GENDER, DIVERSITY AND WORK CONDITIONS IN MINING

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Abstract

Swedish mining companies and surrounding mining communities face many challenges when it comes to social sustainable development. For example, a strong mining workplace culture and community identity can create both strong cohesion but also lead to exclusion of certain groups, rejection of new ideas and reinforce traditional, masculine values. Other challenges include recruitment, as well as health and safety in relation to an increased use of contractors and automation of mining. The social dimension is relatively underdeveloped in studies of sustainable development in general and the mining industry in particular. This report reviews research on social sustainable development and mining with a special focus on (1) diversity of lifestyles, (2) gender, and (3) work conditions. Swedish and international research is reviewed and knowledge gaps are identified. All three areas of research can be regarded as relatively mature and they give important contributions to our understanding of social sustainable development in relation to the mining sector even if they not always explicitly refer to it as such. There is a lack of research that links attitudes, policies and activities within companies to their impact on the wider society, and vice versa. Future research should also include the development of methods and indicators for social sustainability relevant for mining.

Preface

Minerals are essential for human welfare. However, their extraction is associated with both opportunities and challenges. Historical concerns around work conditions and the competitiveness of the mining sector have been complemented by a growing number of other issues. Today, an overarching goal is to find ways by which the mining sector can promote sustainable development.

Sustainable development is often defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Furthermore, it is commonly agreed that this must incorporate economic, environmental and social concerns.

There is a growing literature that examines the relationship between extractive industries and sustainable development, yet much research is still conducted in a siloed fashion. For this reason, the Swedish stateowned iron ore mining company LKAB and Luleå University of Technology initiated a pre-study with the aim to establish a new multidisciplinary research programme on mining and sustainability.

The pre-study was conducted from January to October 2014¹. One part of the pre-study was to review existing research attempting to address mining and sustainable development – the current state-ofthe-art – with focus on the past, present, and future situation in Sweden, but also to put the Swedish case into a broader perspective by comparing several international examples.

One of the outcomes of the pre-study is this report. It reviews research on the relatively underdeveloped social dimension of sustainable development in mining. Focus is on three areas of social sustainable development: diversity of lifestyles, gender, and work conditions. The report highlights a number of future research needs. Four other reviews have also been undertaken as a part of this pre-study. :

- *Making Mining Sustainable:* Overview of Private and Public Responses, by Petter Hojem from Luleå University of Technology.
- *Environmental Aspects of Mining*, by Anders Widerlund and Björn Öhlander from Luleå University of Technology and Frauke Ecke from the Swedish University of Agricultural Sciences.
- Environmental Regulation and Mining-Sector Competitiveness, by Kristina Söderholm, Patrik Söderholm, Maria Pettersson, Nanna Svahn and Roine Viklund from Luleå University of Technology and Heidi Helenius from the University of Lapland.
- Mining, Regional Development and Benefit-Sharing, by Patrik Söderholm and Nanna Svahn from Luleå University of Technology.

Together these provide a broad picture of the challenges and opportunities created by mining.

The pre-study has been made possible through a generous contribution from LKAB. All errors and opinions expressed in this report belong solely to the authors.

Luleå, October 2014

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1. Introduction

The social dimension of the sustainability concept is relatively underdeveloped compared to the environment and the economy, both when it comes to sustainable development in general and the mining industry in particular. Social sustainable development is a complex and large concept and quite difficult to cover in a report like this without ending up on a quite abstract level. In order to be as concrete as possible we have chosen three areas of research: diversity, gender, and work conditions. These areas can be regarded as relatively mature and they give important contributions to our understanding of social sustainable development in relation to the mining sector, even if they not always explicitly refer to it as such.

1.1 Background

Swedish mining companies and the surrounding mining communities face a broad range of practical challenges that provide both possibilities and obstacles when it comes to social sustainable development. The mining companies and communities in Sweden, to varying degrees, share these challenges with mining companies and communities in Australia, Canada, and several other similar countries. For example, mining often takes place in rural districts where regional growth depends on mining (as well as forestry and steel). Many of these districts are home to indigenous people and highly-valued natural areas and they are characterised by "old-fashioned" cultures (at least in the regions' self-image and even more so in the image of the world outside), low education levels (especially among men), depopulation (as women and young people are moving away), stagnation, downsized welfare services and a low level of activity in other sectors (trade, housing, communication, and infrastructure), as well as a gender-segregated labour market with a low degree of differentiation. Some of these problems, however, are offset by more positive trends such as a low level of unemployment, new investments in housing and infrastructure, growing entrepreneurial activity, and an emerging diversity of lifestyles. Handling this complex situation requires dealing with a complex demographic challenge: how can mining companies (and communities) attract

enough people, especially young women, to live and work in these societies? Because the recent mining boom has led to an increase in activity in businesses and industries that have long been dominated by men (and hence have a social milieu with a strong focus on men and masculinity), the risk is that the future will continue to present the same social problems already seen. A challenge for the mining societies is to break up the unequal gendered structure of the local labour market as well as to support a diversity of lifestyles and an open culture, changes that also require an open business climate.

The problems facing the communities can also be found within the mining companies themselves. Positive market trends, global competiveness, and new production and technology demands (e.g., deeper mines and more automation) mean that the mining industry will need to attract skilled labour. In addition, the mining industry will need to develop better expertise, skills, organisational strategies, work environments, and technologies based on social-technical principles and a holistic perspective. In other words, the industry will need to realise lean, effective, and safe mining production. The situation also places the mining industry in need of infrastructure upgrades (social, health, transport, energy, etc.), developing strategies for work organisation, health, and safety as well as accommodating fly-in/fly-out² workers and contractors. Mining companies have consistently ex-

² "Fly-in/fly-out" refers to arrangements by which employees commute to mines, often over long distances, in order to work for a number of days at a time before returning home for rest.



Source: Boliden

pressed a need to be innovative and efficient with respect to productivity as well as to be environmentally friendly, resource and energy efficient and provide a good, attractive, and safe work environment. All these goals may hinge on creating a better way to manage and respect different cultures, a goal that will require a high level of social dialogue. Such a development should help mining companies improve their cultural image, a growing concern for the sector. Despite technological progress that has already provided better economical, ecological, and safe exploitation of raw materials, over the last years there has been an increase in sceptical attitudes towards mining, even in areas that have traditionally been supportive of the industry.

For sustainability to be realised, political discourse needs to move beyond rhetoric; it must also be practically related to the needs, possibilities, and limitations associated with environmental and social realities. To this end, the mining industry needs to define its relevant social priorities. Of course, this is easier said than done. Some trends can be contradictory as what is positive for one process may be negative for another and what is positive for one stakeholder may be negative for another. Even for the individual stakeholder there might be contradictions, albeit sometimes the stakeholder may not even be aware of this. To understand this complex picture and make socially sustainable optimisations, we need to sort out which social priorities and practical constraints from various stakeholder perspectives are relevant in a mining context. This approach, once established, can then form the basis for changing mining companies as well as their surrounding societies, a strategy that should help balance stability and change in the whole system. The existing body of knowledge rarely and insufficiently deals with the interactions between the mining industry and social life around the mines. The latest international reports on mining and sustainable development often list benefits for the community as "further challenges". The lack of knowledge on impact that the mining industry has and can have on the local community is a especially underdeveloped if compared to economical or ecological impact,

1.2 Definitions of social sustainable development

although this is slowly changing.

An oft-cited definition of sustainable development originated in *Our Common Future*, also known as the *Brundtland Report* (United Nation's World Commission on Environment and Development, WCED, 1987): "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The definition covers environmental, economic, and social aspects of sustainable development. The Brundtland Report focuses on human needs: "the satisfaction of human needs and aspirations [should be] the major objective of development" (p. 43). There has been some criticism of the Brundtland definition and the sustainable development agenda as a whole. One extreme criticism is that sustainable development, when defined vaguely to meet the needs of all stakeholders, is a smokescreen behind which business can continue their operations essentially unhindered by environmental concerns, especially in poverty-stricken areas (McKenzie 2004).

The Final Report of the Mining, Minerals and Sustainable Development Project (2002) identifies the main sustainability challenge for the mining industry as "to clearly demonstrate that it contributes to the welfare and wellbeing of the current generation, without compromising the potential of future generations for a better quality of life" (Azapagic 2004). Social aspects of sustainability are studied and addressed less than economic and environmental ones, at least until recently. Social sustainability is a relatively new term that became widely used in international research in the early 2000s. Over the last decade, different definitions have been discussed and reviewed. These debates have resulted in social sustainability being considered as a positive condition when a society or group meets certain sustainability criteria. More often, obtaining social sustainability is seen as a goal that requires considering many aspects. The process of reaching certain social changes is another way of understanding sustainability. These different aspects provide a means for measuring whether social sustainability is decreasing or increasing.

According to Dempsey et al. (2011, p. 291), the scientific literature has identified several aspects of social sustainability in urban environments. These aspects fall under the general headings of non-physical factors and predominantly physical factors. Non-physical factors include the following subcategories: education and training, inter- and intra-generational social justice such as participation and local democracy, health, quality of life, well-being, social inclusion and eradication of social exclusion, social capital, community, safety, mixed tenure, fair distribution of income, social order, social cohesion, community cohesion between and among different groups, social networks, social interaction, sense of community and belonging, employment, residential stability vs. turnover, active community organisations, and cultural traditions. Predominantly physical factors include the following subcategories: urbanity, an attractive public realm, decent housing, local environmental quality and amenity, accessibility (e.g., to local services and facilities, employment, green spaces), sustainable urban design, and walkability of neighbourhoods (i.e., pedestrian friendly).

Focus on the mining industry and its possibility to influence social life brings another perspective. The Global Reporting Initiative (GRI) has proposed several general indicators for social sustainability for mining companies: no bribery and corruption, creation of new/more employment, equal distribution of revenue and wealth, employee education and skills development, equal opportunities and non-discrimination, health and safety, human rights and business ethics, stable shareholder value, good labour/management relationship, good relationship with local communities, stakeholder involvement, and equal wealth distribution (Azapagic 2004, p. 644). Social sustainability concerns, however, require a focus on company employees to a greater extent than what the mining companies are encouraged to report. In many mining districts, a mining company employs so many people that its influence extends to the community itself.

McKenzie (2004) highlights the need to define social sustainability not only as an add-on or facilitator to environmental or economic concerns but also as an independent field of study. This perspective focuses on social sustainability as a life-enhancing condition within communities and as a process within communities by which it can achieve that condition. Social sustainability occurs when formal and informal processes, systems, structures, and relationships actively support the capacity of current and future generations to create healthy and liveable communities. Socially sustainable communities are equitable, diverse, connected, and democratic, qualities that encourage a good quality of life. In addition, McKenzie (2004) argues that the lack of a coherent definition of social sustainability is not something that should be derided or bemoaned, but rather accepted as a natural part of the sustainability agenda. He argues that although discussion over definition is certainly fruitful, pragmatic concerns about the need for collective understanding and cohesive research results need to be considered in an extensive and multidisciplinary approach.

Drawing on, for example, McKenzie (2004) and Dempsey et al. (2011), this report views social sustainability for mining companies and their surrounding communities as providing social, cultural, and economic advantages for both women and men, for a broad variety of people, for different types of businesses and sectors of the labour market, as well as for the natural environment. Social sustainability from the individual's perspective can be described as a possibility to live fruitful, meaningful, and happy lives. To obtain this goal, we believe both women and men should have the opportunity to participate and influence their work, social lives, and private lives through a healthy working life, economic advantages, and cultural and social growth in a broader sense both at and outside work. In our definition, we also include social sustainability from society's perspective (i.e., society should provide a good balance between stability and change). To satisfy these definitions requires building a long-term stable and dynamic society where basic human needs are met and where all groups are offered good opportunities. One way of ensuring this is to develop technologies, organisations, and systems where humans are at the centre of development and innovation. Here we include operations and management practices in the mining companies that are compatible with the above-mentioned social aspects such as good employment opportunities, health, safety, gender equality, learning, and diversity of cultural expressions. Hilson and Murck (2000) identify aspects of sustainability that can be improved by and in collaboration with the mining industry.

Ecological sustainable development in mining (green mining) is often described as invisible, zero-impact mining that leaves as few footprints as possible in nature. It is very much a question of protecting, preserving, and restoring. When it comes to the social dimension of sustainable development, on the other hand, it is almost expected that a mine should leave a footprint (i.e., it should not be invisible or not have zero-impact during operation or after closure). Rather, a mine should contribute to a dynamic society where it is possible to live and prosper. Determining how social sustainability affects the mining industry as well as the social life of the local communities requires developing a model that can assess changes. Comparison over time plays a special role in social sustainability because the temporalities of social sustainability may differ from those of ecological sustainability. Social sustainability is not about preserving or restoring the same cultural and social landscape for future generations or the necessity of perpetual growth of the specific local societies surrounding the mines. Social sustainability is about creating a dynamic and inclusive society here and now. Social sustainability also includes a longer time frame and wider geographical area. That is, communities and mining companies need to be prepared for mine closures and other major changes in the mining operations by, for example, positively responding to the challenge of dismantling communities that may require moving people, buildings, and businesses to other cities or areas in the region while still maintaining a social sustainable development in the larger region. Case studies on social dynamics associated with the mining industry recommend this type of long-term planning (Lansbury & Breakspear 1995).

1.3 Method

Our data mainly comes from reviewing articles in international scientific journals, but we also reviewed some research reports, national as well as international, and some conference papers. For the literature overview, a broad search in scientific databases was conducted based on keywords as well as a pre-reading of international documents such as the final report of the *Mining, Minerals and Sustainable Development project*. Scientific databases such as Web of Science, PRIMO, ProQuest, Scopus, and Google Scholar were used and some subject guides within geoscience under Arctic and Antarctic regions were used. The main focus was on recent research (released after the 2002 *Mining, Minerals and Sustainable Development* report), but to some extent also earlier works were used to gain a broader understanding of the previous scientific context. The chosen studies are mainly from a Swedish context as well as from other developed countries like the US, Canada, Australia, the UK and various European countries. Some studies from South America and India were also included in the reading scope.

1.3.1 Key words used in the literature search

Diversity of lifestyles

 mining (used throughout the search), social, sustainability/ sustainable/sustainable development, community, town, city, area, CSR, cohesion, inclusion, demography, migration, lifestyle, fly-in/fly-out, built environment, housing, leisure, culture.

Gender

mining, mine, work, work organisation, work environment, society, sustainability, social sustainability, sustainable development, gender, gender equality, women, men, masculinity.

Work conditions

 mining, mines, organisation, sustainable, sustain, development, develop, occupational health and safety, occupational safety and health, ergonomics, safety, work environment, epidemiology, fly-in/fly-out, International Institute for Sustainable Development (IISD), Mining Association of Canada (MAC), International Council on Mining and Minerals (ICMM), Mining Minerals and Sustainable Development (MMSD), Whitehorse mining initiative. The keywords were occasionally limited to abstracts, but sometimes we searched the entire article. Two main approaches were taken during the research. One way was to study research on social sustainable development in relation to, and in accordance with, a good work environment, gender, and diversity. The other approach was to do the opposite: to study research on good work environment, gender, and diversity in relation to social sustainable development.

