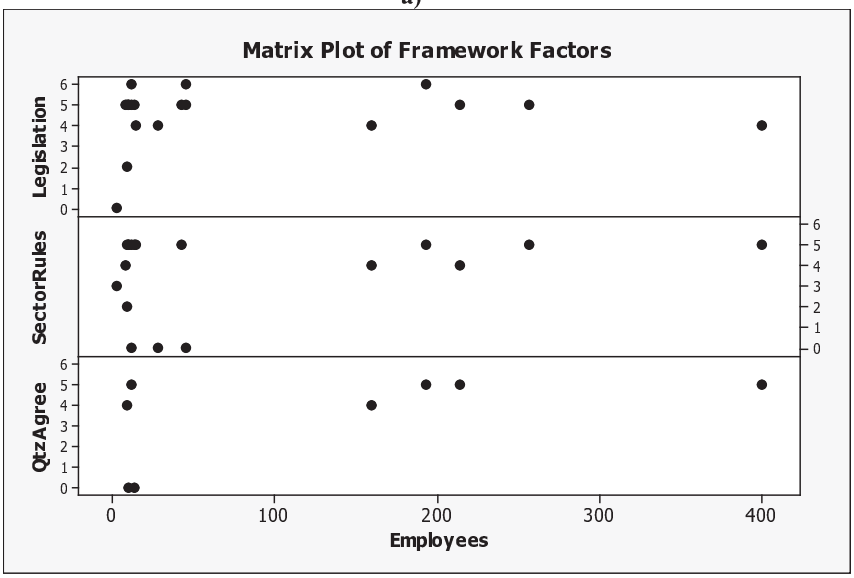
  Some of the respondents expressed the importance of compliance to legal rules. The task of keeping updated with regard to legal requirements is considered comprehensive.

  Definite examples of 'impacts' from legal requirements are listed in table 9. Investments and operational costs are associated with compliance to legal requirements, see chapter 4.1.6. With reference to table 9, some of the respondents reported experiences of arbitrary law enforcement practice mostly by the local regulatory authorities.

Clearly the need for simplifying the legal rules related to SHE activities that was expressed at the time of the survey (2007/2008) was communicated to the regulatory authorities. The regulators initiated a process to improve the legislation structure and recently the number of regulations concerning general SHE activities was reduced from 47 to six. The six new regulations that were presented in December 2011 are effective from January 1st 2013 (Regelhjelp 2011).

- ✓ Business sector rules and quartz agreement: In comparison with the legislation factors, larger spreading in importance scores. Corporate rules exist. Sparse feedback from the respondents both on general corporate rules and the quartz agreement in particular.

a)



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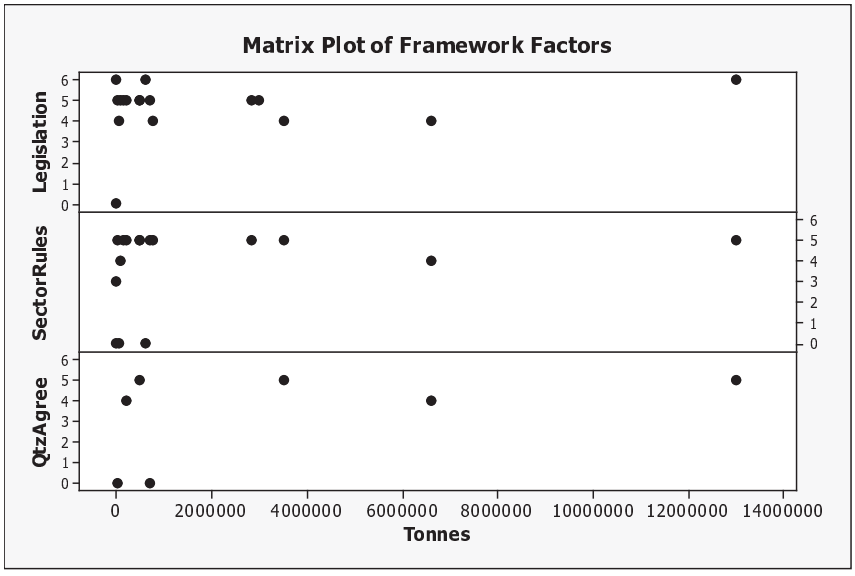


FC-survey response and dropout result: Legislation (N_1=19; R_1=66 %). Business sector rules (N_2=18; R_2=62 %) and the Quartz agreement (N_3=10; R_3=34 %).

Figure 14: Legislation, Business sector rules and Quartz agreement factor plots versus a) staff size and b) production volume

Table 9: Respondent feedback with respect to legal and business sector rules

The influence (impact) of legislation on the SHE activities – respondent remarks summary
Question: Do you know whether new/amended legislation has changed conditions related to SHE activities within your enterprise? Please inform about actual legislation and the consequences.
Summary: Six respondents make the statement that legislation must be complied with. Three respondents mark objections to the complexity of the legislation related to SHE activities. Keeping updated at any time is a comprehensive task. One respondent gives an example of the low degree of legislative coordination related to the use of machinery. To use for instance a truck, you have to relate to and know the definite requirements of more than three acts and three or more regulations. Definite examples of legislative impacts on the responding enterprises' SHE situation are listed by eleven respondents. They are: a) handling of mineral wastes, b) monitoring and monitoring accuracy of threshold limit values (TLV) for nitrogen dioxide (NO_2), c) progressively stricter discharge permit requirements (two respondents), d) more strict requirements to lifting equipment, e) carbon dioxide (CO_2) emission allowances trading system (two respondents), f) safeguarding harbours against possible terror threats, g) explosives storage requirements (three respondents), h) changes in the "Work Environment Act" influences the free time between shifts and i) emergency preparedness (fire, explosions, accident situations, etc).
Law enforcement equality – respondent remarks summary
Question: How do you experience that the regulatory authorities treat enterprises within your business sector?
Summary: Comments from two of the eight respondents are related to environmental issues and an experience that the Norwegian Pollution Control Authority treats enterprise equally, while two respondent experiences different treatment of enterprises in cases handled by the local County Governors' offices. Both the latter respondents belong to corporations/groups of enterprises with plants situated at different regions. A couple of respondents also experienced arbitrary treatment from the same regulatory authority (nonspecified) and also that treatment depends on the executive officers contacted. One of the respondents remarks that the size of company seems to be important, the large ones get enhanced focus compared with smaller ones. Another respondent makes a similar remark related to enterprises with foreign owners versus enterprises with Norwegian owners.

Table 9 (continued): Respondent feedback with respect to legal and business sector rules

Business sector and enterprise rules – summary of respondent comments
Internal rules: Rules are set and communicate corporate SHE requirements to own employees to hired personnel. They set clear responsibilities and are used to create predictable attitudes. Procedures allocated to individual departments or machinery.
Quartz agreement: Quartz content in sidewalls. Respirable dust from our mine may cause pneumoconiosis.

The dropout rate for the *quartz agreement* factor is relatively high. The few responses indicate sparse knowledge about the agreement at some enterprises, more at others. The agreement was developed and signed by European business sectors in 2006 as a response to a recommendation of reducing the TLV for respirable quartz dust from 0.1 to 0.05 mg/m³ by the EU (IMA-Europe, 2006, NEPSI, 2006, SCOEL, 2002). During the years of the FC-survey the implementation work had just started. The implementation included working out 'good practice' procedures in Norwegian, continuous good practice follow-ups and annual reporting (NorskIndustri, n.d.-a).

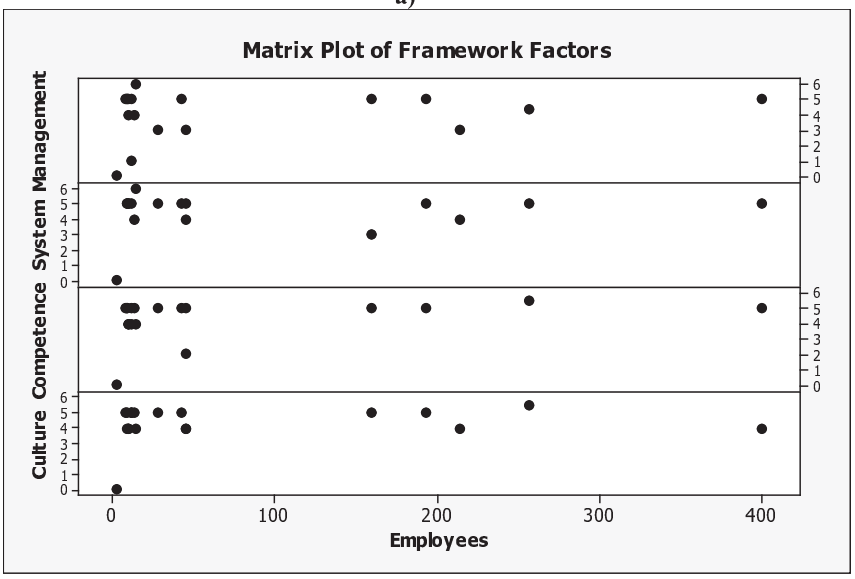
4.1.3 Organisational framework factors

In figure 15 the *SHE-management*, *SHE-system*, *SHE-competence* and *SHE-culture* factors are plotted as a function of a) enterprise size in man-labour years and b) production volume in tonnes.

Table 10 summarises the comments given by the respondents. In appendix 4 all the received comments are listed according to respondent numbers.

- ✓ SHE-management: The importance scores seem to cover the whole scale, although the majority of scores are 3 or higher, corresponding to medium, high, very high and critical.
- ✓ SHE-system: Independent of enterprise size or production volume, most responses plot in the upper part of the importance score scale that is 4-6 corresponding to high-very high and critical importance.

a)



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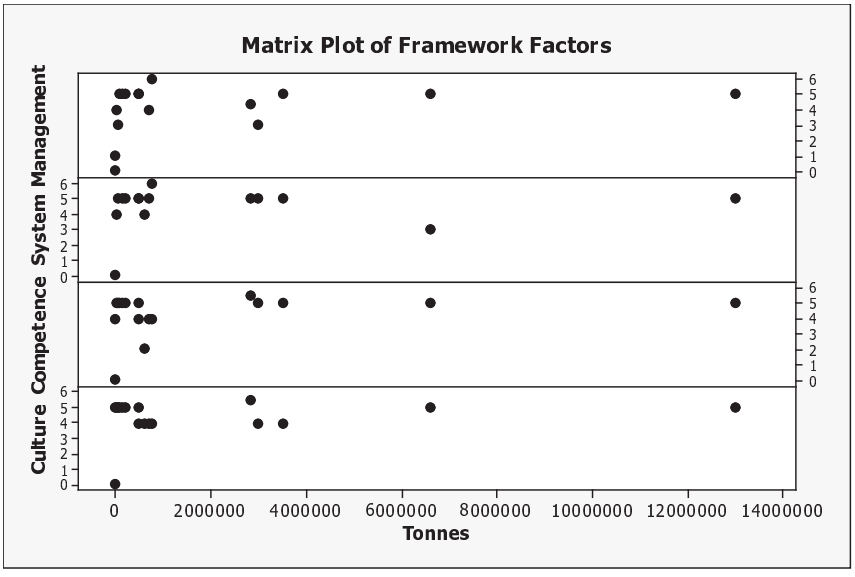


Response and dropout result: *SHE-management (N8=17; R8=59 %), SHE-system (N9=18; R9=62 %), SHE-Competence (N10=12; R10=59 %) and SHE-culture (N11=18; R11=62 %).*

Figure 15: SHE-management, SHE-system, SHE-competence and SHE-culture factor plots versus a) staff size and b) production volume

Table 10: Responses to organisational factors

Management - respondents feedback summary
Enterprise managers are role models and responsible for the SHE activities. Their focus on SHE activities is needed. Various models of organising the SHE responsibilities and activities are indicated by the responses.
SHE-system – respondents feedback summary
The respondents refer to various system models such as the Internal Control System, other to quality assessment systems (ISO 9001), product quality systems and environmental management systems (ISO 14001). One respondent is certified according to ISO 14001. Practices concerning the recording of nonconformances and undesired events are not described in detail by all respondents, but seem to vary. Some respondents refer to written records, one respondent to oral reporting and handling and some to compliance with legal requirements. One respondent is very critical to the extent of their system.
SHE-competence – respondents feedback summary
Positive attitude to SHE activities is emphasised by one respondent and understanding the importance of SHE activities by another respondent. Together the responses indicate various level of safety training. Some enterprises refer to the legally required 40 hour training of personnel safety representatives. Various levels of practical experience. One respondent has observed that inexperienced personnel (new employees) more easily are injured.
SHE-culture/safety culture – respondents feedback summary
With reference to safety, health and environment, the majority of the respondents evaluate their corporate culture as good.

- ✓ SHE-competence: Independent of enterprise size or production volume, most responses plot in the upper part of the importance score scale that is 4-6 corresponding to high-very high and critical importance.
- ✓ SHE-culture: Independent of enterprise size or production volume, most responses plot in the upper part of the importance score scale that is 4-6 corresponding to high-very high and critical importance.

Internal control is "*Systematic measures designed to ensure that the activities of the enterprise are planned, organised, performed and maintained in conformity with requirements laid down in or pursuant to the health, environmental and safety legislation*" (AID 1996:2; DAT 1998:20). In section 4 of the Internal Control Regulation the responsibility for maintaining 'internal control' is allocated to the person

that is responsible for the enterprise. Maintaining internal control shall be done in collaboration with the employees and their representatives. The employees shall participate (AID, 1996, DAT, 1998).

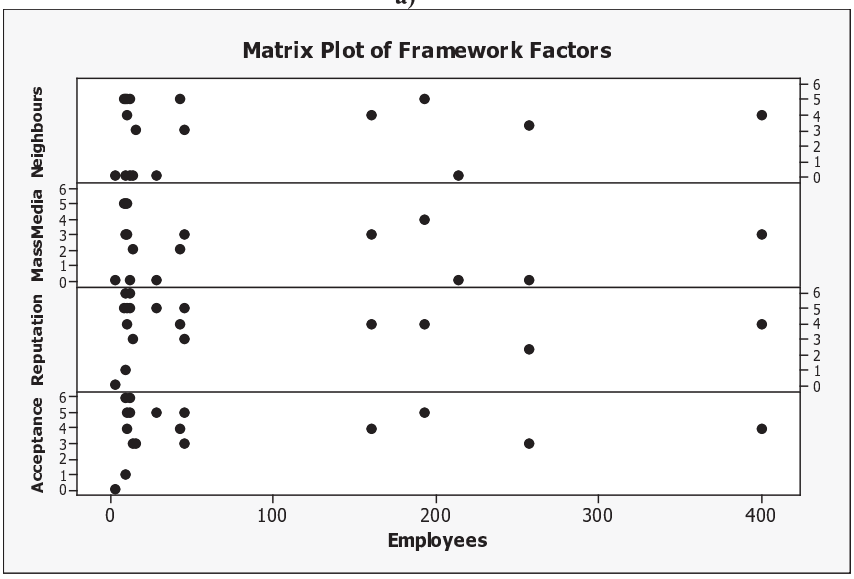
The Internal Control System is legally required while other systems such as the work environment standard SN-BS OHSAS 18001 and the environmental management standards ISO 14001 are voluntarily implemented. The content of the systematic SHE activities and requirements to documentation are described in section 5 of the Internal Control Regulation (AID, 1996, DAT, 1998). Similarly the content and requirements to work environment and environmental management systems are described in standards (Brreg, 2008, SN, 2004, SN, 2007).

4.1.4 External framework factors

In figure 17 the *neighbour*, *mass media*, *reputation* and *society acceptance* factors are plotted as a function of a) enterprise size in man-labour years and b) production volume in tons. Table 11 summarises the comments given by the respondents. In appendix 4 all the received comments are listed according to respondent numbers.

- ✓ Neighbours: The importance scores are either 3-5 that correspond to *medium* to *very high* importance, or zero that corresponds to *No framework factor*. Most of the insignificant responses come from enterprises with a low number of man-labour years and low production volumes.
- ✓ Mass media: Quite a similar distribution of scores as for the *neighbours* factor, but here the scores are either 2-5 correspond to *low* to *very high* or zero that corresponds to *No framework factor*. Most of the *No framework factor* responses come from enterprises with a low number of man-labour years and low production volumes.
- ✓ Reputation: The majority of the importance scores are 3-6 corresponding to *medium* to *critical* importance. Reputation seems to be considered more important by the small enterprises and enterprises with low production volumes.

a)



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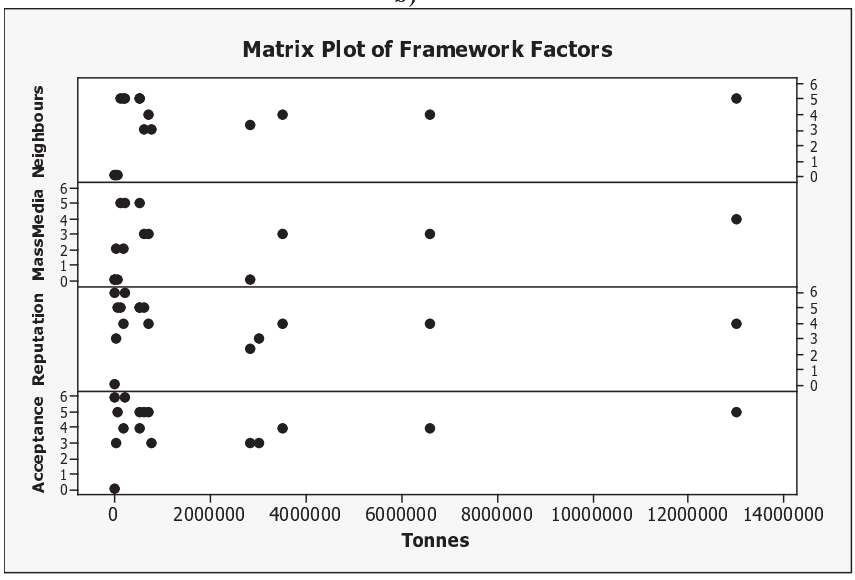


Survey response and dropout result: Neighbours (N12=17; R12=59 %), Mass media (N13=18; R13=62 %), Reputation (N14=17; R14=59 %) and Society acceptance (N15=17; R15=59 %).

Figure 16: Neighbours, Mass media, Reputation and Society acceptance factor plots versus a) staff size and b) production volume

- ✓ Society acceptance: When comparing with the *reputation* factor, quite a similar distribution of scores.

Table 11: Respondent's feedback regarding external influencing factors

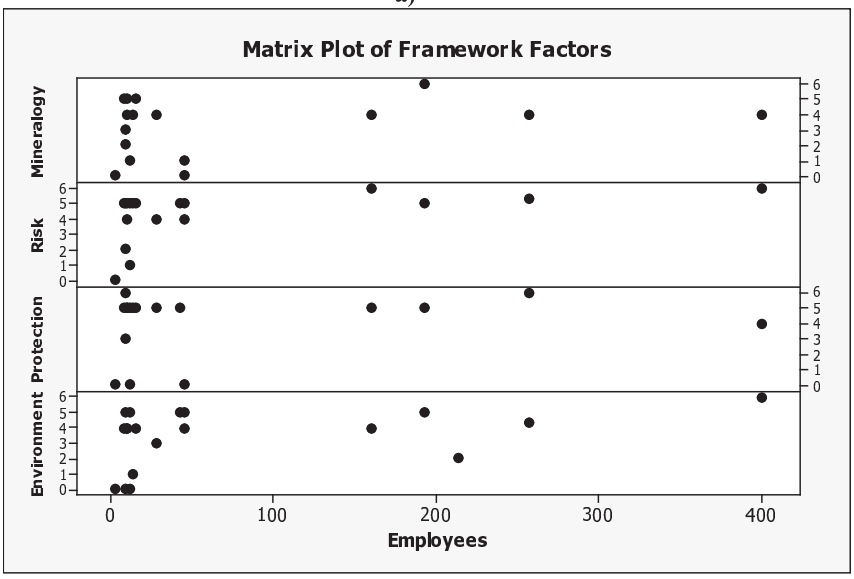
The neighbours factor - respondents feedback remarks summary
Variable distance to the nearest neighbours. Two respondents have no neighbours living nearby. Like the distance, variable characteristic of relationship to neighbours ('bad' to 'good'). One situation is characterised as a conflict. A "not in my backyard" problem is indicated by one respondent. Several plants want to establish a good relationship with their neighbours. Complaints concerning dust emissions are recorded.
The mass media factor - respondents feedback remarks summary
The respondents have experienced both negative and positive media reports. One respondent experiences a lot of work in relation to mass media contact. The importance of cooperating with the media and also being honest and credible are emphasised by some respondents.
The reputation and society acceptance factors - respondents feedback remarks summary
The respondents commenting on the reputation issue are concerned with creating a positive reputation. The importance of reputation is connected to local society and authorities, and for instance in recruiting new workers. The need of acceptance from society is mentioned and considered important. Society acceptance is also connected to the enterprise's reputation by two respondents. One respondent is concerned with respect to what seems to be a public lack of knowledge about the significance of mining industry.

4.1.5 Inherent framework factors

In figure 17 the *mineralogy* and *risk* factors are plotted as a function of a) enterprise size in man-labour years and b) production volume in tonnes. Table 12 summarises the comments given by the respondents for the *mineralogy* and *risk* factors. In appendix 4 all the received comments are listed according to respondent numbers.

