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Sustainability in Finland's extractive industry: Responding to a need for best practice guidelines in early decision making phases

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Bachelor of Science Honours in Sustainability and Environmental Science
Kieran Hooey

Supervisor: Professor Kauko Viitanen
Instructor: Dr. Jukka Mäkinen,
Aalto University School of Business
Department of Management Studies
Instructor: Dr. Saija Toivonen
Aalto University School of Engineering
Department of Built Environment

Author Kieran Hooey

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Abstract

Most of the world is in agreement that climate change is indeed real and it remains one of the most crucial unsolved problems in the 21st century. In Finland, much of the anger and blame was placed squarely on the shoulders of the extractive industry after a massive leakage of the gypsum tailings ponds at Talvivaara Mining Co in 2011. The purpose of this research is to uncover the central issues that the Finnish non-energy extractive industry must improve on to become more environmentally, socially, and economically sustainable. An extensive literature review combined with 20 stakeholder interviews were conducted. The stakeholders are all very highly regarded members in the industry and come from a variety of backgrounds such as government, science/universities, industry, and non-governmental Indigenous organizations. The results of both methods were analysed and combined to create a wholesome list of 10 of the most crucial issues, called themes. The issues/themes that were raised the most in the stakeholder interviews were the need for sustainability to be considered in the exploration phase and that the non-energy extractive industry has lost the trust of stakeholders due to a lack of communication. The literature review also points to these areas as weak spots and insists that social and community engagement techniques must become more effective. These areas can be referred to as leverage points in systems thinking because improving them will have a large impact on the industry as a whole. Other issues include technological improvement, improving biodiversity conservation and protection, and water and tailings management. The study took a participatory research approach by having the interviewees/stakeholders review and make changes throughout the study by means of meetings, phone calls, and emails. During these consultations, several interviewees expressed the need to present the 10 themes in a visually appealing fashion or, they said, many decision makers would not read it. The results section was transcribed into a guidebook along with graphs and figures to create an easy to read document. The stakeholders have all agreed to distribute the guidebook to their contacts. Further research must be conducted with a larger, statistically valid sample size and also to determine how the themes can be best turned into positive actions.

Keywords sustainability, non-energy extraction, mining, natural stone, systems thinking, community engagement, social sustainability, exploration, pragmatic research, Finland

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Tables and Figures

1. INTRODUCTION

In some cases, especially in long academic papers, the motivation and purpose of the document can become unclear or lost in figures, tables, and reasoning. This section defines the author's motivation and states the purpose along with providing a roadmap of this research.

1.1 Motivation

There has been a considerable amount of literature published that attempts to understand why some people actively pursue taking measures to be more environmentally sustainable while some do not (most notably O'Connor et al. (2003) and Kollmuss & Aygeman (2002)). Several important factors include environmental knowledge, motivation, and awareness (Kollmuss & Aygeman, 2002). The industry that is mostly responsible for climate change, based on carbon dioxide emissions, are oil and gas companies and the extractive industry as a whole (Heede, 2014; O'Connor et al., 2003). In his 2014 research commissioned by Greenpeace and the Climate Justice Programme, Richard Heede provides concrete data showing the drastic effect the coal, oil, and gas industries have on climate change. As renewable energies continue to be improved, it seems increasingly probable – and essential - that coal, oil and gas can be eradicated as energy sources (Heede, 2014).

Non-energy resource extraction, unlike coal, oil, or gas, is essential to our way of life and is responsible for providing the material for most of the infrastructure and technology we have today. Without non-energy resource extraction we would not be able to create windmills, solar panels, and rechargeable batteries. Mining companies, and to a lesser extent natural stone and aggregate companies, get grouped in with coal/oil/gas companies as "dirty" businesses. In some cases this is done rightfully because many non-energy extractive companies do not have adequate environmental or sustainability plans or they elect not to follow them. Because the non-energy extractive industry is essential to human well-being and our way of life, we must work with these companies to develop and improve sustainability plans and frameworks to ensure a healthy planet for future generations. Instead of painting the industry and the people running it as "bad" or "dirty", can we open the lines of communication and begin to work together to solve the wicked problem that is climate change?

1.2 Purpose

The purpose of this research is to uncover the central issues that the Finnish non-energy extractive industry must improve on to become more environmentally, socially, and economically sustainable. More specifically this research will answer two questions:

1. What kinds of best practices or guidelines are there in the regulations and literature concerning sustainability in Finland's non-energy extractive industry?
2. According to experts and stakeholders in Finland, what are the major issues and actions that need to be taken to improve the sustainability of Finland's non-energy extractive industry?

1.3 Summary/Course of Action

This paper will first provide a background section (Section 2) that will help define the word sustainability for the purpose of this study as well as situate the reader in Finland's non-energy extractive industry. Once the reader has a basic understanding of the landscape, the methods section (Section 3) will succinctly explain the actions taken in this study and disclose its limitations. Before entering into a series of interviews with leaders and decision makers in the Finnish non-energy extractive industry (Section 5), a detailed literature review will provide the reader with an overview of what has already been done or what is planned in terms of making the industry more sustainable (Section 4). Since Finland is a part of the European Union and is also preparing to implement a Canadian set of mining standards, these markets will be discussed as well. The literature review also highlights a progressive study by Bosch and Nguyen that uses a scientific base to determine central environmental/social/economic issues for an island community (2012). Representatives from all stakeholders and walks of life are then brought together to create a plan of action, thus ensuring each group has a voice and a say in the direction the community will take.

An analysis of the overlapping themes from the literature review and the interviews is presented to the reader in Section 6. It provides concise summaries of the literature review and interviews before merging the two together to create common themes. The results section demonstrates the findings from the literature review using a simple and understandable graph and provides a detailed list of 10 distinct themes/issues that were determined in the Analysis section. The discussion section (Section 8) goes into more detail about what the findings mean for the non-energy extractive sector as a whole. These themes, as the purpose (Section 1.2) above iterates, are areas where the Finnish non-energy extractive industry must improve to do its part for climate change mitigation.

The conclusion section (Section 9) will hopefully leave the reader with a sense of hope that there is an appetite to make these improvements and it presents a potential option for how to take scientific data mixed with participatory research, like is presented in this research, and turn it into action. Because the interviews in this study were conducted with people that are highly regarded in the industry, science, non-governmental organizations, and Indigenous Peoples, much time was spent working in collaboration with all parties. Many expressed the need to present results in a succinct, visually appealing fashion. In response to this, the 10 themes are presented in two easy to read guidebooks in the Appendices.

2. BACKGROUND

This section will help situate the reader in terms of what sustainability means in the context of this paper, since the true meaning of the word has arguably been lost due to catch-phrases like "sustainable bottom-line" and "sustainable economy". Next, it will provide the reader with an overview of the Finnish non-energy extractive industry, noting key stakeholders and developments/events in recent years.

2.1 Sustainability as a philosophy

Some academics and philosophers have recognized the disinterest in sustainability and have tried different approaches to engage people from all walks of life. John Rawls is one of the most well-known and highly regarded philosophers of the 20th century (Richardson, n.d.). His most famous theory, the "Original Position", is beautiful in its simplicity when he asks what would happen if a group of people, say 10, from all walks of life were brought into a room and told that when they came out they might not have the same amount of wealth, intelligence, gender, family, and etc. However, in this room, the 10 people would be allowed to create rules, regulations, social order, and institutions – the "basic structure of society" (Rawls, 1999; Richardson, n.d.). Rawls theorized that when put in this situation, which he calls a "veil of ignorance", most - if not all - people would ensure their basic requirements of life (liberty, water, shelter, food, and the ability to be a part of the global economy) by making a global standard where everyone was guaranteed this (Rawls, 1999; Richardson, n.d.). Simply put, if everything you have could potentially be taken away from you, you will be much more likely to promote social welfare and other measures that benefit the least advantaged people in society because that could potentially be you when you leave the room.

In terms of its relation to climate change, Rawls uses the basic tenets of the Original Position to create the "Just Savings Principle". He theorized that the current generation owes the next generation at least the social minimum of the time. The social minimum should be set a point that maximizes the expectations of the least advantaged group (Rawls, 1999). Most importantly, Rawls goes on to say that if there is no intergenerational component, then we can exploit the wellbeing of future generations and create more or a larger proportion of least advantaged groups over time. Therefore, Rawls would argue for a social minimum to be set that reflects the 2 degree Celsius global warming temperature that is the consensus among scientists as the planetary limit (Rawls, 1999).

2.2 The sustainability divide

The ideas and theories of John Rawls may resonate with many people but there are a large number, typically people from the conservative right of the political spectrum, that are still not convinced. One of the major issues hampering the sustainability movement from truly taking hold is that decision makers in industry and business have not fully bought into the concept. Environmental organizations such as Greenpeace and World Wildlife Fund have heavily scrutinized many large corporations as villains. This has only created a larger divide. It is time that business and industry come to the same table as scientists and environmental organizations and solve the climate change issue. Mining and oil and gas companies have been particularly targeted as the villain in the global warming and climate change arena.

While oil and gas extraction will hopefully be eradicated in the near future through the development of renewable energies like wind and solar power, our society needs minerals and natural resources to survive. As the Brundtland definition notes, true sustainability is taking what we need to survive today without compromising future generations (IPCC, 1987). On one side, environmentalists need to acknowledge that non-energy extractive companies (meaning the extraction from the earth of natural resources and other materials that are not used to create energy) are necessary for our survival. For example, without mining and quarrying, there would be no raw resources to create the large amount of materials needed to produce solar panels or windmills. On the other side, the extractive industry must be ready to come to the table and work with environmentalists, government, local organizations, and scientists to improve the efficiency, process, community engagement strategies, and the image of their industry.