1.4 Disposition of the report

The report has four main parts:

- mining and diversity of lifestyles (social cohesion, housing, migration etc.);
- mining and gender (women in mining, men and masculinity, gender and organisational change, gender equality);
- mining and work conditions (work environment, work organisation, safety, labour market, new technology, etc.); and
- framing mining sustainability aspects of gender, diversity, and work conditions (summary and suggestion for future research).

Lena Abrahamsson wrote the chapter on gender and was the editor for the whole report. Eugenia Segerstedt wrote the chapter on diversity. Magnus Nygren, Bo Johansson, Jan Johansson, Joel Lööw, Ida Edman, and Amanda Åkerlund have contributed to the chapter on work conditions.

2. Mining and diversity of lifestyles

Compared to the environmental dimension, social issues get less attention within sustainable development. According to Bice in *What Gives You a Social Licence? An Exploration of the Social Licence to Operate in the Australian Mining Industry* (2014), this lack of attention may be the result of a lack of ways to measure and define the terms of a social licence.

Diversity is one of the key words for social sustainability. If a community strives to improve life conditions for its citizens, it should make sure that the citizens are able to live their lives in a variety of ways. In this report, diversity is interpreted as a variety of lifestyles that a person can lead in a mining community. We see ethnic and social diversity as two of the many possible positive signs of enabled diversity of lifestyles and social inclusion, but we do not necessarily see this as a goal. It can be argued that all the factors mentioned in the definition above could help one obtain a meaningful life, a life where one is free to choose among many lifestyles. Corruption and discrimination, for example, limit access to services and the job market for disadvantaged groups, resulting in decreased access to life experience and competence for

the latter as well as for the privileged groups. Health and safety issues can be seen as physical limitations to the possibility to live the life one would like to live. Solomon et al. (2008) note that there are many research gaps with respect to understanding the relationships between many of the social issues in mining communities throughout the world:"[There is a lack of] knowledge of specific regional development issues such as the impact of the resources boom on other activities in regions, on social cohesion, on infrastructure and the long-term legacy of mining activities and closure" (2008, p. 146). This research area remains generally underdeveloped. Trends and research gaps in existing studies concerning diversity of lifestyles are analysed in the following chapter.



The chapter is organised into four sub-topics:

- social cohesion and inclusion;
- housing infrastructure;
- migration and demographics;
- · diversity and employers in mining communities.

The chapter ends with an overview of previous and on-going national and international activities and suggestions for future research.

2.1 Social cohesion and inclusion

When it comes to social cohesion and inclusion, a number of studies focus on the local community with respect to decision-making processes (e.g., issuing a "social license to mine") (Owen 2013, Michell 2013). Scientific discussions regarding local license to mine emerged after the International Institute of Environment and Development (2002) published its report Breaking New Ground: Mining, Minerals and Sustainable Development. As Owen points out, the report suggests that local stakeholders do not trust the mining industry. Although the concept of social license contributed to a broader discussion of local social issues, these discussions were not seen as providing a base for collaboration between the industry and stakeholders (Owen 2013). License to mine as a form of social trust has mostly been analysed from a stakeholder perspective. This level, as opposed to a study of a broader view of the community, might not give a social picture of the community as a whole, especially in the case of larger communities or when a whole region might be seen as an area socially influenced by the mining industry.

The area that connects community cohesion and the mining industry can be seen as underdeveloped, although some interesting trends can be identified. One of the scales broadly used to measure cohesion (Buckner's Neighbourhood Cohesion Index, NCI) was used and developed further based on material from a small mining community, Elliot Lake in Canada (Robinson & Wilkinson 1995), but no connection was made between the mining industry and the extent to which community cohesion can be influenced. Swedish studies on mining communities discuss strong community identity (Nilsson 2009, 2010, Hägg 1993), which can be seen as a fertile ground for cohesion, but this identity may also be associated with a certain lifestyle that is not inclusive of the "Other" – and which is characterised by "traditional masculinities". Several international studies have found mining communities to be cohesive (Robinson & Wilkinson 1995, Petrova & Marinova 2013), but local networks were not considered strong and inclusive. Scott et al. take this argument further when analysing discourse around crime: strong communities, may be used as a way to create a perception of indigenous people and fly-in/fly-out workers as the "Other" (Scott, Carrington & McIntosh 2012).

Gender with respect to social inclusion and the mining industry is a broad theme that requires a deeper analysis (see the Gender chapter). Gender issues related to demographic changes in mining communities as well as mining companies and workplaces may be of importance for the local social climate. Such changes are discussed in both Swedish and international studies (Abrahamsson & Johansson 2006, Lozeva & Marinova 2010). These studies examine how challenging conservative gender constructs on the organisational level as well as on the community level can improve people's lives, although there is less focus on the community level in these studies.

Australian and North American studies have examined how the mining industry has negatively affected indigenous people, limiting their ability to practice their traditional lifestyle. Some studies have focused on negotiating land use and inclusive job recruitment policies (O'Faircheallaigh 2013, Crawley & Sinclair 2003). Studies on the mining industry, CSR, and indigenous people often focus on indigenous peoples' possibility to grant free, prior and informed consent to new projects, as these issues relate to international law (Ward 2011). Studies on social inclusion concerning indigenous people in Swedish mining districts fill parts of the existing knowledge gap. Specific circumstances in northern Sweden require an even broader view of ethnic and cultural inclusion. In this region, different languages and cultural identities have coexisted for a long time, so mining exploitation requires a more inclusive social climate.

2.2 Housing infrastructure

Attractive housing opportunities and the built environment are important material factors for social sustainability. During periods of growth, the mining industry will need new workers, resulting in a need for new permanent or temporary housing solutions.

Although it is unclear what responsibilities mining companies should take on with regards to community development and governance, few studies have addressed this issue. At least one study (Morrison et al. 2012) has noted the lack of studies of regional and rural planning which look at collaboration between mining companies and authorities, despite the clear evidence of such approaches taking place."Active and well-resourced mining companies are increasingly recognised as filling the gaps in regional planning and service delivery where government activity is weak and community capacity is low" (Morrison et al. 2012, p. 479). Active participation of mining companies in urban planning could be a problem, however. According to Rudder (2008), such cases would mean citizens would have very limited control and influence over decision-making processes.

Petrova and Marinova (2013) also discuss the role of housing and the social impact of mining. For example, they found that a lack of housing solutions in mining communities leads to higher prices during the boom periods. As a result, some people are no longer be able to afford good housing in their community and have to move.

2.3 Migration and demographics

A number of studies analyse social dynamics consistent with the special circumstances that often accompany mining communities. Smaller and isolated communities go through demographic changes both during a mining boom and during recession.

Two demographic scenarios in northern Sweden, one baseline and one based on the etablishment of a large new mining project, were compared and studied in Ejdemo & Söderholm (2011). The study showed that the new mining project would be accompanied by higher income for the community. Another result is that both public and private non-industrial sectors would grow compared to the baseline scenario although proportionally they would employ a smaller part of the local labour force. It would be interesting to see, nationally and internationally, how mining influences the variety of work available in local job markets. This type of study could include existing case studies that indirectly examine this topic.

Petrova and Marinova (2013) distinguish between mobile and transient populations. Mobility can be measured by calculating the percentage of people who changed their address during a certain number of years, whereas transience is a cultural phenomenon. In the case study they described, fly-in/fly-out workers lived in the mining camp outside the city, where most of the services are provided. These workers did not participate in the life of the local community. The authors found that the transience of mining communities in Australia is associated with lower community cohesion, making it difficult to include new residents in the community network.

When it comes to general demographic patterns in relation to a mining boom and recession, Petkova-Timmer et al. (2009) found that more men than women lived in Australian mining communities, although other demographical patterns varied depending on community history, the size of the mining communities, and other factors. Moreover, they found that it is common for younger women to leave mining communities. However, similar patterns were found in a study of the rural communities of Västernorrland in northern Sweden (Rauhut & Littke 2014), so it might be hard to tell how much of this demographic effect is connected to the mining industry, and how much is the result of rural social patterns that can also be found in geographically remote communities with no mining activity.

2.4 Diversity and employers in the mining counties

In a quantitative study, Iverson and Maguire (2000) found a relationship between job satisfaction and life satisfaction for a large group of male mine workers in Queensland, Australia. The study showed that after the variables of kinship support and family isolation, job satisfaction is the next most significant variable that affects life satisfaction. Further analysis showed that job satisfaction influenced life satisfaction more than the other way around. Based on this finding, it seems important to look at diversity of lifestyles at



Photo: LKAB / Fredric Alm

the community level as well as the company level. Another part of this report examines how good work conditions in the mining industry are an important aspect of social sustainability. Here, we focus on the inclusivity/exclusivity of the job market.

Studies on diversity and mining companies often focus on ethnic and gender diversity. Other parts of this study review the scientific literature for trends with respect to gender issues in mining companies. Several studies have focused on ethnic diversity with a particular interest in the history of exclusion of indigenous people from the recruitment base of Swedish mining companies (Persson 2013) as well as in an international context (Tiplady & Barclay 2007). Crawley and Sinclair have examined how to broaden a mining company's recruitment base by including indigenous people through a strategy based on power sharing (2003). New studies on diversity in local businesses could further develop this perspective. These studies could examine recruitment from the perspective of ethnic diversity in a broader sense and identify measures that could lead to a more inclusive recruitment and work climate, for mining companies as well as for other local businesses.

2.5 Overview of previous and on-going national and international activities

Social aspects of corporate social responsibility do not seem to be of high priority internationally. The United Nations Global Compact initiative lists ten principles that companies should adhere to. Among these are protecting human rights, eliminating employment discrimination, and working against corruption. The ten principles do not address the effects mining has on local communities as a whole or how to protect and develop the diversity of local, often indigenous, lifestyles.

On a European level, social aspects of sustainable development are discussed in broader terms in the common policies for the mining industry and CSR. In the EU strategy for CSR 2011-2014, benefits for society as a whole are discussed in terms of increased employment. Societal effects on mining districts are not mentioned, but local participation in collective discussions prior to mining is anticipated (European Commission 2010).

The 2002 final report of the already-mentioned *Mining, Minerals and Sustainable Development* initiative, run bu the International Institute for Environment and Development, recognised that community development remains a problematic field. Among the new challenges that are emphasised in the scientific literature on mining and CSR is "the dramatic increase in community expectations, including for Free, Prior And Informed Consent (FPIC) [which] must be tackled head on by governments, civil society and companies"" (Buxton 2012, p. 3).

There are a number of national sustainability projects where the diversity of lifestyles in relation to the mining industry plays an important role. For example, an Australian gender-sensitive project has examined the impact of the mining industry on the social processes in the community from a gender perspective (Fung et al. 2009).

At Luleå University of Technology in northern Sweden, mining-related research includes not only engineering, environmental, economic, and technological perspectives, but also social aspects are being studied. Attract, an on-going interdisciplinary project, encourages collaboration between municipalities, building companies, and other stakeholders on sustainable habitats in cold climate. In this interdisciplinary project, the main focus is on delivering technical products such as experimental housing and sustainable energy solutions. Social studies within the project examine different aspects of social sustainability in Kiruna and Gällivare, two mining cities in northern Sweden. One of the pre-studies shows how social and geographical variables correlate with being content with housing. Statistical and geographical correlations are presented in 3D-models of the cities. Quantitative research based on surveys made in Kiruna and Gällivare explore perceptions of social climate, local networks and services, work and leisure time, housing, and infrastructure.

In collaboration with principal actors from the mining industry, researchers at Luleå University of Technology have formed a gender-aware and sustainable research and innovation agenda (GenderSTRIM). This agenda discusses societal aspects and the diversity of lifestyles, both important challenges for the Swedish mining industry:

"One of the major challenges that have been identified by societal players at various geographical levels is how a sufficient number of people will want and be able to live, reside, and work in the societies affected. A gender-oriented research study could map, describe and analyse how town planning, infrastructure, culture, leisure time, education, the labour market, and collaboration need to be designed in order to attract various groups of people. As part of this, strategies can be identified that contribute to the creation of a mixed working life and industry and commerce with many different types of work for both women and men and new types of job for both women and men – i.e., not just mining and the public sector. A crucial question is how skills provision in municipalities and county councils are to be safeguarded when more and more women and men are being attracted to well-paid work in the mining industry." (Andersson et al. 2013)

2.6 Suggestions for future research

Research on the social effects of mining concerning the diversity of lifestyles shows how the mining industry affects mining communities and these effects can be studied both from a community perspective and from a company perspective. Mining companies often employ such a large part of the local labour force that company policies and practices can have a significant influence on the community as a whole. Certain demographic patterns can be identified in mining communities. For example, the number of fly-in/fly-out workers increases and young people, especially women, tend to leave. Some studies have examined gender patterns in Swedish mining communities. Others have addressed community cohesion. Interestingly, some case studies show that stronger community cohesion in mining communities is associated with a lack of social inclusion. On the company level, some studies have examined the history of ethnic exclusion, especially the exclusion of indigenous people.

The main research gap in diversity of lifestyles and the mining industry is the missing link between studies on the company level and the community level as the effect on one another might be significant in remote mining communities. The study on the effect of mining industry on non-mining local business as well as on the housing infrastructure is limited and should be developed further. In the future, for example, existing CSR initiatives in the mining industry should be studied from the point of view of community needs:

"[P]roducers of physical outputs and operators of mining sites are likely to define sustainable development in terms of meeting demand for their products and providing socially desirable employment. By contrast, organisations that see their role as serving the communities and societies they operate in are more likely to define sustainable development in terms of meeting a wider range of human needs, and through embracing a broader scope along the material/product flow life cycle." (Cowell et al. 1999)

Interactive research where mining companies together with local actors define criteria for socially sustainable development is recommended in order to initiate a discussion on diverse social needs in the community and to fill the research gap.

Case studies on mining communities need to study social sustainability from different approaches, not just the community level. For example case studies that depart from the social climate for workers within the mining company would be valuable, especially in the context of mining communities where mines employ a large part of the local labour force.

Case studies on mining communities with a focus on social inclusion and exclusion could change the scientific understanding of the concept of social cohesion in mining communities. As a result, we suggest that these studies be conducted in parallel with the studies that challenge the concept of community cohesion in mining districts and focus on inclusive socially sustainable development. Interactive research with mining companies and local stakeholders could be used to develop initiatives on how to foster inclusive communities and thereby the region and the mining industry. And the concept of social inclusion in the mining industry should be developed further, inter alia to include perspectives on gender-sensitive recruitment and recruitment of indigenous people, and it should be extended to broader studies on social climate.