- ✓ Mineralogy: The importance scores cover the whole scale of scores.
- ✓ Risk: The importance scores cover the whole scale from 0-6 corresponding to *insignificant*, *very low*, *low*, *medium*, *high*, *very high* and *critical*. For enterprises of large staff size or large production volumes, the scores are *very high* or *critical*.

a)



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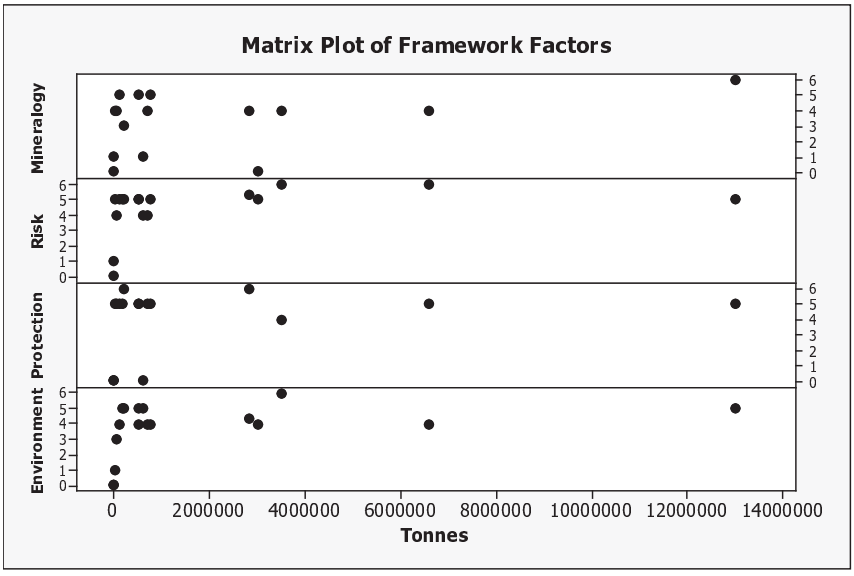
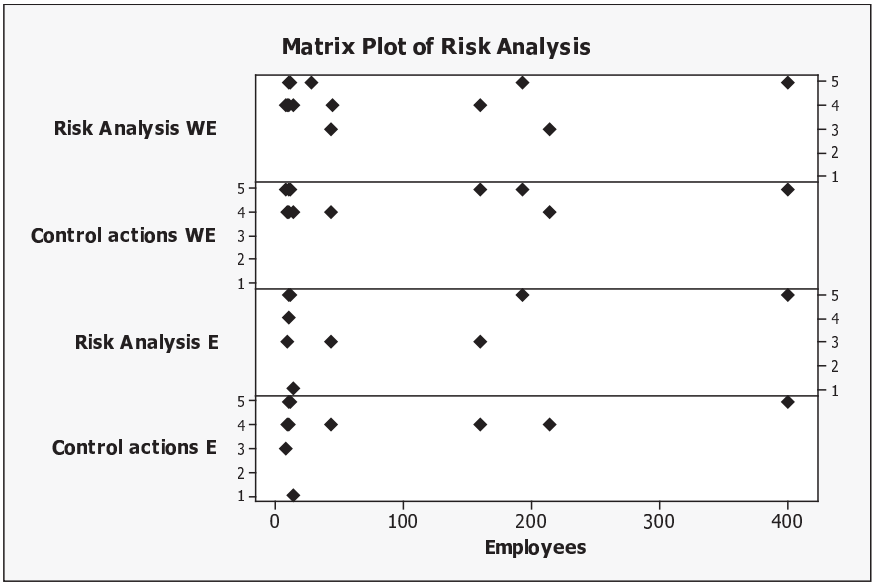


<u>Survey response and dropout result:</u> Mineralogy (N6=17; R6=59 %), Risk (N7=17; R7=59 %), Protection equipment (N17=17; R17=59 %) and Environment (N5=18; R5=62 %).

Figure 17: Mineralogy, Risk, Protection equipment and Environment factor plots versus a) staff size and b) production volume

In table 12 various rock types are reported. Quartz slates, gneisses and quartzites may contain variable amounts of quartz while rock types such as gabbro, diorite and limestone may contain only low amounts or traces of quartz. With reference to table 12, the risk of pneumoconiosis is considered by the respondents but various evaluations of risk levels are made by them, ranging from harmless to high risks.

The respondents were asked to report i) the degree of implementing work environment (WE) and environmental (E) risk analysis and ii) the degree of implementing control actions to reduce the apprehended work environment and environmental risks. The responses are presented in figure 18.



Response scale: 1=Very low degree, 2=low degree, 3=medium degree, 4=high degree and 5=very high degree.

Figure 18: Implementation of work environment (WE) and environmental (E) risk analysis; and control actions

Table 12: Respondent feedback related to the mineralogy and risk factors.

Mineralogy – respondents feedback summary
Questions: Does your products contain quartz, fibre minerals or asbestos minerals? What is the content of these minerals? Variations in deposit rock types reported by the respondents are: quartz schist, phyllitic schists, granodioritic gneisses, gabbro and diorite, gneisses with pegmatite veins and limestones (four respondents). Thirteen respondents reported content of quartz in the deposit or the sidewall and four no content of quartz. The quartz contents vary between 0-89 %. Three respondents reported fibre minerals, nine respondents reported no fibre minerals and one did not know. One respondent reported traces of fibre and asbestos minerals. Dust or particles are considered a work environment problem. One of the respondents reporting quartz in their deposit considers it challenging with respect to compliance with threshold limit values (TLV's). The risk of pneumoconiosis is mentioned by several respondents.
Risk - respondents feedback summary
Question: How does your enterprise implement risk evaluations? Please give a description. Summary: Subsurface mining activities involve inherent risks being different from other industrial activities. Risk evaluation/assessment is considered to be an important work tool being implemented in various work fields as health and safety in the work environment, fire hazard and three respondents mentions the external environment explicitly. Eleven respondents report that they implement risk analysis related to activities and tasks. The methodologies being used vary and so do the regular follow-up frequencies too. Risk analysis is reported to be followed up continuously by some respondents, and may either be implemented on an individual basis or as teamwork. The main status is reported to be followed up annually by three respondents and every third year by one respondent. Industrial groups offer standard templates being used by their daughter enterprises or works. Procedures describing tasks or activities are reported to be derived from risk assessments by three respondents. Basic types of risk analysis technique being reported are the SESAM method (Self Evaluation of Safe Working Methods) being applied on an individual basis and team based methods such as the Job Safety Analysis (SJA), risk and vulnerability analysis (ROS-analysis) and by calculating risk numbers based on frequencies and consequences. Two respondents report using the SESAM method, seven respondents use the SJA method and two respondents use the ROS method.

4.1.6 General framework factors

The rest of the factors can be classified as general framework factors. The score distributions will be discussed but not the respondents' comments. With one exception, the economy factor, most of these factors will not be described in detail.

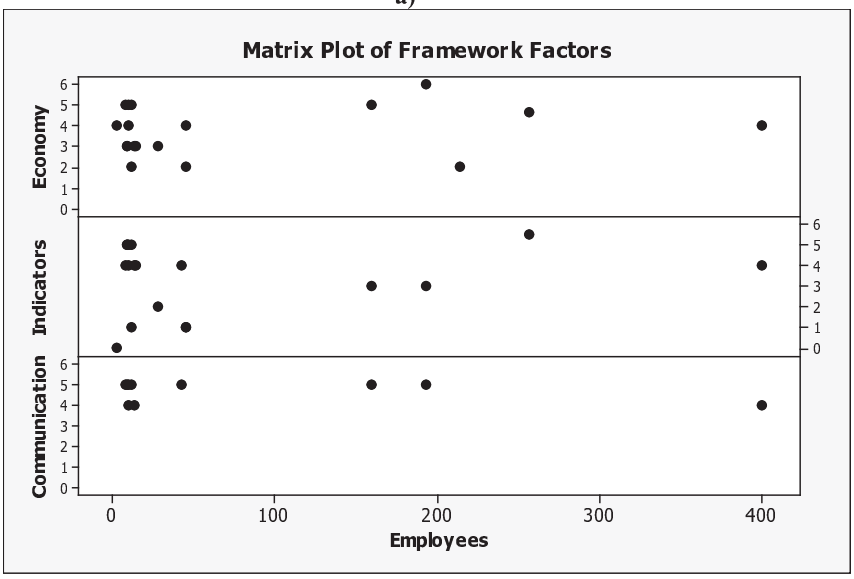
The score responses of the protection equipment and environment factors are presented in figure 17 while score responses to the *economy*, *SHE-indicator* and *communication* factors are presented in figure 19. The comments given by the respondents are referred to in detail in appendix 4.

The general factors are:

- ✓ Protection equipment: The importance is considered to be at high levels (*high*, *very high* and *critical*) by most respondents. Still some respondents consider it to be of *insignificant* importance.
- ✓ Environment: The importance scores are spread over the total score range. Score level does not seem to depend on enterprise size (man-labour years) or production volume.
- ✓ Economy: Scores are 2 or higher, that is *low* importance or higher. No respondents consider this factor insignificant.
- ✓ SHE-indicators: Scores are scattered through the complete score range and all scores are represented.
- ✓ Communication: Due to the fact that the factor was added during the survey, a high dropout rate characterises this factor, especially within the DIMENSIONAL STONES sample. The few responses that were received are found within scores 4-5 that correspond to *high* and *very high* importance.

Protection equipment is considered important by the respondents. Appendix 3D and appendix 4 gives additional information related to the use of personal protection equipment. With respect to the environment factor, environmental issues were emphasised while work environment factors were considered covered by other factors. However comments are related to both work environment and environmental issues. Monitoring of SHE is made by monitoring LTI's, fatal injury rates, sickness absences etc. Comments are presented in appendix 4. The communication factor was unfortunately added during the survey and experienced large dropout rates. All respondents were not asked about this factor. Comments concerning the economy factor are referred to in table 13.

a)



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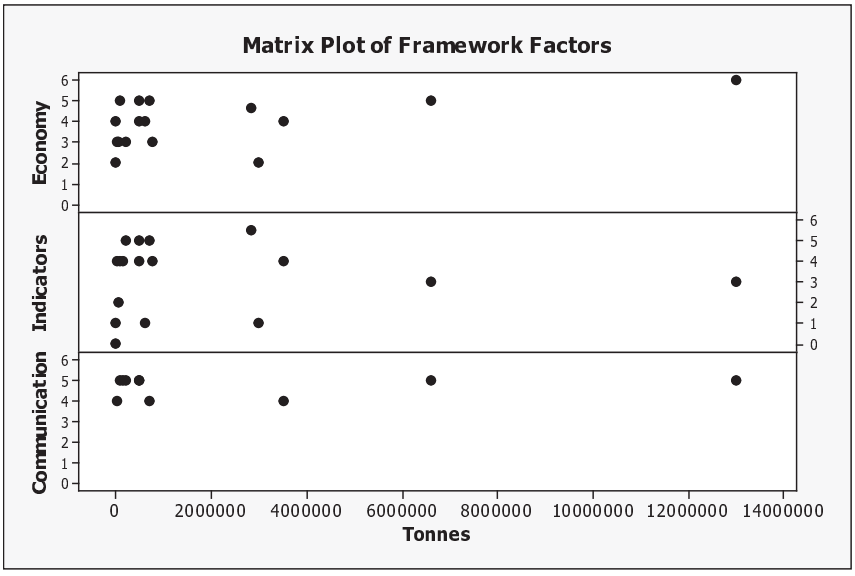

<u>FC-survey response and dropout result:</u> Economy (N4=17; R4=59 %), HSE-indicators (N16=17; R16=59 %), and Communication (N18=10; R18=34 %).

Figure 19: Economy, SHE-indicators and Communication factor plots versus a) staff size and b) production volume

Table 13: Respondents' feedback on economic impacts from legal requirements

Examples of economic impact from legal rules and requirements
Investment needs caused by changes in legal requirements (regulations): i) New explosive storage investment. Costs related to storage container wall thickness, barbed wired fencing surrounding the storage and alarm system. Cost: 10-12 000 €; ii) Lift investment related to scaling in the hanging wall (underground mine). Cost: 240-310 000 €; iii) New discharge permit - requirements to dust emissions and continuous monitoring of dust and gases. Invested in new dust filter/Alarm systems and gas detector investments. Cost: approximately 1 mill. €; iv) Plant rebuilding. Substantiated by increased safety and improved maintenance operations. Cost: 250 000 €; v) Voluntary lift bridge investment due to records of employees strain injuries. Expected pay back from less strain injuries in future. Cost: 50-62 000 €; vi) Emergency preparedness, explosives storage, mining equipment investments, equipment upgrades, ventilation, dust reductions, explosion hazards reductions, mechanical workshop investments and waste handling. Costs: 3.7 mill. €.
The possible conflict between economy and SHE activities – Summary of comments
Three respondents emphasised economy as the main foundation of all business activity, but it includes taking care of SHE issues. Examples of investment needs caused by stricter legal requirements. Conflicts evidently appear, according to remarks given by six respondents. Conflicts can for instance be related to pressed economic situations, choice of control measures etc. One respondent strongly remarked that he had never experienced a "No" to spending money on control measures related to SHE activities, if the measures were thoroughly substantiated, another that economic considerations should not be prioritised at the expense of safety, health and environment.
The potential for reducing cost level by improved quality of SHE activities–summary of comments
Following up SHE costs never gives direct payback. Return of costs may come from avoiding injuries, reduced sickness absence etc. One respondent indicated another dimension of payback, for instance, gains coming from improved operational control, improved dust filter maintenance and the avoidance of external environment pollution events related to investing in a rather expensive monitoring system for gas and dust emissions.

4.2 Framework factors reported by the respondents

The respondents were given the opportunity to present their individual factors of importance to the SHE situation and risks of accidents and occupational illnesses. Factors mentioned are knowledge, resources, personnel, role modeling, employee participation and representatives, communication, corporate requirements, society requirements, vibrations, work environment and climatic conditions.

5. Discussion

In this chapter the quality and the methodological problems of the implemented research design and the framework factor approach will be discussed. The research design and implementation is considered in chapter 5.1, while the framework factors importance related to influences and possible critical influences on the risk of occupational accidents and illnesses are discussed in chapter 5.2.

5.1 The FC-survey – quality, limitations and biases

Research methods are either qualitative or quantitative, and have their individual strengths and weaknesses which should be considered in the design of research program and in the final evaluation of results obtained from the research program. With reference to chapter 1.1 and chapter 3, the research problem was "*Framework factors with Critical Influence on Safety, Health and Environment in the Norwegian Mining Industry*". The emphasis within the safety, health and environment research field was influences on the risk of occupational accidents and illnesses. Research data was collected by a survey collecting responses either through a questionnaire form or a structured interview based on the same questionnaire form, depending on the respondents choice. Here the strengths and weaknesses of the FC-survey are discussed.

Prior to performing the FC-survey, the characteristic feature "critical influence" was connected to the importance of possible framework factors. To maintain the respondent focus on the topics of interest and to avoid dropouts, the extent of questionnaires is recommended to be kept as low as possible (Haraldsen, 1999, Elstad, 2010). In the process of choosing framework factors, see chapter 3.2, the list of factors was kept limited. In total The FC-survey questionnaire form contained about 50 questions. Based on the perspectives of this specific researcher vs. other researchers and scientists and also vs. the industrial representatives responding to the pre-study, the importance and choice of factors can always be argued for or against.

Unfortunately the reduced number of factors influences the detailing level and therefore an increased risk of loosing relevant information about factors, subfactors and their importance. On the other hand the respondents were given the opportunity to list framework factors they apprehended as equally or more important than the listed ones. Five of the respondents (including one subsidiary enterprise response) listed additional framework factors, substantiated their choices and included additional information. The majority of the additional framework factors were closely related to the factors listed in the questionnaire.

Interactions between framework factors represent another research program limitation. In the design of the questionnaire form, possible factor interaction effects were considered to a limited degree. Aspects of interactions covered by the FC-survey were i) legislation and law enforcement practice, ii) legal requirements versus economic impacts and iii) conflicts between SHE and economy. Further research on the influence of conflicting goals and decision-making processes on the risk of accidents and illnesses in small, and medium mining enterprises are recommended. Examples of conflicting goals can be found within corporate requirements to efficiency versus safety. The role of decision-making in the establishing or maintaining of safety boundaries in risk assessments are another aspect.

Other limitations are found within the design of the survey questionnaire. Errors related to interpretation of concepts, questions, response scales and partial dropouts are listed as follows:

- ✓ The framework and framework factors concepts were not thoroughly discussed with the FC-survey respondents. The factor names were assumed to be descriptive. Some of the responses indicate interpretation variations. One definite example is the environment factor where some respondents refer mainly to work environment and others mainly to the environment as a whole. This type of ambiguity should have been avoided. For later surveys, taking better care of key concepts' definitions should be considered an urgent matter.
- ✓ The score scales were not connected to a definite criterion and the responses are made according to the respondents' subjective opinion. Therefore, they are not directly comparable and cannot be used to compare enterprises directly.
- ✓ For some respondents, the response scale concerning framework factor's status (Yes/No) and importance scores from 1-6 caused confusions. Therefore some responses said "No framework factor" but still an importance score was noted. A change of response scale would probably reduce the confusion, for instance using only the score scale 0-6, alternatively 0-5, where 0 corresponds to *Insignificant/not important* and also leaving the *very high* score as the highest one.
- ✓ Survey dropouts and partial dropouts were observed. Probably more intensified respondent follow-ups could have reduced the observed dropout rates. No systematic drop-outs were observed except for, perhaps the more sensitive questions such as the one about conflicts between SHE activities and economy. During interviews, the researcher failed to ask for responses to some questions, usually one or two per interview but not systematically.

Interviews usually reduce the dropout rates and offer the possibilities to make requested issues and response scales clear, but they may introduce other errors not relevant for surveys entirely based on questionnaires. Errors based on interviewer versus respondent interactions are one important example. The interviewers' body language, tone of voice, word emphasis, question rephrasing etc. may influence the responses (Cooper and

Schindler, 2003). In this Survey the interview was made by phone. Thus influences from body language were eliminated. Here the respondents were offered the opportunity to give corrective feedback by e-mail. No such feedback was received.

The choice of stratified sampling was based on the main population merging from three separate industry associations that prior to the FC-survey were apprehended as quite different. In such cases, stratified samples provide more reliable data compared with a sample extracted from the total population (Cooper and Schindler, 2003, Haraldsen, 1999, Løvås, 2004). With reference to observed sample differences in the standard deviations plot described in chapter 4.1.1 and illustrated in figure 12, the choice of implementing a stratified extraction procedure seems reasonable.

Compiling response data always introduces biases of various types. One bias is conflicting responses originating from response scale conflicts. A definite example is referred to above. Other biases originate from recording errors, for instance, recording score 4 instead of 2 from misreading the responses, wrong entries etc. When designing a spreadsheet for handling response data, formula failures etc. may cause additional biases. For the FC-survey a comparison of the influencing factor score entries vs. original response sheets received from the respondents, revealed one or two wrong entries per 5th respondent.

When asking for sensitive information, the responses may reflect what is apprehended as politically correct or socially desirable (Haraldsen, 1999, Elstad, 2010). Here the questions related to economy and also asking for responses concerning a possible conflict between economy and SHE activities can be considered examples of asking for sensitive information. The questionnaire used in the FC-survey was not designed to reveal possible politically correct responses by adding control questions. In future surveys related to sensitive information, this aspect should be considered.

5.2 Framework factors importance – critical factors?

Prior to the research programme, the Norwegian mining industry was considered heterogeneous. Heterogeneity related to staff sizes and production volumes is shown in figure 11, while variations in deposit rock types and partly mineralogy are described in table 12. Other heterogeneities relate to location, enterprise organising, plant design, mineral processing techniques etc. In their study of the social dimensions of Australian mining, Solomon et al. (2008) find that the Australian mining industry is highly diverse in terms of materials, processes, places and social contexts, thus making it difficult to generalise. Similarly one should expect that the enterprises' heterogeneity and also the generalisation of framework factors are reflected in variations in the apprehension of individual framework factor importance among the respondents and probably variations in importance apprehension between the individual mining sectors too. However, the possibility that individual factors are apprehended as equally important by the majority of the respondents is still present.

We may use the inherent framework represented by the factor *mineralogy* to illustrate this problem. First consider the respondents' deposits heterogeneity with respect to mineralogy. With reference to chapter 2.3.1 and chapter 2.4, the risk of health impacts from respirable mineral particles is higher for deposits containing large amounts of quartz compared with deposits containing medium or low amounts. As an example, respondents with a deposit containing mainly limestone and only traces of quartz would hardly agree on the *mineralogy* factor to be of *critical* importance, while respondents with quartzites deposits that are high in quartz content would consider it to be of *critical* importance. Whether the factor importance apprehension is equal among respondents with similar types of deposits, for instance granitic gneisses containing low to medium amounts of quartz as a definite example cannot be answered by this study. However, implementing and maintaining good practice in the management of risks connected to the inherent factors such as harmful minerals, gases, rock strength etc. are strongly recommended. Good practice in relation to managing the inherent hazards will for instance, involve mapping the content of harmful minerals, monitoring exposure to respirable particles, frequent health examinations, monitoring rock strain, performing

permanent rock support measures, initial scaling and bolting of the hanging wall and next controlling and performing supplemental scaling and bolting in underground mines etc. Similar practice is also recommended with regard to gas exposures, chemicals exposures etc.

For the individual framework factors, variations in scores are observed. As described in chapter 3.5 and illustrated in figure 12, to a large degree, the standard deviation will depend on the respondents' agreement in their apprehension of factor importance. Based on the FC-survey results, no framework factors got the average importance score '6' corresponding to *critical* according to the pre-set score scale. However, the *legislation, management, SHE-system, reputation, society acceptance, mineralogy, risk, protection equipment, environment* and *economy* factors are considered *critical* by individual respondents within the three samples.

Variations in average score distributions and standard deviation levels between the samples are observed. With reference to figure 12, the framework factors' importance scores for DIMENSIONAL STONES are differently distributed compared with the MINERALS and AGGREGATES samples, indicating major differences between this trade sector and the two others. Figure 11 shows that the DIMENSIONAL STONES sample is characterised by small production levels that are relatively man intensive compared with the two other sectors. The end products are dimensional stones such as roofing slates, bench plates, tiles of various kinds, headstones for burial places etc. Compared with the two other sectors, the main impression is that the production lines are therefore closely comparable to production lines found in manufacturing enterprises. The typical enterprises comprising the MINERALS and AGGREGATES samples produce bulk products as dry powders or slurries. For some of the MINERALS sample enterprises, the production lines are complex and similar to production lines in the chemical industry, while for other enterprises the production lines are comprised by more simple combinations of processes such as crushing and sieving. Clearly such differences in work environment offer different frameworks with respect to the SHE situation in general and especially the risks of occupational accidents and illnesses.