2.3 Finland's non-energy extractive industry

Recently Finland has been receiving a large amount of attention from international mining companies. Riikka Aaltonen, who is also a central stakeholder/interviewee in this study and the Chief Inspector of Mines at the Ministry of Employment and the Economy of Finland, has been quoted as saying that especially after a major discovery of nickel by Anglo American, many international companies are looking to start exploration in Finland (Invest in Finland, 2014). Ms. Aaltonen's view is supported by the Fraser Institute, which recently ranked Finland as the world's second most attractive jurisdiction for mineral exploration and development (Jackson, 2014). The Fraser Institute sends a yearly survey to approximately 4200 exploration, development, and other mining-related companies around the world and asks them to rank the most attractive countries for exploration and extraction (Jackson, 2014). Currently, only two of the large mines, Kemi and Talvivaara, are under Finnish ownership meaning that engagement and enforcement is more challenging (PwC, 2012). It is estimated that over one eighth of Finland has been designated for mining and exploration and more than 250 new applications were received in 2014 (Vidal, 2014). Finland receives high levels of interest but companies note in the survey that are somewhat worried about the long permit times and the lack of clarity of environmental regulations (Jackson, 2014).

Finland has been attempting to respond to this substantial increase in interest while at the same time react to a series of environmental incidents involving large mining companies in Finland over the past 10 years. Since 2007, environmental regulations and publications have increased substantially. The Finnish Association for Nature Conservation, Finland's largest environmental NGO, has been highly critical of Talvivaara Mining Co over the years for its issues including hydrogen sulfide poisoning that killed many waterbirds and the dust and odours that have dispersed a long way from the mine itself (Suomen luonnonsuojeluliitto, 2012). In November 2012, heavy metals such as cadmium and nickel were released into nearby lakes while the uranium content of the effluent (sewage waste) raised 100-200 times from its regular level (Suomen luonnonsuojeluliitto, 2012).

Despite the Talvivaara incident that made world news, Finland is widely considered to be a progressive country and has taken many steps to become a leader in climate change mitigation. The Sustainability Action Plan to Make Finland a Leader in the Extractive Industry, released

in 2013 by the Finnish Ministry of Employment and Economy, is a good example of this. It contains 35 points of action and the first eight are directed at industry themselves. The action plan is analyzed in the subsequent Literature Review section (Section 4.1). A revised *Mining Act (2011)* was accepted and places a slightly greater emphasis on sustainability and recently Finland is in the process of creating a tool to help mining companies develop sustainably. Because Finland is seen as a leader internationally in sustainable development and has recognized that its non-energy extractive industry is lagging, it is a good location to use as a case study in this research paper.

2.4 Stakeholders in the Finnish non-energy extractive industry

There are a wide variety of actors that contribute to the landscape of the non-energy extractive industry in Finland. Figure 1 presents these stakeholders and gives a brief description of their purpose (Appendix 1 & 2). The table was independently verified by 20 people that work in the industry and who contributed to this study by agreeing to interviews and several follow-up meetings. Figure 1 was taken directly from page "v" of both Appendices 1 and 2, which are guidebooks that culminate the findings of this paper into a useful tool for the non-energy extractive industry.

- ☐ TEM: The Ministry of Employment and Economy (TEM) is an oversight government agency that is responsible for upholding The Mining Act (2011)
- ☐ Tukes: The Finnish Safety and Chemicals Agency (Tukes) is the mining authority granting mining permits outlined in the revised Mining act (2011) including exploration/prospecting permits, mining permits (allowed to mine for a fixed period), chemical permits (when necessary like for radioactive minerals), and explosives permits.
- ☐ AVI: The State Regional Administrative Agency (AVI) makes decisions on environmental permits and licenses pursuant to the Environmental Protection Act and the Water Act.
- ☐ ELY centres: The Centres for Economic Development, Transport and the Environment (ELY centres) are responsible for the regional implementation and development tasks of the central government & ensuring the environmental permit is followed.
- ☐ SYKE & YM: Finnish Environment Institute (SYKE) and Finnish Ministry of Environment (YM) are government agencies assisting in environmental mining issues and have created useful environmental guidebooks and data on groundwater investigations in mining
- ☐ Municipality: Local people must be contacted by law and have the possibility to voice their complaints. The municipality is also responsible for giving construction permits.
- ☐ Sami people: The Indigenous people of Finland, represented by Sami Parliament & Skolt Council. Considered in many laws including the Mining Act.
- ☐ Reindeer Herder's Association: Tasked with directing reindeer husbandry, developing and researching reindeer herding, and handling reindeer husbandry relations with the rest of society including the mining industry
- ☐ FinnMin: The Finnish Mining Association (FinnMin) ensures national and international political interests of mines where all mines in Finland are members and pay a yearly fee.
- ☐ INFRA: Involved with infrastructure around mines and also act as the membership association for aggregate extraction companies.
- ☐ Finnish Natural Stone Association: Membership association to ensure political interests of natural stone industry. All companies pay a small yearly fee.
- ☐ GTK: The Geological Survey of Finland (GTK) is a branch of government but can also be hired as consultants for geological and environmental surveys and impact assessments.
- ☐ SITRA: Government fund that has free realm to invest and create projects. Currently responsible for creating the Sustainable Mining Network along with FinnMin.
- ☐ Tekes: Funding authority for technology. They are currently investing and funding heavily in Green Mining.
- ☐ VTT: A specialized technology firm that receives funding from industry and Tekes. Currently working on SAM that looks to improve the social responsibility of mining companies.
- ☐ FANC and environmental non-governmental organizations: Finnish Association for Nature Conservation of Finland (FANC) is the biggest environmental NGO in Finland
- ☐ Tourism: Finpro (Visit Finland) promotes tourism and helps small and medium sized Finnish enterprises grow while also promoting foreign direct investment in Finland
- ☐ Universities: UEF, Helsinki, Aalto, Tampere, etc. receive Tekes funding and work with industry to develop new best practices and technology for industry. Aalto is working on mine tailings used in asphalt while the University of Helsinki is involved in the SAM project
- ☐ Banks and Funders: Nordea and other lenders help fund mining in Finland

Figure 1*:* A list of primary stakeholders in the extractive industry (Appendices 1 & 2)

2.5 The important role of ELY centres

Figure 1 touches on the role that the Centres for the Economic development, Transport and the Environment (ELY centres) play in the non-energy extractive industry. ELY centres are arguably the most important stakeholders to the extraction companies themselves because they make regular check-ups and are in constant communication with each other. Once the environmental impact assessment is accepted by the State Regional Administrative Agency (AVI) and an environmental and/or water permit is given, it is the role of the ELY centres to ensure extractive companies are following the permit (ELY keskus, 2012). For example, Eva Ruokonen, who is the Director of Sustainability at Talvivaara Mining Co, notes in her interview (Section 5.1) that when the issues with the gypsum pond happened, representatives from the ELY centres were there at least once a week.

In 2012, the ELY centres published a strategy document for 2012-2015 where they outlined several important goals: increase sustainable use of natural resources starting from the sourcing of raw material, protection groundwater and the water supply for communities, and taking direct action to halt the loss of natural diversity (ELY keskus, 2012). These action points are important to extraction companies because ELY centres will be demanding improvements in these areas from everyone in the industry. In the stakeholder interviews section later in this research, it can be clearly determined that almost every stakeholder/interviewee feels as though the ELY centres have significant scientific and environmental knowledge. Therefore they have the scientific, technical, and legislative ability to uphold environmental requirements and hold companies accountable. This is particularly important for this study because not as much emphasis had to be placed on highly scientific data such as heavy metal water contamination or air quality due to the tremendous expertise the ELY centres bring in dealing with these issues.

3. METHODS AND LIMITATIONS

This section will take the reader through a step-by-step description of each action that was taken in the development and creation of this project. The limitations of the study are presented as well in hopes that future studies could eliminate these limitations in order to effect greater and positive environmental change.

3.1 Methods

Emails or phone calls were placed to 57 people or companies within the mining, natural stone, and aggregate industry. This included industry, government, scientists, NGOs and Indigenous groups. Many stakeholders were represented but not all could be reached or failed to agree to a meeting. However, during some of the preliminary interviews, the interviewees recommended other people or stakeholders that they thought should be included in the study. For example, the Finnish Ministry of Employment and Economy (TEM) recommended the Reindeer Herders Association of Finland and TEM sent an email to them to help arrange a meeting. As the author is unable to speak Finnish, having interviewees pass along his information was a useful way to gain trust and credibility. This snowball effect helped create an impressive list of 20 people from a variety of different backgrounds and institutions that agreed to 30 minute to one-hour interviews.

The interview type was set to be as open as possible to allow the interviewee to feel confident and comfortable enough to share their values and insights regarding what needs to be done in terms of sustainability in the mining and extractive industry. However, during all interviews, six questions were asked to ensure validity and fairness in the research. These questions are presented at the beginning of Section 4, where the stakeholder interviews are presented. The main topic of the interviews was to determine what the interviewee thought were the biggest issues hampering the Finnish non-energy extractive industry from becoming more sustainable. The reason for this was to align the interviews with the purpose of the study, which was to determine these central issues so that they can be targeted in the future as leverage points for positive environmental change. It was essential during the interview that no biases became evident so that the interviewee could give an honest account of where they thought the non-energy extractive industry was most lacking in terms of sustainability. At the end of the interview, the interviewees were asked if they would be interested in being active members of the project and help provide feedback throughout the process. All 20 interviewees, even CEO's of large companies and high-level government employees, agreed to offer assistance.