3. Mining and gender

The literature that discusses social sustainable development in the mining industry from a gender perspective is not particularly extensive, although it is growing. The literature focuses mainly on mining in developing countries as well as on social problems. For example, Ahmad and Lahiri-Dutt (2006) and Lahiri-Dutt (2012a) note that women and men have well-demarcated gender roles in indigenous communities, so the impacts of mining on women and men are not the same. Whenever such a community suffers from the losses of environmental resources, Ahmad and Lahiri-Dutt argue, it is the women who suffer the most. In some cases, women have lost their work and relative economic independence and have to start earning a living in the informal sector (perhaps as sex workers). Indian women, especially those living in villages, do not have legal rights over land and are rarely titleholders of land. The compensation process usually assumes that the adult male is the head of the household and fails to consider the needs and requirements of women. Compensatory jobs, if any, usually go to men, and women risk unemployment. Navak and Mishra (2005) add that the mining industry in India can contribute to sustainable development by promoting women's economic advancement and reducing women's poverty, ensuring greater involvement of women in the mining sector. In an Australian gender study, Lozeva and Marinova (2010) show that mining can negatively impact local communities, especially local women and the environment. They argue that there is an urgent need for the mining industry to transform itself in order to meet sustainability imperatives. Lahiri-Dutt (2012a) also notes that in developing countries both large-scale, capitalised mining and small-scale, artisanal mining introduce rapid social changes that affect women more negatively than men.

There are some exceptions in the literature that present more positive examples. Kemp et al. (2010) describe how one of the world's largest mining companies works to integrate gender considerations at the mine site. The company aims to counteract the male-centric mining industry by integrating gender considerations into community relations at all stages of the mine project development cycle, from exploration through construction, operation, and closure. The study, however, does not present any examples of long-term results such as organisational change at the mine-site level. Eveline and Booth (2002) describe how a new diamond mine in Australia had strategic plans to control the labour force by developing an industrial and economic stable environment, but the article concluded this attempt at social sustainability failed and resulted in almost the opposite.

Gender issues were also included in a baseline study of the socio-economic effects of Northland Resources' planned mining activities in Pajala, Sweden and Kolari, Finland. The baseline study, commissioned by Northland Resources, Inc., was carried out during 2007-2008 by a research team led by Professor Jan Johansson, Department of Human Work Science, Luleå University of Technology. The project included ten sub-studies: Demography, Labour Supply, Local trade, Infrastructure, Governance, Work environment, Gender, Preferences (of the citizens), Transnational history, and Indigenous people. The report on gender (Organisational gender aspects) describes how internal gender patterns are related to external conditions (Abrahamsson 2008). For example, explanations of the very low percentage of women in mining can be found in culture, the labour market, and educational traditions at the national level, at the regional/local level, as well as within the mining companies themselves.

The report presents an optimistic and, at that time, a somewhat provocative scenario where more women want to stay in the region and more women are employed in the mine. This also includes a change in attitudes and opportunities meaning that more girls choose technical and industry programs in upper secondary school. It also includes a changing of local cultural attitudes about women and work, liberating them from old-fashioned feminine and masculine identities. This scenario also meant that men will work more steadily and closer to their homes, that they will share responsibility for childcare and housework on equal terms with women, that they will start working in traditionally female-dominated sectors such as healthcare, that more boys choose social and healthcare related upper secondary school programs, and that men in general start to take education more seriously. Today, we can actually see tendencies in this direction and this is very positive from a gender equality perspective, good for the region, and advantageous for the mining company and probably also for other companies active in northern Sweden (Abrahamsson 2012). Of course, there are also less positive changes. The local culture is quite robust and to some degree resists change. Because of mining traditions and the local culture, mining companies still mainly recruit men. With such a strategy, new mines risk falling into the same trap that older companies are trying to get out of -a gender unequal work organisation (where a gender homogeneous organisation is one type and a gender-segregated organisation is another) that runs the risk of producing organisational inflexibility and barriers to communication, learning, innovation and change.

"Breaking ore and gender patterns" (Andersson et al. 2013), the strategic research and innovation agenda for the mining industry, identifies important links between gender equality, efficient use of resources, attractiveness, innovation, and sustainable growth. The agenda is based on the discussion on social sustainable development in the mining sector as an important part of meeting challenges regarding skills provision. Opening up mining companies, up- and downstream business, society, and academia to new target groups and thereby taking advantage of new skills and perspectives creates opportunities for a new approach and new forms of collaboration that promote innovation and growth. Gender equality is clearly seen as a strategic profile issue in the Swedish mining industry, but it is complex and represents a challenge for both mining companies and local communities. The agenda was financed by the Swedish innovation agency VINNOVA (2012-2013) and included researchers from Human Work Science and Mining Technology at Luleå University of Technology, the Rock Tech Centre, actors from the mining industry (e.g., LKAB, Boliden AB, and Northland Resources), as well as actors from the surrounding society. The agenda reviews the development of gender equality in the Swedish mining industry and the need for gender equality interventions.

As the field of gender on social sustainable development in mining so far is fairly limited, we have chosen a broader approach in the rest of this chapter, presenting five areas related to gender and mining:

- 1. women in mining;
- 2. mining work and masculinity;
- gender-based barriers to organisational and technological change;
- 4. gender in mining societies; and
- 5. gender equality interventions targeting men and masculinity.

3.1 Women in mining

Today, the mining industry in Sweden is a typical male-dominated sector. In the major mining companies, 90-95% of the blue-collar workers are men. Similar figures can be found in many other countries, such as India (Nayak & Mishra 2005, Lahiri-Dutt 2012) and Australia (Eveline & Booth 2002, Bryant & Jaworski 2011). The most obvious gender issue for the Swedish mining industry is the very low percentage of employed women (10-20%) of which an even lower percentage actually work in the mines (5-10%) (Andersson et al. 2013). Hence, "women in mining" is a large research theme that mostly focuses on why and how women are excluded from the mining industry.

One interesting (and perhaps surprising) result from this research theme is the highlighting of women's long history as mine workers. Particularly during the pre-industrial period many women worked in the Swedish iron ore mines. Henriksson (1994), Blomberg (1995, 2006), Karlsson (1997), and Ohlander and Strömberg (1996) show that from 1700 to 1850 many women worked both above and under ground in all production areas. This included physically demanding work that is now associated with male mine workers. In some mines (e.g., Nora bergslag), women accounted for as much as half of the labour force. This was a period when mining was seasonal work and typically the whole household worked in the mines and often combined mining with other activities, usually farming. This phenomenon was not restricted to Sweden (Lahiri-Dutt 2007). During the early 1900s, the proportion of women among coal mine workers in India was as high as 40–50%. In the early mines in India, women and men – usually from indigenous communities – worked together as part of a family labour unit. Men dug the mineral ores and women carried and processed them.

It is clear that mining was once, if not a traditional female work, at least quite normal work for women. However, during the 1900s the mining industry in Sweden underwent a process of masculinisation (Abrahamsson 2006, 2007, Karlsson 1997, Blomberg 1995). During this period, women almost totally disappeared from mining work. In 1850 women constituted 15-20% of the total labour force in Swedish mines, but by 1950 the number was 1% (Blomberg, 1995, Karlsson, 1997)³. How did mining work become purely male? What made mining work synonymous with male identity? One answer, according to Blomberg (1995), is that around 1850 mining work for women started to be questioned. Women's appearance and their morality was criticised if they partook in heavy manual labour and a growing opinion said that mining work, especially underground, rendered women incompetent as wives and mothers. Discussions about eternal femininity were a general part of the public debate during the industrialisation period. Additionally, in 1900, Sweden introduced a law that forbade women from working underground, although by then almost all women had already left the mines⁴.

When LKAB's iron ore mine in Kiruna was established in the early 1900s, mining work had the purely male character that we know today. In the beginning, there were no women at all working as mine workers, but more and more women came to the growing city of Kiruna, not only as wives and daughters, but also in search of a source of income. They worked in the service sector – cleaning, restaurants, and lodging – as well as at the mine hand-picking and sorting ore. However, the more the work became mechanised, the less women were employed in the mine, just as in other industries during the industrialisation period. This process was parallel with the more discursive or symbolic masculinisation of mining work (Blomberg, 1995). According to Blomberg and Karlsson, the very active exclusion, both by labour unions and employers, of women from mining work can be seen as part of the construction of a male mine worker identity (cf. Lahiri-Dutt 2012a).

Similar tendencies can be found in other countries as well (e.g., England, Belgium, Japan, and India) (Lahiri-Dutt 2012b). Between 1900 and 2000, the percentage of women employed in Indian coal mines fell from around 44% to less than 6% of the mining workforce. Lahiri-Dutt (2012b) identifies some interrelated factors that may be largely responsible for the fall in the number of women as compared to men in Indian coal mines: the protective legislation that prohibited women from working in underground mines and at night; the model of a "decent" woman whose primary responsibilities were reproduction and the home; technological improvements that displaced women's labour; the marginalisation of gender issues and the neglect of women workers' needs and interests by the trade unions and the mining company; and the open and harsh gender discriminatory attitudes at workplaces. Blomberg (1995, 2005) presents more or less the same explanations for why women disappeared from the Swedish mining sector. Lahiri-Dutt (2012b) also argues that it is a question of power, class, and race since many of the Indian women mine workers were from societal groups with little education and few resources. It can also be concluded that mining narratives by both trade unions and the mining industry made women invisible and devalued their efforts with respect to mining work (Lahiri-Dutt 2013, Blomberg 1995, 2005).

Clearly, the character of mining per se does not define mining as male (or female), but rather mining is defined by complex historical societal processes and prevailing notions of masculinity and femininity. One part of the masculinisation is the global historical myth that the presence of women in mines leads to accidents and deaths. When visiting museum mines such as the Sala silver mine and the Falu copper mine,

³ The low number in the 1950s was probably partly due to the law that forbade women to work underground.

⁴ This law was not removed until 1978. However, the mining companies could ask for exemption and many did so. In the 1960s and 1970s LKAB recruited several women mine workers, for work tasks both above and under ground. 1975 there was 2-3% women of all employees. During 1979-81 the total proportion of women was around 10%. In 2005 the proportion of women was still 10%. But the last years the number of women has risen to almost 20% (2014). But the number of women mine workers is still low (around 5%).

these stories, perhaps told with playful seriousness, keep this myth alive. Andersson (2012) describes a case from LKAB where a group of mine workers during a workshop discussed an old tale: the rock is a whimsical woman who does not accept the competition of other women, and this jealousy causes falls and accidents in the mine. Related to this tale was the prejudice that all miners are "macho men" and that women do not belong in the mine. Participants at the workshop claimed that these legends still circulate in the workplace, but as jokes and do not really matter any more. Furhermore, the women in the group argued that mining unions disseminate this outdated image, take advantage of old prejudices, and use these tales to scare women away from working underground. Similarly, Nayak and Mishra (2005) note that even if this myth is almost dead, there is a common belief in India that women should not perform mining work. This negative view is also the case in US, as women were stigmatised as inferior mine workers in the 1970s, 1980s, and 1990s (Tallichet 2000).

Today, most of the women in India's mining industry have menial lower rung jobs as sweepers, cleaners, or attendants in mining offices (Nayak & Mishra 2005). Lahiri-Dutt (2013) also notes that women do not own mines or land where mining activities take place. Nayak and Mishra (2005) found that women are rarely employed in the organised mining sector in India, whether public or private. In India, women mine workers are mostly found in small, private, or unorganised mines where they are employed in head loading, stone breaking, cleaning, and other forms of daily wage labour, work that places them entirely at the mercy of petty contractors where they have absolutely no work safety or security and are easily retrenched. For example, women often work beyond normal hours, they are often exposed to mercury and cyanide, they have no leave benefits or childcare facilities, and they are subject to sexual exploitation⁵. In modern mines (e.g., in Indonesia), the mining companies that hire women for shift work fail to provide a supportive environment for them, including the lack of provision for childcare, so many women truck operators in modern open cut mines quit their jobs after a few years of service (Lahiri-Dutt 2012a).

Tallichet (2000) found that coal mines hired women in record numbers after 1978, but these women were rarely promoted to more highly skilled, better paying jobs underground. Instead, they were assigned to specific "women's jobs" and this has led to a gender segregation of work tasks. In addition, Lahiri-Dutt (2011) found that gender segregation in mining resulted in dualistic gender metaphors that imagine that these dichotomies play an important role in organising both social and production activities within the industry. As is now well known, such perceived differences between women and men and the assigning of different roles with different status have little to do with the actual differences between the two sexes or the reality of the situation (cf. Acker 2006, Abrahamsson 2009). Swedish mining workplaces are also gender segregated, with a very low number of women (Andersson 2012). Women are mainly found in jobs and tasks away from the core production, the rock, and the ore face. In LKAB's mines in Kiruna and Malmberget, most women work as drivers of loaders that retrieve and empty ore in pits underground. Some women in resource teams also rotate between units in the Malmberget mine. In Kiruna, women are involved in mine development and construction. Underground, however, there are few women and still some basic requirements are missing at several remote sites, such as toilets. The men do not experience these lack of facilities as a problem, as they simply relieve themselves wherever they are.

Two significant studies that address the theme "women in mining" – Eveline and Booth (2002) and Eveline (1989, 2001) – use a diamond mine, the Emerald Site (Emsite), as a case. In the 1980s, the new mine gained renown as a social laboratory of innovation in socio-technical systems management as it used democratic and self-managing teams and an on-site training centre. This strategy viewed attitudinal learning as important as technological and mechanical training. The mine's planners also aimed to produce a new type of worker, an employee fit for a fresh, carefully designed mining culture. For the company, a crucial goal was to develop a labour force that could be controlled through the use of an industrially and economically stable environment. The

⁵ Similar health and safety problems for women are discussed in relation to the informal, small-scale and artisanal mining in developing countries. However, this large area of research has not been included in this overview.

mine was touted as a model for how women could enter into male-dominated occupations. Since then, the organisation has won two Australian Affirmative Action Awards for its equal opportunity strategies, a rare honour for a mining company. There were no physical or legal barriers to women working in the mine, and more than 1000 women applied to work there in 1984 and the workforce later consisted of 28% women (Eveline & Booth 2002).

The company had a gendered reason for employing women as miners. The mine was remotely located and had a fly-in/fly-out system of staffing. With no town or housing for families, and given the usual concentration of male miners, management worried that there would be too few women to provide the necessary "civilising influence". In addition, the women miners were informally expected to be responsible for care and control over the male colleagues. Eveline and Booth found that while most women were aware of this expectation, they held opposing ideas as how they should respond. Some felt that, as latecomers to the world of mining, they should go along with the designated ordering of gender and sexuality. Others refused to play the feminine role; they called it "the problem of women as minders". The idea of using women as "change agents" in a male-dominated workplace is a very common approach, but as Kanter noted in 1977, such an arrangement will not work well since the token status of women prevents them from having any impact on the work culture. According to Kanter, the workforce must be at least 15% women to reduce minority effects and preferably 30% women to obtain real positive effects of gender mixing.

In addition, Eveline and Booth noted that the women had to deal with subtle sexism as well as open hostility, sexual harassment, and an open opposition to the advancement of women. Moreover, the men at the mine openly opposed discussions about gender equality, the demand for women's toilets in work areas, and the provision of small-sized safety gloves. The men used offensive language and told sexually explicit stories and jokes. Some practical jokes generated physical dangers for women. For example, some men dumped ore in unsafe places, placing the women who were operating loaders and other machinery at risk. Some men refused to inform female colleagues about the dangers they faced. These calculated measures were done to discourage women from remaining at the mine and most women indeed left after the first three years. Moreover, some groups of men found they could keep women away, or at least to a minimum, by openly displaying pornography. The managers ordered the removal of the sexist materials, but the group of men literally repapered the walls and ceiling with pornographic pictures. Most women felt torn over the issue. They wanted the offensive photographs removed, but they also felt a sense of solidarity with the men over other aspects of management/ worker relations (cf. Abrahamsson 2009). The women felt they were continually on trial, a type of trial in which it was much easier to prove themselves inadequate in the mining workplaces than it was to gain approval.