Generally the DIMENSIONAL STONES sample's importance scores are found at lower levels compared with the two other samples. The factors considered most important (very high and high importance levels) are the *quartz agreement*, *SHE-culture*, *SHE-system* and the *SHE-competence* factors. The factors considered least important are the *neighbours*, *mass media* and *environment* factors. The quartz agreement factor is characterised by the highest score but also the largest dropout rate. Another interesting feature is the low scores in relation to neighbours and mass media and also environmental issues that should be subject to a closer examination to find the causes of differences compared with the two other sectors. Possible explanations are that unlike aggregates and sand production, quarrying as the dominant excavation method is to a much lower degree associated with emissions of particles and probably also emissions of noise and vibrations. Roof slates and headstones are traditional products, some of them considered branded goods, characterised by high reputations. Therefore enterprises that belong to the DIMENSIONAL STONES sample most probably experience higher acceptance levels by the local society, their nearest neighbours and therefore avoid the types of conflicts with their nearest neighbours that are characteristic for aggregate plants. Quarrying involves visual landscape changes independent of the mining sector. In general and independent of belonging to the mining sector, requirements to clearance of mine areas and safeguarding the mine area are given in the Mineral Act and the accompanying regulation (NHD, 2009, NHD, 2010).

The MINERALS and AGGREGATES samples' factor score distributions are basically quite similar, see figure 12. They are both found at considerably higher average score levels compared with the score distribution belonging to the DIMENSIONAL STONES sample. Generally, with one exception, the AGGREGATES sample scores are four to five corresponding to *high* or *very high* importance, while the MINERALS sample's average scores are close to three and five. The standard deviations are found between zero and one, indicating a high degree of agreement among the respondents. The exception with respect to score level for the AGGREGATES sample is the *quartz agreement* factor which is considered to be of medium importance, but as for the

DIMENSIONAL STONE sample, one should consider the large dropout rate in relation to sample size.

With reference to the AGGREGATES sample responses, one should ask whether the high degree of framework factor importance agreement is problematic or not. A high degree of agreement should be considered positive for the general SHE situation and is most probably an indication that SHE is highly emphasised. However, the high degree of factor importance agreement may be an indication of difficulties in prioritising SHE activities or actions, for instance in relation to risks of occupational accidents and illnesses versus more general SHE issues. With reference to figure 11, most of the AGGREGATES sample enterprises employ about 10 man-labour years. Small organisations must cover relatively wider ranges of requirements, competencies and problems of immediate concern compared with larger organisations. These matters will be discussed later.

The Social Dialogue Agreement on Respirable Crystalline Silica (quartz agreement) was intentionally signed by European business sector organisations to avoid stricter TLV's regarding exposure to respirable crystalline quartz particles. This agreement together with certification schemes, standards, sustainability reporting etc. represents the emergence of new regulation forms (Solomon et al. 2008). Probably alternative regulation forms will grow in importance in future. When the FC-survey was performed, the agreement was quite new and not very well known by the FC-survey respondents. A central point of the agreement is the implementation of 'good practice' in the handling of materials containing respirable crystalline quartz. Here the importance of this agreement should not be linked to whether stricter TLV's are implemented or not, but instead the influence of 'good practice' in reducing the risk of health impacts from exposure to respirable, crystalline quartz particles compared with the previous situation. However, the annual reporting requirements may represent an additional 'burden' and a factor of moving focus from activities related to reducing the risk of health impacts and general safety activities for the enterprises.

Initially, the heterogeneity with regard to production volumes and staff sizes of the Norwegian mining industry was mentioned. Both production volume and staff size variations are considerable, see figure 11. In the figures 14-17 and figure 19, the scores per factor for all samples are plotted as a function of staff size in man-labour years and production volume in tons. The staff size and production volume generally seem to be indicators of observed variations in scores per factor. In general, and with the *SHE-culture* and *Communication* factors as exceptions, a considerable spread in importance scores for the enterprises with less than about 50 man-labour years and production volumes less than one million tons is observed. The spread indicates a general disagreement with respect to framework factor importance. Enterprises with staff sizes above 50 man-labour years and production volumes above one million tonnes agree on a high or very high importance level for the *legislation*, *business sector rules*, *quartz agreement*, *SHE-competence*, *SHE-culture*, *mineralogy, risk* and *protection equipment* factors, and partly for the *SHE-management* and *SHE-system* factors. On the other hand, more disagreement regarding the importance of the *neighbours*, *mass media*, *reputation*, *society acceptance*, *environment*, *economy*, *SHE-indicators* factors is observed for the same enterprises.

What are then the causes of the observed variations in framework factor importance apprehensions related to enterprise size and production volume? Initially the heterogeneity of the mining industry was indicated as one plausible cause. The staff sizes of the MINING INDUSTRYsample[21] vary from three employees up to 400 for the largest enterprise. Unfortunately the enterprises were not asked about their organising of SHE responsibilities, but one should expect differences related to enterprise staff size, and also due to the positions of those responding. Within the small enterprises the respondents are middle managers or chief executive officers (CEO's), in the medium sized enterprises safety officers, middle managers or CEO's, and in the large enterprises safety officers. The observed similarities between framework factors importance levels versus staff size and production volumes may indicate that production volume is a function of staff size where large production volumes require large staff sizes. This may

[21] The MINING INDUSTRY sample is comprised by the MINERALS, DIMENSIONAL STONES and AGGREGATES subsamples.

to some degree be true within the individual samples being examined but it is not necessarily true across the complete industry. Figure 11 is based on reported production volume versus staff size data. It shows no correlation between production volume and staff size. However the organisation of staff, staff responsibilities and SHE activities versus enterprise size would be interesting with respect to research follow-ups.

Research studies concerning managerial or organisational causal relations to occupational accidents and illnesses indicate that management will focus on matters of immediate concern. Rasmussen (1997) emphasises economic pressure as a particularly important matter of concern. Other matters of concern can be found within the general framework or the SHE framework, for instance post-accident activities such as dealing with the regulatory authorities, accident investigations etc. In such cases the risk of paying less managerial and organisational attention to regular, systematic safety activities than actually needed, is therefore present. Violations of safety defence mechanisms are probably more frequently observed in such situations due to lack of managerial follow-ups. Accident investigations show that accidents are frequently caused by several events or violations which occur in coincidental manners not foreseen (Wagenaar and Groeneweg, 1987).

From being a practitioner within the mining industry, experience sometimes confirms the Norwegian saying "An accident rarely comes alone". Although not statistically proven, it seems not unusual that an accident is followed by a new accident or a series of accidents. In the context of focusing on the most pressing tasks or problems, the cause is probably less managerial and organisational attention to the daily safety routines. With this as a background the further discussion is related to the two Svea North accidents referred to in table 1. First the fatal injury which happened in July 3rd 2005 and next, the mine fire that occured on July 30th 2005. The fire was connected to a maintenance operation involving hot work (pipeline welding work). It resulted in a temporary closure of the mine for about eight months. Did the organisational activities related to the proceeding fatal accident investigation move management and organisational focus away from the daily safety activities in preference of issues related to the fatal accident? In principle this question should be considered relevant. An actual

shift of focus away from the daily safety activities would violate a principle of being 'mindful'. Weick and Sutcliffe (2007) refer to mindfulness as the quality of attention and an awareness that unexpected events may unfold unexpectedly, while Hollnagel, Woods and Leveson (2006) focuses on how to help people cope with the complexity under pressure to achieve success in safety activities. Resilience in this respect involves a deep knowledge of the technology, the system, the co-workers and most of all oneself at the various organisational levels involved. In order to maintain resilience and the possibility of recovery from a pressured situation like the two events being referred to, the general framework must offer available resources to deal with both the pressured situation that involve accident investigations etc. and the total SHE situation in order to keep the risk of future accidents or events that may lead to such accidents under control. In crisis situations, the organisation of HRO may change spontaneously to deal with the crisis or high work loads aroused from crisis (LaPorte and Consilini, 1991). To what extent mining organisations are able to reconfigure responsibilities and tasks in such situations was not examined here, but would be an interesting aspect of future research.

The accident and the subsequent mine fire and the question of whether the two incidents are linked is relevant to any other accident or series of accidents that may happen. In order to find the underlying causes of the accidents, accident investigations according to the procedure referred to by Jørgensen (2011) or others, are recommended. Positive effects from applying this systematic investigation tool are improved understanding of accident causes, improved risk perception and accident prevention (Jørgensen, 2011).

Without disregarding the heterogeneity of the enterprises involved, one should expect that a continuously changing focus on matters of immediate concern will occur more prominently in the small and medium sized enterprises and will therefore be a greater threat to the ability of keeping the risk of occupational accidents and illnesses in small and medium sized enterprises under control. Hypothetically this situation would be due to differences in the resource situation and therefore a major framework difference related to enterprise size. Compared with the large enterprises, the small and medium enterprises usually possess relatively less organisational or staff resources to handle the operational activities, maintenance, safety activities, environmental activities, redesign

and rebuilding of process lines etc. Therefore the risk of losing track of important safety issues is probably larger for managers in the small and medium sized enterprises. The small and medium sized enterprises also possess less specialist competencies compared with the larger enterprises and both technical and operational management needs to be involved in a wider sense, related to the pool of tasks available. However, the small organisations are more transparent, their production processes are usually simpler etc. Hence keeping an overview of risks related to occupational accidents and illnesses is easier and would counteract other contributions to increased risk of accidents.

The significance of the resource framework in relation to enterprise staff size and the risk of occupational accidents and illnesses should be examined further. Due to a belief that production volumes are more related to technical solutions, a similar coherence between resources and production volumes is not considered here, although it is not completely excluded. Of course increased production volumes may improve the overall financial resources and therefore the possibilities of investing in safety measures.

With reference to figure 13, the *legislation*, *SHE-management*, *SHE-system*, *SHE-competence*, *SHE-culture*, *risk* and *communication* factors are considered to be the most important framework factors by the Norwegian mining industry and therefore possible critical factors. The respondents' commentary feedback presented in table 10 enhances the role of enterprise management in safety activities and their commitment to safety in particular. The apprehended importance of legislation and especially the management and organisational factors' importance is coherent with the scientific research reports, see table 6 and table 7.

"*Accidents are the consequences of highly complex coincidences. Among the multitude of contributing factors human errors play a dominant role*" (Wagenaar and Groeneweg 1987:587). In this context, common conclusions of accident investigations are that the accident was the victim's own fault (Jørgensen, 2011). Perrow (1999) refer to similar experiences in relation to definite mining accidents. Wagenaar and Groeneweg (1987) characterise human errors as the error category which is most simply controlled and also

the option that will be most successful. Therefore behavioural control is commonly implemented as a measure to control risk of occupational accidents and illnesses. Human errors are closely connected to rules. Legal and corporate rules are usually made to deal with specified situations. Generalising and adapting existing rules to apparently similar situations may introduce the danger of actually increasing the hazard in specific situations or under specific circumstances. In such cases, following the rules may actually cause an accident while violation of the existing rule may actually prevent an accident. In other situations, non-intentional or 'good intentions' of efficiency or other causes may cause deviations from the existing rules (Alper and Karsh, 2009, Lawton, 1998). Therefore rules or procedures are seldom followed to the letter, perhaps except in specific situations related to very high risks within HRO environments, and one will always find a rule or several rules being compromised (Rasmussen, 1997). Alper and Karsh (2009) refer to rule violations as a symptom of system design problems. A too high focus on rule compliance and behavioural control may take its place at the expense of developing increased safety perception, improved safety culture, general health and safety improvements, environmental improvements etc. within the organisation, and is therefore not recommended. Improving the present safety culture is more complicated compared with implementing behaviour control of individual persons. In this context the choice of measure will depend on the managements' main philosophy and approach to the safety management. The efficiency of allocating resources to rule compliance and behavioural control instead of safety culture improvement, safety commitment and commitment to resilience should always be carefully considered and evaluated.

Although recognising the importance of the legislation factor and emphasising the importance of compliance to legal rules (legal framework) and trade sector/corporate rules, the respondents are critical to the complexity of the legal framework and the equality in law enforcement practice allocated by the local regulatory authorities in particular. New regulations that simplify the legal framework related to the SHE situation are made effective from January 1st 2013. Hopefully the enterprises will experience the change as an improvement of the present legal framework. However, the paradigm shift introduced to the legal framework in the 1990's involving a change from prescriptive rules to descriptive rules in term of responsibilities, introduces challenges

for the organisations both with regard to interpreting the legal rules within the definite enterprise context and with regard to compliance. Compliance to legal rules, environmental requirements etc. will require a wider competency level, and represent a challenge for the enterprises and especially for the small and medium sized enterprises.

As previously described concerning dealing with 'issues of immediate concern', another aspect of management is the handling of conflicting goals as described in chapter 2.7.5 and decision-making. Emphasis should be allocated to organisational decision-making processes and means of communication, and especially an emphasis on the relation of the conflicting goals and decision-making processes to an increased risk of occupational accidents and illnesses. This is because, one single decision is seldom the cause of a major or large accident, while decisions made by several parties at various levels and locations involved, may increase the probability of an accident (Rasmussen, 1997). Decision making processes are usually more complicated to follow in large organisations, the risk of fragmented decision-making increases, and therefore the risk of accidents and illnesses also may increase with the organisation's size and the number of parties involved in decision-making.

The mining enterprises' management and organisations will always face the risk of occupational accidents and illnesses. As previously mentioned, the causes of accidents, although released by human actions, are frequently found to be related to managerial and organisational issues. Hence, focusing too intensively on behavioural control is not recommended. Instead behavioural shaping mechanisms should be considered (Rasmussen, 1997). Management commitment to safety is here considered to be very important and critical. The positive impact of increased management commitment on safety culture is demonstrated by Devine et al. (2008) and a study of Weyman, Clarke and Cox (2003). With reference to table 10 and appendix 4, some of the respondents express that their safety culture is fairly good. This view may be the basis of complacency and a comforting feeling of dealing with the situation in an appropriate way. Weick and Sutcliffe (2008) warn against complacency, and especially in relation to long accident free periods.

Regarding behavioural shaping mechanisms, theories and models related to decision research, management and organisational theories, occupational safety research and major accident research should be known by practitioners and researchers within the SHE specialised field. These models represent valuable contributions in the understanding of human factors in order to keep occupational accidents and illnesses under control, and therefore a basis for further development and research within safety management. Due to limitations in model boundaries, the implementation of theoretical models into practice can be challenging and difficult.

In table 10 related to the *SHE-competence* factor, one of the respondents states that inexperienced personnel suffer from more frequent injuries than experienced personnel. A study by Groves, Kecojevic and Komljenovic (2007) supports this and indicates elevated risk of injuries for young people with work experience less than five years, but also an elevated risk of fatalities for workers older than 55 years. This may very well be true, but not necessarily. High reliable organisations with large turnovers such as the aircraft carriers that continuously train personnel do experience errors and deviations, but the consequences are usually bearable, and they do not necessarily experience higher accident frequencies due to inexperience (La Porte and Consilini 1991; Rochlin, La Porte and Roberts 1998:77). This is a contradiction in relation to postulating a hypothesis that inexperience is an important cause of occupational accidents and illnesses but also an incentive to do more research on the subject. Means to reduce the effect of inexperience as transferred from HRO theories are the presence of personnel with overlapping responsibilities, physical conditions for interactions and an organisational culture that encourages inexperienced people to seek advice (Rosness et al. 2009).

The present legal framework related to SHE emphasizes hazard surveillance, risk analysis and risk assessments (DAT, 1998, DAT, 2007) . Risk assessments are generally part of mining industry discharge permits. The FC-survey responses indicate a high to very high degree of risk analysis and subsequent control actions implementation in relation to work environment and lower performance in relation to environmental issues. Various methods were reported in the comments. The fatal and nonfatal injuries

generally show decreasing trends, see figure 1 and figure 3 respectively. However the effectiveness of risk analysis and risk assessments in the mining industry was not documented here, and should be subject to further research. Here, employees' participation in risk assessment programs is anyhow considered to be positive with respect to risk perception, in behaviour shaping and organisational commitment to safety.

Emphasis will be placed on management commitment in combination with implementing the PDSA cycle in the safety management as the primary general measure in improving the general safety activities and in reducing the risk of occupational accidents and illnesses in the mining industry. The PDSA cycle is based on three questions: "*1. What are we trying to accomplish? ...2. How will we know that a change is an improvement? ...3) What changes can we make that will result in improvement? ...*" (Langly, Nolan and Nolan 1994:81-82). In order to succeed in implementing the PDSA cycle, the objectives in relation to question 1) must be established in combination with 'a plan' for carrying out the scheme. Next, in the 'do' sequence plans are carried out, experiences and problems are documented and analysis are prepared. In the following 'study' sequence, the analyses of data is completed and compared with predictions and finally a summary of what is learned. The cycle is fulfilled by deciding what changes are to be made and whether the cycle should be repeated. In this context the safety element method (SEM) represents a method of monitoring progress related to the SHE situation (Alteren, 1999). Implementation of this method is possible for all sizes of enterprises. The experiences reported during the research project were positive and deal with central issues such as management commitment, safety culture changes, safety perceptions, learning and extending competencies related to safety and safety management (Alteren, 1999). An important aspect of management commitment in creating a 'good' safety culture is that it will never end. A continuous commitment and pressure is required to counteract or compensate the functional pressures of the work environment.

Ideally, a motion towards improvements would be expected as an outcome by using the PDSA cycle. However setbacks may appear and should be expected too. They would be caused by deficiencies in following the full cycle, not asking the correct questions in the planning phase, deficiencies in the theoretical background etc.

6. Concluding remarks

This chapter presents the final outcome from the research programme made in relation to the definition of framework factors and critical framework factors in terms of conclusions and recommendations.

6.1 Conclusions

The following conclusions concerning factor importance in relation to risk of occupational accidents, illnesses and the SHE situation in general can be made from this thesis:

- ✓ In comparison with other Norwegian business sectors, public statistics show higher levels of fatal and non-fatal injuries in the mining industry. From 2000 both fatal and non-fatal injuries show decreasing trends, see figure 1 and figure 3. However the Norwegian level is also high compared with examples of corresponding levels in international mining industry.
- ✓ In literature, accident investigations show that accidents are the consequences of highly complex coincidences. Although human errors play a dominant role, these errors can be connected to insufficient risk perceptions, confidence in

dealing with the hazards or risks, good intentions regarding efficiency or completing the work and seldom deliberate risk taking. Underlying causes are found in work system deficiencies, organisational factors such as focus on matters of immediate concern, work situation goal conflicts and in decision-making processes.

- ✓ Experiences from high reliability organisations show that they are not error free, but the errors are usually bearable.
- ✓ In safety management research, the management's commitment to safety is considered important in creating a good safety culture for keeping occupational accidents and illnesses under control. A continuous managerial pressure is necessary to maintain a good safety culture.
- ✓ Based on survey results, no framework factor got the average importance score 6 corresponding to *critical*, see table 11, figure 12 and 13.
- ✓ Individual responses characterise the *legislation, management, SHE-system, Reputation, Society acceptance, Mineralogy, Risk, Protection equipment, environment* and *economy* factors' importance as *critical*.
- ✓ The DIMENSIONAL STONES sample distinctly separate from the MINERALS and AGGREGATES samples. With one exception, the importance scores are generally at lower levels compared with the two other samples. The importance of the *quartz agreement* factor, as the one exception, is considered *very high*.
- ✓ Although producing quite similar framework factor score distributions, the AGGREGATES sample differs from the MINERALS sample. With one exception, the AGGREGATES sample generally considers all factors to be of *very high* importance. The exception is the *quartz agreement* factor which is considered to be of *medium* importance.
- ✓ A large disagreement with respect to framework factor importance are generally observed for enterprises with sizes less than 50 man-labour years and production volumes less than 1 million tonnes.
- ✓ An agreement on importance for the *legislation*, *business sector rules*, *quartz agreement*, *SHE-system*, *SHE-competence*, *SHE-culture*, *risk*, *protection equipment* factors are observed for enterprises with sizes above 50 man-labour years and production volumes above 1 million tonnes.

- ✓ A disagreement on importance for the *SHE-management*, *neighbours*, *mass media*, *reputation*, *society acceptance*, *environment*, *economy*, *SHE-indicators* factors are observed for enterprises with sizes above 50 man-labour years and production volumes above 1 million tonnes.
- ✓ The *legislation*, *SHE-management*, *SHE-system*, *SHE-competence*, *SHE-culture*, *risk* and *communication* factors are considered to be the most important framework factors by the Norwegian mining industry and therefore possible critical factors. The respondents' commentary feedback enhances the role of enterprise management in safety activities and their commitment to safety in particular.
- ✓ Compliance to legal, business sector rules, corporate instructions are emphasised by the respondents.
- ✓ The respondents are critical to the complexity of the legal framework and the equality in law enforcement practice by the local regulatory authorities in particular.
- ✓ The respondents consider their safety culture to be of high standard.
- ✓ The mining environment (underground mines, quarries, mineral processing plants etc.) is characterised by inherent framework factors such as deposit mineralogy and content of minerals that can be harmful to human health. Other inherent hazards are connected to deposit features such as rock strain, faults and weakness zones, gases etc.
- ✓ Various risk analysis and risk assessment techniques are implemented to a high degree in relation to the work environment and to a lower degree in relation to environmental issues.

6.2 Recommendations to SHE practitioners

Most of the Norwegian enterprises are small and medium sized enterprises. To keep the risk of occupational accidents and illnesses under control, the following recommendations are stressed with respect to the Norwegian mining enterprises:

- ✓ Practitioners in SHE specialised fields of Norwegian mining are recommended to implement the PDSA cycle (Demings' circle) in their safety improvement work. The PDSA cycle together with a practical approach according to the safety element method (SEM) as part of the safety management are recommended. Further research on the effects of this approach is recommended.
- ✓ Accident investigation routines are recommended to be implemented in order to enhance organisational risk perception and safety commitment at all levels of the organisations.
- ✓ Maintaining good practice in the management of inherent mining hazards such as monitoring exposure to harmful minerals, rock strains, concentrations of gases etc. are recommended to keep the risk of occupational illnesses under control as part of the improvement work.