An extensive literature review was completed along with the stakeholder interviews. Some interviewees provided literature that they deemed very important when discussing sustainability in Finland's non-energy extractive industry. For example, the Geological Survey of Finland (GTK) published Finland's Minerals Strategy in 2010 and they were an active stakeholder group during this project. While much of the literature was found before the interviews, many of the stakeholders had access or knew exactly where to find some important research papers that were essential for this project. During the interview process, it was clear that many Finnish extraction companies were having issues communicating effectively with local people and the media. External literature was consulted to fill this void. Therefore, the literature review was constantly being added to throughout the study, creating an extensive list.

Once the author felt satisfied that a reasonable amount of interviews and literature reviews were completed, the information was synthesized into themes, or critical issues of importance. This analysis was done by comparing the interviews to the literature review and determining which issues overlap the most and presented in the analysis and results sections. At this point, every interviewee and their organizations were given this list of 10 themes and were asked to give feedback. In order to ensure the reliability of the information, interviewees were also given a shortened form of their interviews and were allowed to make edits. All interviewees responded with their changes such as re-wording in the interviews or creating more emphasis on certain themes. The themes were critiqued and honed through many conversations, meetings, and telephone conversations.

After the positive feedback from the consultations for the themes, many interviewees expressed that it would be useful to present them in a visually appealing fashion so that more people would be inclined to read them. A guidebook presenting the 10 themes was created, with the exact wording that was unanimously agreed upon from the Results section being used. A computer designer external to the study reviewed the guidebook and made suggestions on colours and layout. After his review, changes were made and then the guidebook was sent to the interviewees and stakeholders. They were given an opportunity to make changes and ensure that the guidebook was of high quality. During this consultation, the interviewees and stakeholders in natural stone and aggregates stated that they would prefer that they have their own separate guidebook than the mining industry because they felt their issues were quite different. More research and literature was reviewed and it was decided that two guidebooks would be created. The final changes were made and then the guidebooks were resent to all the interviewees/stakeholders. They were asked if their names or company logos could be placed on the guidebook. Everyone agreed and many offered to send out the guidebooks to all of their contacts in the industry. The discussion and conclusion sections were then written to finish this research.

3.2 Limitations to the research

As a Masters student unable to offer funding or much incentives, it is understandable that some people may not have taken the initial email or phone call seriously and discarded it. The result of this is that 20 people were consulted out of the initial 57 that were highlighted as potential useful participants. While the general requirements for this scientific research were only to conduct 10-15 interviews, the author feels that further research must be done so that all stakeholders have a say. Most notably SITRA, TEKES, Finpro and the tourism industry as whole, ELY centres, AVI centres, Tukes, banks and investors, the Sami and Skolt Council, and local people/municipalies were not available or unwilling to be interviewed. The absence of Indigenous Peoples and local people/municipalities is represented in a subsequent paragraph due to the severity of the limitation. The author hopes that because many well-known and respected people have been a part of this study that these missing stakeholders will reach out to be a part of the project and/or be more inclined to agree to future interviews.

A minor limitation was the sheer complexity of the mining and extraction industry as a whole in Finland. As a result of this, the majority of the time in the first few interviews was spent figuring out the complex list of stakeholders and their roles. For example, Tukes is the

permitting authority for search and exploration, AVI is the permitting authority for extraction, ELY centres ensure the permit agreements and Environmental Impact Assessment plans are being followed, and TEM (The Ministry of Employment and Economy) is the oversight authority that upholds the law. As the author is from Canada and only came to Finland in September 2014, this was quite difficult to comprehend even after an extensive literature review. The result of this is that the first few interviewees perhaps did not have the chance to iterate as fully as others their values and recommendations because most of the interview was spent explaining this complexity. The major interview affected was the first one with Dr. Mikael Rinne of Aalto University.

The author's lack of ability to neither speak nor read the Finnish language was also a major limitation. In the initial emails for interview requests, the author made it clear that interviews would be held in English and some people may have felt uncomfortable by this. Furthermore, many of the websites and publications that directly relate to the topic are only published in the two official languages of Finnish and Swedish. Therefore, the author had to rely on the interviewees to give an overview of these publications.

A lack of time and financial resources prevented the author from visiting cities close to mines like Joensuu and Sotkamo, where local people and other stakeholders had agreed to be interviewed. This resulted in a noticeable absence from municipalities, local stakeholders, and Indigenous Peoples. As this paper's primary intent was to benefit all stakeholders and create mutually beneficial agreements, it is a crucial limitation to the study. The author is acutely aware of the historical trend that local and Indigenous people have been most negatively affected due to the fact that their voice was not heard or ignored completely.

Though it is not an acceptable reason to override this limitation, the author's background in social sustainability, community engagement, and Indigenous relations ensured that local people were considered. When reading the guidebooks in the appendix section, each step requires industry to consult local people and gives reasons why it is imperative that they do so. The author's bias towards systems thinking and the Bosch and Nguyen (2012) relationship map clearly demonstrate that local people's well-being is crucial to the effectiveness of the tool created. More information on their work is presented in section 4.6 of the Literature Review. Furthermore, the literature review includes a summary and critique of the Towards Sustainable Mining (TSM) tool and the Cornerstone Standards Council (CSC) tool. These tools, particularly the CSC tool, have consulted local people and reflect their interests to a certain extent so they can be relied on in part to help fill the void in this study. It is the author's sincere hope that when a local person reads this research or the issues/themes, they will feel satisfied that their voice will be heard and their best interests are acknowledged and represented.

4. LITERATURE REVIEW

In this section, a timeline of the major Finnish publications since the beginning of the mining and extraction boom in the last ten years is presented and each publication is summarized. These publications are essential to understand where the non-energy extractive industry is headed in Finland so it can be easier to determine what is needed. Next, this section shifts its focus to major global issues that are hampering the extractive industry from becoming more sustainable. A piece will highlight the social aspect of sustainability and why it has become a major, if not the largest issue, for the Finnish non-energy extractive industry. Finally, a well-known study by Bosch and Nguyen will be reviewed for its innovative approach to uncovering major sustainability issues in a defined area and then using participatory and pragmatic approaches to solving them through stakeholder collaboration.

4.1 A timeline of Finnish publications related to sustainability in the non-energy extractive industry

Finland's response to the substantial mining boom and the increasing environmental concerns can be documented through a series of publications and regulation changes since 2007. These publications build off of each other and have helped to create a clear environmental course of action regarding non-energy extraction companies. While many publications are not reviewed, the most essential publications that have been suggested or given to the author by the stakeholders in this research are reviewed in chronological order in this subsection. The year that the research was published is represented in red on the timeline above the title of each publication.

2007-2007 ----------2015

Finnish Ministry of Trade and Industry: "Exploration and mining in Finland's protected areas, the Sami Homeland and the reindeer herding area"

The guide published in 2007 by the Ministry of Trade and Industry (which is now a part of the Ministry of Employment and the Economy) was created through a steering group of professionals in the field including Pekka Nurmi of the Geological Survey of Finland, who is an interviewee and stakeholder in this research. The exploration guide is the primary reference of this research because: "The purpose is to provide the prime target groups - Finnish and foreign exploration and mining companies, and the permit and supervisory authorities - with all the necessary facts" (Ministry of Trade and Industry of Finland, 2007). Like this research paper, the exploration guide was created for industry. Therefore it has been written very concisely and provides companies with the information they need. The exploration guide was created because there was a growing need from within industry and authorities on how to apply for a reservation claim or mining permit in specially designated areas.

The exploration guide was very useful because it showed exactly how a mining or reservation permit would need to be submitted if the area is near the Sami Homeland, reindeer herding areas, and Natura 2000 sites and all other protected areas. The first section systematically reviewed and showed the importance of all applicable laws related to mining. For example, the

Environmental Protection Act (2000) and the Radiation and Nuclear Energy Act (1991) are summarized in a short paragraph and the guide clearly shows what measures need to be taken by mining companies if their proposed plan falls within these laws. The Mining Act (1965) is analyzed in detail and the Appendices help show exactly how to submit a reservation and mining permit.

The exploration guide contains a large amount of essential information that helps the average, non-lawyer person understand how laws and regulations work in Finland. For example, the guide notes that while Natura 2000 sites are new throughout the European Union (EU protected sites for their natural beauty and biodiversity) and causing a lot of legislative issues, 97% of the Natura 2000 areas in Finland were already protected areas. This has made the transition quite easy compared to other jurisdictions. The guide goes through all of the programs already in places such as the herb-rich woodland conservation programme (1988) that protects herb-rich forests of different types in different herb-rich vegetation zones and the bird wetland conservation programme (1982) that covers a total of 74,700 hectares where most of the approximately 287 sites included in the programme are shallow and eutrophic water areas that are important for birds as breeding grounds and for resting during migration (Ministry of Trade and Industry of Finland, 2007). The guide also provides essential information about what authorities are responsible for granting the survey permit as shown in Figure 2. Furthermore, the exploration guide presents a wide range of options to use when exploring specific areas and explains that the Geological Survey of Finland has already done much of the exploration. Most of the maps are available online and drill cores and samples are available at the National Drill Core Register (Ministry of Trade and Industry of Finland, 2007). This information is extremely important to this study.