This harassment resulted in a drop from 28% women in 1984 to only 4% in 2000 (Eveline & Booth 2002). Even by the time Emsite won its second gender equality honour in 1993, the number of women was decreasing. Some women have been replaced, but these are usually wives or partners of male miners. The company now assumes that women with a male "protector" on site are likely to stay longer and receive less antagonism from male colleagues. A rueful joke among the women no longer employed there is that equal opportunity means having a male partner on site.

Similar depressing stories of opposition and sex discrimination against women miners can be found in other research: Andersson (2012), Saunders & Easteal (2013), Tallichet (2006, 2000, 1995), and Lahiri-Dutt (2007, 2011, 2012, 2013). Saunders and Easteal (2013) found that sexual harassment was more common in the traditionally defined masculine occupations like agriculture/horticulture and mining (i.e., male-dominated rural workplace environments). Women miners are among the most at risk for being subjected to sexist work environments, group offending behaviour, and one-on-one harassment.

Tallichet (2006) found that some women were "scared to death" by the men while other women felt they had to adapt and to be tougher and "just see how stupid the men are". Lahiri-Dutt (2013) found that women who wanted to resist traditional gender patterns had to "act as men" in order to fully belong. Miller (2004) found that the strategies that women in male-dominated workplaces develop to survive, and, up to a point, to thrive, are double-edged in that they also reinforce the masculine system, resulting in short-term individual gains and an apparently longterm failure to change the masculine values of the industry (cf. Lindgren 1985). Similarly, Saunders and Easteal (2013) point out that change is hindered by women in mining who, faced with such entrenched masculine cultural norms and behaviours, tend to use certain survival techniques and coping mechanisms, such as denial and repression, for their day-to-day workplace existence.

Andersson (2012) found similar results from LKAB's mines where women miners seemed to thrive on the job and not at all regret their career choice, although it was clear that they suffered many of the "minority effects" that Kanter (1977) and Lindgren (1985) describe (see also Eveline & Booth 2002, Miller 2004, Tallichet 2006, 2000, 1995, Lahiri-Dutt 2007, Saunders & Easteal 2013). They were usually the only women on their work teams and had very little contact with each other. Many of the women had been subjected to comments about being in the wrong place, comments that suggested that women did not belong in the mine and that the job was too dangerous, too unhealthy, too demanding, or too technical for them: "gender equality has gone too far"; "you cannot sit beside a woman on the bus without being accused of sexual harassment"; and "there are enough women in the mine now" (even though only 4% of the underground miners were women) (Andersson 2012). It is also very easy to recognise the common individual strategies used in dealing with such minority effects - including being a "mum", "a pretty mascot", or "one of the guys" (cf. Kanter 1977, Lindgren 1985).

3.2 Mining work and masculinity

Laplonge (2014) criticises the mining industry's obsession with "women in mining", and bemoans the lack of attention that is paid to broader research on gender. He is not alone, as related to "women in mining" is the extensive research agenda on "men

and masculinity in mining", research that mainly focuses on the problematic aspects of the common type of mining masculinity. Today, mining workplaces are male in a concrete and obvious way, but also in a discursive and cultural sense (Andersson et al. 2013). Historically, male ideals - men and blue-collar masculinity – have dominated structures, practices, and procedures for the blue-collar working professional (see Willis, 1979, Whitehead 2002, Collinson 1992), and this is also the case for professional ideals of mining (Andersson 2012, Lahiri-Dutt 2007, 2012a). In mining, as in other male-dominated industrial organisations, the workplace cultures are often based on male bonding, homosocialisation, as well as identification and exclusion of "others" (e.g., women, office staff, and management) (Tallichet 2000). Although this type of masculinity is sometimes seen as obstructively conservative in many ways, it enjoys certain support in the local community and the men seem to experience it as an enjoyable and undemanding form of social interaction. Working-class masculinity may be a way to deal with feelings of subordination and inferiority (cf. Willis 1977, Collinson 1992).

There is not only an overt visibility of men in the mining sector, but also an obvious conflation of men with competence and expertise. There are also structures and technologies posing to be gender-neutral that actually favour men (Lahiri-Dutt 2011). This kind of confusion of qualifications and gender is very common in gender homosocial workplaces (Ely & Meyerson 2010). Workplace culture is based on likeness and identification (and conversely, considering managers, office staff, etc. as "others" that do not fit in) and this system controls and reinforces similarities between workers (cf. Lysgaard's (1961) theory of the workers' collective). Lucas and Buzzanell (2004) have noted the pressence of a status hierarchy as well as a clear pride around mining. This pride is closely connected to the working class self-image of miners, their traditions, and their perception of a long history of male solidarity (Lahiri-Dutt 2007).

Similar tendencies can be found in the oil industry (Miller 2004, Ely & Meyerson 2010). Miller (2004) suggests that there are three primary processes that structure the masculinity of the oil industry: everyday interactions that exclude women; values and beliefs specific to the dominant occupation of engineering that reinforce gender divisions; and a consciousness derived from the powerful symbols of the frontier myth and the romanticised cowboy hero.

One dimension of the masculinity associated with mining is the difficult working conditions that existed in early modern mines (Somerville & Abrahamsson 2003, Abrahamsson & Somerville 2007, Abrahamsson & Johansson 2006, Lahiri-Dutt 2012a). Men and mining became conflated, giving rise to a masculine work culture with hard, unrefined men, in some ways frightening and for this reason repellent, yet attractive because they are masculine and sensuous (Lahiri-Dutt 2012a). The socially constructed male miner is often portrayed as the quintessential male representative of the working class (Lahiri-Dutt 2012a, Eveline 1998). Lahiri-Dutt (2007, 2012a) notes that early industrial mining was a dangerous, risky, and hazardous job, characteristics romanticised into the myth of masculinity. Consequently, mining is seen as a job in which men go down into the mines, endangering their lives, to earn the daily bread for their families. Even as technology has contributed to improving the working situation in mines, the halo of risky, heavy, and dirty work has continued to surround mining (Lahiri-Dutt 2007, Eveline & Booth 2002). Andersson (2012) concludes that mining masculinity in Sweden is constructed around mystery, history, braveness, manual hard work close to the ore face, as well as practice-based knowledge of the rock and its extraction.

Within mining, expressions of masculinity can take on extreme forms such as, "macho-masculinity", almost so outlandish they can be difficult to take seriously (Somerville & Abrahamsson 2003). The fear of being seen as less masculine is a common theme in these kinds of workplaces. Here, more than in other workplaces, men find it difficult to be associated with competencies, attitudes, or behaviours that have a female gender-code (Eveline 2001, 1989, Somerville & Abrahamsson 2003, Abrahamsson & Somerville 2007, Eveline & Booth 2002). Male identity/hegemony depends on seeing women as the "other", but the constitution of masculinity is not only a negative mirror of femininity; it also builds barriers against other men and other masculinities, especially unmanliness (Connell 1995).

The concept of "hegemonic masculinity" (Connell 1995) is used to illuminate the fact that there are many parallel and interacting versions of masculinity, but one form will generally have dominance over other expressions of masculinity. We see a similar pattern in mining workplaces, but on a smaller scale. For example, mining culture includes "mining hero stories" and some macho men archetypes around which the local hegemonic masculinity is built (Somerville & Abrahamsson 2003, Lahiri-Dutt 2007, 2012, Eveline & Booth 2002). Behind these over explicit discourses of macho-masculinity, there is a wide spectrum of individual expressions. Andersson (2012) describes two types of men: a few outspoken men who think that gender equality has gone too far and a large group of men who think that gender equality is important and benefits everyone. The majority of male mine workers do not live or act fully according to the ideals and norms projected by macho-masculinity. They take a distanced position, but many of them still often glorify, protect, and promote hegemonic masculinity. They choose to be in this masculinity's "neighbourhood" as a "follower" or "liker". Connell (1995) calls them "complicit masculinities". In this way, they get some of the respect, the authority, the power, and the material and economic benefits that come with top-masculinity, but without the risks that come with being on the frontline. But they all share the same picture of what a real mine worker is - a man underground doing manual, dangerous, and mysterious work - and they restore and conserve the old story of mining work (Abrahamsson & Somerville 2007, Somerville & Abrahamsson 2007).

This miner masculinity functions not only as a gatekeeper towards women (as described under the section "women in mining") and as an obstacle to gender equality interventions (Eveline & Booth 2002), but it also preserves normative and problematic masculine traits (Andersson 2012). One example is the miners' criticism of and resistance towards new types of jobs and new technologies. To take care of ore production is increasingly about mastering technology, where technology is implicitly understood as a masculine domain (cf. Berner 2003, Mellström 1999). Men have become associated with gigantic machines that the mining industry is known for

(Lahiri-Dutt 2012a). However, as Andersson (2012) shows, male miners do not identify with new technologies but rather with traditional methods and tools. Another example is the relationship between masculinity and risk-taking (see Eldh 2004, Fitzpatrick 1980, Iacuone 2005, Gherardi & Nicolini 2000). The idealisation of a mining masculinity with roots in the old manual, heavy, and dangerous mining results not only in informal opposition to new technologies but also in opposition to safety procedures (Somerville & Abrahamsson 2003, Abrahamsson & Somerville 2007, Andersson & Abrahamsson 2007, Ely & Meyerson 2008, Olofsson 2010, Andersson 2012, and Wicks 2002). Wicks (2002), in a study of a deadly explosion in a Canadian underground coal mine, sees a connection between masculine institutionalised identities and organisational dysfunction, which created a situation in which the accident occurred. The study shows that rather than being a case of disobedience, this institutionalised identity was characterised by the miners' antagonism to management and their obedience to an institutionalised discourse that trivialized safety issues and made production more important than safety. It also shows that the logic of orthodoxy, preventing the miners from behaving in unconventional (although correct) ways, sustained the identity of miners as risk-takers and patriarchs, prioritising their breadwinning function before safety (Wicks 2002). Andersson (2012) also notes that male mine workers often take risks because of solidarity with other men, a kind of moral obligation between them (i.e., the men within the workers' collective).

Abrahamsson and Johansson (2006) found that the identity aspects of work (i.e., how the individuals create and recreate identity and self-image) and the symbolic aspects (e.g., storylines, myths, ideas, and perceptions about what a real mine worker is, and what mining work or competence is) lag behind the more structural changes at the workplace such as new technology and new qualification demands. It seems that the symbols of the work are "cemented" in some aspects. In such cases, parts of the individual's practices and interactions in work organisations can be interpreted as symbolic actions following old symbols rather than as a result of demands of new technology or the "company line" (Somerville & Abrahamsson 2003, Eveline & Booth 2002, Wicks 2002). However, it is not only a question of defending old culture or identity. We can also see indications of change: something is happening with the constructions of masculinities. There are new types of masculinities (and femininities) that share space with the old and perhaps fading macho-masculinity – not only in mining workplace cultures, but also in the local surrounding society (Abrahamsson & Johansson 2006, Andersson 2012, Ely & Meyerson 2010, Somerville & Abrahamsson 2003, Abrahamsson & Somerville 2007). In other words, rather than being given "female" or "male" work, these definitions are culturally situated and defined and therefore dynamic and flexible. Hence, it is possible to challenge and transform them. To do this involves not a focus on individuals, but rather on the institutions, organisations, discourses, cultures, and practices that sustain gender patterns.

3.3 Gender-based barriers to organisational and technological change

The literature clearly concludes that "gender in mining" is not only a question of individuals (women or men). Many articles explore work organisations and the links between structures, symbolism, and identities. Research on organisational gender aspects is an important theme; however, this is not as large a theme as the two previous themes ("Women in mining" and "Masculinity and mining").

Strong homosocial relations and gender-segregated workplaces risk, as mentioned in previous pages, conflating gender (in this case masculinity) with competence (Ely & Meyerson 2010). Such connections between work/professional identity and gender make the workplace culture even more robust and create difficulties in changing attitudes and behaviours both on the organisational level and the individual level. A strong unequal gender order keeps individuals in narrow spaces, both physically and mentally. Ideas of gender - femininities and masculinities - are often conservative and can create trouble and restoration responses during organisational and technological changes (Abrahamsson 2000), and this is also evident in mining companies (Somerville & Abrahamsson 2003, Abrahamsson & Somerville 2007, Andersson & Abrahamsson 2007, Abrahamsson & Johansson 2006). An unequal gender order in the organisation hinders

dialogue, communication and the mixture/integration of different work experiences and exchange of different skills/knowledge. Therefore, strong gendered workplace cultures can create problems for organisational as well as individual learning and change. If ignored, the gender-based organisational processes can form an almost inherent element that fuels restoration. There could be restoration of existing organisational structures and the prevailing behaviours and attitudes despite the desires of management to achieve the opposite outcome (Abrahamsson 2000). This phenomenon of organisational restoring responses is especially common when the companies start implementing new organisational ideas that, as a side effect, rummage about in the prevailing gender order.

Abrahamsson and Johansson (2006) and Andersson (2012) give some examples from LKAB in Kiruna. Over a period of 50 years, the Kiruna iron ore mine has transformed from underground work to remote control work at the surface. What characterised the old underground face work was the close relation between workers and the hard rock based on hard physical work under dangerous conditions. The workplace culture, as in many other similar workplaces, was characterised by a form of "macho-masculinity". Today, the ore face workers are located on ground level in a modern building close to the mine. This has created new types of jobs where physical work environment improvements are obvious. The workers have left their old blue-collar contexts and moved into a "white-collar environment". In the most extreme forms, the operator makes only occasional visits to the machine, which is remotely controlled from above ground. Remote technology may make it possible to locate the mine control room in Stockholm or even in India (Abrahamsson et al. 2009). Modern technology has created a new type of work when it comes to competence and knowledge as well as workload. Since work is no longer conducted in a difficult and tough environment, the aura of mystery, job secrets, and tacit knowledge disappears. "Rock sense" is not needed in a control room and there is perhaps not much mystery in remotely controlling a truck with joysticks. It can also be difficult to keep the feeling of uniqueness of mining work and the connection to the old history of the mine. Therefore,

old workplace cultures, worker identities, as well as old types of macho behaviour are challenged by both new technology and new competency demands (Eveline & Booth 2002, Ely & Meyerson 2010). The workers need to find new ways of defining qualifications and competencies and new ways of constructing identity and gender. It is very likely that very different types of people and competencies will need to be recruited in the future.

However, this process is not at all simple and not without resistance. An interesting example of the strength of the workplace culture is the case from LKAB when the first front loaders at LKAB's mine in Kiruna were moved from underground up to the remote operations centre at level 7 in the office building. The workers still saw themselves as miners, as underground miners, even changing their clothes after every shift in spite of the fact that they were just as clean as when they arrived. After a year or so, they stopped doing this, but it is understandable that they wanted to be seen as real miners. The introduction of remote control, and especially the move up to level 7, had to some extent resulted in a division of workers, "we" and "them". The underground miners, especially those working with more manual work tasks, still saw themselves as real miners compared to the remote control workers who were seen as weaker and womanish. The underground workers referred to the remote control operators as "velour-miners" (Andersson 2012). Similarly, in mining subcontractor workplaces, new technologies and machines introduced as a result of automation, computerisation, and robotisation often undergo a process of "feminisation" (Olofsson 2010).