6.3 Recommendations to further research

Most of the Norwegian mining enterprises are small and medium sized enterprises. In this context, further research on framework factors will contribute with new knowledge regarding their influences on risks of occupational accidents and illnesses. With an objective of reducing the risk of occupational accidents and illnesses in the Norwegian mining industry, the following recommendations are stressed with regard to further research:

- ✓ Examine the interacting effects of enterprise size, resources, goal conflicts, decision-making processes and management commitment to safety versus safety culture and behaviour shaping mechanisms.
- ✓ A requirement of assessing risks is a central part of the legal SHE framework. Further research related to status concerning implementation of risk assessments; choice of risk acceptance criteria and criteria for decision and the efficiency of the previously mentioned requirement is recommended.

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Appendix 1

Framework factors in the mining industry

Figure A1-A presents the selected framework factors being examined in the FC survey. Details concerning the individual factors and describing keywords are presented in figure A1-B Rule associated factors, figure A1-C Organisational factors, figure A1-C Exteral factors, figure A1-D Inherent factors and figure A1-E General factors.

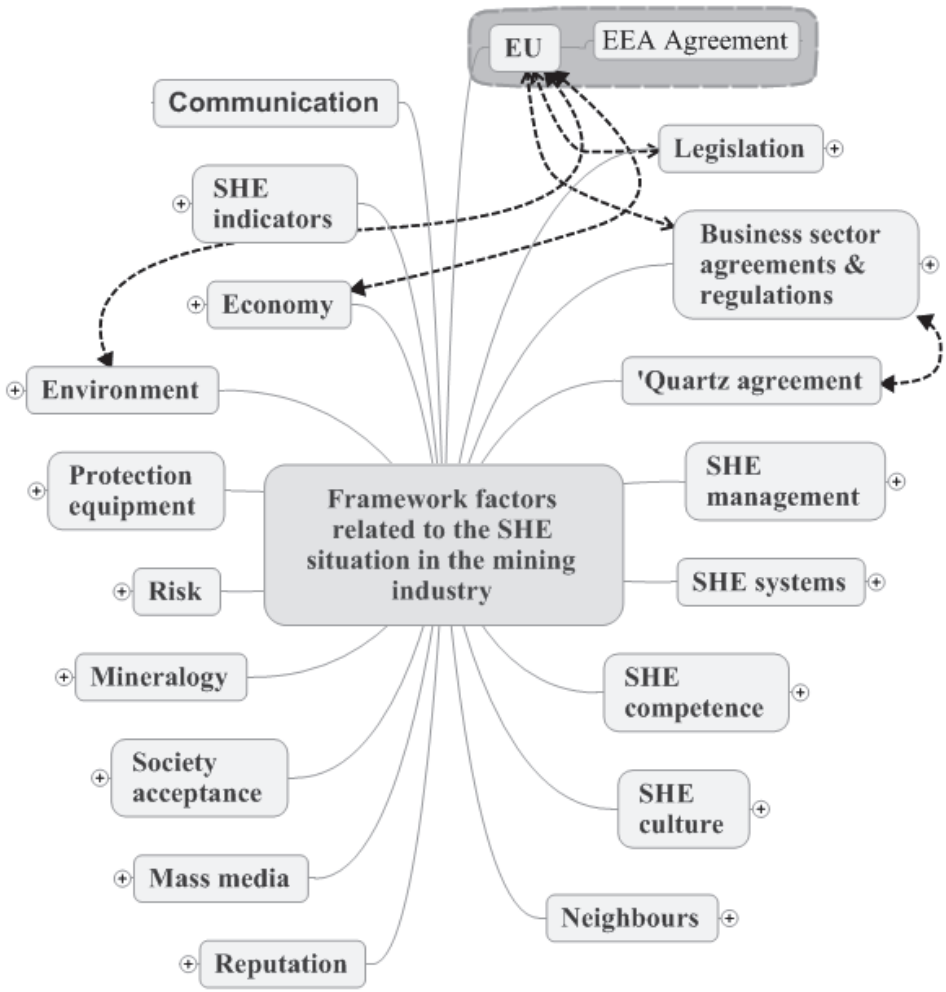

Figure A1-A: Framework factors related to the safety, health and environment in the mining industry - main factors.

Appendix 1

Framework factors in the mining industry

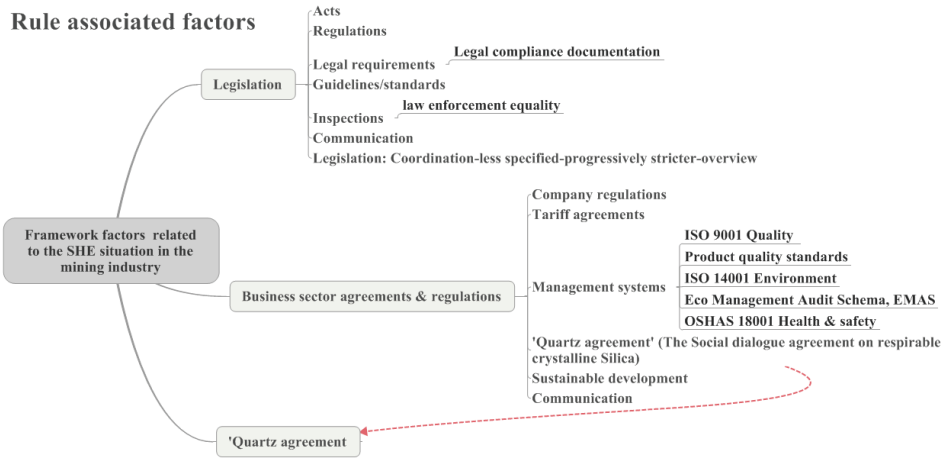

Figure A1-B: Framework factors related to the safety, health and environment in the mining industry – rule associated factors.

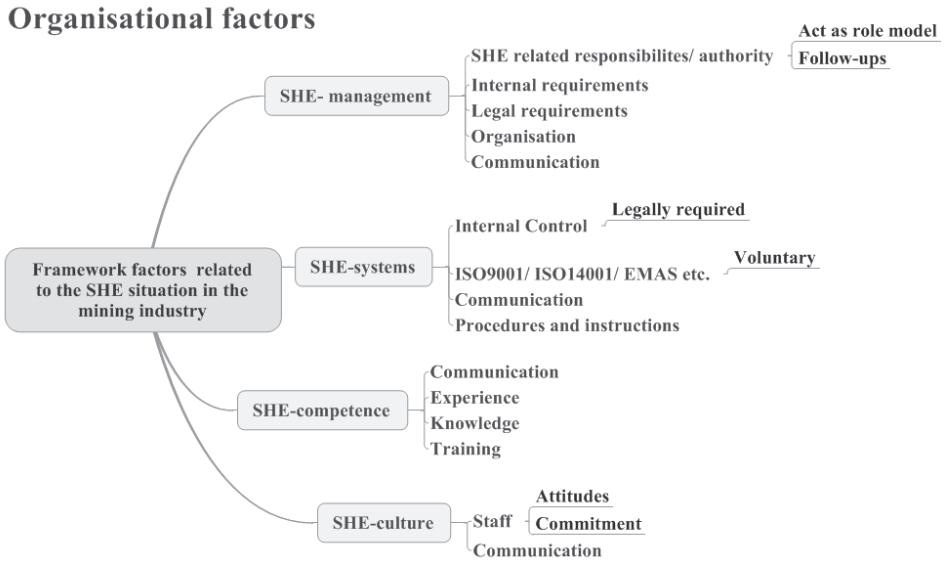

Figure A1-C: Framework factors related to the safety, health and environment in the mining industry – organisational factors.

Appendix 1

Framework factors in the mining industry

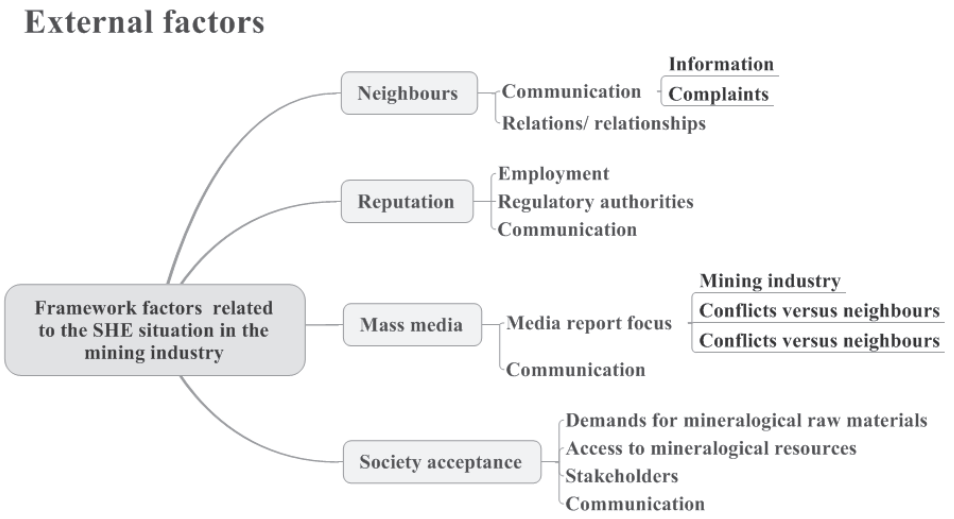

Figure A1-D: Framework factors related to the safety, health and environment in the mining industry – external factors.

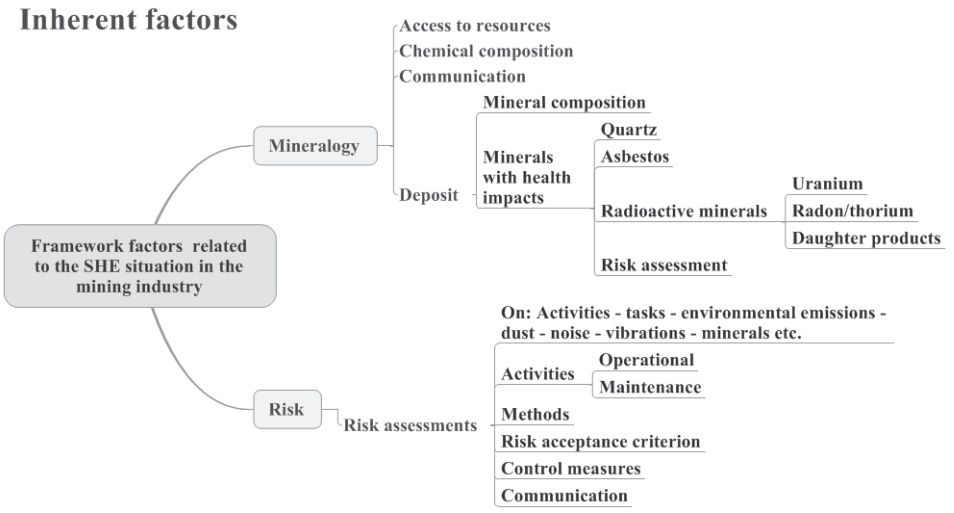

Figure A1-E: Framework factors related to the safety, health and environment in the mining industry – inherent factors.

Appendix 1

Framework factors in the mining industry

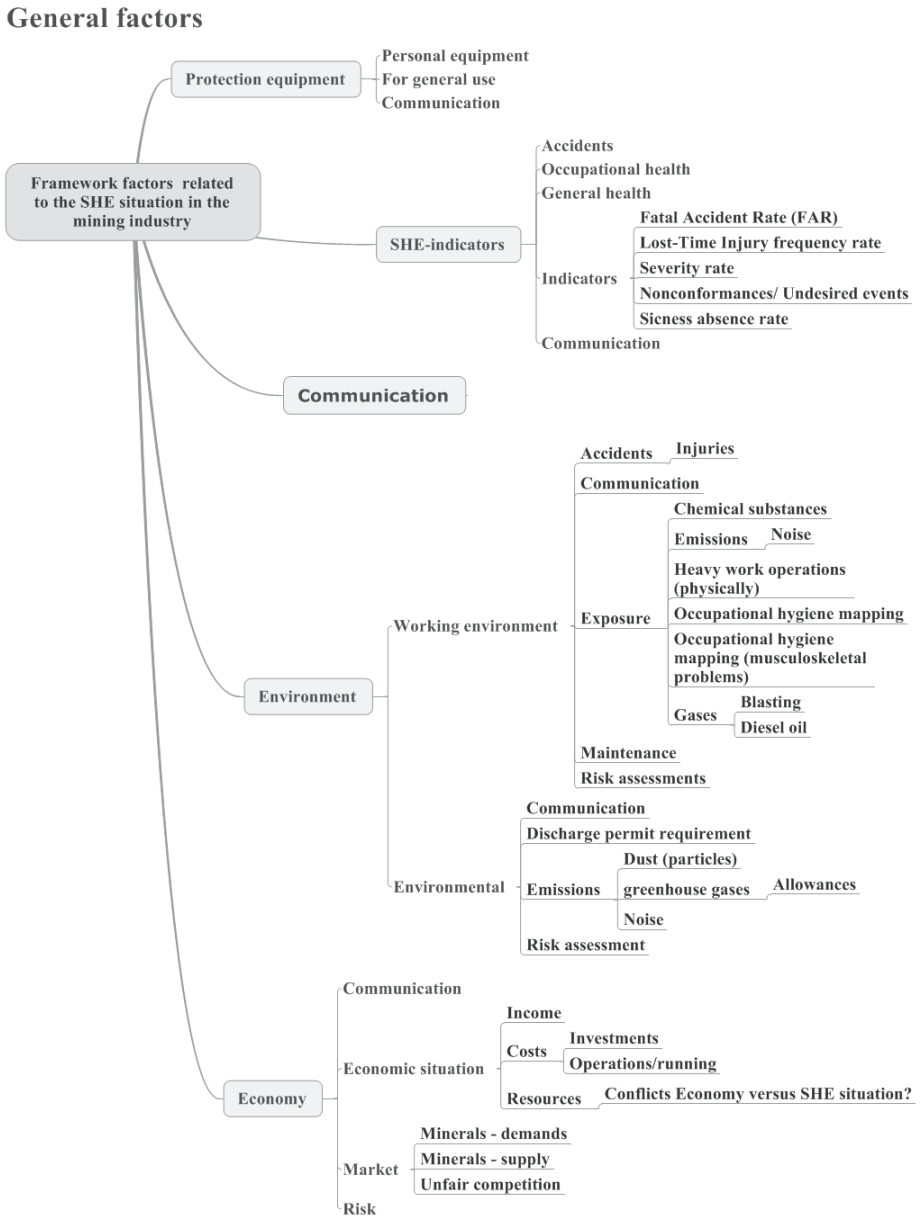

Figure A1-F: Framework factors related to the safety, health and environment in the mining industry – general factors.

Appendix 2

FC-survey samples

MINERALS (Extracted from The Association of Norwegian Mines, BIL)

Brønnøy kalk AS
Elkem Tana[2)]
Hustadkalk[1)]
Franzefoss Miljøkalk AS, (konsernet/NorFraKalk)
Naas kalksteinsbrudd[3)]
Norbar Minerals[2)]
Norcem Brevik
North Cape Minerals (konsernet)
Norwegian Talc Altermark
Scancem International[1)]
Store Norske Spitsbergen Grubekompani
Verdalskalk AS

DIMENSIONAL STONES (Extracted from The Federation of Norwegian Stone Industry, SIL)

Jogra Industrier[3)]
Koloritt marmorbrudd
Liskifer
Minera Norge AS
Oppdal Sten
Palmer Gotheim skiferbrudd
Snåsaskifer[3)]

AGGREGATES (Extracted from The Norwegian Aggregates Producers Association, PGL)

Etne sand og pukk[3)]
Franzefoss Pukk (Vinterbro)
Hanset Sand[3)]
Jarle Nordby[3)]
Lauvåsen Pukk AS[2)]
Lier grustak[3)]
Maskinservice AS[3)]
Mona Sand & Singel
Norstone (konsernet)
Ramlo sandtak[3)]
Skolt pukkverk
TT Anlegg AS[3)]

MINERAL PRODUCTION

All the enterprises belonging to the MINERALS, DIMENSIONAL STONES and AGGREGATES samples.

[1)] *Removed by screening* [2)] Replaced enterprises removed by screening [3)] Not responded

FC-survey: Production volumes and employees

Table 3A: FC-survey statistical data. Production volume in tonnes versus enterprise staff size (employees) in man labour years

Sample		Production volume in tonnes					Standard	Dropout
		Total	Average	Median	Maximum	Mininmum	deviation	rate in %
MINERALS	Tons	24 107 000	2 678 556	750 000	13 000 000	25 000	4 554 872	10.0
	Man-labour years	1 021	113	45	400	9	150	10.0
	Productivity	23 611	23 611	16 667	32 500	2 778		
DIMENSIONAL	Tons	69 000	23 000	3 500	65 000	500	36 404	57.1
STONES	Man-labour years	266	53	12	214	3	90	28.6
	Productivity	259	432	292	304	167		
AGGREGATES	Tons	8 400 000	1 680 000	500 000	6 600 000	500 000	2 758 985	58.3
	Man-labour years	200	40	10	160	10	67	58.3
	Productivity	42 000	42 000	50 000	41 250	50 000		
MINING	Tons	32 576 000	1 916 235	500 000	13 000 000	500	500 000	41.4
INDUSTRY	Man-labour years	1 487	78	15	400	3	15	34.5
	Productivity	21 907	24 485	33 333	32 500	167		

Framework factor responses

Questions - statements	Score	MINERALS			N= 10						
		FC15	FC18	FC21	FCA	FC22	FC24	FC30	FC33	FC34	FC36
Production volume [Tonnes]		750 000	620 000	3 000 000	2 830 000	25 000	220 000	13 000 000	3 500 000	162 000	D
Employees [Man-labour years]		15	45	45	257	14	9	193	400	43	D
Framework factors:											
Legislation	0-6	4	6	5	5	5	5	6	4	5	D
BusinessSectorRules	0-6	5	0	P	5	5	5	5	5	5	D
QuartzAgreement	0-6	P	P	P	P	0	4	5	5	V	D
Management	0-6	6	P	3	4	4	5	5	5	5	D
SHE-system	0-6	6	4	5	5	4	5	5	5	5	D
Competence	0-6	4	2	5	6	5	5	5	5	5	D
SHE-Culture	0-6	4	4	4	6	5	5	5	4	5	D
Neighbours	0-6	3	3	P	3	0	5	5	4	5	D
MassMedia	0-6	V	3	V	0	2	5	4	3	2	D
Reputation	0-6	V	5	3	2	3	6	4	4	4	D
Society acceptance	0-6	3	5	3	3	3	6	5	4	4	D
Mineralogy	0-6	5	1	0	4	4	3	6	4	V	D
Risks	0-6	5	4	5	5	5	5	5	6	5	D
Economy	0-6	3	4	2	5	3	3	6	4	P	D
Environment	0-6	4	5	4	4	1	5	5	6	5	D
SHE-indicators	0-6	4	1	1	6	4	5	3	4	4	D
ProtectionEquipment	0-6	5	0	P	6	5	6	5	4	5	D
Communication	0-6	P	P	P	P	4	5	5	4	5	D

Key to symbols and importance scores:

V=Don't know
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5=Very large
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6=Critical

Framework factor responses

Questions - statements	Score	DIMENSIONAL STONES				N= 7			AGGREGATES			
		FC10	FC11	FC12	FC13	FC28	FC37	FC42	FC25	FC26	FC27	FC29
Production volume [Tonnes]		65 000	3 500	P	500	P	D	D	500 000	100 000	500 000	700 000
Employees [Man-labour years]		28	12	9	3	214	D	D	12	8	10	10
Framework factors:												
Legislation	0-6	4	6	2	0	5	D	D	5	5	5	5
BusinessSectorRules	0-6	0	0	2	3	4	D	D	5	4	5	5
QuartzAgreement	0-6	P	P	P	P	5	D	D	5	V	P	0
Management	0-6	3	1	5	0	3	D	D	5	5	5	4
SHE-system	0-6	5	P	5	0	4	D	D	5	V	5	5
Competence	0-6	5	4	5	0	P	D	D	5	5	4	4
SHE-Culture	0-6	5	5	4	0	4	D	D	5	5	4	4
Neighbours	0-6	0	0	0	0	0	D	D	5	5	5	4
MassMedia	0-6	0	0	3	0	0	D	D	P	5	5	3
Reputation	0-6	5	6	1	0	P	D	D	5	5	5	4
Society acceptance	0-6	5	6	1	0	P	D	D	5	P	4	5
Mineralogy	0-6	4	1	2	0	P	D	D	P	5	5	4
Risks	0-6	4	1	2	0	P	D	D	5	5	5	4
Economy	0-6	3	2	3	4	2	D	D	5	5	4	5
Environment	0-6	3	0	0	0	2	D	D	5	4	4	4
SHE-indicators	0-6	2	1	5	0	P	D	D	5	4	4	5
ProtectionEquipment	0-6	5	0	3	0	P	D	D	5	5	5	5
Communication	0-6	P	P	P	P	P	D	D	5	5	5	4