Type of protected area	Authority granting the survey permit
National parks	Metsähallitus (Finnish Forest Research Institute) Ministry of the Environment (for 18 parks)
Strict nature reserves	Ministry of the Environment
Other nature reserves	Metsähallitus Ministry of the Environment (mire conservation areas)
Privately owned nature reserves	Regional Environment Centres
Wilderness reserves	Metsähallitus

Figure 2**:** Protected areas in Finland and the authorities responsible for granting the permit (Ministry of Trade and Industry of Finland, 2007)

There are very few critiques to be made about this research. It has been cited as a reference in many of the preceding documents and also as a primary reference for the European Commission's guidebook they created for the exploration industry. The clear, concise writing style combined with a useful table of contents makes navigation and getting to information very efficient. Certain points have been placed in yellow text boxes to clarify or bring emphasis to them – these points are typically suggestions directly for mining companies so they will be drawn to this information. This exploration guide can be used as a reliable resource and particularly in how to improve exploration to be more sustainable and how to

apply all applicable laws in mining and exploration effectively. It also can be cited when determining how to protect and conserve the biodiversity of the area.

2007----------2010----------2015

Geological Survey of Finland: "Finland's Minerals Strategy"

Finland's Minerals Strategy is an important document for this research because it helps explain why the mining, natural stone, and aggregate industries are essential for human well-being and scientific advancement. The strategy highlights the need for these industries as information and communications technology depends on a new range of metals that were previously only used to a very small extent (Geological Survey of Finland, 2010). Furthermore, a growing population requires more infrastructure to meet these needs. It provides a list of 12 action proposals that can be split up into three broad categories: strengthening minerals policy, securing the supply of raw resources, reducing the environment impact of the minerals sector and increasing its productivity, and strengthening resource and development operations and expertise.

The proposals that are of most interest to this research are the ones that seek to reduce the environmental impact of the minerals sector while increasing its productivity (Geological Survey of Finland, 2010). Action proposals 7-10 are relevant in this research and they are useful because they highlight which organizations are responsible for doing the action. Proposal eight states that incentives should be created for the recycling and re-use of stockpiled waste materials, tailings, mineral products and earth materials associated with construction industries. The strategy calls on the Ministry of Environment and the Ministry of Employment and the Economy of Finland, Tekes, companies, VTT, the Geological Survey of Finland, and Motiva Oy to help create this action (Geological Survey of Finland, 2010). While the Mineral's Strategy helps explain the reasoning behind why the extraction industry is crucial for human well-being and development, the action proposals are too general to be of any real usefulness to this research.

2007----------2011----------2015

Finnish Ministry of Employment and the Economy: "Mining Act"

The Mining Act is, by nature, an incredibly important reference for this research. It is easy to read and follow but it can get quite confusing because it refers to many other laws and regulations. For example, in some sections it will refer to the Land Use and Buildings Act (1999) or the Water Act (1961) so it requires the reader to research these related acts and find the sections that focus on extraction. The Mining Act states this in Section 3: "In addition to the provisions laid down in this Act, decisions on permit issues or other matters hereunder and other activities in accordance with this Act shall comply with, inter alia, the provisions of the Nature Conservation Act (1096/1996), the Environmental Protection Act (86/2000), the Act on the Protection of Wilderness Reserves (62/1991), the Land Use and Building Act (132/1999), the Water Act (264/1961), the Reindeer Husbandry Act (848/1990), the Radiation Act (592/1991), the Nuclear Energy Act (990/1987), the Antiquities Act (295/1963), the Off-

Road Traffic Act (1710/1995) and the Dam Safety Act (494/2009)" (Ministry of the Employment and the Economy – Mining Act, 2011).

Besides the slight nuisance of not being all encompassing, the Mining Act is very clear and direct. It gives the requirements in a way that they are easily understood. Section 18 on the obligations of the mine permit holder is a good example of this:

Section 18 - Obligations of the mining permit holder

The mining permit holder is obliged to ensure that:
1) mining activities do not cause damage to people's health or danger to public safety;
2) mining activities do not cause significant harm to public or private interests, nor, in relation to the overall costs of the mining operations, reasonably avoidable infringement of public or private interests;
3) excavation and exploitation do not entail obvious wasting of mining minerals;
4) potential future use and excavation work at the mine and deposit are not endangered or encumbered. The mining permit holder is obliged to submit an annual research to the mining authority on the extent and results of the exploitation of the deposit and to inform of any essential changes in the information on mineral resources. Further provisions related to the information to be provided to the mining authority may be given by government decree (Ministry of the Employment and the Economy – Mining Act, 2011).

In 2011, the Mining Act was revised; the largest change was that the Finnish Safety and Chemicals Agency (Tukes) would become the mining authority instead of the Ministry of the Employment and the Economy. This change helps make it clear that all mining permits are directed to Tukes while the State Regional Administrative Agencies (AVIs) are responsible for environmental and water permits. It is not very clear in the Mining Act (2011) when the environmental and water permits are required so it is important to read the act carefully and understand what is required considering the type of extraction.

Sections 9-15 explain what is required to achieve an exploration permit. Sections 16-18 pertain to the mining permit as Section 16 outlines what permission the permit gives the permit holder while Sections 17 and 18 state the requirements and obligations for the permit holder. Section 50 is useful because it focuses entirely on the Sami Homeland and the added requirements if there is potential that their way of life or culture could be affected by the mine or quarry. Finally Chapters 12 and 13 are useful because they give a lot of information on the legal requirements for safety within the mine (Ministry of the Employment and the Economy – Mining Act, 2011).

2007----------2013----------2015

Finnish Ministry of Employment and the Economy: "Making Finland a leader in the sustainable extractive industry – action plan"

The action plan to make Finland a sustainable leader in the extractive industry is important to understand because it was created right after the Talvivaara leak. It was created by a steering

group that included many of the interviewees in this study such as Riikka Aaltonen at the Ministry of Employment and the Economy, Tapani Jarvinen (former CEO of Outotec), and Pekka Suomela who is the Executive Director of the Finnish Mining Association (Ministry of the Employment and the Economy – Action Plan, 2013). The Prime Minister also attended the meetings, which shows the importance of the action plan. The steering group members each held their own sessions with a larger group of stakeholders and from there they created a list of 35 points of action that would make Finland a leader in the sustainable extractive industry. The action plan itself is unclear about when the measures are proposed to be completed but Maija Uusisou is a stakeholder in this project and gave extra information stating that the proposed actions are to be finished by 2019 (Uusisuo, 2013).

Actions 1-8 are of specific importance to this research because they are targeted towards industry. Making all companies aware of these guidelines is important because the government will begin to enforce them if voluntary measures are not taken. The actions are as follows:

1. The creation of water-management plans for mines and the development of water technology.
2. Activities and research related to the sorting of waste and the utilisation of tailings and waste rock shall be increased.
3. The energy-efficiency of the extractive industry shall be developed systematically.
4. The safety of mines and quarries and the related competences shall be developed.
5. CSR programmes shall be adopted by companies and applicable indicators, researching and monitoring will be developed.
6. Active, diverse and interactive dialogue shall be conducted with various stakeholder groups.
7. Synergies with local actors shall be sought actively.
8. The companies' communications shall be developed in a more rapid and open direction.

Some of the proposed actions are vague meaning that companies will need direction on how to achieve them. The guidebook created in this document helps provide solutions to this document. Actions five and six are also quite important because it was out of these actions that came the Sustainable Mining Network, which is reviewed below in this section. The major critique of the action plan as a whole is that it does not talk about biodiversity protection whatsoever. These comments were mentioned in an interview with Riikka Aaltonen and Maija Uusisuo (Section 5.1), even though they were active members of the project.

2007——————————————————————2013——————————2015

Finnish Ministry of Employment and the Economy: "Guide: environmental impact assessment procedure for mining projects in Finland"

The environmental impact assessment (EIA) Guide is a useful tool because even though many companies hire an external company such as Ramboll or the Geological Survey of Finland to conduct an EIA, it is good to have the baseline knowledge to understand what is required. The EIA Guide does a good job at explaining why an EIA is necessary by law and also for the protection of biodiversity. The EIA Guide references the Environmental Impact Assessment Act (1994) stating that is the mining project developer's responsibility by law to conduct and pay for an EIA. The guide includes many pictures and diagrams that shows the typical amount of time it takes for an EIA and when it should be completed in the life of the mine. The guide

suggests that several EIAs be completed throughout the lifespan of the mine because the natural and mining conditions change substantially (Ministry of the Employment and the Economy – EIA Guide, 2013). This point is highly relevant in this research. The EIA guide is easy to read and includes figures and tables that help enhance their points.

2007----------2014-----2015

SITRA: "Finnish Network for Sustainable Mining"

As previously mentioned in the review of Finland's Sustainability Action Plan (2013), the Sustainable Mining Network was created in response to action points five and six of the action plan to make Finland a sustainable leader in the extractive industry. It was supported by SITRA, who are given a government fund to invest in projects, and the network began in 2014. SITRA held regular meetings with working groups in attempts to build trust from companies. The working groups conducted comparative studies of international mining standards (Fraboulet-Jussila, 2014). It was chosen that the Finnish Network for Sustainable Mining would pursue the Canadian Towards Sustainable Mining standard because it is site-based and also guided by input by an external and independent multi-stakeholder panel. It has had relative success in Canada (Sjostedt, 2015). Currently, the Finnish Mining Association has taken over the Network for Sustainable Mining from SITRA as they attempt to tailor the Canadian standard to Finland (Sjostedt, 2015). There has not been much recent information as to how the process is going but it is expected that the Finnish standard will be ready by early/mid 2016 (Sjostedt, 2015). Since not much is known about what the Finnish standard will look like, a review of the Canadian Towards Sustainable Mining standard was conducted below.