Andersson (2012) characterises the conflicting emotions and behaviours among (male) miners at LKAB in three ways: 1) glorifying the mystery, the cultural heritage, and the history of mining and being negative towards new technology – yet being proud of and relying on the technological progression and the modern work environment; 2) encouraging nonchalant attitudes towards risks – yet emphasising the concept of a safe mine; and 3) preserving "macho-masculinity" – yet striving towards gender equality. These conflicting emotions and behaviours were also noted by Eveline and Booth (2002). The planners of the Emsite diamond mine aimed to "produce" a new type



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of mine worker, an employee fit for a fresh, carefully designed new mining culture. During the start-up in 1984, recruits were selected on the basis of characteristics such as flexibility, open-mindedness, change willingness, team orientation, nonaggressive demeanour, and having a wide-range of interests. Part of the new type of mining culture was, as described above, learning. But these goals were met with obstacles from the male miners. The derogatory nickname for the on-site training centre, often used by male superintendents and male workers, was "Fairyland", the allusion being that its ideas were unrealistic and "soft", not enough manly. Most women, by contrast, wanted the opportunity for more training. Another example is that the equipment on which women excelled, particularly the huge computerised trucks and the difficult-to-handle 824 dozer, were being designated as "women's machines". As a result, a number of men refused training in the use of these machines, as they thought such training would diminish their sense of manhood, not to mention their desire not to be outperformed by a woman (cf. Abrahamsson 2009).

Restoration responses can be seen as a type of direct disobedience conducted by individuals or groups (Fältholm 1998, Lysgaard, 1961). Passivity and tolerance of the status quo can also be used to resist change. The miners who refuse to learn and take on new behaviours or working practices are usually, in spite of the goals of the company's strategy, allowed to carry on in more or less the same way that they always have done. This phenomenon is usually well known and sanctioned, within certain limits, by the management/employer. Lysgaard (1961) describes this attitude as the workers' collective. Fältholm (1998) points out that the tolerance of the workers' collective should not be underestimated. There might even be reason to see the tolerance towards individuals who are unwilling to change their behaviours or attitudes as a strategy of the collective to resist change and restore the old organisation, at least in the short run. Lysgaard argues that blue-collar workers develop and maintain collective strategies to counteract the inexorability of the so-called techno-economic system (e.g., productivity targets) in industrial organisations. These strategies include limiting output, keeping secret production rates, keeping down working-hours, and even sabotaging activities (Fältholm 1998). The collective system also functions as a set of norms, controlling the workers' relations with each other and the extent to which behaviours that deviate from the norm (e.g., certain types of masculinity, negative attitudes to management, and change) are counteracted or accepted. These strategies can also be discussed in terms of organisational disobedience and misbehaviour (Karlsson 2012, Collinson & Ackroyd 2005, Linstead et al. 2014). The normative system is

also based on a culture of resistance in order to gain informal control over the work situation and to protect practical and hard physical work (see Willis 1979). Consequently, the introduction of new technology or management concepts is often resisted by the workers' collective (Fältholm 1998) and this resistance is also the case in mining (Andersson 2012, Andersson & Abrahamsson 2007). Regardless of whether this phenomenon and other types of resistance are described and understood in terms of disobedience (perhaps from a management perspective) or in terms of protection (as with Lysgaard), norms of workplace behaviour and identity can be destructive and even dangerous, creating problems in implementing safety practices (Wicks 2002).

In spite of the fact that there are clear connections between the workers' collective and gendering processes, very few studies have looked at the workers' collective from a gender perspective; the most famous exception is Lindgren's (1985). Similarly, these connections have rarely been used in research of mining contexts, with the notable exceptions of Abrahamsson and Somerville (2005), Andersson and Abrahamsson (2007), and Andersson (2012). Lindgren (1985) found that when women enter a male-dominated workplace, norms of likeness and the common identity of the workers are challenged, resulting in the activation of a gender order system. In contrast to the workers' collective, which is built on and by processes of interaction and identification among the workers and sustained by norms, the gender order system is built on and sustained by the separation of and the unlikeness between the genders. In male-dominated industrial work-places studied by Lindgren, the strength of the gender order system was manifested by conformity to "rules" and norms of unlikeness and separation between women and men. These processes can also be understood in terms of reproduction of hegemonic masculinities and homosocial processes, well documented in studies on managers (see Wahl 2014), but less researched in blue-collar work-places and even less in male-dominated workplaces like mining, which is built on and sustained by homosocial and excluding processes within the workers' collective. (see Lindgren 1999 and Wahl 2014). In practice, this also functions as a gatekeeper for newly hired women in mining companies.

3.4 Gender in mining societies

As described above, it is clear that a gender theoretical perspective can contribute to better strategic change processes within the mining companies' organisations (cf. Abrahamsson 2000). The same applies also for the surrounding communities. For example, Dymén (2014) describes how a gender theoretical perspective on municipal spatial planning and participatory approaches can contribute to efficient and well-informed climate change response. In addition to the development of efficient and well-informed responses, a dimension of democracy and gender equality (on a regional and national perspective) must be considered.

Many mines in Sweden are located in peripheral and rural districts with small cities and communities that have a history of economic stagnation, depopulation, and emigration. As a result, these communities have had to cut down in welfare services and the situation also creates lower level of activities in other areas such as trade, housing, communication, and infrastructure. However, Kiruna, Gällivare, Pajala, and other communities in Norrbotten and Västerbotten are currently experiencing an almost paradoxical situation. The thriving mining industry creates a shortage of housing and low unemployment. Despite this relative good situation, it seems to be a complex challenge to recruit enough people who are willing and able to live and work in these communities (Abrahamsson 2008 and Andersson et al. 2013). Consequently, companies experience difficulties in recruiting enough people with the right skills. This is often called "skills shortages" or the "skills gap", but as Bryant and Jaworski (2012) argue, the term "skills shortage" can put the responsibility on the state. Therefore, the term needs to be contextualised, related to the specific company, region, and local culture. They also argue that underlying assumptions about gender and race in organisations need to be addressed for rural-based organisations to more fully utilise the available workforce. Bryant and Jaworski (2012) suggest using the term "skills gaps" as it draws attention to the opportunities of developing the existing supply side of the labour market.

Clearly, mining companies find it difficult to recruit women. It might be tempting to go the easy way, to

follow local traditions and routines, and just recruit men, because men apply for these jobs. We can note that women have higher educational levels than men in these regions (and perhaps as a consequence, we see a rising number of women in higher positions in the mining companies), but also that there is a clear deficit of women living there. It is a well-known and often discussed problem that young people, especially women, move out of the region (Abrahamsson 2008, Jakobsson 2011, Saunders & Easteal 2013). Part of the problem lies probably in the culture and working life of the mining communities of Norrbotten and Västerbotten. The picture is ambiguous, as Abrahamsson (2008) argues, but still the culture can, somewhat simplified, be described as traditional, patriarchal, and male-centred with a more gender-segregated division of labour between women and men compared with other regions in Sweden, in working life as well in domestic life, and a culture where women often are clearly subordinated or "invisibilised" (cf. Nilsson 2010, Hägg 1993, Jakobsson 2008, Jakobsson & Waara 2008, Jakobsson & King 2011, Rauhut & Littke, 2014). An expression of this culture, although local people joke about this with a high degree of self-irony, is the anxiety among men of doing (or at least be seen doing) something that can be connected to "women things" or "women job". Another important part of this culture is the low educational level among men. As in the rest of Sweden, many women in the region study for professions that require higher education. The men, on the other hand, are characterised by their lower educational attainment compared to the nation as a whole and women in particular. They take on blue-collar work, that does not require higher education. Furthermore, the men in the region seem to be more deeply rooted in their place of birth, choosing to stay close to their original home. Similar patterns can be found in Australia (Bryant

& Jaworski 2012, Saunders & Easteal 2013) and the USA (Mercier 2012). The increased exodus of young women from rural communities risks intensifying the "masculine" culture that can be found there. Myths about place and work have intertwined to reinforce gender inequalities in logging, mining, and longshoring (Mercier 2012). Saunders and Easteal (2013) show that rural and male dominated workplace environments are more likely to be permeated with sexual harassment. Abrahamsson (2008) argues that mining companies in the region need to develop a strategy to deal with and manage these risks.

Gender segregation is also associated a business structure with a low degree of differentiation and such a business structure is vulnerable in many ways. Therefore, Kiruna and Gällivare need to break up gendersegregated structures, a substantial challenge albeit key to the success of these cities and the mining industry. The boom in the mining sector has mainly benefited companies and industries (mining, construction and their suppliers) that have long been, and still are, male-dominated (Knobblock 2013). Development in the mining industry has led to an opening for new firms: the rise of not only small-scale mining and junior companies, but also of firms performing related activities that can provide livelihood for the local population in areas with small labour markets. In Västerbotten's mining industry, productivity has increased and jobs and workplaces have been generated, although mostly for men (Knobblock 2013). It seems as both the new and old jobs go to men rather than women. The mining sector, even if it is slowly becoming more diversified, seems to lock the labour market, making it even more difficult to break up the gendered structures.

Moreover, Reeson et al. (2012) show that the high incomes associated with the Australian mining sector may also lead to greater inequality. That is, the income gap between women and men increases when mining employment increases in a region. In an Australian study, Lozeva and Marinova (2010) found fundamental problems associated with gender discrepancy and power negotiation which marginalised women and traditional owners of the land where the mine operated. These problems resulted in a decline of the population during a mining boom. The local society became "a men's town" where fly-in/fly-out mining operations flourished, offering limited opportunities for women and the local younger generation. Because of this, Lahiri-Dutt (2011) argues that fly-in/ fly-out systems reduce diversity and heterogeneity.

Eveline and Booth (2002) found that when Emsite introduced a fortnightly fly-in/fly-out system, which allowed employees to leave their families in the nearest city and fly the 2000 km to work and back, it was considered a high-standard modern mining company with high ambitions with regards to its socio-technical systems management as well as gender equality. The fact that all workers had to leave family responsibilities behind for two weeks every month was not viewed as a gender issue. However, Eveline and Booth conclude that the fly-in/fly-out system had different effects on women and men since none of the women employed at Emsite had children under eighteen, whereas more than half of the male interviewees did.

In sum, this means that there is a high risk that there will be "more of the same" in Swedish mining regions, more of what created many of the regions' problems, if we do not break the gendered patterns (Abrahamsson 2012, 2008). If women continue to move out to the same extent as they do today, there is a risk that some mining areas will be reduced to "fly-in/fly-out communities", with a small service sector dominated by low paid women and high paid fly-in/fly-out men. However, on the positive side, we have so far not seen much of the above-mentioned fly-in/fly-out problems in Swedish mining regions. Contrary to mining operations in Australia or Canada, a large part of mine workers in Sweden are locals who live nearby (Knobblock 2013), where drive-in/drive-out (rather than fly-in/fly-out) might be a bigger issue for the mining sectors located in the northernmost parts of the country (Nygren 2013). All in all, this means that the local culture is particularly relevant when it comes to understanding current conditions (Bryant & Jaworski 2012, Abrahamsson 2008) and also serves as a factor that might affect future development.

Local politicians and other social actors in Kiruna and Gällivare see opportunities in the on-going city transformation projects and are trying to avoid recreating social structures dominated by the old male dominance, gender segregation, and stereotyped perceptions of women and men (Andersson et al. 2013). With examples from Dalarna, Stenbacka et al (2014), draw similar conclusions: that in order for the local labour supply needs (for example in the mining sector) and the youth's education and career choices to be consistent there is a need for changing the traditional images of male or female professions, perhaps even make them disappear. Local traditions in education, labour market, and everyday life are part of lingering structures that are inherently difficult to change, but if these are recognised and acknowledged, there are opportunities for reflection and change. Clearly, if Swedish mining towns want to be attractive, they must offer both a diverse labour market and meaningful recreation for women. There is a need for modern and attractive workplaces for both women and men in the mines as well as in other sectors. But this is easier said than done. Lahiri-Dutt (2013) describes how mining towns and mining camps are important sites for "doing gender" as well as "doing ethnicity". Abrahamsson and Johansson (2006) and Andersson (2012) show that even if changes occur in Kiruna, both the local culture and the miners' culture are still very much based on a type of miner masculinity that has its roots in old ideas of what it means to be a "a real miner". Similar patterns can be found in the construction sector and in the surrounding small businesses that rely on the mine. Nilsson (2010) sees the city transformation project in Kiruna as an instrument of power that favours men and reproduces masculinity; it confirms traditional masculine interests. The professional cultures that are imbued with status are those usually occupied by men. Similarly, Bell and York (2010, 2012) show that strategies of "the Friends of Coal" included the appropriation of cultural icons that exploited the hegemonic masculinity of the region. Bell and Braun (2010) note that this functioned as a deterrent against men's involvement in the environmental movement. King, Barry, and Berg (2008) conclude that even if gender equality is seen as important to the citizens of Kiruna, conflicting ideas, ranging from neoliberal strategies to more traditional ones, may result in failure to change the culture. Stenbacka (2011) highlights the role of national mass media, movies, and television in contributing to the construction of the image of rural masculinities as welfare dependent and "backward", and of rural men as gender unequal and traditional as well as deviant and out of place compared with their urban peers. This marginalisation of rural men may perpetuate gender inequality.

3.5 Gender equality interventions targeting men and masculinity

The last research area within gender and mining presented in this report is "gender equality interventions" and this is the smallest one, especially if we add "targeting men and masculinity". One of the starting points for this research area is the fact that gender inequality is also problematic for mining companies. The global mining industry is required to meet increasing demands on environment, safety, technology, and organisational development in order to be competitive, efficient, and modern (Abrahamsson et al. 2009). Several on-going projects aim at implementing lean, effective, and safe mine production. The mining industry therefore needs employees with new skills, knowledge, attitudes, and behaviours. For future capacity building, as the mining companies themselves expresses, they cannot be limited to half the recruitment base, that is, limited to just men. They need to attract young people and women to education and jobs in mining. To attract new competencies to the region and to the mining industry will require removing gendered structures, at both the societal level and organisational level (i.e., within the mining company).

Therefore, mining companies are working consciously and strategically with gender equality (Andersson et al. 2013). Over the last several years, the large mining companies LKAB and Boliden have implemented several ambitious gender initiatives, both within the companies and in collaboration with local communities (e.g., wage mapping systems, women's networks, gender-aware trainee programs, particular efforts for recruting women to higher positions and as technology experts, and also a mining program at the upper secondary school level which aims at a female participation rate of 50%. In addition, as part of their branding, these companies are trying to show that women are important to modern mining. For example, the new mining company Northland Resources is the main sponsor of a professional women's basketball league. Recently, LKAB was the first mining company in Sweden to finance a research project about gender in the mining industry: "Attitudes, masculinity and safety in mining" (see Andersson 2012). The intent of the study was to make it possible to transform the masculine workplace culture of miners in order to

promote gender equality and safe work practices. Despite these ambitious initiatives, it is still very hard for mining companies to break the industry's male-oriented gender patterns.