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Framework factor responses

Questions - statements	Score	N= 12							
		FC32	FC35	FC38	FC39	FC40	FC41	FC43	FC44
Production volume [Tonnes]		6 600 000	D	D	D	D	D	D	D
Employees [Man-labour years]		160	D	D	D	D	D	D	D
Framework factors:									
Legislation	0-6	4	D	D	D	D	D	D	D
BusinessSectorRules	0-6	4	D	D	D	D	D	D	D
QuartzAgreement	0-6	4	D	D	D	D	D	D	D
Management	0-6	5	D	D	D	D	D	D	D
SHE-system	0-6	3	D	D	D	D	D	D	D
Competence	0-6	5	D	D	D	D	D	D	D
SHE-Culture	0-6	5	D	D	D	D	D	D	D
Neighbours	0-6	4	D	D	D	D	D	D	D
MassMedia	0-6	3	D	D	D	D	D	D	D
Reputation	0-6	4	D	D	D	D	D	D	D
Society acceptance	0-6	4	D	D	D	D	D	D	D
Mineralogy	0-6	4	D	D	D	D	D	D	D
Risks	0-6	6	D	D	D	D	D	D	D
Economy	0-6	5	D	D	D	D	D	D	D
Environment	0-6	4	D	D	D	D	D	D	D
SHE-indicators	0-6	3	D	D	D	D	D	D	D
ProtectionEquipment	0-6	5	D	D	D	D	D	D	D
Communication	0-6	5	D	D	D	D	D	D	D

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Framework factor responses

Questions - statements	Score	MINERALS						
		Average	Maximum	Average	Minimum	Median	SD	Dropout rate
Production volume [Tonnes]		2 678 556	13 000 000	2 678 556	25 000	750 000	4 554 872	10.0
Employees [Man-labour years]		113	400	113	9	45	150.3	10.0
Framework factors:								
Legislation	0-6	5.0	6	5	4	5	0.6	10.0
BusinessSectorRules	0-6	4.4	5	4	0	5	0.0	20.0
QuartzAgreement	0-6	3.5	5	4	0	5	2.4	50.0
Management	0-6	4.7	6	5	3	5	0.8	30.0
SHE-system	0-6	4.9	6	5	4	5	0.4	10.0
Competence	0-6	4.6	6	5	2	5	0.2	20.0
SHE-Culture	0-6	4.6	6	5	4	5	0.6	20.0
Neighbours	0-6	3.5	5	4	0	4	1.9	30.0
MassMedia	0-6	2.7	5	3	0	3	1.8	10.0
Reputation	0-6	3.9	6	4	2	4	1.2	20.0
Society acceptance	0-6	4.0	6	4	3	4	1.2	10.0
Mineralogy	0-6	3.4	6	3	0	4	2.0	10.0
Risks	0-6	5.0	6	5	4	5	0.4	20.0
Economy	0-6	3.7	6	4	2	4	1.4	30.0
Environment	0-6	4.4	6	4	1	5	1.6	20.0
SHE-indicators	0-6	3.5	6	4	1	4	1.5	20.0
ProtectionEquipment	0-6	4.5	6	5	0	5	0.8	20.0
Communication	0-6	4.6	5	5	4	5	0.5	50.0

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Framework factor responses

Questions - statements	Score	DIMENSIONAL STONES						
		Average	Maximum	Average	Minimum	Median	SD	Dropout rate
Production volume [Tonnes]		23 000	65 000	23 000	500	3 500	36 404	57.1
Employees [Man-labour years]		53.2	214	53	3	12	90.4	28.6
Framework factors:								
Legislation	0-6	3.4	6	3	0	4	2.4	28.6
BusinessSectorRules	0-6	1.8	4	2	0	2	1.8	28.6
QuartzAgreement	0-6	5.0	5	5	5	5		85.7
Management	0-6	2.4	5	2	0	3	1.9	28.6
SHE-system	0-6	3.5	5	4	0	5	2.4	42.9
Competence	0-6	3.5	5	4	0	5	2.4	42.9
SHE-Culture	0-6	3.6	5	4	0	4	2.1	28.6
Neighbours	0-6	0.0	0	0	0	0	0.0	28.6
MassMedia	0-6	0.6	3	1	0	0	1.3	28.6
Reputation	0-6	3.0	6	3	0	3	2.9	42.9
Society acceptance	0-6	3.0	6	3	0	3	2.9	42.9
Mineralogy	0-6	1.8	4	2	0	2	1.7	42.9
Risks	0-6	1.8	4	2	0	2	1.7	42.9
Economy	0-6	2.8	4	3	2	3	0.8	28.6
Environment	0-6	1.0	3	1	0	0	1.4	28.6
SHE-indicators	0-6	2.0	5	2	0	2	2.2	42.9
ProtectionEquipment	0-6	2.0	5	2	0	2	2.4	42.9
Communication	0-6							

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Framework factor responses

Questions - statements	Score	AGGREGATES						
		Average	Maximum	Average	Minimum	Median	SD	Dropout rate
Production volume [Tonnes]		1 680 000	6 600 000	1 680 000	100 000	500 000	2 758 985	58.3
Employees [Man-labour years]		40.0	160	40	8	10	67.1	58.3
Framework factors:								
Legislation	0-6	4.8	5	5	4	5	0.4	58.3
BusinessSectorRules	0-6	4.6	5	5	4	5	0.5	58.3
QuartzAgreement	0-6	3.0	5	3	0	4	2.6	66.7
Management	0-6	4.8	5	5	4	5	0.4	58.3
SHE-system	0-6	4.5	5	5	3	5	1.0	58.3
Competence	0-6	4.6	5	5	4	5	0.5	58.3
SHE-Culture	0-6	4.6	5	5	4	5	0.5	58.3
Neighbours	0-6	4.6	5	5	4	5	0.5	58.3
MassMedia	0-6	4.0	5	4	3	4	1.2	66.7
Reputation	0-6	4.6	5	5	4	5	0.5	58.3
Society acceptance	0-6	4.5	5	5	4	5	0.6	66.7
Mineralogy	0-6	4.5	5	5	4	5	0.6	66.7
Risks	0-6	5.0	6	5	4	5	0.7	58.3
Economy	0-6	4.8	5	5	4	5	0.4	58.3
Environment	0-6	4.2	5	4	4	4	0.4	58.3
SHE-indicators	0-6	4.2	5	4	3	4	0.8	58.3
ProtectionEquipment	0-6	5.0	5	5	5	5	0.0	58.3
Communication	0-6	4.8	5	5	4	5	0.4	58.3

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Framework factor responses

Questions - statements	Score	MINING INDUSTRY						
		Average	Maximum	Average	Minimum	Median	SD	Dropout rate
Production volume [Tonnes]		1 916 235	13 000 000	1 916 235	500	500 000	3 367 325	41.4
Employees [Man-labour years]		78	400	78	3	15	112.1	34.5
Framework factors:								
Legislation	0-6	5	6	5	0	5	1.4	34.5
BusinessSectorRules	0-6	4	5	4	0	5	1.9	37.9
QuartzAgreement	0-6	4	5	4	0	5	2.2	65.5
Management	0-6	4	6	4	0	5	1.6	41.4
SHE-system	0-6	4	6	4	0	5	1.3	37.9
Competence	0-6	4	6	4	0	5	1.3	41.4
SHE-Culture	0-6	4	6	4	0	5	1.2	37.9
Neighbours	0-6	3	5	3	0	4	2.2	41.4
MassMedia	0-6	2	5	2	0	3	1.9	37.9
Reputation	0-6	4	6	4	0	4	1.6	41.4
Society acceptance	0-6	4	6	4	0	4	1.6	41.4
Mineralogy	0-6	3	6	3	0	4	1.9	41.4
Risks	0-6	4	6	4	0	5	1.6	41.4
Economy	0-6	4	6	4	2	4	1.2	41.4
Environment	0-6	3	6	3	0	4	1.9	37.9
SHE-indicators	0-6	3	6	3	0	4	1.7	41.4
ProtectionEquipment	0-6	4	6	4	0	5	2.0	41.4
Communication	0-6	5	5	5	4	5	0.5	65.5

Key to symbols and importance scores:

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FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINERALS			N= 10	
			FC15	FC18	FC21	FCA	FC22
Factual response data (production volume, employees, costs etc.):							
1.1	Production volume [Tonnes]		750000	620000	3000000	2830000	25000
1.2	Employees [Man-labour years]		15	45	45	257	14
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK	N	P	P	P	N
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	N	850000	2500000	P	N
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	N	N	5000000	N	N
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	N	N	5000000	N	N
4.17.2	In your deposit/products, what is the content of quartz?	%	P	P	0	P	0
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	P	0	P	P
4.46	What is the distance to your nearest neighbour(s)?	meters	300	100	200	150	1000
4.46	What is the distance to your nearest neighbour(s)?	meters	300-400	100-300	200	150-300	1000

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINERALS			N= 10	
			FC24	FC30	FC33	FC34	FC36
Factual response data (production volume, employees, costs etc.):							
1.1	Production volume [Tonnes]		220000	13000000	3500000	162000	D
1.2	Employees [Man-labour years]		9	193	400	43	D
							D
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK	N	P	P	N	D
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	N	P	35000000	N	D
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	P	N	20000000	N	D
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	P	N	P	N	D
4.17.2	In your deposit/products, what is the content of quartz?	%	0	20	P	1	D
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	0	P	0	D
4.46	What is the distance to your nearest neighbour(s)?	meters	50	20	1000	50	D
4.46	What is the distance to your nearest neighbour(s)?	meters	50	20	1000-10000	50	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	DIMENSIONAL STONES N= 7						
			FC10	FC11	FC12	FC13	FC28	FC37	FC42
Factual response data (production volume, employees, costs etc.):									
1.1	Production volume [Tonnes]		65000	3500	P	500	P	D	D
1.2	Employees [Man-labour years]		28	12	9	3	214	D	D
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK	P	P	P	N	P	D	D
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	100000	80000	500000	N	4000000	D	D
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	P	N	N	N	N	D	D
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	P	N	N	N	N	D	D
4.17.2	In your deposit/products, what is the content of quartz?	%	P	P	P	0	25	D	D
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	0	0	0	0	D	D
4.46	What is the distance to your nearest neighbour(s)?	meters	P	P	P	200	500	D	D
4.46	What is the distance to your nearest neighbour(s)?	meters	P	P	P	200	500	D	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	AGGREGATES N= 12 FC25	FC26	FC27	FC29	FC32	FC35
Factual response data (production volume, employees, costs etc.):								
1.1	Production volume [Tonnes]		500000	100000	500000	700000	6600000	D
1.2	Employees [Man-labour years]		12	8	10	10	160	D
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK	N	N	N	P	P	D
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	N	N	N	P	P	D
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	N	N	N	N	P	D
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	N	N	N	N	2000000	D
4.17.2	In your deposit/products, what is the content of quartz?	%	P	25	P	P	P	D
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	0	0	0	0	D
4.46	What is the distance to your nearest neighbour(s)?	meters	70	200	300	P	P	D
4.46	What is the distance to your nearest neighbour(s)?	meters	70	200-500	300	P	P	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	AGGREGATES		N= 12			
			FC38	FC39	FC40	FC41	FC43	FC44
Factual response data (production volume, employees, costs etc.):								
1.1	Production volume [Tonnes]		D	D	D	D	D	D
1.2	Employees [Man-labour years]		D	D	D	D	D	D
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK	D	D	D	D	D	D
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	D	D	D	D	D	D
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	D	D	D	D	D	D
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	D	D	D	D	D	D
4.17.2	In your deposit/products, what is the content of quartz?	%	D	D	D	D	D	D
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	D	D	D	D	D	D
4.46	What is the distance to your nearest neighbour(s)?	meters	D	D	D	D	D	D
4.46	What is the distance to your nearest neighbour(s)?	meters	D	D	D	D	D	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINERALS Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Factual response data (production volume, employees, costs etc.):								
1.1	Production volume [Tonnes]		2678556	13000000	25000	750000	4554872	10.0
1.2	Employees [Man-labour years]		113	400	9	45	150	10.0
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK						100.0
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	12783333	35000000	850000	2500000	22980970	70.0
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	12500000	20000000	5000000	12500000	10606602	80.0
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	5000000	5000000	5000000	5000000		90.0
4.17.2	In your deposit/products, what is the content of quartz?	%	4	20	0	0	8.8	50.0
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	0	0	0	0.0	50.0
4.46	What is the distance to your nearest neighbour(s)?	meters	319	1000	20	150	446.5	10.0
4.46	What is the distance to your nearest neighbour(s)?	meters	1067	10000	20	300	2704	50.0

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	DIMENSIONAL STONES Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Factual response data (production volume, employees, costs etc.):								
1.1	Production volume [Tonnes]		23000	65000	500	3500	36404	57.1
1.2	Employees [Man-labour years]		53	214	3	12	90	28.6
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK						100.0
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	1170000	4000000	80000	300000	1896558	42.9
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK						100.0
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK						100.0
4.17.2	In your deposit/products, what is the content of quartz?	%	12.5	25	0	13	17.7	71.4
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0.0	0	0	0	0.0	28.6
4.46	What is the distance to your nearest neighbour(s)?	meters	350.0	500	200	350	212.1	71.4
4.46	What is the distance to your nearest neighbour(s)?	meters	350.0	500	200	350	212.1	71.4

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	AGGREGATES Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Factual response data (production volume, employees, costs etc.):								
1.1	Production volume [Tonnes]		1680000	6600000	100000	500000	2758985	58.3
1.2	Employees [Man-labour years]		40	160	8	10	67.1	58.3
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK						100.0
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK						100.0
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK						100.0
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	2000000	2000000	2000000	2000000		91.7
4.17.2	In your deposit/products, what is the content of quartz?	%	25	25	25	25		91.7
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	0	0	0	0.0	58.3
4.46	What is the distance to your nearest neighbour(s)?	meters	190.0	300	70	200	115.3	75.0
4.46	What is the distance to your nearest neighbour(s)?	meters	185.0	300	70	185	162.6	83.3

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINING INDUSTRY Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Factual response data (production volume, employees, costs etc.):								
1.1	Production volume [Tonnes]		1916235	13000000	500	500000	3367325	41.4
1.2	Employees [Man-labour years]		78	400	3	15	112	34.5
4.2.1	In your enterprise, what is the operational cost level related to legal SHE requirements?	NOK						100.0
4.2.2	In your enterprise, what is the investment cost level related to legal SHE requirements?	NOK	6147143	35000000	80000	850000	12804474	75.9
4.3.1	In your enterprise, what is the critical, operational cost level related to SHE?	NOK	12500000	20000000	5000000	12500000	10606602	93.1
4.3.2	In your enterprise, what is the critical, investment cost level related to SHE?	NOK	3500000	5000000	2000000	3500000	2121320	93.1
4.17.2	In your deposit/products, what is the content of quartz?	%	9	25	0	1	12.1	72.4
4.18.2	In your deposit/products, what is the content of fibrous minerals?	%	0	0	0	0	0.0	48.3
4.46	What is the distance to your nearest neighbour(s)?	meters	296	1000	20	200	324.5	51.7
4.46	What is the distance to your nearest neighbour(s)?	meters	266	1000	20	200	315.4	69.0

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINERALS				N= 10
			FC15	FC18	FC21	FCA	FC22
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):							
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V	N	J	J	J	V
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V	N	J	J	J	N
4.9	Does your enterprise manage a discharge permit?	J/N/V	P	P	P	J	J
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V	P	P	P	P	J
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V	N	N	J	N	N
Deposit mineralogy (Y/N):							
4.17.1	Does your deposit/products contain quartz?	J/N/V	J	P	N	J	N
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V	N	P	N	J	J
Organisational issues (Y/N):							
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V	P	J	P	P	N
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V	P	J	P	J	N
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V	P	P	P	P	N
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V	P	P	J	P	J
4.47	Have you experienced neighbours' complaints?	J/N/V	P	P	P	P	0
4.51	Have you experienced mass media reports?	J/N/V	J	J	J	J	J
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V	P	J	P	J	J
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V	P	J	P	J	J
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V	P	J	P	P	J
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V	P	J	P	P	J
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V	P	P	P	P	J

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINERALS				N= 10
			FC24	FC30	FC33	FC34	FC36
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):							
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V	N	J	J	V	D
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V	N	J	J	N	D
4.9	Does your enterprise manage a discharge permit?	J/N/V	J	J	J	J	D
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V	J	J	J	N	D
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V	J	N	J	N	D
Deposit mineralogy (Y/N):							
4.17.1	Does your deposit/products contain quartz?	J/N/V	N	J	J	J	D
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V	N	N	J	N	D
Organisational issues (Y/N):							
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V	N	J	J	J	D
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V	N	J	N	N	D
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V	N	J	J	J	D
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V	J	J	J	J	D
4.47	Have you experienced neighbours' complaints?	J/N/V	0	3	4	4	D
4.51	Have you experienced mass media reports?	J/N/V	J	J	J	N	D
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V	J	J	J	J	D
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V	J	J	J	J	D
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V	J	J	J	J	D
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V	J	J	J	J	D
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V	J	J	J	N	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	DIMENSIONAL STONES				N= 7		
			FC10	FC11	FC12	FC13	FC28	FC37	FC42
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):									
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V	P	P	J	P	J	D	D
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V	J	J	J	N	J	D	D
4.9	Does your enterprise manage a discharge permit?	J/N/V	P	P	P	P	J	D	D
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V	P	P	P	P	J	D	D
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V	P	N	N	N	N	D	D
Deposit mineralogy (Y/N):									
4.17.1	Does your deposit/products contain quartz?	J/N/V	J	J	J	N	J	D	D
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V	V	N	N	N	N	D	D
Organisational issues (Y/N):									
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V	P	P	P	P	N	D	D
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V	P	P	P	P	N	D	D
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V	P	P	P	P	J	D	D
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V	P	P	P	P	J	D	D
4.47	Have you experienced neighbours' complaints?	J/N/V	P	P	P	P	3	D	D
4.51	Have you experienced mass media reports?	J/N/V	N	J	J	J	J	D	D
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V	P	P	P	P	J	D	D
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V	P	P	P	P	J	D	D
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V	P	P	P	P	J	D	D
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V	P	P	P	P	J	D	D
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V	P	P	P	P	J	D	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	AGGREGATES		N= 12			
			FC25	FC26	FC27	FC29	FC32	FC35
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):								
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V	J	V	N	J	J	D
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V	N	N	N	J	J	D
4.9	Does your enterprise manage a discharge permit?	J/N/V	N	J	J	N	J	D
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V	N	J	N	J	N	D
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V	N	N	N	N	J	D
Deposit mineralogy (Y/N):								
4.17.1	Does your deposit/products contain quartz?	J/N/V	J	J	J	N	J	D
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V	N	N	V	N	N	D
Organisational issues (Y/N):								
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V	N	N	N	J	N	D
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V	N	N	N	N	J	D
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V	J	J	J	N	J	D
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V	J	N	J	J	J	D
4.47	Have you experienced neighbours' complaints?	J/N/V	5	1	4	3	4	D
4.51	Have you experienced mass media reports?	J/N/V	N	J	J	J	J	D
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V	J	J	J	J	J	D
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V	J	J	J	J	J	D
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V	J	J	J	J	J	D
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V	J	N	N	J	J	D
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V	J	N	N	P	J	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	AGGREGATES			N= 12		
			FC38	FC39	FC40	FC41	FC43	FC44
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):								
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V	D	D	D	D	D	D
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V	D	D	D	D	D	D
4.9	Does your enterprise manage a discharge permit?	J/N/V	D	D	D	D	D	D
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V	D	D	D	D	D	D
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V	D	D	D	D	D	D
Deposit mineralogy (Y/N):								
4.17.1	Does your deposit/products contain quartz?	J/N/V	D	D	D	D	D	D
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V	D	D	D	D	D	D
Organisational issues (Y/N):								
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V	D	D	D	D	D	D
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V	D	D	D	D	D	D
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V	D	D	D	D	D	D
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V	D	D	D	D	D	D
4.47	Have you experienced neighbours' complaints?	J/N/V	D	D	D	D	D	D
4.51	Have you experienced mass media reports?	J/N/V	D	D	D	D	D	D
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V	D	D	D	D	D	D
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V	D	D	D	D	D	D
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V	D	D	D	D	D	D
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V	D	D	D	D	D	D
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V	D	D	D	D	D	D

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINERALS	Distribution in % Yes!	No!	Do not know	Dropout rate
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):							
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V		50.0	20.0	20.0	10.0
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V		50.0	40.0	0.0	10.0
4.9	Does your enterprise manage a discharge permit?	J/N/V		60.0	0.0	0.0	40.0
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V		40.0	10.0	0.0	50.0
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V		30.0	60.0	0.0	10.0
Deposit mineralogy (Y/N):							
4.17.1	Does your deposit/products contain quartz?	J/N/V		50.0	30.0	0.0	20.0
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V		30.0	50.0	0.0	20.0
Organisational issues (Y/N):							
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V		40.0	20.0	0.0	40.0
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V		30.0	40.0	0.0	30.0
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V		30.0	20.0	0.0	50.0
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V		60.0	0.0	0.0	40.0
4.47	Have you experienced neighbours' complaints?	J/N/V		0.0	0.0	0.0	100.0
4.51	Have you experienced mass media reports?	J/N/V		80.0	10.0	0.0	10.0
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V		70.0	0.0	0.0	30.0
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V		70.0	0.0	0.0	30.0
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V		60.0	0.0	0.0	40.0
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V		60.0	0.0	0.0	40.0
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V		40.0	10.0	0.0	50.0

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	DIMENSIONAL STONES	Distribution in %		
			Yes!	No!	Do not know	Dropout rate
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):						
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V	28.6	0.0	0.0	71.4
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V	57.1	14.3	0.0	28.6
4.9	Does your enterprise manage a discharge permit?	J/N/V	14.3	0.0	0.0	85.7
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V	14.3	0.0	0.0	85.7
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V	0.0	57.1	0.0	42.9
Deposit mineralogy (Y/N):						
4.17.1	Does your deposit/products contain quartz?	J/N/V	57.1	14.3	0.0	28.6
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V	0.0	57.1	14.3	28.6
Organisational issues (Y/N):						
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V	0.0	14.3	0.0	85.7
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V	0.0	14.3	0.0	85.7
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V	14.3	0.0	0.0	85.7
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V	14.3	0.0	0.0	85.7
4.47	Have you experienced neighbours' complaints?	J/N/V	0.0	0.0	0.0	100.0
4.51	Have you experienced mass media reports?	J/N/V	57.1	14.3	0.0	28.6
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V	14.3	0.0	0.0	85.7
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V	14.3	0.0	0.0	85.7
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V	14.3	0.0	0.0	85.7
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V	14.3	0.0	0.0	85.7
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V	14.3	0.0	0.0	85.7