2007----------2015-2015

Mining Association of Canada: "Towards Sustainable Mining"

As Finland prepares to adopt the Canadian Towards Sustainable Mining (TSM) standard, it is important to understand exactly what the standard does and what criticisms have been offered. The TSM is mandatory for any Mining Association of Canada member. Once the company is a member they commit to research their performance against 23 indicators annually. The results are publicly available and externally verified every three years. The appeal of the TSM standard is that it is the only standard in the world where the assessments are conducted at the facility level where the mining activity is actually taking place (Mining Association of Canada, 2015). A community of interest panel that consists of a wide variety of stakeholders such as Indigenous leaders, community members, environmental non-governmental organizations, and financial institutions makes yearly recommendations to specific companies and to the standard as a whole.

The 23 indicators are separated into seven identifiable sections that have been restructured in 2015. The first section is Aboriginal and Community Outreach as Canada, like Finland, has a large Indigenous population. The indicators in this section are: Community of Interest (COI) Identification, Effective COI Engagement and Dialogue, COI Response Mechanism, and Researching. Communities of interest refer to the Indigenous communities that live or use the

land near the mine (Mining Association of Canada – Aboriginal protocol, 2015). Companies rank themselves along with the input of the Indigenous and local communities out of a five-point scale (C, B, A, AA, AAA). The second section is Energy use and greenhouse gas emissions where the indicators are management systems, researching systems, and having performance targets. A detailed view of the five-point grading scale for this section as well as an in depth look at the requirements for the energy and greenhouse gas management systems are presented in Figure 3 and Figure 4. The other sections are Tailings management, Biodiversity conservation, Safety and health, and Crisis management, and Mine closure.

Energy Use and Greenhouse Gas Emissions Management Assessment Criteria	
Level	**Criteria**
C	No systems in place; activities tend to be reactive; procedures may exist but they are not integrated into policies and management systems
B	Basic systems/processes developed; comprehensive system planned and under development
A	Comprehensive systems/processes are developed and implemented
AA	Integration into management decisions and business functions
AAA	Excellence and leadership

Figure 3**:** TSM five-point grading scale for the greenhouse gas emissions and energy use management systems (Mining Association of Canada – Energy, 2015)

Energy Use and Greenhouse Gas Emissions Management Systems
ASSESSMENT CRITERIA

Level	Criteria
C	No formal management system in place.
B	Basic energy use and greenhouse gas emissions management system established that includes: ■ demonstrated senior management commitment to manage energy use and GHG emissions at the facility level ■ facility-level responsibility for energy use and GHG emissions assigned to department or individual (e.g.., Energy Leader) ■ established processes to determine energy consumption sources and associated GHG emissions on a defined frequency for sources accounting for substantial consumption and/or offering considerable potential for energy performance improvement and with a level of disaggregation by major process activity (e.g., mill, mine, smelter, refinery, etc.) ■ identification and estimation of significant sources of non-energy GHG emissions ■ standard quantification and estimation methodologies used to convert energy and GHG emission data into comparable units, including process emissions data ■ records of facility level data are maintained.
A	Comprehensive energy use and GHG emissions management system established that includes these additional elements: ■ facility or business unit have identified and annually reviewed what energy and emissions sources are material according to their established criteria ■ clear accountability for energy use and GHG emissions management assigned to operational managers ■ energy data is reviewed regularly and integrated into operator actions for energy intensive processes ■ actions and process controls related to energy use and GHG emissions are included in management systems for material sources ■ general energy and GHG awareness training is provided to personnel with additional training for key personnel
AA	■ Energy use and GHG emissions are considered in business planning at the facility and/or business unit level. ■ Energy use and GHG management system has been subject to internal or external verification.
AAA	Energy use and GHG management system is integrated into a broader sustainable business strategy that includes at least 2 of the following: ■ procurement and supply chain management policies that incorporate energy efficiency and GHG reduction criteria ■ voluntary corporate investments in research and development, feasibility studies and/or demonstration of technologies and/or new processes that target energy efficiency and reduced GHG emissions. ■ corporate investments in renewable energy projects and/or energy recovery projects ■ participation with communities of interest to improve energy efficiency and reduce GHG emissions (e.g., community events, environmental non-government organizations, government energy efficiency programs

Figure 4**:** Assessment criteria for TSM energy use and greenhouse gas emissions management systems (Mining Association of Canada – Aboriginal, 2015)

At a first glance the TSM standard may seem to be quite appealing, criticisms are not hard to find. The most credible critique comes from Mining Watch Canada, which is a non-governmental organization committed to demanding the highest standards of environmental and social practices from Canadian and international mining companies. Mining Watch correctly states that while standards are mandatory for members, less than half of the mining companies in Canada are part of the program. The largest weakness is that the TSM works primarily to develop management processes rather than focus on real outcomes. The most crucial example of this is that the indicators for the Tailings management section are: management policy and commitment; management system development; assigned accountability and responsibility; annual management review; and an operation, maintenance and surveillance manual (Mining Watch, 2010). There are no direct standards that focus on improving the quality of water discharged from the facilities. Therefore companies can create manuals and achieve a high rating without improving their discharges. The issues/themes created in this research recognize these critiques and it is hoped that when Finland creates their own TSM standard that they respond to these critiques as well.

2007–2015–2015

VTT and Geological Survey of Finland: "SAM – Sustainable Acceptable Mining"

Sustainable Acceptable Mining (SAM) is a new nationally funded project under the Green Mining plan from the Finnish government. VTT and the Finnish Environment Institute (SYKE) lead the project with help from the Geological Survey of Finland and the University of Helsinki (VTT, 2015). The project seeks to create a holistic view of sustainability related to the mining industry with special emphasis on improving social acceptance towards minerals use on a local and regional level (Geological Survey of Finland, 2015). Since the project has just begun, there is little information being presented at this point but its roadmap gives a good idea of the direction:

1) learning and creating mining industry
2) developing the corporate culture in mining industry
3) a mining industry accepted by the local community
4) developing the authority actions
5) minding the life-cycle of the whole mining action and after the mining action
6) tailored communication (Geological Survey of Finland, 2015).

It is hoped that the results from this research could help the SAM project in creating very effective strategies and achieve its objectives. The SAM project is a very important example of the Finnish government's intent to drastically improve sustainability in the extractive industry. The government has clearly recognized the importance of social and community engagement in today's landscape.

4.2 European Union Guides

Even though Finland has chosen to use the Canadian TSM standard, it is important to see what has been published around the world but particularly in Europe. In 2010, the European Commission published a guide on Natura 2000 and the non-energy extractive industry. It is obvious why Finland elected to choose the TSM standard because the guide is long and goes into detail with many issues without offering a tool to help improve the situation. The document contains nine chapters that focus heavily on biodiversity. Therefore the document could be used as a source in the biodiversity section within the TSM but with chapter two talking primarily about the habitats and birds directive, it would be difficult to summarize the conclusions effectively into a tool (European Commission, 2010).

4.3 Aggregate industry tools

There is another new standard from Canada that specifically targets the aggregate industry. Since this paper focuses on the non-energy extractive industry as a whole, the Cornerstone Standards Council (CSC) tool is a useful addition because it has been praised by both environmental organizations and industry. Included in this section are two academic papers that help to cover weaker points from the CSC standard.

The CSC tool is the first tool in the world that promotes sustainability in the aggregate extraction industry. The CSC has created a "Responsible Aggregate Standard" to help companies achieve a higher level of social, economic, and environmental sustainability. Furthermore, the CSC provides independent auditing and monitoring of aggregate sites. The standard was created through inclusive participation from a good balance between industry and non-industry representation such as Indigenous groups and environmental NGOs (Cornerstone Standards Council, 2015). By being inclusive and transparent throughout the research, the CSC has produced a standard that seems to be appealing to all stakeholders.

The CSC is similar to the TSM standard as it has seven principles: Compliance with laws, Community notification, consultation and participation, Respect for Aboriginal peoples' rights and culture, Benefits to host communities and employees, Site stewardship and impacts to environment, Resource efficiency and conservation, and Point of origin (Cornerstone Standards Council, 2015). There are many overlaps with the TSM standard however the CSC is being praised because it goes one step further and has a list of core requirements within each principle. The core requirements are the actions that the applicant company must take in order to receive the standard. For example, in the Point of origin principle, the applicant must have a system in place to track aggregate product from its point of origin to the next stage of production (Cornerstone Standards Council, 2015). This allows for a more accurate representation of the actual greenhouse gas emissions created.

The CSC makes suggestions to not use explosives whenever possible but they provide little insight as to what alternatives can be used. Further research suggests that there are three possible solutions. Firstly, new versions of diamond and chain saws have a considerable amount of cutting power and can in many instances cut long channels in to the rock that will free up pieces (Hem, 2012). Secondly, expansion mortars expand wide enough in the ground to release the material if done correctly. The most used and known and used expansion

mortars are Dexpan and Rockfrac (Hem, 2012). Finally, some non-detonating chemicals such as Nonex and Magnum Buster can be used but they have some environmental effects of their own (Hem, 2012). Make risk analyses and having a strong knowledge of the extraction area combined with good technology can significantly reduce safety, environmental, and economic issues.

One other small criticism for the standard is that does not go into a great amount of detail about pollution related to aggregates. Ayodele et al. (2014) reviewed heavy metal pollution in an abandoned granite quarry and found that most of the heavy metal pollution was low enough that it would not danger humans or animals however the iron levels were high. They suggest that quarries must do a better job to reduce the amount of heavy metal pollution and suggest a method called phytoremediation. They note that a native plant near the quarry, Chromolaena odorata (Christmas Bush), had an affinity for iron. Therefore by determining which native plants can handle high levels of the polluting heavy metal, the plants can do the remediation almost entirely on their own.