One part of the problem is that many of the current gender equality interventions are under-pinned by the assumption that increasing the number of women would rebalance the dynamics of power and, ultimately, contribute to a changed gender order. This assumption dates back to the seminal work of Kanter (1977), and since then, the concept of "critical mass" has had great impact on the design of gender equality initiatives (see Eveline & Booth 2002). Yet, as the previous discussions have noted, the "critical mass" approach may not be sufficient to ensure change. Mayes and Pini (2010) identify similar problems in the commonly enunciated discourses that suggest women, as a group, possess a number of naturally occurring traits and characteristics that are advantageous to modern mining. This discourse intersects with a discourse in Australian mining sector that suggests that gender change has occurred in the mining sector and significant numbers of women have entered these traditionally masculinised domains. This "feminine revolution" in mining could be seen as potentially transgressive, opening up space for women. However, at the same time, the dominant storyline of gender change, Mayes and Pini argue, renders it illegitimate for women to speak of inequities or discrimination and it suggests that any continuing numerical difference in men's and women's representation in leadership in the sector must be a related to female choice or a woman's individual shortcomings.

Based on our own studies (e.g., Fältholm et al. 2010, Andersson et al. 2013) and on other existent research (Meyerson & Kolb 2000), we believe that liberal feminist approaches based on the concept of critical mass are not enough to dissolve the tokenisation of women or to transform mining organisations. Rather than expecting the few women to take responsibility for the change towards gender equal mining workplaces, there is an urgent need for knowledge on innovative approaches and solutions for how unequal gender patterns in mining can be challenged and transformed. The strategic research and innovation agenda for the mining industry, *Breaking ore and gender patterns* (Andersson et al. 2013), concludes that there is a need for more knowledge on how to do this. In other words, there is a need for extended research and new strategies for cultural changes in work organisations.

While gender equality interventions over the last several decades have focused on women in male-dominated workplaces, less focus has been on men in female-dominated fields and perhaps even less on interventions targeting men in male-dominated workplaces (Eveline & Booth 2002). Moreover, less attention has been given to how to design and implement gender equality interventions in male-dominated workplaces based on masculinity studies and gender theory. Laplonge (2014) argue for this new view of gender which focuses on multiple and diverse ways of acting out as men and women. But the application in the mining industry has been be difficult, he notes, not least because it demands we think about gender in terms of men and masculinities. An upstarting study at Luleå University of Technology (developed by Fältholm, Andersson, and Abrahamsson) aims at addressing this research gap by merging theory on the workers' collective with gender theory and knowledge on gender equality interventions. The project starts 2015 with financing from the research council FORTE. A related approach can be found in the same research group's project "SEARCH-Nordic Mining and the search for women: Designing new gender equality interventions", a project that focuses on analysing and learning from the mining sector. The project started 2014 with financing from NordMin, a network founded by the Nordic Council of Ministers. The background for these studies, together with several others project ideas, is described in the R&I agenda Breaking ore and gender patterns (Andersson et al. 2013).

Such an approach presumes that that organisations are gendered and that differences between women and men are socially constructed, created, and sustained by gendering processes, such as formal practices and polices, informal work practices, symbols and images, everyday social interactions, as well as internalisations and expressions of gender identities (Meyerson & Kolb 2000). Therefore, although the numerical domination of men in mining influences power relations, it is important to not merely address the number of women and men in different positions in projects that aim to attract, recruit, and support women in mining workplaces. That is, it is also important to address the conceptions of masculinity and femininity, power relations between women and men in social interactions, as well as why people consider some work as female work and some work as male work (Eveline & Booth 2002, Lahiri-Dutt 2012a). A major challenge is the ambition of using these aspects, not only as a framework for understanding gendered identities and segregating mechanisms in mining, but also as a tool for change. This challenge can be approached by the search for "cracks" in the collective system, representing possibilities for change towards gender equality, to see men as change agents (Wahl 2014). This means that the gendered organisational processes and power relations in mining need to be rendered visible and, rather than be treated as bottlenecks or potholes for development, be seen as places for development, opportunities for creating change. This view calls for new ways of approaching the problem, theoretically as well as methodologically, that may result in a "degendering movement" (Lorber 2000). A recent study of an initiative designed to enhance safety and effectiveness at two offshore oil platforms concluded such a change was possible. Rather than replacing their conventional masculinity with a new one, they were "undoing" gender (Ely & Meyerson 2010).

4. Mining and work conditions

Our literature search showed that there is a lack of studies focusing on work conditions related to social sustainable development in mining. Although the literature search using the keywords "mining", "work conditions", and "social sustainable development" (and variations thereof) produced several articles, only a fraction actually connected the themes directly. "Sustainable work" and "sustainable work systems" have been frequently used and developed in working life policies and human work science for the last two decades, so it was a little surprising not to find it among the articles on mining work conditions. The word "sustainable" seems to be a trendy word to use, regardless of context, and almost always refers to external environmental and climate impacts, not to physical and psychosocial work environment, safety or other company internal organisational aspects. Since the field of work science perspectives on social sustainable development in mining is fairly limited, we have chosen a broader approach and present four areas relating to mining and work conditions:

- 1. physical work environment;
- 2. safety;
- 3. psychosocial work environment; and
- 4. social sustainable development outside the mine.

The chapter ends with some suggestions for future research.

Research on work conditions in the mining industry has a long and important tradition in human work science and related fields (see Johansson 1986). Studies of mining work actually played an important starting point for the development of the socio-technical theory (Trist & Bamforth 1951). The theory grew out of an analysis of the introduction of new technology (the semi-automated long-wall method) in English coal mines. Rational production flows constitute the nucleus of the theory. Added to this is a systems theoretical approach; that is, people, organisations, and technology characterise and are characterised by their surroundings. The conclusion drawn by Fred Emery, Eric Trist, and others was that the interdependence between the different working shifts in the studied coal mines was not supported by an integrated and holistic social system of interaction between the workers. Instead, the work organisation and wage and status disparities between different work tasks had the opposite effect and contributed to a further fragmentation of the production system. In a later phase of their work, the researchers came into contact with a mine where the long-wall method worked very well. Productivity was higher than that of other comparable mines. The difference was that, at this mine, the workers themselves had created a work organisation based on broader roles and that included work rotation both within and between work shifts. They had also succeeded in creating a social system that harmonised with the technical system, and the new system incorporated a high degree of autonomy. The researchers had "discovered" the autonomous group. This theory was field-tested on a national scale in Norway in partnership with Einar Thorsrud (see Emery & Thorsrud 1969, Emery & Trist 1965). The basic assumption in the socio-technical approach is that all organisations have both social and technical aspects, and these aspects are related to each other. The better this relationship is formed, the more efficient the organisation. The socio-technical approach therefore recommends a simultaneous and coordinated optimisation of both the social and technical systems as an alternative paradigm for organisational design.

4.1 Physical work environment

The physical work environment in mining is a large research area and therefore difficult to cover in a report like this. For example, it includes research on dirt, dust, radiation, gases, chemical exposure, ventilation, heavy lifts, transport, noise, vibrations, darkness, lighting, musculoskeletal work load, work time, information/alarm systems, and man-machine interaction (Johansson et al., forthcoming). Historically, there has been a focus on basic and practical workplace safety and physical work environment to ensure that mine workers are not injured on the job. In developing countries, these are the issues that still bring the most attention. Although being important research areas in themselves, this report does not include research on individuals' health, occupational medicine, or the kind of applied research that is typically presented at conferences. Rather, we focus on theoretical, critical, and applied research at the organisational level and socio-technical perspectives based on issues such as how good physical and psychosocial environment positively influence a company's productivity and innovation and the employees' well-being and learning. See for example Grane et al. (2012) where the "operator of the future", who works closest to the value adding process, is seen as key for the future competitiveness of mining companies.

Almost all of the articles point out the importance of taking a broad perspective on occupational health and safety (OHS) to create a good sustainable work environment. Indeed, it seems obvious that work-related illness is caused by the interaction between organisational, psychological, environmental, and physical factors. For example, in The Management of Occupational Health and Safety in the Australian Mining Industry, Cliff (2012) concludes that incidents, injuries, and illnesses indicate systemic problems, not just human error. Several of the papers note a lack of integration of these issues into mining research such as research on mine planning and production and organisational development. Some articles discuss the importance of human factors and ergonomics related to future mining. For example, in A review of Australian human factors research and stakeholder opinions regarding mines of the future, Lynas and Horberry (2011) discuss how human factors and ergonomics merge with the automation in the mining industry. The articles are all consistent on the point that human factors and ergonomics need to be included in the technological development aspects of sustainable development. A major on-going work in this area is currently being done within the large EU-project I²Mine, The intelligent mine of the future. In one of the work packages, a research group at Luleå University of Technology is developing a handbook. This book includes a broad theoretical review of the state-of-the-art in work environment research in mining as well as easy-touse and digitalised checklists for integration of work environmental aspects in mine planning: "Designing the attractive mine: Basic guidelines for early mine planning with a focus on human safety and health in deep future mines" (Johansson et al., forthcoming).

One important issue that needs special attention is work conditions in conjunction with automation development and remote operation centres, ROCs (Bainbridge 1987). This relationship is thoroughly discussed in the literature, and occasionally connected to sustainable development (Bassan et al. 2008, Noort & McCarthy 2008). For example, Abrahamsson and Johansson (2006) note that work conditions for miners have changed significantly over the last couple of decades, from physically hard and strenuous manual labour to less-physically intensive work that depends on high-tech equipment and machinery, sometimes even in the comfort of office-like settings in control rooms above ground. These work conditions include cleaner underground air, better personal protective equipment and technical safeguards, and better safety training (Elgstrand & Vingård 2013). However, accidents and incidents still occur, and this new work environment has led to new work problems, such as computerised work tasks that run the risk of creating repetitive monotonous work for the miners. Widzyk-Capehart and Duff (2007) point out that automation in mining can lead to increased safety as well as the opposite. Li et al. (2011) found that control rooms in Australian mineral processing plants were noisy due to machines, people, and alarms and that the workers reported high workload and stress. Nachreiner et al. (2006) found that mining control room operators have a difficult and complex work situation and that neither the technology nor the training of the workers had been developed and adapted for their situation (see EEMUA 2002). A number of system vendors have introduced a human factor approach into their product development (Lundmark 2008, Nimmo & Moscatello 2004), but there is still much to improve (Hollnagel 2007). In sum, there is still a need for further research on the physical work environment in mining operations, especially in the light of technical, technological and organisational development.

4.2 Safety

Safety is a large and important research area related to the physical work environment and is, for obvious historical reasons, important for a sustainable mining process. One theme in this area is safety training for mine workers. Especially in Canada and Australia, this is a large research area. Lööw (2013) concludes that this is an effective method to reduce accidents and occupational injuries and ill health, but it is a rather expensive method (Shooks 2014). Besides basic safety courses, which are mandatory for all workers, the level of training can differ depending on if the work is performed by the mining company itself or a contractor. In-house personnel might receive further training that contractor employees do not, which can create a gap in competency level. In some instances, general safety training for both groups is done online using specially developed interactive educational platforms. The development towards interactive online solutions and how this form of safety training connects to the actual work environment and work processes are emerging themes within safety research. Studies in human work science have shown that workplace-based learning is an effective way of getting employees to acquire new knowledge and develop new competencies, something that is applicable and relevant also in a mining health and safety context (Somerville and Abrahamsson 2003). Another theme is mine rescue stations, especially in coal mining contexts in Australia (Abrahamsson & Somerville 2007, Somerville and Abrahamsson 2003), mine rescue and disaster handling (Burke et al. 2006, Robson 2012), and occupational health clinics (Apostle, O'Connell & Vezeau 2011). Other safety measures include, for instance, new intelligent personal protective equipment for miners (Nadeau et al. 2013). Development of some sort of personal protection is suggested for deeper mining, since deeper mining operations lead to increased risks due to higher humidity and temperatures, air supply, vehicular traffic, dynamiting operations, etc. According to the authors of the article, such protection should include at least a GPS signal as well as an audio-visual communication system that does not require manual operation for communication with co-workers above ground.

It is common practice among mining companies to measure the overall safety performance of the organisation using a number of indicators:

- Number of fatalities;
- accident and injury rates, e.g., lost time injury frequency rate (number of injuries/1 000 000 hours worked);
- rates and numbers of occupational diseases; and
- sick leave statistics.

These reactive key indicators are used to monitor the work environment and prioritise actions against different existing problems. Reactive key indicators measure various aspects of the actual work environment with its risks and benefits in contrast to socalled proactive key indicators, which measure the promotion of safety in the work environment ex ante of an accident or incident (Johansson 2010a). Reactive key indicators have a long-standing tradition in the mining industry and still play an important part in safety management. However, in order to get a broader view of the safety performance of the organisation, proactive indicators can be used, for instance, to provide a picture of the work environment competency level among the workforce and to understand how well the work environment management system (WEMS) has been implemented. These monitoring indicators include the status of the WEMS (i.e., overall functionality), fulfilment of action plans (e.g., efficiency in reducing recorded risks), and competency level among managers with regards to WEMS (Johansson & Johansson 2008). In current research, the safety-related behaviours of the workforce are also making headway as important aspects to consider in safety performance (see Christian et al. 2009, Griffin & Neal 2000, Tholén, Pousette & Törner 2013). These behaviours can be measured using self-administered questionnaires, where the respondents are asked about two specific forms of safety behaviour, namely safety compliance (the tendency to follow rules and regulations) and safety participation (voluntary actions promoting general safety in the workplace). Using self-evaluation to measure safety behaviour has some obvious drawbacks, like the difficulty of administering large-scale surveys, but studies have shown that self-evaluation is a reliable

way of evaluating the overall behavioural aspects of safety performance (Neal & Griffin 2006), especially in connection to simultaneous measurements of the safety climate(s) of the organisation (see below "Safety culture and safety climate").

In a recent study, Bahn (2013) proposed a typology of common OHS hazards in underground mining, emphasising the multitude of problems that might arise in these settings (Table 1).

Category	Examples of hazards
Obvious	Unguarded machinery, electrical leads lying in water, uneven ground, unsupported ground
Trivial	Tools left lying on the ground, cables across access ways, broken light switches
Emerging	Loose rung on a ladder, unlabelled chemi- cal bottles, repetitive work, improper use of equipment
Hidden	Ungrounded electric cable, unexpected ground movements, falling rock, explosions, exposure to hazardous gases

Table 1: Typology of hazards in underground mining (Bahn 2013).

As seen, there are many hazards in mining that are physical in nature as the work environment is deep underground and the equipment that is used in the work processes can create context-specific hazards that need to be controlled. These hazards can be obvious, such as uneven ground that can cause trips and falls, or hidden, such as explosions and falling rock. A mining accident in Turkey in May 2014, where nearly 300 workers lost their lives, was a clear example of a hidden hazard, which in this case also had catastrophic consequences. Emerging hazards, such as repetitive work and improper use of equipment, highlight the importance of considering physical, organisational, and cultural factors and the role they play in the emergence of accidents and incidents.