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	AGGREGATES	Distribution in % Yes!	No!	Do not know	Dropout rate
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):							
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V		25.0	8.3	8.3	58.3
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V		16.7	25.0	0.0	58.3
4.9	Does your enterprise manage a discharge permit?	J/N/V		25.0	16.7	0.0	58.3
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V		16.7	25.0	0.0	58.3
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V		8.3	33.3	0.0	58.3
Deposit mineralogy (Y/N):							
4.17.1	Does your deposit/products contain quartz?	J/N/V		33.3	8.3	0.0	58.3
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V		0.0	33.3	8.3	58.3
Organisational issues (Y/N):							
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V		8.3	33.3	0.0	58.3
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V		8.3	33.3	0.0	58.3
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V		33.3	8.3	0.0	58.3
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V		33.3	8.3	0.0	58.3
4.47	Have you experienced neighbours' complaints?	J/N/V		0.0	0.0	0.0	100.0
4.51	Have you experienced mass media reports?	J/N/V		33.3	8.3	0.0	58.3
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V		41.7	0.0	0.0	58.3
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V		41.7	0.0	0.0	58.3
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V		41.7	0.0	0.0	58.3
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V		25.0	16.7	0.0	58.3
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V		16.7	16.7	0.0	66.7

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Responses to additional questions

Questio	Supplemental questions and statements	Scale	MINING INDUSTRY	Distribution in %			
				Yes!	No!	Do not know	Dropout rate
Legal rules, mineral wastes/tailings disposal and economy (Yes/No):							
4.1.1	Has legal SHE regulations changed conditions related to SHE activities?	J/N/V		34.5	10.3	10.3	44.8
4.1.2	Has legal SHE regulations changed conditions related to economy?	J/N/V		37.9	27.6	0.0	34.5
4.9	Does your enterprise manage a discharge permit?	J/N/V		34.5	6.9	0.0	58.6
4.10	Does your enterprise manage a mineral wastes disposal site?	J/N/V		24.1	13.8	0.0	62.1
4.3	Is it possible for you to define a critical cost level related to SHE?	J/N/V		13.8	48.3	0.0	37.9
Deposit mineralogy (Y/N):							
4.17.1	Does your deposit/products contain quartz?	J/N/V		44.8	17.2	0.0	37.9
4.18.1	Does your deposit/products contain fibrous minerals?	J/N/V		10.3	44.8	6.9	37.9
Organisational issues (Y/N):							
4.29.1	Certified ISO 9001 (product quality management standard)?	J/N/V		17.2	24.1	0.0	58.6
4.29.2	Certified ISO 14001 (environmental management standard)?	J/N/V		13.8	31.0	0.0	55.2
4.24	Are your enterprises making a mandatory SHE plan?	J/N/V		27.6	10.3	0.0	62.1
4.35	Are your enterprises planning competency developments (competency plan)?	J/N/V		37.9	3.4	0.0	58.6
4.47	Have you experienced neighbours' complaints?	J/N/V		0.0	0.0	0.0	100.0
4.51	Have you experienced mass media reports?	J/N/V		55.2	10.3	0.0	34.5
4.57.1	Personal protection equipment (PPE): Are 'hard hats' prohibited?	J/N/V		44.8	0.0	0.0	55.2
4.57.2	PPE: Are 'protective footwear' prohibited?	J/N/V		44.8	0.0	0.0	55.2
4.57.3	PPE: Are 'hearing protection' prohibited?	J/N/V		41.4	0.0	0.0	58.6
4.57.4	PPE: Are 'respirable protection' prohibited?	J/N/V		34.5	6.9	0.0	58.6
4.57.5	PPE: Are 'other safety devices' prohibited?	J/N/V		24.1	10.3	0.0	65.5

Scale: J=Yes, N=No, V=Don't know, D=Dropout, P=Partial dropout

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	MINERALS FC15	FC18	FC21	FCA	N= 10 FC22
Production volume and employees:							
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	750000	620000	3000000	2830000	25000
1.2	Employees [Man-labour years]		15	45	45	257	14
Legal rules and corporate/sector rules:							
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	1	IS	3	3	V
4.8	What is the degree of law enforcement equality?	V/1-5	3	4	2	3	P
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	P	P	P	P	P
SHE-activities versus economy:							
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	1	3	4	P	0
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	1	3	1	1	P
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	4	3	4	4	P
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	P	P	P	P	P
Organisational issues (management, system, culture, competence):							
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	4	3	5	5	5
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	5	4	5	5	5
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	5	3	5	5	5
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	5	3	4	P	4
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	P	3	P	P	4
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	P	P	P	P	1
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	P	P	P	P	1
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	5	P	4	4	4
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	P	P	4	P	4

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	Scale details, see page 3D.11 & 21	FC24	FC30	FC33	FC34	FC36	
Production volume and employees:									
1.1	Production volume [Tonnes]			220000	13000000	3500000	162000		D
1.2	Employees [Man-labour years]			9	193	400	43		D
Legal rules and corporate/sector rules:									
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5		V	3	3	V		D
4.8	What is the degree of law enforcement equality?	V/1-5		P	V	2	3		D
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5		0	5	4	V		D
SHE-activities versus economy:									
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5		V	5	3	V		D
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5		6	3	2	1		D
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5		7	3	4	3		D
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5		P	1	3	3		D
Organisational issues (management, system, culture, competence):									
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5		5	5	4	4		D
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5		5	4	4	3		D
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5		5	5	4	4		D
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5		4	5	5	3		D
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5		4	5	5	4		D
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5		3	5	5	3		D
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5		4	P	5	4		D
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5		5	4	5	4		D
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5		5	3	4	4		D

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	DIMENSIONAL STONES FC10	FC11	FC12	FC13	FC28	N=
Production volume and employees:								
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	65000	3500	P	500	P	
1.2	Employees [Man-labour years]		28	12	9	3	214	
Legal rules and corporate/sector rules:								
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	P	P	2	P	2	
4.8	What is the degree of law enforcement equality?	V/1-5	P	1	V	P	4	
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	P	P	P	P	4	
SHE-activities versus economy:								
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	P	2	V	0	2	
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	4	3	3	4	1	
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	P	2	4	1	2	
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	P	P	P	P	P	
Organisational issues (management, system, culture, competence):								
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	4	3	5	3	4	
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	3	4	3	3	2	
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	4	4	4	3	3	
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	5	P	P	P	3	
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	P	P	P	P	4	
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	P	P	P	P	P	
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	P	P	P	P	4	
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	4	3	4	5	4	
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	3	3	5	3	4	

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	7		AGGREGATES		
			FC37	FC42	FC25	FC26	FC27
Production volume and employees:							
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	D	D	500000	100000	500000
1.2	Employees [Man-labour years]		D	D	12	8	10
Legal rules and corporate/sector rules:							
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	D	D	4	3	0
4.8	What is the degree of law enforcement equality?	V/1-5	D	D	2	4	3
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	D	D	3	V	V
SHE-activities versus economy:							
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	D	D	0	4	0
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	D	D	1	1	1
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	D	D	3	1	2
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	D	D	P	V	4
Organisational issues (management, system, culture, competence):							
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	D	D	5	1	4
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	D	D	5	P	5
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	D	D	5	P	4
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	D	D	5	4	5
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	D	D	5	5	5
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	D	D	5	V	5
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	D	D	5	3	5
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	D	D	5	4	4
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	D	D	5	3	4

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	N= 12				
			FC29	FC32	FC35	FC38	FC39
Production volume and employees:							
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	700000	6600000	D	D	D
1.2	Employees [Man-labour years]		10	160	D	D	D
Legal rules and corporate/sector rules:							
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	4	3	D	D	D
4.8	What is the degree of law enforcement equality?	V/1-5	4	2	D	D	D
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	P	3	D	D	D
SHE-activities versus economy:							
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	3	2	D	D	D
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	3	4	D	D	D
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	3	3	D	D	D
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	3	V	D	D	D
Organisational issues (management, system, culture, competence):							
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	4	5	D	D	D
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	4	5	D	D	D
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	3	5	D	D	D
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	4	4	D	D	D
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	4	5	D	D	D
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	4	3	D	D	D
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	4	4	D	D	D
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	4	3	D	D	D
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	4	3	D	D	D

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	FC40	FC41	FC43	FC44
Production volume and employees:		Scale details, see page 3D.11 & 21				
1.1	Production volume [Tonnes]		D	D	D	D
1.2	Employees [Man-labour years]		D	D	D	D
Legal rules and corporate/sector rules:						
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	D	D	D	D
4.8	What is the degree of law enforcement equality?	V/1-5	D	D	D	D
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	D	D	D	D
SHE-activities versus economy:						
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	D	D	D	D
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	D	D	D	D
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	D	D	D	D
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	D	D	D	D
Organisational issues (management, system, culture, competence):						
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	D	D	D	D
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	D	D	D	D
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	D	D	D	D
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	D	D	D	D
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	D	D	D	D
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	D	D	D	D
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	D	D	D	D
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	D	D	D	D
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	D	D	D	D

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	MINERALS Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Production volume and employees:								
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	2678556	13000000	25000	750000	4554872	10.0
1.2	Employees [Man-labour years]		113	400	9	45	150	10.0
Legal rules and corporate/sector rules:								
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	2.6	3	1	3	0.0	20.0
4.8	What is the degree of law enforcement equality?	V/1-5	2.8	4	2	3	0.6	30.0
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	3.0	5	0	4	2.6	70.0
SHE-activities versus economy:								
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	2.7	5	0	3	2.2	30.0
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	2.3	6	1	2	2.0	30.0
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	4.0	7	3	4	1.5	30.0
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	2.3	3	1	3	1.2	70.0
Organisational issues (management, system, culture, competence):								
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	4.4	5	3	5	0.5	20.0
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	4.4	5	3	5	0.8	20.0
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	4.6	5	3	5	0.5	10.0
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	4.1	5	3	4	0.8	20.0
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	4.2	5	3	4	0.5	40.0
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	3.4	5	1	3	1.7	50.0
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	3.5	5	1	4	1.7	60.0
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	4.4	5	4	4	0.5	20.0
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	4.0	5	3	4	0.6	40.0

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	DIMENSIONAL STONES Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Production volume and employees:								
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	23000,0	65000	500	3500	36404	57,1
1.2	Employees [Man-labour years]		53,2	214	3	12	90	28,6
Legal rules and corporate/sector rules:								
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	2,0	2	2	2	0,0	71,4
4.8	What is the degree of law enforcement equality?	V/1-5	2,5	4	1	3	2,1	57,1
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	4,0	4	4	4		85,7
SHE-activities versus economy:								
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	1,3	2	0	2	1,2	57,1
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	3,0	4	1	3	1,2	28,6
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	2,3	4	1	2	1,3	42,9
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5						
Organisational issues (management, system, culture, competence):								
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	3,8	5	3	4	0,8	28,6
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	3,0	4	2	3	0,7	28,6
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	3,6	4	3	4	0,5	28,6
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	4,0	5	3	4	1,4	71,4
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	4,0	4	4	4		85,7
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5						100,0
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	4,0	4	4	4		85,7
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	4,0	5	3	4	0,7	28,6
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	3,6	5	3	3	0,9	28,6

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	AGGREGATES Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Production volume and employees:								
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	1680000	6600000	100000	500000	2758985	58,3
1.2	Employees [Man-labour years]		40,0	160	8	10	67	58,3
Legal rules and corporate/sector rules:								
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	2,8	4	0	3	1,6	66,7
4.8	What is the degree of law enforcement equality?	V/1-5	3,0	4	2	3	1,0	58,3
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	3,0	3	3	3	0,0	66,7
SHE-activities versus economy:								
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	1,8	4	0	2	1,8	75,0
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	2,0	4	1	1	1,4	58,3
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	2,4	3	1	3	0,9	58,3
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	3,5	4	3	4	0,7	66,7
Organisational issues (management, system, culture, competence):								
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	3,8	5	1	4	1,6	58,3
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	4,8	5	4	5	0,5	66,7
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	4,3	5	3	5	1,0	66,7
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	4,4	5	4	4	0,5	58,3
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	4,8	5	4	5	0,4	58,3
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	4,3	5	3	5	1,0	58,3
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	4,2	5	3	4	0,8	58,3
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	4,0	5	3	4	0,7	58,3
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	3,8	5	3	4	0,8	58,3

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	MINING INDUSTRY Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
Production volume and employees:								
1.1	Production volume [Tonnes]	Scale details, see page 3D.11 & 21	1916235	13000000	500	500000	3367325	41.4
1.2	Employees [Man-labour years]		78	400	3	15	112	34.5
Legal rules and corporate/sector rules:								
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5	3	4	0	3	1.2	51.7
4.8	What is the degree of law enforcement equality?	V/1-5	3	4	1	3	1.0	48.3
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5	3	5	0	4	1.7	72.4
SHE-activities versus economy:								
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5	2	5	0	2	1.7	55.2
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5	2	6	1	3	1.5	41.4
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5	3	7	1	3	1.4	44.8
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5	3	4	1	3	1.1	75.9
Organisational issues (management, system, culture, competence):								
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5	4	5	1	4	1.1	37.9
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5	4	5	2	4	0.9	41.4
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5	4	5	3	4	0.8	37.9
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5	4	5	3	4	0.8	48.3
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5	4	5	3	5	0.7	58.6
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5	4	5	1	4	1.4	65.5
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5	4	5	1	4	1.2	65.5
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5	4	5	3	4	0.6	37.9
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5	4	5	3	4	0.8	44.8

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score
Production volume and employees:		Scale details, see page 3D.11 & 21
1.1	Production volume [Tonnes]	
1.2	Employees [Man-labour years]	
Legal rules and corporate/sector rules:		
4.5	Legal SHE-requirements: What is the degree of impact on the SHE activities?	V/1-5
4.8	What is the degree of law enforcement equality?	V/1-5
4.19	Quartz agreement'. What is the degree of 'good practice' implementation?	V/1-5
SHE-activities versus economy:		
4.4	Legal SHE-requirements: What is the degree of economic impact ?	V/1-5
4.6	What is the degree of conflict between economic and SHE considerations?	V/1-5
4.7	By improving the SHE activities - what is the potential of reducing costs?	V/1-5
4.30	Certification (ISO 9001, ISO 14001, EMAS etc.). What is the degree of market benefit?	V/1-5
Organisational issues (management, system, culture, competence):		
4.32	In your enterprise, what is the degree of systematic SHE activities?	V/1-5
4.33	Nonconformances/undesired events (NC/UE): What is the degree of NC/UE-recording?	V/1-5
4.34	NC/UE: What is the degree of implementing NC/UE control measures?	V/1-5
4.20.1	Risk analysis (RA)-work environment: What is the degree of implementation?	V/1-5
4.20.3	Risk analysis-work environment: What is the degree of implementing control measures?	V/1-5
4.20.2	Risk analysis-environmental: What is the degree of implementation?	V/1-5
4.20.4	Risk analysis-environmental: What is the degree of implementing control	V/1-5
4.58	Obligated safety devices/protection equipment: What is the degree of use?	V/1-5
4.59	Obligated safety devices/protection equipment-no use: What is the degree of prosecution ?	V/1-5

Response scale:

All questions:
V=Don't know, D=Survey dropout, P=Partial dropout/question dropout

Most questions:
1=Very low, 2=Low, 3=Medium, 4=High, 5=Very high degree

Question 4.19:
1=Equal, 2=Quite egual, 3=Either-or, 4=Quite different, 5=Different

Question 4.38-4.45:
1=True, 2=Quite true, 3=Either-or, 4=Quite false, 5=False

Question 4.48:
1=Bad, 2=Quite bad, 3=Either-or, 4=Quite good, 5=Good

Question 4.49:
1=Seldom, 2=Quite seldom, 3=Either-or, 4=Quite frequent, 5=Frequent

Question 4.53:
0=Neutral, 1=Negative, 2=Quite negative, 3=Either-or, 4=Quite positive, 5=Positive

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	MINERALS				N= 10
			FC15	FC18	FC21	FCA	FC22
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	4	0	4	5	5
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	4	0	4	5	5
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	P	P	P	P	5
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	P	P	P	P	0
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	P	P	P	P	2
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	P	4	P	P	P
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	4	4	P	P	5
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	P	4	P	P	5
4.27	To what degree is SHE discussed in management meetings?	V/1-5	5	5	3	4	2
4.28	To what degree is SHE discussed in management meetings?	V/1-5	5	5	3	4	2
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	P	P	P	P	P
4.38	Our SHE activities are very important!	V/1-5	2	2	1	1	1
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	1	1	1	2	3
4.40	NC/UE are consequently recorded!	V/1-5	1	3	1	2	1
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	1	1	1	2	1
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	2	2	1	2	2
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1	1	1	1	1
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	1	2	2	1	1
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	1	2	1	2	1
Neighbours and mass media:							
4.48	How do you experience the relationsship to your neighbours?	V/1-5	5	4	4	5	5
4.49	What is the frequency of neighbours' complaints?	V/1-5	1	2	3	3	0
4.53	What is your characteristic of media reports?	V/0-5	0	3	3	3	0

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	FC24	FC30	FC33	FC34	FC36
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	5	5	4	5	D
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	5	5	4	5	D
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	4	5	3	4	D
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	0	3	4	4	D
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	3	5	4	3	D
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	5	5	4	3	D
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	5	5	4	3	D
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	4	5	4	3	D
4.27	To what degree is SHE discussed in management meetings?	V/1-5	5	4	4	4	D
4.28	To what degree is SHE discussed in management meetings?	V/1-5	5	3	4	4	D
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	4	4	4	4	D
4.38	Our SHE activities are very important!	V/1-5	1	1	1	1	D
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	1	3	1	1	D
4.40	NC/UE are consequently recorded!	V/1-5	1	3	1	1	D
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	3	2	1	2	D
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	1	3	2	2	D
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1	2	1	1	D
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	1	2	1	2	D
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	1	2	2	1	D
Neighbours and mass media:							
4.48	How do you experience the relationsship to your neighbours?	V/1-5	3	5	4	3	D
4.49	What is the frequency of neighbours' complaints?	V/1-5	2	3	2	2	D
4.53	What is your characteristic of media reports?	V/0-5	5	2	3	N	D

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	DIMENSIONAL STONES					N=
			FC10	FC11	FC12	FC13	FC28	
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	3	5	5	1	4	
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	4	5	5	1	4	
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	P	P	P	P	3	
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	P	P	P	P	3	
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	P	P	P	P	4	
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	P	P	P	P	4	
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	P	P	P	P	4	
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	3	V	5	5	4	
4.27	To what degree is SHE discussed in management meetings?	V/1-5	4	4	IS	IS	4	
4.28	To what degree is SHE discussed in management meetings?	V/1-5	4	4	IS	IS	4	
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	P	P	P	P	P	
4.38	Our SHE activities are very important!	V/1-5	2	2	1	2	1	
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	2	2	1	2	1	
4.40	NC/UE are consequently recorded!	V/1-5	2	5	2	5	4	
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	1	1	2	P	3	
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	2	P	1	P	3	
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1	P	1	1	2	
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	1	P	2	1	3	
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	1	P	1	2	2	
Neighbours and mass media:								
4.48	How do you experience the relationsship to your neighbours?	V/1-5	P	P	P	5	4	
4.49	What is the frequency of neighbours' complaints?	V/1-5	P	P	P	0	1	
4.53	What is your characteristic of media reports?	V/0-5	N	2	2	2	2	

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	7		AGGREGATES		
			FC37	FC42	FC25	FC26	FC27
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	D	D	4	5	0
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	D	D	4	P	5
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	D	D	4	3	4
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	D	D	5	1	4
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	D	D	4	1	3
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	D	D	5	5	5
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	D	D	5	3	5
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	D	D	5	5	5
4.27	To what degree is SHE discussed in management meetings?	V/1-5	D	D	5	5	4
4.28	To what degree is SHE discussed in management meetings?	V/1-5	D	D	5	5	4
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	D	D	5	V	4
4.38	Our SHE activities are very important!	V/1-5	D	D	1	2	1
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	D	D	1	1	3
4.40	NC/UE are consequently recorded!	V/1-5	D	D	1	5	1
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	D	D	1	P	1
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	D	D	1	P	1
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	D	D	1	P	2
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	D	D	1	P	1
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	D	D	1	P	2
Neighbours and mass media:							
4.48	How do you experience the relationsship to your neighbours?	V/1-5	D	D	4	4	4
4.49	What is the frequency of neighbours' complaints?	V/1-5	D	D	0	2	2
4.53	What is your characteristic of media reports?	V/0-5	D	D	N	2	3

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	N= 12				
			FC29	FC32	FC35	FC38	FC39
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	4	4	D	D	D
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	4	4	D	D	D
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	4	5	D	D	D
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	3	4	D	D	D
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	3	3	D	D	D
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	4	4	D	D	D
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	4	4	D	D	D
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	4	4	D	D	D
4.27	To what degree is SHE discussed in management meetings?	V/1-5	3	4	D	D	D
4.28	To what degree is SHE discussed in management meetings?	V/1-5	4	4	D	D	D
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	4	V	D	D	D
4.38	Our SHE activities are very important!	V/1-5	2	1	D	D	D
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	1	2	D	D	D
4.40	NC/UE are consequently recorded!	V/1-5	2	2	D	D	D
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	2	2	D	D	D
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	2	1	D	D	D
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	2	1	D	D	D
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	2	3	D	D	D
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	3	2	D	D	D
Neighbours and mass media:							
4.48	How do you experience the relationsship to your neighbours?	V/1-5	3	P	D	D	D
4.49	What is the frequency of neighbours' complaints?	V/1-5	2	3	D	D	D
4.53	What is your characteristic of media reports?	V/0-5	3	3	D	D	D