4.4 Academic papers on the extractive industry's major sustainability issues

A strong case could be made that the Finnish papers presented as a timeline earlier in this section do not sufficiently go into enough detail about the non-energy extractive industry's major sustainability issues. Therefore, academic literature was reviewed and emphasis was placed on peer reviewed and highly cited academic papers to ensure credibility. A handful of papers were reviewed and a theme begins to be seen where social sustainability issues are becoming most prevalent in the highly digitalized age we live in where information is easily accessible. Non-energy extractive companies must improve their community engagement and media relations strategies in order to not tarnish their name and reputation.

It is important to understand the global situation of the extractive industry. An exploratory paper by Prior et al. (2012) has been peer-reviewed and heavily cited, making it an important paper for the field. Prior et al. make the argument that metals and minerals are essential for humans and that social and environmental issues must not be treated as externalities and need to be internalized in the determination of mineral production costs (2012). They argue this effectively by showing that when a resource is exploited it is generally quite easy to extract and the quality is high but as this continues, it becomes progressively harder to extract the resource and the quality is much less high. Therefore the environmental issues such as biodiversity loss and higher levels of waste become higher. This can create strained social relationships with local communities. They put forward the term of "peak minerals" that means that when the cost of the resource gets to a certain point due to lower quality and these social and environmental concerns, the area has reached its peak (Prior et al., 2012). They explain that while improving technology can prolong the area's time before it reaches its peak, it will get there eventually since the extractive industry consists of non-renewable resources. They argue that even as technology improves, waste levels will continue to rise and that creates a tremendous environmental, social, and economic burden on the company. In conclusion, Prior et al. effectively show that because the metal and mineral industry is non-finite, environmental and social concerns play a central role in the cost of production and

maintenance. Shifting to better practices such as companies creating a better waste management system for local communities will help reduce their own waste and reduce a social or environmental crisis (Prior et al. 2012).

Mudd (2010) presents a convincing argument for the essential need of improving environmental sustainability in mining that has been extensively cited in academic literature. He strongly agrees with Prior et al. that it is somewhat of a paradox to say that a non-finite industry needs to be more sustainable because this is inherently impossible. The paper presents the results of a landmark study on historical mining in Australia. Mudd then compiles this data and shows major sustainability concerns using graphs and tables (2010). What becomes quite obvious is that ore grades are declining substantially, which is putting a large strain on the industry. Furthermore, the relationship between these declining ore grades and increased waste rock is quite evident and places a larger social, environmental, and economic strain on the industry. Mudd notes that the industry must adapt quickly or it could face significant economic challenges (2010). He suggests that a greater collaboration between governments, shareholders, communities, and the industry itself is the only way to deal with these issues. Furthermore, there is an essential need to recognize when the area has reached its peak and cannot withstand extraction. This is also important when choosing an area to extract metals or minerals so that social and environmental issues can be lessened and economic growth can be recognized (Mudd, 2010).

A forward thinking study that attempts to predict the trends of the Finnish metal mining industry by Tuusjarvi et al. notes that the recent rapid growth of the industry has raised people's hopes in terms of the economic benefit of the industry (2014). However, there is a clear and obvious fear of environmental degradation. They use three scenarios to help predict what could happen largely based on whether there are enough metals to propel healthy development. Two of the three scenarios depict strong growth while the third shows low levels of growth (Tuusjarvi et al., 2014). The authors caution that management of environmental impacts is essential but they state that the largest potential deterrent is to raise the industry's social licence to operate. In other words, successful stakeholder interactions and responsibility is imperative to success (Tuusjarvi et al., 2014).

More recently, Mononen (2015) conducted an analysis of the Talvivaara mine and the surrounding community and determined, perhaps more positively, that the community does not oppose mining in general but they expect that operations should not pollute the environment and demand transparency in terms of information on the mine's impacts. Eerola et al., in their review of local acceptance of a mine company from the municipal economy point of view (using the Finnish mine Sodankylä as an example), concur with these findings (2015). They determine that the some of the factors adding acceptance in Sodankylä are economic and employment effects, economic compensations (to landowners), and open communication. However there are several factors that decrease acceptance including cases when the municipality is not benefiting from the mine or no special compensation is paid for natural resources, the company rarely participates to the development of the municipality, natural values, and hearing about unsuccessful mining projects such as Talvivaara in the news (Eerola et al., 2015). It is clear that companies can do a lot to improve the community acceptance of the mine.

4.5 The role of social/community engagement and engagement strategies

Using an extensive literature review and a comparison of the sustainability management plan of two companies, Hilson and Murck (2000) expand on the ideas of the previous articles (particularly Eerola et al., 2015) by offering proven solutions. They begin by showing how there is a lot of literature focused on global sustainability but very little that focuses on what can be done at the corporate level. They attempt to fill that void. Hilson and Murck (2000) seem to agree in large part with the works of Prior et al. and Mudd but they go into much greater depth on the essential need for social improvement by corporations in the extractive industry. They present peer-reviewed data combined with two contrasting case studies that effectively show the benefits of social improvements. Their primary suggestions are:

- Gathering local community perceptions on mine development
- Determining beforehand the likely effects of development on normal evolutionary processes within the community (way of life, relationships, behaviour, and social resilience)
- Identifying the possible effects of the project on religious or historic elements of the community's way of life
- Determining the likely participation of local people in the mine project
- Assessing whether there is a need for relocation of the population as a result of the mine project
- Determining whether or not there is potential for community conflict
- Calculating economic costs of protecting the community's cultural values
- Identifying beforehand the potential project benefits and negative impacts to the community (Hilson & Murck, 2000)

As evidenced, these measures are almost entirely based on social sustainability issues and they argue that many risks can be averted if they are conducted. There is a noticeable emphasis on making good connections and decisions before the mine is created, which had not been stated in previous literature (Hilson & Murck, 2000). They even go on to highlight the importance of the formation of sustainability partnerships. They suggest that by reaching out to stakeholders beforehand, these partnerships can be made and can be mutually beneficial from economic, social, and environmental perspectives (Hilson & Murck, 2000).

Owen and Kemp (2013) present further arguments for a social license necessity in mining. They determine, not surprisingly, that several highly regarded research papers and academic literature have found that the extractive industry is distrusted by stakeholders and under threat from opposition groups such as environmental non-governmental organizations. Owen and Kemp convincingly argue that a social license to operate must be renewed by extractive industries (2013). This has resulted in a well-cited article that explains the consequences of not renewing the social license. For example, they explain that we live in a world that is tremendously easy to gain information so remaining hidden is no longer an option for extraction companies. Therefore, they must learn to work with local people and organizations or risk larger attacks from media and large NGOs that could destroy their credibility and

potentially decrease the amount of interest from investors and shareholders or business partners (Owen and Kemp, 2013). Owen and Kemp claim that the first step for corporations is to shift from a defensive approach to social issues and begin to be more inclusive to stakeholders and local people. This, as mentioned by Hilson and Murck (2000) and others, will improve the possibilities of creating win-win situations that reduce environmental and social impacts while benefitting financially.

Anthony and Brandon, in their 2008 analysis of attitudes of local people towards protected parks in Romania, determine that education level and whether people have an economic dependence on the area are important. They show that conducting a community attitude index can shed light on the perceptions of local people. For example, negative views of the park were usually related to perceived fuel-wood shortages even though this was not the case (Anthony and Brandon, 2008). Anthony and Brandon used a questionnaire that was administered to households in the area and showed that this technique could be somewhat effective at delivering useful information (2008). However, they note that this technique does not effectively make a change in people's attitudes and is simply a mechanism to gain information.

Hilson and Murck (2000) created a very thoughtful and useful academic paper about sustainability and social engagement and have some very useful suggestions. However it could be quite difficult for extractive companies to enact some of the suggestions. For example, companies may not have the knowledge or expertise to gather community perceptions on mine development, like they suggest. Working with researchers that are not directly apart of the mines, like Eerola et al. (2015) in their community acceptance review in Sodankylä, could be an option. Other techniques such as multi criteria decision analysis and economic/social/environmental impact assessments can be useful to help companies create internal plans but they do not deal with the issue of stakeholder interaction. There needs to be a way that companies can quickly, efficiently, and cheaply gain information from all the affected stakeholders from their operations and make plans that benefit all parties.

4.6 A systems thinking approach to identify leverage points for sustainability

Section 4.5 emphasizes the essential need to increase stakeholder interaction in the extractive industry. However, it is quite difficult to find a tool or paper that outlines a process that would be appealing to extractive companies. Extractive companies need to find out what stakeholders want in order to make more informed decisions that have low social risks but because many companies are small, the measure must be inexpensive and time efficient. Hilson and Murck (2000), as summarized in Section 4.4 above, present a variety of suggestions that they believe are necessary to improve the social sustainability of extractive companies. However their suggestions, such as gathering local people's suggestion on mine development, can be extremely expensive and time consuming. A tool could only be useful and useable to the vast majority of extractive companies if it is inexpensive and time sensitive.

Bosch and Nguyen's tool that they created and applied in Cat Ba, Vietnam emerged as a useful option because it brings all the stakeholders together to collaboratively create a management plan (2012). Their research has been heavily cited and peer reviewed and was endorsed by Dr. Gary Metcalf, a well-known systems thinking researcher in his own right, during a lecture at Aalto University at Aalto University on October 17th, 2014. Furthermore, the paper clearly shows how effective the tool was in Cat Ba, Vietnam where the authors had to spend a large amount of time capacity building (in some cases teaching people how to write or understand complex concepts) with the local stakeholders (Nguyen and Bosch, 2012). In a developed country like Finland, this is not necessary and therefore it can be expected to have a higher level of success or achieve success at a faster rate.