The standard methods for identifying OHS hazards and risks are accident and incident reporting, risk analysis, and safety rounds. Once the identification is completed, the following actions can be undertaken to minimize the problem(s):

- 1. Preventative measures already at the planning stage. For example, through automation to eliminate some underground work.
- Isolating the individual hazard. For example, by designing ventilation and layouts so that the blasting fumes cannot spread outside the risk zone.
- 3. Changing process technology and behaviour. For example, drilling with water hydraulics rather than pneumatics to reduce dust emissions.
- 4. Limiting the hazard through enclosures. For example, by building concrete borders and railings at the shaft openings.
- 5. Isolating personnel from the hazard risk area. For example, by supplying the mining vehicle with safety cabs and good climate control.
- 6. Risk reduction by instructions, procedures, training, etc. For example, procedures for safe handling of explosives.
- Risk reduction through personal protective equipment. For example, functional working clothes with added protective layers.

Depending on the complexity and severity of the problems, a number of combinations of the above-mentioned measures might be needed (Johansson 2010a). In LKAB, two additional methods are also frequently used in the promotion of workplace safety: 30 Second Risk Analysis and Safety Walks. The 30 Second Risk Analysis simply means that before each work assignment the miner stops for 30 seconds and reflects on the possible risks involved in the work task at hand ("What could happen if I do this?"). Safety Walks ("säkerhetsrundor" in Swedish) consist of workers approaching people performing a work task and, using a specially developed checklist, asking some basic questions about safety and work conditions. All employees must perform at least two safety walks per year to facilitate informal conversations about safety among the miners in the actual work environment.

The number of accidents has been reduced dramatically in LKAB⁶, but they still torment the industry as a whole and create big headlines in the press when they occur. During the last couple of years, much public interest has been paid to severe accidents and fatalities where contractors have been involved

⁶ E.g., the number of accidents per one million hours worked in LKAB has gone from 12 in 2004 to 7.9 in 2013 (LKAB 2014).

and the safety measures have been questioned and debated in the media. This has led to a surge in safety-awareness among mining companies in general, with a shift in focus towards the worker and his (the industry still being male-dominated) need for personal safety in the daily work practices. With an emphasis on the psychological, social and cultural aspects of the work environment, "Safety First" is hailed as a hallmark of the global modern mining industry. Here, we can see Australia as the best example where a strategic and persistent implementation of safety culture during the last 10-15 years has led to a clear shift in workplace culture and significantly lower number of fatal accidents compared to Sweden (Safe work Australia). In his review Occupational health hazards in mining: an overview (2004), Donoghue emphasises the need for more effective risk communication and safety management, since the mining industry today is facing increasing intolerance of environmental and occupational health risks even though these risks are better handled today than in the past. He bases this suggestion on the fact that risk management has been proven successful when preventing occupational hazards since it has decreased the injury frequency rates substantially.

This could be contrasted with the culture of risk-taking that still plays a significant part of what it means to be a "real" miner, where personal safety in some instances is downplayed in favour of generally unsafe work practices (Abrahamsson & Somerville 2007, Andersson 2012, Somerville & Abrahamsson 2003). In the strategic implementation of the Safety First-concept, cultural aspects have consequently also become an important part of proactive safety management. In 2010-2011, LKAB began offering courses to inhouse personnel focusing on organisational safety culture and the importance of joint values, attitudes, and behavioural norms when it comes to safety. Other Swedish mining companies, such as Zinkgruvan, Boliden, and Dannemora Mineral, have also shown an interest in similar strategic safety culture programs as a way of ensuring the health and safety of their workers. A case can certainly be made for safety culture having become synonymous with "sustainable work environment" in the modern Swedish mining industry.

4.2.1 Safety culture and safety climate

There are still no generally agreed upon definitions of safety culture and safety climate, although the basic theoretical underpinnings of each concept have begun to solidify in recent years. Safety culture, conceptualised as being a part of the overall organisational culture, often refers to the shared basic assumptions and norms of an organisation in relation to safety (i.e., deeper cultural layers that can be difficult to interpret – even by the members of the organisation themselves) (Guldenmund 2010, Törner 2010). Richter and Koch (2004) defined safety culture as "the shared and learned meanings, experiences and interpretations of work and safety - expressed partially symbolically – which guide peoples' actions towards risks, accidents and prevention" (p. 705). Safety climate, on the other hand, refers to the shared perceptions of safety-related matters in an organisational setting. Zohar's (1980) basic definition is still widely used, where climate is seen as "a summary of molar perceptions that employees share about their work environments" (p. 96). If studies of safety culture mainly focus on qualitative descriptions of the basic assumptions and norms located in the deeper cultural layers of an organisation, then safety climate could be seen as a snap shot of that culture through the quantitative measurement of the shared perceptions of a work group regarding policies, procedures, and practices in relation to safety. Taking an organisational psychology perspective on workplace safety, safety climate is then viewed as one of many possible antecedents to safety performance (i.e., safety behaviour), which, in turn, directly precedes safety outcomes such as accidents and injuries (Christian et al. 2009).

Research into safety culture and safety climate in the mining industry is still sparse. One exception is a study by Bahn (2013) where a move from having a workforce comprised of both in-house personnel and contractors to only having in-house personnel was seen as significantly strengthening the safety culture. Heterogeneous work groups working under different management systems and having different basic assumptions regarding safety could lead to a lowering of overall safety performance. Other examples of problems are, as mentioned earlier, the connections between risk-taking and a special type of masculinity ("macho-masculinity") that has been common in mining workplace cultures (Abrahamsson & Somerville 2007, Andersson 2012, Somerville & Abrahamsson 2003).

In LKAB's strategic safety culture program, a version of the following model is sometimes used.



Figure 1: Basic model of safety culture.

Contrary to the more theoretical perspective of safety culture as described by Richter and Koch (2004), this model is seemingly an attempt to turn the concept of safety culture into something that can be used more practically in safety management. The three factors - management (rules, regulations, and policies affecting the organisation), comprehension (how the rules and regulations are actually understood), and behaviour (how management and comprehension is transformed into behaviour) - are seen as creating the safety culture of the organisation. In order to create joint values, norms, and positive attitudes with regards to safety among the workers, all three aspects need to be taken into consideration as well as the intricate interplay between the human component of the socio-technical system and broader organisational conditions such as the psychosocial environment.

The importance of taking a broader perspective on safety becomes apparent in the modern mining industry, considering the development towards outsourcing certain tasks to contractors and suppliers, such as construction, maintenance, transport, or planning of projects. This offers volume flexibility and expertise for the larger mining companies, and can involve everything from local small and medium-sized enterprises (SMEs) to large national and international companies. However, this trend needs special attention in future research. On the one hand, this arrangement can be positive for the local labour market and businesses, especially if the local SMEs broaden their activities to other sectors making them not totally dependent on the large mining company and the ups and downs in the global metal market and mining industry. On the other hand, it makes recruitment and development of the whole mining workforce complex and it can be problematic in connection to training in safety, implementation of lean mining, production optimisation, and the development of a safety culture and a learning organisation (Johansson et al., forthcoming). Such processes are more complex and difficult when many organisations and sub-cultures are involved. Experiences from Swedish, Polish, and Finnish mining companies indicate that it is difficult to maintain equal and good health and safety practices when many contractors are engaged (Johansson 2010b, Johansson & Johansson 2008). At Luleå University of Technology, a four-year research project is currently underway focusing on these and related matters, with an emphasis on the safety and work conditions of contractors in underground mining.

4.3 Psychosocial work environment

Previous studies into psychosocial factors in mining work have focused on stress (Amponsah-Tawiah et al. 2013), lack of social support (Torkington et al. 2011), information overload, confusing alarms (Li et al. 2011), and job dissatisfaction (Paul 2009). Focusing on organisational stressors in the form of piece rate wages, Johansson et al. (2010) carried out a literature review on their effect on health and safety. The study shows that although research is sparse and fragmented, much of the accumulated knowledge about the effects of piece rates points to it having a negative effect on health and safety. The fact that 27 of the 31 studied research articles found negative effects of piece rates on different aspects of health and safety did not prove causality, although together they provide very strong support for the hypothesis that in most situations piece rates have adverse health effects. Strong correlations are also reported from the mining sector. After a mine strike at LKAB in the winter of 1969-70, the wage system at the company was changed from a piece rate system to fixed monthly wages. The monthly wages varied depending on the type of work. According to Kronlund et al. (1973), statistics regarding accidents calculated two years after this change indicated three major changes: severe accidents decreased by 95%, normal accidents decreased by 70%, and minor accidents increased by 45%. There were several reasons for this development, but the change from piece rates to fixed wages was considered to be the most important, as risk-taking among the miners was reduced and sick leave due to minor injuries no longer reduced the earnings in a significant way. Working for piece rate pay, many miners ignored injuries from minor accidents so as not to lose income.

Over the last several decades, the use of extended workdays (regular shift lengths of 10 or 12 hours per day, while still maintaining 40 hours of work per week) has become more and more common. It seems that the use of extended workdays is a popular solution for fly-in/fly-out miners due to the increase in days off, including weekends, when compared to traditional schedules. There are, however, also clear fears by management, workers, unions, and experts on OHS that working long shifts will increase the risk of OHS problems, and perhaps increase psychosocial problems. Dembe et al. (2005) conclude that long working hours indirectly increase workplace accidents by inducing fatigue or stress, a problem that is also underlined by Muller et al. (2007) in relation to fly-in/fly-out and shift work. Furthermore, many researchers mention the fact that shift work may be associated with poor diet, high blood pressure, and the risk of fatigue-related injury (especially travel injuries). For mining work, it seems important to be aware of the documented and obvious risks and if possible avoid overtime and extended working hours. Employers and trade unions have a shared responsibility to emphasise the risks when drawing up agreements about shift forms and working hours.

4.3.1 New skills for the mine worker of the future

A key issue for a sustainable mining industry is the ability to recruit skilled workers to the mines, which are often located far from larger communities. Education and training for mine workers is a large research theme (Abrahamsson & Johansson 2006, Hebblewhite 2008, Peterson et al. 2001, Scoble & Laurence 2008). One main focus is how the future labour and skills supply and methods will handle globalisation. A modern mine is so technically advanced that the proportion of unskilled labour will decrease significantly or disappear. From an international perspective, there is a great shortage of skilled labour as the result of a long period of robust growth in the metal, ore, and mining sector. Today, the forecasts are a bit more pessimistic, but production growth continues and the need for skilled workers remains greater than the supply (Hebblewhite 2008). From a Swedish perspective, it has not yet been a major problem recruiting the needed labour force, at least for the large mining companies. The situation is a little bit different for SMEs and contractors connected to the mining sector. In addition, the present workforce is ageing and the mining companies fear or have difficulties recruiting young people. A long-term threat is also that women and youth will move out of the northern mining communities. A precondition for being able to recruit the right workforce is that the mining industry can offer a challenging work environment and safe workplaces that attract young people. This segment of the population, especially young men, is traditionally also more likely to engage in long distance work travel, especially when it comes to work performed in connection to mining, such as construction (Nygren 2013). This further underlines the complexity of getting young people to become permanent residents of mining communities as well as highlights the problematic nature of these male-dominated and sometimes travelprone occupations.

Still, the mining sector must account for globalisation. The large mining companies (for example, BHP Billiton, Rio Tinto, Newmont, Xstrata, Vale, Anglo, and Barrick) are global (operating in several countries) and act on a global market. Projects compete globally and staff must be able to move and operate in several countries. Although Swedish mining companies are



Photo: LKAB / Fredric Alr

still essentially national, they will eventually have to act in a global context, which will impact their business in many ways.

Other requirements to be considered are new technologies, automation, remote control, new machinery, new mining techniques, and especially new ways to organise and conduct business. As a result of the increasing level of technology, the role of the worker has changed in relation to both the technical system and the rock itself (Abrahamsson & Johansson 2006). While there has always been a machine between the worker and the rock, over time that machine has tended to become bigger and more technically sophisticated. Work processes have become automated or remotely controlled. These changes have created new types of work where improvements to the physical work environment are obvious. In the mine, the bulk of heavy lifting work has been eliminated and the hazards associated with noise and dangerous gases have been diminished. For many mine workers, actual contact with the rock is minimal. In some cases, the operator makes only occasional visits to the machine that he or she remotely controls. The operator can return home after work as clean as he or she arrived, without ever having to worry about traditional OHS risks and hazards.

Remote control centres are also creating new professional roles. Bassan et al. (2008) predicts an increasing degree of remote control where the operators have monitoring and coordinating activities across the value chain. The operators are supported by intelligent and automated decision systems and use the Web 2.0-system of global communication, information, and learning. These changes also include changes in qualifications, knowledge, and skills (Abrahamsson & Johansson 2006). A clear transformation can be seen from the traditional craftsman-like qualifications reflected in a degree of autonomy, the use of manual skills, and sensitivity to material (rock-sense) to the more technical qualifications based on abstract knowledge necessary to operate the new technologies. Workers are also subject to new demands for teamwork, responsibility, autonomy, and a comprehensive understanding of production flow. These trends can be seen as a movement from qualifications dependent on the process to more process-independent qualifications. Process-dependent qualifications include the forms of knowledge and the skills needed for undertaking the work tasks specific to the production processes at the work site and can take two main forms: craftsman-like or technical. Examples of process-independent qualifications are more generic skills, such as flexibility, technical intelligence, perceptive ability, technical sensibility, and a sense of responsibility, trustworthiness, and independence.

Mallet and Orr (2008) point out that the mining industry needs effective methods for on-the-job learning and a learning organisation. What was once the mine worker's tacit knowledge is now formalised and codified into automated routines and computer programs. As a result, contradictory movements of 'upskilling' (rapidly changing skill demands, more theoretical and comprehensive tasks) and 'deskilling' (fragmentation of individual craft knowledge and whole tasks) are evident (Abrahamsson & Johansson 2006). One effect of remote control operations is that the work tasks seem much simpler when they have been moved out of their context, away from the physical place where the loading or drilling machines operate. The work tasks probably are as simple or as complex as before, but since they do not need to be undertaken in a difficult work environment, the aura of job secrets and mystique, previously embodied and expressed through traditional tacit knowledge, run the risk of disappearing (Abrahamsson & Johansson 2006, Andersson 2012).

This change will be neither simple nor without resistance. Taken together, new technology, the better work environment, new qualification demands, new

type of work tasks, and other changes challenge old behaviours and attitudes of the mine workers. The resilience of the traditional workplace culture can be demonstrated in nonchalant attitudes towards risks, emphasising the concept of a hazardous mine (which may be associated with demands for higher wages), and tendencies of a hesitant attitude towards technological development, including seeing new technology as a threat to the uniqueness of mining work, glorifying the cultural heritage of mining, and male workers' active resistance towards women in the workplace (Andersson 2012). The identity aspects of work (i.e., how individuals create and recreate identity and sense of self and the symbolic aspects of work such as stories, myths, ideas, and perceptions of what a "real" mine worker is like) lag behind the structural changes at the workplace such as new technology and new qualification demands (Abrahamsson & Johansson 2006). As described earlier, the old mine worker masculinity plays a significant part in this (Abrahamsson & Somerville 2007, Andersson 2012, Somerville & Abrahamsson 2003).