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	FC40	FC41	FC43	FC44
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	D	D	D	D
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	D	D	D	D
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	D	D	D	D
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	D	D	D	D
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	D	D	D	D
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	D	D	D	D
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	D	D	D	D
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	D	D	D	D
4.27	To what degree is SHE discussed in management meetings?	V/1-5	D	D	D	D
4.28	To what degree is SHE discussed in management meetings?	V/1-5	D	D	D	D
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	D	D	D	D
4.38	Our SHE activities are very important!	V/1-5	D	D	D	D
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	D	D	D	D
4.40	NC/UE are consequently recorded!	V/1-5	D	D	D	D
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	D	D	D	D
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	D	D	D	D
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	D	D	D	D
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	D	D	D	D
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	D	D	D	D
Neighbours and mass media:						
4.48	How do you experience the relationsship to your neighbours?	V/1-5	D	D	D	D
4.49	What is the frequency of neighbours' complaints?	V/1-5	D	D	D	D
4.53	What is your characteristic of media reports?	V/0-5	D	D	D	D

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	MINERALS					
			Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	4.1	5	0	5	0.5	20.0
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	4.1	5	0	5	0.5	20.0
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	4.2	5	3	4	0.8	50.0
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	2.2	4	0	3	2.0	70.0
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	3.4	5	2	3	1.1	50.0
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	4.2	5	3	4	1.0	50.0
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	4.3	5	3	4	0.9	30.0
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	4.2	5	3	4	0.8	40.0
4.27	To what degree is SHE discussed in management meetings?	V/1-5	4.0	5	2	4	1.0	20.0
4.28	To what degree is SHE discussed in management meetings?	V/1-5	3.9	5	2	4	1.0	20.0
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	4.0	4	4	4	0.0	60.0
4.38	Our SHE activities are very important!	V/1-5	1.2	2	1	1	0.0	10.0
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	1.6	3	1	1	1.0	10.0
4.40	NC/UE are consequently recorded!	V/1-5	1.6	3	1	1	0.8	20.0
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	1.6	3	1	1	0.8	10.0
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	1.9	3	1	2	0.7	20.0
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1.1	2	1	1	0.4	20.0
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	1.4	2	1	1	0.5	10.0
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	1.4	2	1	1	0.5	10.0
Neighbours and mass media:								
4.48	How do you experience the relationsship to your neighbours?	V/1-5	4.2	5	3	4	0.9	20.0
4.49	What is the frequency of neighbours' complaints?	V/1-5	2.0	3	0	2	1.1	20.0
4.53	What is your characteristic of media reports?	V/0-5	2.4	5	0	3	1.6	20.0

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	DIMENSIONAL STONES					
			Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	3.6	5	1	4	1.7	28.6
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	3.8	5	1	4	1.6	28.6
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	3.0	3	3	3		85.7
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	3.0	3	3	3		85.7
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	4.0	4	4	4		85.7
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	4.0	4	4	4		85.7
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	4.0	4	4	4		85.7
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	4.3	5	3	5	1.0	28.6
4.27	To what degree is SHE discussed in management meetings?	V/1-5	4.0	4	4	4	0.0	57.1
4.28	To what degree is SHE discussed in management meetings?	V/1-5	4.0	4	4	4	0.0	57.1
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	#DIV/0!	0	0	#NUM!	#DIV/0!	100.0
4.38	Our SHE activities are very important!	V/1-5	1.6	2	1	2	0.5	28.6
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	1.6	2	1	2	0.5	28.6
4.40	NC/UE are consequently recorded!	V/1-5	3.6	5	2	4	1.5	28.6
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	1.8	3	1	2	1.0	42.9
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	2.0	3	1	2	1.0	57.1
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1.3	2	1	1	0.5	42.9
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	1.8	3	1	2	1.0	42.9
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	1.5	2	1	2	0.6	42.9
Neighbours and mass media:								
4.48	How do you experience the relationsship to your neighbours?	V/1-5	4.5	5	4	5	0.7	71.4
4.49	What is the frequency of neighbours' complaints?	V/1-5	0.5	1	0	1	0.7	85.7
4.53	What is your characteristic of media reports?	V/0-5	2.0	2	2	2	0.0	42.9

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	AGGREGATES					
			Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	3,4	5	0	4	1,9	66,7
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	4,3	5	4	4	0,5	66,7
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	4,0	5	3	4	0,7	58,3
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	3,4	5	1	4	1,5	58,3
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	2,8	4	1	3	1,1	58,3
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	4,6	5	4	5	0,5	58,3
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	4,2	5	3	4	0,8	58,3
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	4,6	5	4	5	0,5	58,3
4.27	To what degree is SHE discussed in management meetings?	V/1-5	4,2	5	3	4	0,8	58,3
4.28	To what degree is SHE discussed in management meetings?	V/1-5	4,4	5	4	4	0,5	58,3
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	4,3	5	4	4	0,6	58,3
4.38	Our SHE activities are very important!	V/1-5	1,4	2	1	1	0,5	58,3
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	1,6	3	1	1	0,9	58,3
4.40	NC/UE are consequently recorded!	V/1-5	2,2	5	1	2	1,6	58,3
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	1,5	2	1	2	0,6	66,7
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	1,3	2	1	1	0,5	66,7
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1,5	2	1	2	0,6	66,7
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	1,8	3	1	2	1,0	66,7
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	2,0	3	1	2	0,8	66,7
Neighbours and mass media:								
4.48	How do you experience the relationsship to your neighbours?	V/1-5	3,8	4	3	4	0,5	66,7
4.49	What is the frequency of neighbours' complaints?	V/1-5	1,8	3	0	2	1,1	66,7
4.53	What is your characteristic of media reports?	V/0-5	2,8	3	2	3	0,5	66,7

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score	MINING INDUSTRY					
			Average	Maxi-mum	Mini-mum	Median	SD	Dropout rate
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5	4	5	0	4	1.7	41.4
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5	4	5	0	4	1.4	41.4
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5	4	5	3	4	0.8	62.1
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5	3	5	0	3	1.7	69.0
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5	3	5	1	3	1.1	62.1
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5	4	5	3	4	0.7	62.1
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5	4	5	3	4	0.7	55.2
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5	4	5	3	4	0.7	44.8
4.27	To what degree is SHE discussed in management meetings?	V/1-5	4	5	2	4	0.8	44.8
4.28	To what degree is SHE discussed in management meetings?	V/1-5	4	5	2	4	0.8	44.8
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5	4	5	4	4	0.4	69.0
4.38	Our SHE activities are very important!	V/1-5	1	2	1	1	0.5	34.5
4.39	SHE-activities are always discussed in operational meetings!	V/1-5	2	3	1	1	0.8	34.5
4.40	NC/UE are consequently recorded!	V/1-5	2	5	1	2	1.5	37.9
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5	2	3	1	1	0.7	41.4
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5	2	3	1	2	0.7	48.3
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5	1	2	1	1	0.4	44.8
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5	2	3	1	1	0.7	41.4
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5	2	3	1	2	0.6	41.4
Neighbours and mass media:								
4.48	How do you experience the relationsship to your neighbours?	V/1-5	4	5	3	4	0.7	51.7
4.49	What is the frequency of neighbours' complaints?	V/1-5	2	3	0	2	1.1	55.2
4.53	What is your characteristic of media reports?	V/0-5	2	5	0	3	1.2	44.8

FC-survey: Score responses to additional questions

Question	Supplemental questions and statements	Score
4.14	Consumers waste handling: What is the degree of implementing routines?	V/1-5
4.15	Hazardous waste handling: What is the degree of implementing routines?	V/1-5
4.25	SHE mandatory plan: What is the degree of keeping it ajour?	V/1-5
4.36	Competency plan: What is the degree of including SHE-training?	V/1-5
4.37	Employees' involvement in SHE activities: What is the degree?	V/1-5
4.26.1	Foreman level involvement in SHE activities: What is the degree?	V/1-5
4.26.2	Middle management involvement in SHE activities: What is the degree?	V/1-5
4.26.3	CEO involvement in SHE activities: What is the degree?	V/1-5
4.27	To what degree is SHE discussed in management meetings?	V/1-5
4.28	To what degree is SHE discussed in management meetings?	V/1-5
4.31	To what degree does certification lead to more focus on the quality of SHE-activities?	V/1-5
4.38	Our SHE activities are very important!	V/1-5
4.39	SHE-activities are always discussed in operational meetings!	V/1-5
4.40	NC/UE are consequently recorded!	V/1-5
4.41	In relation to serious NC/UE, control measures are immediately implemented!	V/1-5
4.42	In relation to NC/UE, control measures are consequently implemented!	V/1-5
4.43	It is unacceptable that our employees neglect SHE-activities!	V/1-5
4.44	It is unacceptable for our employees neglect SHE-activities!	V/1-5
4.45	Our management consequently respond to neglection of SHE-activities!	V/1-5
Neighbours and mass media:		
4.48	How do you experience the relationsship to your neighbours?	V/1-5
4.49	What is the frequency of neighbours' complaints?	V/1-5
4.53	What is your characteristic of media reports?	V/0-5

Response scale:

All questions:
V=Don't know, D=Survey dropout, P=Partial dropout/question dropout

Most questions:
1=Very low, 2=Low, 3=Medium, 4=High, 5=Very high degree

Question 4.19:
1=Equal, 2=Quite egual, 3=Either-or, 4=Quite different, 5=Different

Question 4.38-4.45:
1=True, 2=Quite true, 3=Either-or, 4=Quite false, 5=False

Question 4.48:
1=Bad, 2=Quite bad, 3=Either-or, 4=Quite good, 5=Good

Question 4.49:
1=Seldom, 2=Quite seldom, 3=Either-or, 4=Quite frequent, 5=Frequent

Question 4.53:
0=Neutral, 1=Negative, 2=Quite negative, 3=Either-or, 4=Quite positive, 5=Positive

FC-survey – Respondents' comments

Resp. No.	3.1. Legislation (acts and regulations) and 3.2. Business sector agreements. Are they framework factors?
FCA	Acts and regulations give guidelines that we are obligated to follow according to the Internal Control Regulation. Legal changes make us improve and focus on new factors. Examples are new ships loader, changing from oil to propane. It's important to follow-up internal rules.
FC01	Acts and regulations are the foundation for our SHE-work. Internal rules are set at corporate level, so the plants deal with common rules and procedures. Special procedures at each plant are made only extraordinarily.
FC02	Acts and regulations being related to each others are not coordinated. The lack of such coordination is a critical framework conditions. You have for instance to relate to "Maskinforskriften", the Internal Control Regulation, "Veitrafikkloven", "Arbeidsmiljøloven", "Lov om fagopplæring i arbeidslivet", "kjøretøysforskriften", regulations from the Labour Inspection Authority etc. to operate production machinery. This list may become very long. Acts and regulations follow-up. Preventive health and safety work. The requirements to employees training programmes and documentary work have caused increased costs. Stricter rules related to dust- and noise emissions require control actions investments related to dust- and noise. Internal rules set follow-up requirements to everyone. Framework conditions could be better by coordinating acts and regulations. Corporate SHE requirements: Set and communicate requirements to both own employees and to hired personnel (external).
FC10	It's difficult to keep fully updated with regard to requirements in acts and regulations. In visits at the plant, representatives from the Labour Inspection and the fire brigade have called attention to missing documents. The authorities should be clever in informing what rules and documents that should be available. Heard about "regelhjelp", but has not visited the home page. Not able to evaluate the applicability for "our company". It's challenging to keep updated. New regulations seem to show up when adjustment to present regulations has been done. One example: Invested in a container (metal) for storing explosives to adjust to new regulations. According to new regulations coming one year later, this investment was not satisfactory, due to: 1) the walls of the container were too thin, 2) missing barbed-wire fence surrounding the storage and 3) missing warning installations. This container is not visible, and is placed behind a road barrier. Power supply to the required warning installations is problematic. Alternatives are solar cells or diesel oil generators.

FC-survey – Respondents' comments

Resp. No.	3.1. Legislation (acts and regulations) and 3.2. Business sector agreements. Are they framework factors?
FC11	To be able to relate to all SHE requirements given by acts and regulations, the enterprise must employ a separate person to work with these issues (minimum 50 %). A 50 % employment is an annual expense of 150000-200000 NKr. This is a considerable amount of money for our company. To push things to extremes, our company cannot afford this employment/expense. Because of break-ins to explosive storages, the authorities have changed the regulations for storing explosives (latest change was in 2006). For us required the regulations change investments in new storage with alarm systems. Investment costs were about 80000 NKr. For a period the requirements for storing explosives were not fulfilled in satisfactory way. Our new storage was ready for use in March 2007.
FC12	We don't feel that we are fully updated and have a complete overview over legislation related to the SHE situation, but our company has set objectives to keep a higher level than required. One example is acts and regulations related to licenses and working plans. New regulations should not cause different conditions of competition. The objective of the owners is to be in front of the legislative requirements. We have not tried "Regelhjelpen", and have therefore no experience with the tool. Internal procedures exist.
FC15	Treatment by the authority representatives varies, depending on who you are in touch with or are talking to. In addition has our corporation its own internal procedures and rules.
FC18	Too complex legislation. The extent of acts and regulations makes it difficult to keep an overview. The enterprise keeps updated by buying such service from our corporate main office. Legislation changing economical or SHE conditions are "the act related to greenhouse gas allowance allocation for the period 2008-2012" and the "regulation related to wastes handling". The latter gives requirements to continuous monitoring of gas discharges from combustion exhausts, discharge requirements. New requirements to noise emissions.
FC18 (contin.)	Allocation of emission allowances gave differences in treatment of operators due to the choisce of base years. At our company were the production level was low during the base year, giving a low number of free allowances. Appealing didn't give any changes. Differences in the treatment of "old" operating companies and new entrants to the system exist, provided that the present legislation proposal stays. Pool-enterprises cooperate and they are able to bypass the act. The present act is not good well founded when allowances are allocated to 46 enterprises according to exceptions clauses.

FC-survey – Respondents' comments

Resp. No.	3.1. Legislation (acts and regulations) and 3.2. Business sector agreements. Are they framework factors?
	The Norwegian Pollution Control Authority treats enterprises in a similar way. The enterprise experiences different treatment from The county governors. It seems to be different practice among the various County governors' offices. Discharge permits are already tough and difficult to manage. Expects further restrictions. "Maskinforskriften" section 5.5 introduces new rules with respect to the use of lifting equipment for people related to scaling of the hanging wall. Difficult to find approved equipment. Use of working time (hidden costs). Dispensations want be given from the Labour Authority. So far investment costs of 2.5 million NKr.
FC21	Experience of different treatment by representatives coming from the same regulatory authority. Depending on the person. "Bergvesenet" has disappeared, and more responsibility is transferred to the community and people without professional and technical knowledge related to mining. Community representatives commonly see problems everywhere and with everything. The internet site www.regelhjelp.no is useful. You may just put in your organisational number and the relevant legislation related to your business sector is being listed.
FC25	In our enterprise, it's a matter of course to follow-up acts and regulations. Our quality system takes care of all parameters within economy, environment, risk etc in a professional way (seriously running enterprise with reporting routines).
FC26	Legislation is something we have to relate to and try to act in conformance to. Internal rules: Clear responsibilities, predictable attitudes. Social dialogue: The rock type is not sensible to quartz.
FC28	Acts and regulations are fundamental for the implementation of the Internal Control System. Internal regulations are specific for each department and the single machinery being used.
FC30	CO_2 emission allowances and the Social dialogue agreement related to good practice in handling crystalline silica
FC32	The use of lifting equipment. New section within the Pollution regulation regarding operation of aggregates plants. Large enterprises get enhanced focus from the regulatory authorities when comparing with small enterprises (equal treatment by the regulatory authorities?). The small enterprises seem to get away with most issues.

FC-survey – Respondents' comments

Resp. No.	3.1. Legislation (acts and regulations) and 3.2. Business sector agreements. Are they framework factors?
FC33	Acts and regulations represent requirements that can not be neglected. Examples are emergency preparedness related to fire protection, oil pollution, air traffic and running a public airport. Our company experiences more intensive follow-up from the regulatory authorities due to enhanced risks related to the mining operations compared with other operations (The respondent has worked within the Labour Inspection) Due to content of quartz in the sidewall, does the social dialogue agreement related to silica require follow-up related to dust concentrations in the working atmosphere. Respirable dust from our mine may cause lung disease (pneumoconiosis).

FC-survey – Respondents' comments

Resp. No.	3.3. Economy: Is it a framework factor?
FCA	Important to gain a solid economical foundation to meet the future challenges.
FC01	We are following our approved budgets as all others. When that's said, I've never experienced getting "no" to exceed budget limits when measures are well substantiated.
FC2	A solid economical foundation and management focus gives good conditions for the SHE-work. Stricter rules and requirements to reductions related to dust and noise emissions have caused investment needs.
FC10	Reduced employers' national insurance contributions (payroll tax) give rather good economical conditions, except costs related to transportation and communication. Environmentally speaking, transporting products by train should be favourable, but the railway company has closed down this type of transportation, even though the side track exists. Our company allocates 150000 NKr for SHE-related objectives, and the employees participate in the decisions related to use of these means. Actual SHE-related costs are close to 200000 NKr.
FC11	Two years ago the economy situation was pressed. Our company wishes to invest in equipment making work operations easier.
FC12	Conflicts between economy and SHE issues exist. Sales income is about X mill. NKr, and the profit about 1/10 of the sales income. Investment costs related to a new lift table was about 4-500000 NKr which is a considerable part of our profit. We expect that this investment pays back through more healthy employees (from improved working positions and less repetitive strain injuries).
FC18	The regulation related to wastes handling requires continuous monitoring of dust and waste gas composition. The investment costs for monitoring equipment (dust and gas) was 850000 NKr. Additional costs are related to operating costs. Positive effects are better process control, maintenance of dust filter and reduction of emissions to the recipient (ambient air).
FC21	The enterprise attitude is that economical reasons shall not be prioritized at the sacrifice of health, safety and environmental (SHE) reasons. Safety is made the objective no. 1 and quality no.2. For instance, the "Maskinforskriften" sets requirements to controlling machinery annually, causing costs related to SHE. Following up the SHE situation costs and gives never direct payback. Payback comes through avoiding injuries.
FC26	Basic condition

FC-survey – Respondents' comments

Resp. No.	3.3. Economy: Is it a framework factor?
FC28	The enterprise has invested in a new production plant (totally 30.4 mill. NKr), where about 4 mill. NKr was used in air cleaning, lifting equipment and other measures to improve working conditions (New dust filter and washing plant).
FC32	Costs related to the latest legislation changes are not known for the time being. Rebuilding plants to be able to totally disable production equipment and production sections when doing maintenance operations.
FC33	An economical platform is necessary to be able to meet SHE costs. Safety is put first, not secondary to economy. SHE costs are related to legal requirements to emergency preparedness (airport, oil pollution, fire hazards etc) and the storing of explosives, new mining equipment investments and cost related to upgrading old mining equipment (about 30 mill. NKr), ventilation, dust reduction, reducing the explosion hazards, mechanical workshop investments and wastes handling. Defines **critical cost** as costs related to legal requirements. In this case the cost of emergency preparedness (20 employees/materials – 20 mill. NKr). Cost improvements may come from reduced sickness absence.

FC-survey – Respondents' comments

Resp. No.	3.4. Environment: Is it a framework factor?
FCA	Increasing focus from the society. Improve our daily life.
FC01	Discharge permits for emissions to ambient air and water, to keep in mind.
FC02	Stricter rules and requirements related to dust and noise emissions. Dust and noise emissions must be reduced.
FC10	Wrecked stone is put on a waste disposal site. The directorate of Mining has given requirements to a working plan. Dust, noise and vibrations are monitored.
FC11	Dust filters in the production hall. Dust containing quartz is emitted to external environment without any cleaning (dust removal). Long distance from the plant to the nearest living neighbour.
FC12	Ordinary wastes (house hold wastes) are not being sorted before disposal in separate container. Hazardous wastes are sorted. Luminous tubes and waste oil is handled properly. Waste oil is handled by the a hired maintenance company doing the routine maintenance of our vehicles/machinery. Mineral waste is disposed at a local wastes site in our quarry.
FC15	Dust, noise and vibrations have been monitored acted on our own initiative.
FC18	Dust from our process line is deposited in the sea. We have documented the dust content through chemical analysis. Reports are sent to the Norwegian Pollution Control Authority, SFT. New discharge requirements are expected, including requirements to land fill deposits. SFT evaluates the requirements based on our documented information. SFT experiences more pressure from external interest groups and must to a larger extent defend their decisions compared with previous situations. Mass media claims that the discharges of mercury from the process line will be reduced by changing the fuel. The main discharges of mercury are related to the limestone itself, not the fuel. The enterprise tries to get an approval for using the quarry area as a waste disposal site. There is a possibility of mixing dust from the lime kiln in lime products used in farming. Investigations show that deposited lime dust does not form big subsurface heaps below the discharge point. What happens with the dust? Does it remain suspended, transported by streams?

FC-survey – Respondents' comments

Resp. No.	3.4. Environment: Is it a framework factor?
FC21	Dust is problematic. A project has been made to remove dust from a drilling rig. Dust collector is being built. The collected dust is supposed to be sold to farmers. Water can not be used during winter time. Addition of chemicals is not possible to flotation disturbances (subsequent processing). Dust is being discharged to the water system (recipient). Amount of dust discharges are for the time being below the required levels, but the enterprise expects discharge restrictions. Mounds are being built to reduce noise discharges. Complaints have been made to fan noises.
FC22	No influence!
FC26	Limited discharges to air and water. Fines from the production are problematic (put on waste disposal site?). Sampling of water has been done by the local public health service. Waste handling routines exists.
FC27	Discharge permit for sewer to the local public sewage treatment system. Handling routines for hazardous wastes like waste oil, batteries.
FC28	Our enterprise pollutes the external environment to a low degree. Water from the production is discharged to water recipient (discharge permit). The enterprise has its own waste disposal site. Both SFT and the County Council Environmental Departments are regulatory authorities. The handling of wastes and hazardous wastes are according to present regulations (Procedures are described in the SHE manual.
FC30	Emissions to air. We monitor emissions of carbon dioxide, hydrochloric acid, sulphur oxides, nitrogen oxides, mercury, dioxine, dust
FC31	Monitoring dust and noise emissions to ambient air. Environmental impact from wastes disposal at sea. Solids, process water emissions etc. The monitoring programme applied to water emissions (wastes discharged to sea disposal site) is quite extensive.
FC32	Discharge permit are allocated by the authorities. Monitoring of mineral dust and quartz dust to ambient air and water is required. Mineral dust is emitted via process water.
FC33	Discharge permit requirements are strict. Requirements to emergency preparedness related to oil pollution. Requirements to wastes handling (household waste and hazardous waste). The reporting system related to discharge permits (administrated by SFT) is user-friendly to a low degree. Reporting is made via ALTINN. You need a set of password codes and accreditation to be able to do the reporting. A more flexible system should be applied. Emission to ambient recipients is mainly dust.