The tool is a seven-step process where each step builds off each other:

1) A stakeholder map must be created that includes all stakeholders. Invite all stakeholders to a workshop.
2) You must explain your business in simple terminology in all necessary languages to build capacity. Stakeholders will then write down their biggest issues.
3) As a large group, you will place the issues on a large piece of paper. For instance, small business owners may worry about noise and traffic from a mine in front of their shops that will reduce the amount of customers.
4) As a large group, or breaking up into small groups, determine leverage points (areas within the system that make a big difference). For example, if many people determine traffic to be a large issue, then new roads and infrastructure would be a leverage point.
5) As you and the stakeholders work together, you will begin to see exactly what you have to do and offer to the community and what they will give you in return. For example if you create a road that avoids the city, the city may agree to take your waste and use it in local construction. These win-win situations will come up during this session and ensure trust and support from the community.
6) Create a master plan of what will be done where each stakeholder is given a role.
7) No model will ever be perfectly correct so having another meeting annually or biannually is a good idea to repeat the process and improve it (Nguyen and Bosch, 2012).

The project that Nguyen and Bosch worked on was based on pollution in the biosphere on Cat Ba Island. The pollution was causing fewer tourists to come to the island but the tourists were primarily causing the pollution in the first place. Nguyen and Bosch's inclusive method allowed the stakeholders to determine what the central issue was themselves and then collaboratively create a solution to fix it. In the Cat Ba case, the stakeholders decided to reduce the water usage of tourists by 15% on resorts. By doing this, they were able to deal with the pollution issue (Nguyen and Bosch, 2012). Many, if not all, of the issues that mining companies would face could be uncovered and potentially solved using the tool and it has an added benefit that trust and mutual respect is created. A better image increases the potential of investors and opens up many opportunities.

5. STAKEHOLDER INTERACTIONS

Interviews with 20 stakeholders in Finland's non-energy extractive industry were conducted. Figure 5 shows their names and how they were thanked in the guidebooks (Appendices 1 & 2) while Figure 6 demonstrates graphically in which sector the interviewees work. Many stakeholders could be placed in several categories due, for example, to a scientific education but they are currently working in the extractive industry. The person's current position is how they are grouped. Two people work at the Geological Survey of Finland and because it is a scientific institute and also linked to government, one person was represented in the government section and one in the science section.

This guidebook could not have been created without the help of these experts who contributed valuable information, offered access to their archives and gave a tremendous amount of time and resources. Thank you all for your time and support.

Riikka Aaltonen: Senior Advisor of Mineral Policy, ***TEM***
Maija Uusisuo: Development Officer, **TEM**
Eeva Ruokonen: Director of Sustainability, ***Talvivaara***
Dr. Sari Kauppi: PhD Researcher, ***SYKE***
Tapani Järvinen: Board Member of several mines and former CEO of ***Outotec***
Pekka Suomela: Director, ***Finnish Mining Association***
Sanna Hast: Land Use Management Advisor, ***Reindeer Herders Association***
Markus Ekberg: CEO, ***Endomines***
Dr. Jussi Leveinen: Professor of Env./Geophysical Mining, ***Aalto University***
Tomi Gutzen: Risk Assessment Specialist, ***Mining***
Anne Ollila: Executive Director, ***Reindeer Herders Association***
Dr. Olli Salmi: Lead Researcher, ***VTT***
Pekka Jauhiainen: CEO, ***Finnish Natural Stone Association***
Pekka Nurmi: Research Director, ***GTK***
Dr. Mikael Rinne: Professor of Environmental Engineering, ***Aalto University***
Toni Eerola: Lead Researcher, ***GTK***
Zhen Song: PhD candidate/Tailings expert, ***Aalto University***
Eija Ehrukainen: Director of Sustainability, ***INFRA***
Maria Palin: Communications Manager, ***Palin Granit Oy***
Heikki Palin: Managing Director, ***Palin Granit Oy***

Figure 5: A List of all stakeholder interviewees in the research as presented in the guidebooks (Appendices 1 & 2)

The interviews were recorded and then transcribed onto the computer. While the interviews were designed to be open, six questions were asked in some form to every person:

1. What is your background and how does it relate to mining?
2. How do you think the mining industry is doing in terms of sustainability in Finland?
3. How can mining companies be more prepared when they begin in terms of environmental sustainability?

4. In terms of environmental sustainability, what do mining companies need to do better and what are their major issues?
5. Do you think that a tool needs to be created to help mining companies in Finland? Do you think a set of guidelines or a checklist would be helpful? How should it differ from tools like the TSM or already developed tools in Finland?
6. What are the most essential things you think this tool needs?

Because every interviewee was asked the six questions above, the interviews were summarized that way. Since the author feels strongly about including stakeholders from the beginning to the end of the research, the interviewees were given the summaries of their interviews and were allowed to make changes if they felt they wanted to include more or clarify a certain point. Once all interviewees were satisfied with the summaries, a final draft was created and presented below in chronological order. Considering that nearly every interviewee was quite adamant about one or several sustainability issues plaguing the Finnish non-energy extractive industry, these are clearly expressed in question six in bolded point form. After the interview, all interviewees were asked if they would be interested in giving feedback on the tool after the first, second, and final drafts. Every interviewee agreed to help.

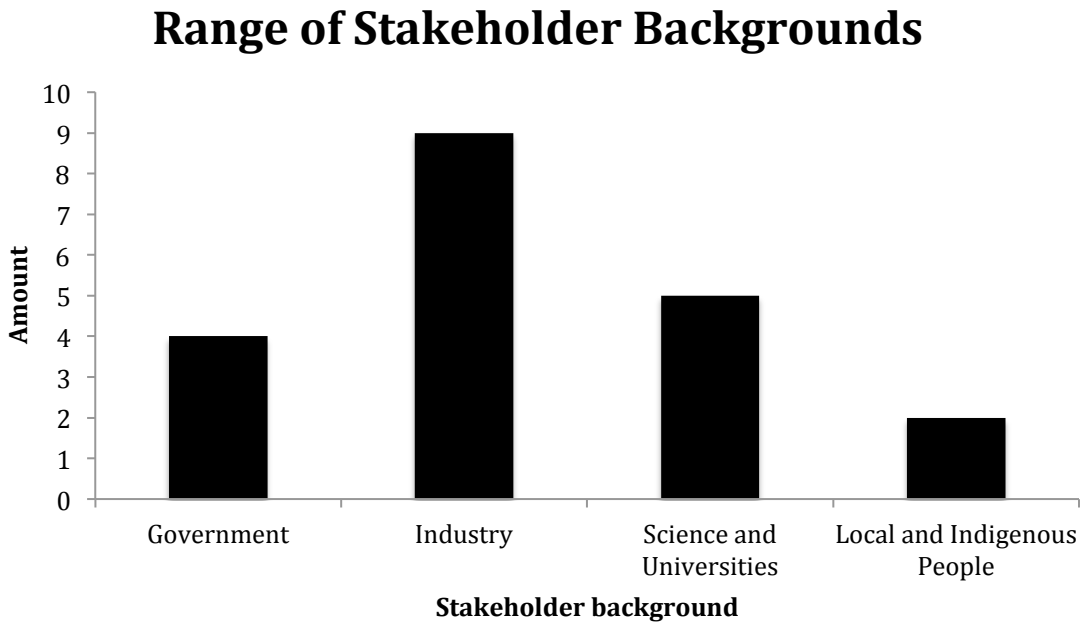

Figure 6**:** The range of stakeholder backgrounds within this study

5.1 Summaries of Stakeholder Interviews

1. **Dr. Mikael Rinne**
   Interview: April 8th, 2015, Aalto University, Espoo

1. Background: Dr Rinne is a professor in rock and mining engineering at Aalto University. He is the Professor in Charge of European Mining, Minerals and Environmental Program (EMMEP) – Joint European university program – emphasis on rock fracturing and engineering side.
2. Sustainability of mining industry in Finland: There have been discussions – one big problem is that it is much harder to get the decisions from authorities and takes more time. That has scared many exploration companies away.
3. How to improve sustainability in early phases: Main point is spot out the black swan. How to detect the black swan in the early stage is the key. Talvivaara crusher did not work as well as it should have. Graphite was in the rock. Pilot scale looked good but when it started they were not getting nickel out. Time was running out, money was running out and the crusher was not working to its full capacity.
4. Main issues of mining companies and how do they improve: Financial dependence, spot black swans early.
5. Tool, set of guidelines, checklist? How should it differ from others? Mining is hard and not like a building because it is not well known. It has no boundaries. Authorities do not know what restrictions and laws to put on it. Long delays with decisions and politicians get involved and fight with each other. But the tool would be very complex.
6. What are the most essential things this tool needs to address from your perspective?
   - **Mining law and permits are confusing, make it easier**
   - **Spot out the black swan – the weak link. For example it could have been the faulty crusher at Talvivaara that started the vicious cycle**
   - **Use systems thinking to find weaker areas in the beginning phases and improve them before they become larger issues**

2. **Eeva Ruokonen**
   Interview: April 29th at Café Esplanad, Helsinki

1. Background: Since 2010, Ms Ruokonen has been the Chief Sustainability Officer at Talvivaara mine. She is currently a PhD candidate at Aalto University for her thesis on Corporate environmental strategies and their significance in the mining industry. Currently helping in creating the Sustainability Network.
2. Sustainability of mining industry in Finland: There are only a few mines in Finland. They are large companies. There are 40 mines but you don't call them mines. Only the few that are large are called mines. Their issues are much more significant and generally the main concern are water issues.
3. How to improve sustainability in early phases: Increase communication from the beginning. Talvivaara was considered the saviour for Sotkamo area because it brought wealth and jobs so they got complacent. Create a water plan – keep water out and circulate the water inside. In the case of Talvivaara, too much water got in and

authorities would not allow it to be released so they were put in tailings ponds – this only made the situation worse.