4.3.2 New tools for the mine worker of the future

The modern mine is characterised by close cooperation between the mining staff and the suppliers as well as customers. Virtual reality (VR) technologies as production tools have great potential, especially the use of VR in real time, to visualise and control production processes. "Extended business" and "open collaboration" are two concepts that refer to the integration of different parts of the value chain. Here, VR technology can be used to link production functions such as planning, mining, maintenance, logistics, and purchasing as well as for coordination of external contractors, suppliers, and customers, all connected to a production flow with a shared goal. Common visualisation of problems and opportunities in the system enables all workers to optimise the whole chain rather than individual parts (Bassan et al. 2008).

In the future, the mine site will be a "connected community" where people, equipment, infrastructure, and rock sensors provide and share data. Primarily, it is a system for verbal communication, but it would be interesting to see if the system also can support image information and communication. Miners equipped with mini-cameras could for everyday and emergency situations provide their colleagues in the control room with information that is difficult to convey verbally. Portable video communication systems are already being used in German coal mines (Skirde & Schmid 2008). Different types of machine-machine communication will grow in use.

In the on-going project "The operator of the future" ("Framtidsoperatören" in Swedish), the overall aim is to increase the competiveness of Swedish industry by developing an advanced toolbox that meets the above mentioned future challenges - and here the mining companies LKAB and Boliden are part of the consortium (Grane et al. 2012). In this project, prototypes of tools are being developed with a modern IT-interface in order to be well integrated in the production system and adapted to a modern organisation. The tools are intuitive and situation-adapted and the aim is to "strengthen senses and power of the mine worker". The advanced and supportive technology fosters teamwork, communication, and learning, making the jobs more interesting and stimulating for the workers. The toolbox should give added strength to the operators of the future by making them the key to enhanced innovation and competiveness of the Swedish mining industry.

4.4 Social sustainable development outside the mine

Several articles discuss how to attain social sustainable development outside the mine (although without real connections to the mining company). The main strategies recommended are communicating with the local citizens, involving them and the staff in decision-making, and providing equal opportunities to all regardless of gender, ethnicity or disabilities (Hilson & Murck 2000). Other recommendations for the mining company includes contributing to education of the local citizens and investing in various community projects such as schools, hospitals, and local sports activities (Azapagic 2004, Natural Resources Canada 2003). In the discussions of mining companies' responsibilities for social sustainable development, it is also mentioned that the mining companies should contribute to a strong technical and social infrastructure to ensure survival of the local culture and society after mining activities cease (Ail & Baffi 2007, Wibowo & Rosyid 2008). However, it is unlikely that

an individual mining company alone can do this and it is especially difficult in small remote communities. Here satellite-controlled mines from a major city might be a solution.

When a new mine is established, the influx of outsiders comes with both positive and negative consequences. If handled in a good way, this influx can certainly increase the diversity of the local society. An expanding community can also result in thriving businesses and better health-care delivery. However, such a rapid change in demographics can also place difficult pressures on the local society. A risk for increased prostitution, sexually transmitted diseases, alcoholism, and violence are a few of the negative consequences that the influx of outsiders can cause (Natural Resources Canada 2003). In the reviewed literature, there seems to be two different orientations of the matter, and some of them mention fly-in/fly-out work as both a cause and a solution. Fly-in/fly-out work in mines may result in a loss of tax benefits for the local community since the workers do not live there full time but still use the community's services and infrastructure. Another problem is that the fly-in/fly-out mine workers are either working at the mine site or asleep. The miners only see the town when passing through it and therefore do not see themselves as citizens of the community so they do not engage in activities of the local societies. Some of the reviewed articles discuss the problem of how local businesses price their products and services according to miners' wages. This situation is seen as one reason why many families cannot afford to live in mining towns. Some articles mention that fly-in/fly-out work can contribute to depopulation, and the majority of the literature believes it is better to discourage fly-in/fly-out communities. The main reason to why this type of work is implemented is the lack of skills and knowledge in the local society (Azapagic 2004).

An emerging issue relates to how indigenous people are treated when a mine site is being developed. The issue, raised in a background paper written in Canada in 2003 (Natural Resources Canada), requires a sensitivity to preserving indigenous people's traditions, spirituality, hunting grounds, etc. as a means to sustainable development. Furthermore, when developing a mine, involvement of indigenous communities should be encouraged and an adequate proportion of the workforce should come from the indigenous population.

4.5 Suggestions for future research

Although work environment is a large research area, the research is brief when it discusses the relations between sustainable mining and a good work environment, regardless of whether it relates to physical or psychosocial factors.

Clearly, there is a need to conduct more workplace level studies and learning studies. According to basic knowledge about sustainable and good work environments, workplace learning, skills development, and training are vital aspects as well as a learning organisation, communication, and social interaction. All of these benefits should be available for all employees. A related area for future research is automation, including work task design for automated production, remote control, and other high-tech areas. It is important to avoid creating monotonous and degrading jobs, a goal that can be addressed by developing new IT and computer-based tools for miners which departs from the actual work situation. In other words, when developing mining technology, the mining sector should integrate organisational and technological development using socio-technical principles.

The development of more high-tech, automated, professionalised and specialised production, however, might result in more fly-in/fly-out and drivein/drive-out communities because automation may require specific competencies unavailable locally. This development may be very good for the society from a diversity perspective, but it is important that the industry also promotes competency development and workplace learning so the local citizens can raise their education level, creating the possibility to live in the same community they work in, thereby encouraging a sustainable community. How to do this is not obvious, so this is an area for future research. In addition, fly-in/ fly-out work and shift work with long hours is not always compatible with good work conditions because of the problems of balancing work and family responsibilities. Presently, contractors perform a significant part of the total number of hours worked within the mining sector, making the safety culture and organisational development more complex. Outsourcing and

contracting in relation to work conditions are important aspects to consider in further research.

This brings us to the issue of health and safety, which is another huge area that needs further investigation when it comes to creating social sustainable growth. Many mining companies are currently working with strategic safety management programs focusing on Safety First, with an overall aim to create safer work conditions for both in-house personnel and contractors. Safety culture has become one of the most popular ways of addressing issues related to social cohesion and personal safety, where culture in many cases is seen as something that can be "engineered" in a simultaneous top-down and bottom-up fashion. From this, a number of research approaches can be taken:

- One possible avenue for further research could be LKAB's Safety First-program and strategic work with the development of a safety culture. How does the seemingly top-down/ bottom-up engineering approach to the development of a safety culture affect participation, influence, and a gainful and healthy working life, i.e., social sustainability from the individual worker's point of view? Are there differences between in-house personnel and contractors, and if so, how and why?
- The power perspective is certainly relevant in this context, as the development of a safety culture is inextricably intertwined with power and thus also, possibly, conflict (Antonsen 2009). Is safety culture meant to be the same for everyone at every level of the organisation? How are we to understand the existence of subcultures and the role they have in shaping organisational dynamics and safety culture? Taking this approach, culture, power, conflict, and resistance would be important aspects to explore in relation to social sustainable development.
- Another interesting avenue would be workers' identity and how it is affected by contracting and fly-in/fly-out and drivein/drive-out. Are we witnessing the growth of a new kind of worker's identity in the modern Swedish mining industry? And if so, how are we to understand it? In order to further conceptualise and describe the intricate interplay between diversity, gender, and work conditions – in relation to social sustainable development – one fruitful research approach might be identify studies through ethnography.

The result of our literature review on work conditions indicates that most of the literature covers the physical work environment and the social environment outside the mine. Both these areas are important when discussing social sustainable development related to work conditions, but two areas are missing: the psychosocial work environment and organisational development. A growing area related to this is lean mining. However, relatively few articles address these areas, so this vital part of social sustainable development needs more research.

One explanation to why the physical work environment is more investigated than psychosocial is that the work environment in the mines initially involved injury and fatality prevention. The connection between this and the physical work environment is perhaps more obvious than it is to the psychosocial work environment. Improvements in the physical work environment are also much easier to see and measure than in the psychosocial work environment. During the last 50 years, improvements in the work environments in the mining industry have been easy to measure regarding physical aspects. For example, workers no longer endure the hard work environment of underground mining as today it is possible handle the mining process from clean production centres above ground. It is possible that the focus on safety and the shift towards more office-like work conditions will make it easier to introduce research of psychosocial work environments in mining.

Even so, social sustainable development outside the mine seems to be more investigated than the psychosocial work environment. One explanation to this is the obvious direct links to the mine industry's economic interests such as the need for a skilled work-force and social infrastructure around the mine as well as the need for discussions on how to handle protests against mining. The question of a "social licence" is frequently raised, but it is rarely clear or globally defined what a social license represents. There is a need for a clearer definition of criteria that form the basis of the social licenses so more obvious and measurable indicators can be developed. Questions to consider include how social impacts of mining can be tested in a way that is meaningful to mining companies, but without belittling the complexity inherent in social situations.

5. Framing mining sustainability aspects of gender, diversity, and work conditions

5.1 Summary of literature review

This background report identifies and describes three areas of research on social sustainable development with respect to mining companies and communities: gender equality, work conditions, and social diversity. All three areas of research can be regarded as relatively mature and they provide important contributions to our understanding of social sustainable development in relation to the mining sector, even if they not always explicitly discuss sustainable development in mining.

We conclude that the field of **gender** studies in mining has largely focused on describing and analysing problems. For example, the problems that women face include high risks of being subjected to restrictive norms, open resistance, harassment and discrimination in male-dominated mining workplaces and in rural communities. Other examples are the problems that the strong link between occupational identity and masculinity creates for the implementation of safety, new technologies, new organisational forms and environmental awareness as well as the possibility of a diversity of lifestyles for men. Some studies have examined the problems that gender segregation and gender stereotypes create with respect to changing organisations and structures in both mining companies and societies. In this area, researchers at Luleå University of Technology have done research, for example, on safety, learning, and masculinity in Australian coal mines (Somerville & Abrahamsson 2003, Abrahamsson & Somerville 2007), on gender, skills, and technology at LKAB (Abrahamsson & Johansson 2006), on the gender dimension of socio-economic aspects of the new mine establishment in Pajala (Abrahamsson 2008), on mining, mystery, and masculinity at LKAB (Andersson, 2012), and on the strategic research and innovation agenda for

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the mining industry "Breaking ore and gender patterns" (Andersson et al. 2013). Moreover, an on-going project with funding from NordMin involves analysing and learning from the gender equality measures and initiatives that mining companies have made and will be used to develop new initiatives suitable for male-dominated workplaces, which are common in the mining sector. But this research is mostly based on company-internal perspectives and does not include specific analyses of the links to other aspects of social sustainable development, especially outside the companies, so we see a clear need for future research in this area.

We also conclude that research in the fields of **work** environment and work organisation in the mining industry can be considered a developed field. One common argument is that aspects of work environment/occupational health and safety (OHS) need to be included in the design of the production system and the automation to create a good, attractive and sustainable work organisation. The research builds on basic theories on how interactions between organisational, mental, environmental, and physical factors cause work-related illness. Some examples of research themes include safety culture, risks, stress, work hours, and organisational development. Some research is applied and focuses on development of intelligent tools for mine workers, tools adapted for the mining operator of the future. There are several on-going studies on work environment and work organisation in the mining sector at Luleå University of Technology, for example "I²Mine" (with financing from the EU), "Health and safety for contractors in mining" (with financing from the Hjalmar Lundbohm Research Centre), and "The operator of the future" (financing from VINNOVA). Although these studies, like similar studies at other universities, have a companyinternal perspective, they lack deeper analyses of the connections to the local society level. Since mining companies usually are significant employers in the local communities, they influence the safety, health, culture, and social life of their workers and their workers' families, as well as of emplyees in other local companies. In future research, work environment and work organisation in the mining industry needs to be

interlinked with social issues in local communities, especially in connection to fly-in/fly-out, automation, safety, and risk.

We also describe research in the fields of social sustainability on the community level when it comes to diversity of lifestyles and preferences in mining communities. Social trends such as strong community identity can be seen as a good ground for cohesion, but this identity is also associated with a certain lifestyle that is not inclusive, representing a traditional (rural and mine worker) masculinity. Some research describes the establishment or growth of a mining company as a major strain on the local housing market as demand rapidly increases. Moreover, an active role of mining companies in housing policy might be controversial if citizens have limited control over the decision-making process. As described in the background report, there are limits to the existing body of knowledge on the interrelations between mining companies and local mining communities such as the measures that can lower the social risk associated with a boom-recession cycle. Compared to economic end ecological impacts, research on the social impacts of the mining industry on local communities is underdeveloped and not linked to the more developed field of socially sustainable work environment and work conditions. The eventual problems caused by the differences in wages between the mine workers and the rest of the local society need to be studied further. Existing studies link mining to the demographic changes, housing infrastructure, and social phenomena such as community cohesion and inclusion, but the character of the interaction needs further study. However, here we can draw inspiration from previous research (e.g., the baseline study for Pajala) and the on-going research on attractive living in cold climates focusing on the city transformations of Kiruna and Gällivare (the projects "ALICE" with financing from FORMAS and "ATTRACT" with financing from VINNOVA). This research analyses the broad social context of the mining communities, but does not adequately include the influence of mining companies. There is a need for future research that examines the influence of mining companies on local communities.

5.2 Suggestions for future research

In order to obtain a more dynamic picture of social sustainable development with regards to mining, we suggest that future research should add to what has already been done by focusing on a broader range of aspects of sustainability in mining companies and local mining societies – i.e., the studies should include and integrate the three areas of research presented in this report: gender, work conditions, and diversity. These areas also need to be interlinked, put in global and intersectional perspective, and approached from the theoretical as well as the applied level.

Within the theoretical dimension, it is important to develop general and deeper understanding of the complex problematic patterns when it comes to gender, working conditions, and a diversity of lifestyles in the mining industry as well as in societies with mining activities. There is especially a need of research that links attitudes, policies and activities within companies and their impact on the wider society, and vice versa. As a part of the more applied dimension, it is important to identify, analyse, and define parameters and indicators of gender equality, good working conditions, and a diversity of lifestyles (all parts of social sustainable development) relevant for a mining context as well as suggestions for methods, practical solutions and alternative strategies. It is especially interesting to link this to the on-going urban transformation processes in Kiruna and Gällivare.

A possible starting point for the suggested research could be to learn from history: What worked poorly and what worked well? Socio-economic aspects of sustainable development have been important issues for LKAB during its 125-years of business, different aspects and in different ways in different times, so these historical trends and lessons learned should be examined further.

Suggestions for future research goals:

- to compare today's situation with LKAB's historical societal footprints of 125 years of mining operation when it comes to gender, working conditions, and a diversity of lifestyles, i.e., use the past as a way to understand the present and the future;
- to develop and analyse social sustainability indicators (especially for gender, working conditions, and a diversity of lifestyles) and identify different scopes and temporalities

 short-term and long-term influences on the local communities, companies, and regions;
- to identify and analyse the links and crossroads between the mining industry and different stakeholders and perspectives for these issues;
- to suggest practical solutions and alternative strategies and to assess possible consequences of different scenarios; and
- to develop theories and methods for how to integrate these issues of social sustainable development in for example the on-going urban transformation processes.

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