FC-survey – Respondents' comments

Resp. No.	3.5. Mineralogy: Is it a framework factor?
FCA	Map our resources to get a sustainable development for our quarries/mines.
FC01	The mineralogy is of importance to the degree of harm to health and environment. In our case we don't need to worry of impact to employees and external environment.
FC02	At our company are dust concentrations in the working environment measured annually. Both total dust and respirable dust are monitored (25.52005). Dust in working environment is bothersome, so far no documented hazardous effects (pneumoconiosis/silicosis).
FC10	Our feed stock contains quartz. Dust is then a working environment problem.
FC11	The production of slate is made from a quartz schist giving concentrations of quartz in the working environment. Dust concentrations were monitored. Quartz dust is emitted when the slabs of schist rocks are broken, not when split according to the layers of the schist. Brushing is not allowed. Cleaning is done by flushing with water. We have tried sprinkler systems but negative effect due to increased moisture content in the air.
FC18	Mineral dust are mainly a work environment problem
FC22	Traces of fibres and asbestos minerals.
FC26	Granodioritic gneisses, dolerite, gabbro and diorite. Quartz occurs as big grains 0.5-2 mm. The social dialogue agreement related to silica and quartz is not implemented. We intend to get informed and familiar with the agreement terms.
FC27	Feed stock is mainly gneisses with pegmatite veins and beryl. The content of quartz and fibre minerals is not known. Does not know about the social dialogue agreement related to crystalline silica.
FC28	The feed stock contains large amounts of quartz. Keeping the concentration of dust in the working environment within acceptable levels is quite a challenge. Dust concentrations in the working environment are monitored.
FC32	Different types of rock material depending on location of the plants. The content of quartz varies a lot depending on rock type and location. Our company works with implementing the social dialogue agreement related to silica. Training has been done at some plants. Some plants are still waiting for this training.

FC-survey – Respondents' comments

Resp. No.	3.5. Mineralogy: Is it a framework factor?
FC33	Quartz is present in the sidewall and may contaminate the product. The quartz content is not known. Respirable dust from our feed stock may cause lung diseases (pneumoconiosis). Regular follow-up routines connected to dust concentrations in the working environment and employees health check-ups.

Resp. No.	3.6. Risk: Is it a framework factor?
FCA	Risk evaluation is important in the preventive work including knowing which challenges we are up to. We assess risk levels for personnel, materials and external environment. Assessment is made as group work (personnel safety representatives, managers) coordinated by the SHE department.
FC01	Based on risk assessment, lists of control measures, use of protection equipment, procedures for special work operations are being made. All departments do risk assessment. Risk assessment are made by work groups each third year at each department.
FC02	Our companyt must train employees to consider risk and attitudes to risk. Risk assessment is made by each department and generally at each plant. Risk assessment is made systematically for work operations and work areas and done by local management, employees and personnel safety representatives.
FC10	Risk assessment related to fire hazard is made to a separate procedure (matrix form). Risk assessments made within the quarry are made as common sense type evaluations. On the last general meeting the issue of driving truck in the hallway was discussed and a set of internal rules/regulations have been made based on this discussion.
FC11	Risk assessments are made continuously, but not formally as a risk assessment event. No one is deciding that now we're going to do a risk assessment. We try to use common sense and reasoning. Risk is assessed especially within the quarry, but also in the production elsewhere. For instance: If someone is going to bring a sheet, this person decides whether a forklift is needed or if the sheet may be lifted by the person himself. The latter involves muscle strain risks. We have never experienced serious injuries. Risk is assessed continuously and our employees are experienced and know what may happen.

FC-survey – Respondents' comments

Resp. No.	3.6. Risk: Is it a framework factor?
FC12	Risk assessments (Safety Job Analysis, SJA) have been done in the quarry and for outside areas and slate tips. Risk is assessed for special work operations, for instance scaling, and at the slate tip.
FC15	Risk assessment is made on issues related to ambient environment and production processes. Job Safety Analysis (SJA) is used on large operations.
FC18	Risk evaluations are made in relation to external environment (annually), work operations and extraordinary projects, during safety visits to the plant and SHE audits related to procedures. Risk evaluations are documented.
FC21	Subsurface mining operations incorporate inherent occupational hazards (risk) being different to other industrial activity. That's life and has to be expected and accepted. Risk evaluations are being made on operations like crushing, drilling, blasting and so on. Risk evaluations are being made individually (SESAM). In addition risk evaluation are being made by making a matrix giving risk numbers based on probability/frequency and consequence evaluations. Consequence evaluations may consider economical factors like cost.
FC22	Risk evaluations are related to dust in the working environment (monitoring dust concentrations)- The impression over time is that new employees are more exposed to injuries compared to long time and more experienced employees. This despite good quality safety training and the fact that new employees are working together with experienced workers. We do put quite some effort in safety training, for example going through the internal control system files including instructions etc., safety training records (machinery and equipment), personnel safety representatives safety training etc.
FC25	Our own reporting system.
FC26	Working environment – employees are checked (lungs, x-ray monitoring). Risk is related to unanticipated public conditions and distortion of competition. Employees' low absence and job satisfaction indicate a low risk level.
FC27	Safety prioritized related to large slopes (bench heights). Protection equipment being used. Follow up procedures. Dust reduction by using salt and water sprays. Control actions related to changing wearing plates in the coarse crusher. The plate weight is 3 tons. Risk evaluations for working operations are made by filling in two forms. In the first form the risk number is found by giving numbers to both probability of an incident (What may happen) and the consequence on a scale from 1-3. The risk number is found by multiplying the probability and consequence numbers, ranging from 1-9. In form 2 the incidents, their corresponding risk numbers

FC-survey – Respondents' comments

Resp. No.	3.6. Risk: Is it a framework factor?
	and proper control actions are being filled in and prioritized. An example related to the course crushing unit was enclosed.
FC28	Risk assessment is made routine and according to decided plans. Assessments is made in cooperation with the occupational health service.
FC30	ROS-analysis, Safety Job Analysis, Risk evaluations of ny fuels and raw materials (feed stock). Projects – always SHE work groups and risk evaluations.
FC32	Risk assessments/evaluations are being updated each third year or when needed. There are improvement potentials related to doing Safety Job Analysis. Risk assessment made by standard procedures by trained employees.
FC33	Risk assessments are made as Safety Job Analysis and ROS-analysis.

Resp. No.	3.7. SHE management: Is it a framework factor?
FCA	This is important. Management is role models.
FC01	Without management focusing on SHE issues, the SHE work will not be functioning properly. Management focus is needed.
FC02	Our enterprise has its own SHE department as part of the organisation.
FC11	Our employees work independently, show responsibility for each other and consider safety. If someone starts to sweep/brush, the other tell him to stop. The management functions are mainly to follow-up and keep the eyes open. General manager spends time on making work operations more effective and the working day as easy as possible for our employees. The objective is to avoid health impacts. The well being of our employees are considered very important. A lot of our employees were previously lumbermen. Working shifts have been the replacement. To our experiences an easy working day and well being increases productivity.
FC15	The management is responsible.

FC-survey – Respondents' comments

Resp. No.	3.7. SHE management: Is it a framework factor?
FC22	No accreditations
FC26	No separate focus on SHE-management especially, responsibility for SHE is delegated to each department. SHE objective lists are not being made, tried to implement but no one takes the responsibility. General manager performs the SHE follow-up. SHE is part of the agenda at meetings.
FC27	The responding persons SHE working time is spent on two yearly SHE meetings, training and weekly safety visits to the plant. The SHE objectives are fully integrated in the operations.
FC28	SHE schedule containing control actions/measures are made at each department and corrected yearly. SHE issues are fixed on the management meeting agendas.

Resp. No.	3.8. SHE systems: Is it a framework factor?
FCA	Systems are important to keep overview and as support.
FC01	Our SHE system is made part of our quality systems, and is the basis of all SHE work at our corporation.
FC02	Our SHE system is comprehensive. Follow-up through the Internal Control System.
FC11	A loose-leaf binder was made for the internal control system (SHE system). Every issues were documentary work are required according to the Internal Control Regulation are not documented. Written records of nonconformances/undesired events were previously required by the management, but now a days are the nonconformances reported orally and handled immediately (no written documentary work).
FC12	We don't feel fully updated related to legal requirements concerning the SHE situation, but our enterprise has set objectives to keep a higher standard than required. In our view is good performance related to SHE issues an advantage and a competitive factor.

FC-survey – Respondents' comments

Resp. No.	3.8. SHE systems: Is it a framework factor?
FC12 (contin.)	SHE is important for our corporation. SHE engineer visits our plant monthly. We report nonconformances and undesired events related to the SHE situation. The employees have preprinted notepads for reporting nonconformances and undesired events. Several employees with backs causing pain. To avoid further injuries was a lift table ordered as a response to the records of nonconformances. Generally are control actions performed immediately.
FC15	Our SHE system is designed to meet the public requirements.
FC21	Our enterprise has established an SHE system based on internal control (IK). Activities shall be documented. So far is the environmental management system ISO 14001 not considered and has not been implemented. The enterprise does not use the conception "non-conformances", but uses instead the conception "undesirable event" (UE).
FC26	A bit ambitious to characterize it as a safety, health and environmental system. No accreditations (ISO 9001, ISO14001, EMAS).
FC27	The enterprise is not approved with regard to the standards ISO 9001, ISO 14001, EMAS or Miljøfyrtårn. Approvals are connected to production quality standards related to aggregates (NS-EN 12620 (concrete aggregates), NS-EN 13242 (road aggregates) and NS-EN 13043 (asphalt aggregates). The requirements related to the above standards are related to 1) organisation, 2) procedures related to product control, 3) product management, 4) product testing, 5) documentary work, 6) non-conformance products, 7) handling, storage and further product treatment, 8) transport and packaging and 9) personnel training. Annual audits by representatives from the "Kontrollrådet", checking the production control system. All aggregates producers are supposed to follow this system.
FC28	No certifications (ISO 9001, 14001, EMAS or "Miljøfyrtårn"). To little focus on non-conformances and undesired incidents (UE).
FC33	Internal Control System. Accredited according to ISO 9001. ISO 14001 is relevant and may be implemented within two years time. Our company has so far experienced one customer request about ISO 9001. A new system, containing modules related to database storing of procedures and recording undesired events/non-conformances, has

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Resp. No.	3.8. SHE systems: Is it a framework factor?
	been implemented (Windows Sharepoint based system).

Resp. No.	3.9. SHE competence (knowledge and experience): Is it a framework factor?
FCA	Understanding the importance of SHE and why is important
FC02	Formal education, training, long work experience both internally and externally. Continuous SHE training and focus on behaviour.
FC10	Our company was the first local enterprise joining the Cooperation Agreement on a More Inclusive Workplace (IW). New employees get more easily injuries from squeezing compared with experienced employees.
FC12	Employees with extended responsibility related to SHE have been trained (40 hours SHE training)
FC21	Personnel safety representatives are being trained. Employee turnover leads to training needs. All employees should get safety, health and environment (SHE) training (the standard 40 hours SHE courses)
FC26	No SHE competence objective list, but such lists exists for machinery training. Employees answer well to practical SHE related questions
FC28	Personnel safety representative and management at all levels are trained according to requirements. Create a positive attitude to SHE among personnel safety representatives and middle managers.

Resp. No.	3.10. SHE-culture: Is it a framework factor?
FCA	Our SHE culture is a driving force in SHE activities. It makes us focus on the correct things.
FC02	

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Resp. No.	3.10. SHE-culture: Is it a framework factor?
	A continuous process.
FC10	Our impression from participating at safety protection training is that our company has developed a good safety culture.
FC15	Applying control actions to all reported nonconformances is an objective at our company. Control actions are always applied to non-conformances classified as serious incidents. In addition such nonconformances require an investigating committee.
FC26	A good work environment makes no need for discussing SHE issues. No undesired events needed to be reported. Takes care of serious non-conformances immediately. Control actions related to nonconformances are done.
FC27	The cooperation between the employees are very good and likewise the relation to the management (marked as a framework condition, score 5). Employees follow up procedures and use protection equipment.
FC28	Too few non-conformances are reported.
FC33	The SHE culture can be described as good. At our company is it important to make people feel comfortable and make the threshold to report undesired events low. One comment to management response to internal rules violations related to no use of protection equipment was that you may know the employee well and it's not easy to respond in all cases (important factor!).

Resp. No.	3.11. Neighbours: Is it a framework factor?
FCA	To get a good reputation. We want to stand out as conscious related to society and environmental issues.
FC01	Our plant has no neighbours living close to our plant objecting to our SHE activities. The distance to the nearest neighbours is several kilometres.
FC02	We wish to have god relations and dialogue with our neighbours.

FC-survey – Respondents' comments

Resp. No.	3.11. Neighbours: Is it a framework factor?
FC12	No neighbours living nearby. The closest residential property was bought by the enterprise in 2003.
FC21	Both close and more remote neighbours. One of the neighbours is particularly discontented with the location of the enterprise and may be characterised as an opponent to our enterprise (conflict situation).
FC26	Works continuously to keep good relations to the neighbours. No one likes an aggregates plant as their neighbour, but the relations to the neighbours are good. Information meetings were made before establishing the enterprise activity, not later.
FC32	The distance to the nearest neighbour is not reported. Difficult, because the respond is made collectively for 12 different plants. Likewise the relation to the neighbours varies and is characterised as "very bad" to "very good" due to plant locality.
FC33	Variable distances to our neighbours. Complaints are mainly related to dust emissions. Information is usually presented by the local newspaper.

Resp. No.	3.12. Mass media: Is it a framework factor?
FCA	Important to keep a good cooperation with mass media.
FC01	Our plant has never experienced mass media reports related to SHE situation.
FC02	Mass media contributes in making our enterprise known. An information channel to society. Mass media is difficult to influence.
FC10	No reports in mass media.
FC18	Handling mass media requires a lot of work. If you know what you are doing, you'll survive the media interest. A recent reader's letter demonstrates that this particular newspaper reader is not satisfied with the propaganda against our company.
FC21	No experience of mass media as a framework condition as the situation is today. The enterprise is regularly being referred to in the local newspapers. The reports are both positive and negative but dominantly negative. Someone should write about the importance of

FC-survey – Respondents' comments

Resp. No.	3.12. Mass media: Is it a framework factor?
	mining to society and about sustainable development within the mining business sector.
FC26	We try to be honest and credible. Usually are the mass media reports positive.
FC27	Media attention regarding a new local development plan and connected to emissions of dust, noise and vibrations.
FC28	The relations to mass media and local news papers are clear (orderly). Generally are the reports positive. Serious accidents at the enterprise have got attention in mass media. Approximately 25 reports per year all together.
FC32	A total of 12 different plants. Mass media references vary from "being praised" to "negative (critical)".
FC33	For the time being are we more restrictive to giving statements in mass media, less restrictive previously. Most references are given by the local newspaper.

Resp. No.	3.13. Enterprise reputation: Is it a framework factor?
FCA	We investigate reputation by doing surveys, to define improvement potentials.
FC10	A good reputation is necessary when recruiting new workers and in relation to the local authorities.
FC12	We want to gain profit, but not big profit over short time. Handling of previous slate tips got positive references.
FC18	Important with regard to the local society and the authorities.
FC21	It's important for the enterprise to be considered as a safe and serious working place for its employees and the society. This means that the enterprise have to behave decent/respectable. Think about how your employees apprehend and describe the enterprise and their work place.
FC26	We hope that our reputation is positive. You have to ask others.

FC-survey – Respondents' comments

Resp. No.	3.14. Society/ Society acceptance: Is it a framework factor?
FCA	We are running quarries/mines. It's important to follow-up.
FC02	All enterprises need society acceptance. A challenge to keep updated.
FC10	A good reputation is necessary when recruiting new workers and in relation to the local authorities (same as reputation).
FC21	Cf. the enterprises reputation. Most people don't know the significance of the Norwegian mining industry (mineral extraction industry). Someone should try to inform people about the significance. Someone should also inform the public that the Norwegian mining industry acts in a serious way and tries to be as sustainable as possible. Areas are claimed protected zones even though containing mineral resources that preferably could have been extracted, giving development, welfare and work places, are protected to such activity (respondent gave example/reference to a local area).

Resp. No.	3.15. SHE monitoring tools or indicators: Is it a framework factor?
FCA/ FC02	Injuries are being reported when they cause absence from work (25.5.2005). Monitoring parameters are important with regard to finding improvement potentials.
FC10	The number of injuries with absence is not counted. The enterprise looks on the total number of injuries.
FC12	We are implementing new routines for recording sickness absence. The sickness absence calculations were done wrongly before. Some absence due to treatment for small injuries, health checks etc.
FC18	Sometimes customers want make business with enterprises showing that their internal control system is not functioning properly. Cheating with SHE indicators like LTI-rates and severity rates are common.
FC21	Lost Time Injury (LTI) frequency values are not being calculated for the time being. The last injury happened 1277 days ago. Sickness absence ratio is 4-5 % (per 6. June 2007)

FC-survey – Respondents' comments

Resp. No.	3.15. SHE monitoring tools or indicators: Is it a framework factor?
FC22	The impression over time is that new employees are more exposed to injuries compared to long time and more experienced employees. This is despite good quality in safety training and that new employees are working together with experienced workers. We do put quite some effort in safety training, for example going through the Internal Control System files including instructions etc., safety training records (machinery and equipment), personnel safety representatives safety training etc.
FC25	The injury in 20XX didn't cause any absence.
FC26	Normative for our control actions. The sickness absence is rather low (1.61 % in 2008, previously as in 2008) and we have few non-conformances related to SHE. No injuries, and hence no LTI-values being documented.
FC27	No injuries during 2007 and 2008, and hence no LTI-rates to report.
FC28	In 2007: 5 injuries causing absence. In 2008: 9 injuries causing absence.
FC30	The 2007 severity rate is 95, while the 2008 severity rate is 79.
FC32	Sickness absence numbers and LTI-values (except LTI 2008) are not reported. Require to much work to collect data according to the respondent.

FC-survey – Respondents' comments

Resp. No.	3.16. Protection equipment: Is it a framework factor?
FCA	Important to use in our daily work. Rules exist for the use of protection equipment. There exist other and more critical framework conditions for our enterprise.
FC02	All employees have their minimum level personal protection equipment available (helmet, protective footwear and protective googles).
FC10	Applied protection equipment (dust masks, hearing protection) works well.
FC12	Protection equipment is important against dust containing quartz in the working environment. Dust protection is not prohibited.
FC18	In my opinion, there are other more important and critical factors or framework conditions within my enterprise.
FC21	Protection equipments are functional. The use of personal protection equipment is prohibited.
FC25	Hearing and respiratory protection equipment is required in predefined zones.
FC26	The employees are sometimes a bit careless with regard to wearing helmets.
FC33	Visible working clothes (containing reflexes) are required.

Resp. No.	3.17. Communication: Is it a framework factor?
FC2	Communicate enterprise SHE work both internally and externally (to society).
FC26	Informal and direct. Open with regard to the enterprise results.

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Resp. No.	3.18-3.23 Enterprise remarked framework factors
FCA/ FC02	**Knowledge and availability of resources:** Important framework conditions. **Personnel:** Committed colleagues/co-workers being aware of how important the SHE work is. **Role modelling:** Management, line management, SHE personnel and employee representative should be role models and set requirements. **Employee participation:** All employees should participate. Set requirements. **Employee representatives:** Increase their status. Set requirements. **Communicate enterprise SHE work:** Internal and external (to society). **Corporate SHE requirements:** Set and communicate requirements to both own employees and to hired personnel (external). **Society requirements:** A challenge to keep updated. The legal framework could be better by coordinating **acts and regulations**.
FC10	**Vibrations:** Air driven working tools should be dampen to a larger extent. Vibrations may cause "vibration white fingers" The producers of such equipment seem not to put much effort in developing more dampened tools.
FC12	We experiences difficulties recruiting employees to our profession.
FC21	**Working environment:** Dust collectors. Important, believes that dust reductions will gain increased importance during time. About vibrations, see below! **Vibrations:** Monitoring operator exposures to vibrations, based on requirements given within the "Maskinforskriften". No one is able to define which level of exposure that causes danger of health injuries. Monitoring was made by the enterprise by using rented monitoring equipment. Monitoring equipment and PC communication problems (monitoring data transferring problems) was being experienced.
FC26	**Climatic conditions:** Only marked as a framework condition, no further comments.

Appendix 5

List of corrections

Page	Correction
11	First paragraph: “unnelling” are corrected to “tunnelling”.
37	Second paragraph: Bullet points in listing are replaced with “*v*”. Missing full stops (dots) are added.
53-54	Listing of framework factors: Italics in factor names were removed and factor names are underlined. Missing full stops are added.
57	Second paragraph: Added a line feed between first and second paragraph. Due to the extra line feed, the last paragraph of page 58 becomes the first paragraph of page 59.
58	First paragraph: … appendix 3A)-D) was changed to …appendices 3A-3D.
71	Last paragraph – Listing of framework factors: All factor names except SHE-management were underlined. “SHE-management” are corrected to “<u>SHE-management</u>”.

Trondheim August 14th, 2012
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