4. Main issues of mining companies and how do they improve: Do not let vicious cycles happen in the first place. Good planning and knowing the flows of the water is imperative.
5. Tool, set of guidelines, checklist? How should it differ from others? Yes we need one that specifically focuses on the beginning phases. If those are done right, it drastically reduces the chance of issues later on.
6. What are the most essential things this tool needs to address from your perspective?
   - **Water barriers, circulate water, reduce freshwater**
   - **Open communication lines, blogs, website – diffuses tension**
   - **Make pictures and easy to read checklists so people will actually read it**
   - **Explain that companies need several different permits: local, chemical (in certain cases), and environmental**
   - **Showing financial benefit would be useful because in many cases that is the only way the company will do it**

3. Riikka Aaltonen & Maiia Uusisuo

Interview on April 29th, TEM headquarters, Helsinki

1. Background: Ms. Riikka Aaltonen is the Senior Advisor of Mineral Policy at the Ministry of Employment and Economy in Finland(TEM) while Ms. Maiia Uusisuo is a Development Manager and a core member of the steering group for the Action Plan on Sustainable Mining in Finland.
2. Sustainability of mining industry in Finland: While there seems to be a lot of positive developments in the mining industry of Finland, we need to bring the central issues from stakeholders such as local and Indigenous people to the decision-making table. Furthermore, there are a lot of permits and parties – their roles need to be clarified
3. How to improve sustainability in early phases: Make contact with all stakeholders in the early phases and help them. Going beyond the legislative requirement can help gain social acceptance later on.
4. Main issues of mining companies and how do they improve: Mining companies have a negative image to begin with so working with stakeholders about potential issues can help improve their image and create good possibilities for healthy partnerships.
5. Tool, set of guidelines, checklist? How should it differ from others? While there have been guidebooks made for Sami areas and nature conservation areas, there needs to be a guidebook created specifically for industry.
6. What are the most essential things this tool needs to address from your perspective?
   - **Even in the Action Plan [TEM, 2013], biodiversity was not mentioned**
   - **It needs to encourage industry to go past legislative requirements and make them see the benefit of doing that. For example, not just cleaning the water but purifying it so that people can drink it could significantly improve the mine's image among local people**
   - **The tool must clearly explain the roles of each stakeholder and the permitting process**

- **There is increased pressure for buffer zones around tourism areas such as ski hills but more pressure and emphasis for buffer zones around the Sami homeland and reindeer habitats is essential**

5. Pekka Jauhiainen

Interview on May 8th, Finnish Natural Stone Association headquarters, Helsinki

1. Background: Mr. Jauhiainen is the CEO of the Finnish Natural Stone Association.
2. Sustainability of mining industry in Finland: The whole industry has been heavily affected by Talvivaara and the natural stone industry is trying to separate itself from that. Natural stone extraction is much less intrusive and has very few environmental concerns especially since it does not have dirty water as a waste product.
3. How to improve sustainability in early phases: The biggest issues for natural stone companies are land issues and traffic. Having good plans in the early to reduce traffic and the use of explosives (if possible) could safe a lot of confrontation in the future.
4. Main issues of mining companies and how do they improve: Natural stone companies need to use less explosives, have better traffic plans, and reduce noise disturbances when possible.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool would be very useful to the natural stone industry however the issues for mining companies and natural stone companies are quite different. Natural stone does not affect groundwater and does not use chemicals
6. What are the most essential things this tool needs to address from your perspective?
   - **Have a checklist specifically for natural stone because it is different than mining**
   - **Work with local authorities to improve the traffic situation in the early phases**
   - **Waste stone can usually be used in construction in nearby areas so having a plan beforehand can save time and money**
   - **Help explain that granite and schist companies must follow the Land Extraction Act while soapstone and marble companies for the Mining Act**

6. Dr. Jussi Leveinen

Interview on May 12th, Aalto University, Espoo

1. Background: Dr. Leveinen is a professor at Aalto University in geology at the Department of Civil and Environmental Engineering. He also worked previously as a senior scientist at GTK.
2. Sustainability of mining industry in Finland: Currently the mining industry needs to stop focusing only on the areas where there are the most minerals but also look at the engineering conditions of the bedrock more widely.
3. How to improve sustainability in early phases: The tailings ponds need to be positioned in the right spot. GTK has the ability to measure seismic activity and determine where the cracks are.
4. Main issues of mining companies and how do they improve: Talvivaara put acidic water in their tailings ponds when it was created for neutral water. Doing good tests

such as hydrogeological tests and seismic activity can help determine the right areas for tailings ponds to reduce risks in the future.

5. Tool, set of guidelines, checklist? How should it differ from others? A tool would be very useful but it must be very simple. It must tell the industry exactly what they need to do in very simple terms so they can read it and understand it.
6. What are the most essential things this tool needs to address from your perspective?
   - **Do extensive tests to determine the best position for the mine considering the condition of the bedrock, the groundwater and hydrogeological cycle, and the seismic activity**
   - **It must be extremely simple in easy language**
   - **Demand more from industry and investors to ensure they are at the very least meeting the best practices in mining**

7. Eija Ehrukainen

Interview on May 13th, INFRA headquarters, Helsinki

1. Background: Ms. Ehrukainen is the Director of Sustainability at INFRA.
2. Sustainability of mining industry in Finland: The mining industry in Finland has a very negative image and the aggregate industry is much better. We only have about 10 major aggregate companies and about 400 small ones.
3. How to improve sustainability in early phases: GTK has a very good sand and gravel database and SYKE mapped groundwater in Finland. Companies need to start using these databases.
4. Main issues of mining companies and how do they improve: The aggregate industry needs to be protected from the bad image of the mining industry because many companies are small family enterprises. They have good connections with the local people because they are members. This poor image is making it difficult for some small companies to continue.
5. Tool, set of guidelines, checklist? How should it differ from others? This is a good idea. It must be in simple words and include lots of pictures.
6. What are the most essential things this tool needs to address from your perspective?
   - **Use mapping from SYKE and GTK because many small companies may not be aware of it**
   - **Include lots of pictures and explain the benefit of each point**
   - **Maintain a strong connection with the local municipality because it makes everything much easier**
   - **Have a separate tool for aggregates because we have different issues that mines**

8. Toni Eerola & Pekka Nurmi

Interview on May 13th, GTK headquarters, Espoo

1. Background: Mr. Nurmi is the Research Director at GTK and Mr. Eerola is a senior scientist. They both helped work on the Action Plan for sustainable mining in Finland.

2. Sustainability of mining industry in Finland: In recent years there has been a mining boom in Finland due to a high level of resources but this has also made permit times extremely long and put environmental issues in mining in the public eye.
3. How to improve sustainability in early phases: Because of growing pressure for sustainability, companies like Ramboll and Poyry began to look at every possible issue that could go wrong. This made EIAs extremely long and very hard to read. The EIAs need to be more consistent and short while focusing on the essential issues.
4. Main issues of mining companies and how do they improve: GTK has a wide variety of knowledge that is accessible but some companies do not use it until after the planning phase. More emphasis needs to be placed on sustainability in the planning phase.
5. Tool, set of guidelines, checklist? How should it differ from others? Guidebooks are currently too long so they need to be simple. Hiring or asking GTK to help looks good for a company's public image so this needs to be told in the guidebook.
6. What are the most essential things this tool needs to address from your perspective?
    - **GTK has a wide wealth of knowledge that needs to be better used**
    - **Tool must be simple and focus on the essentials**
    - **Using all available tools in the exploration phase can help make good decisions before the mine is even up and running. This save a lot of time, money, and risk**

10. Pekka Suomela

Interview on May 13th, FinnMin headquarters, Helsinki

1. Background: Mr. Suomela is the CEO of FinnMin and is also a member of the steering group for the Action Plan. Previously, Mr. Suomela was the Chief Inspector of Mines in Finland. As the Sustainable Mining Network moves from Sitra to FinnMin, Mr. Suomela will have an active role in making it operational.
2. Sustainability of mining industry in Finland: The image of the mining industry is not ideal and we have recognized that over the last few years. The Sustainable Mining Network and using the TSM standards from Canada will help improve this image and make the industry as a whole more environmentally friendly.
3. How to improve sustainability in early phases: Many mining companies in Finland are not extremely large and they do not have enough money and time to follow environmental standards. Making access to resources more simple and increasing communication will help them get the resources they need.
4. Main issues of mining companies and how do they improve: The main issues in mining are the tailings, water issues, and underground issues. Unlike the TSM in Canada, every mine is a member of FinnMin so there is a greater acceptance potential for a mining standard to help companies correctly deal with these issues.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool would be very useful because the standard from the Sustainable Mining Network will not be ready for a little while. The TSM standard is good because it site based but when the tailings leave the mine they are not considered. A tool must consider this because it affects the credibility of the company.

6. What are the most essential things this tool needs to address from your perspective?
    - **Better understanding of tailings ponds, water issues, and underground issues**
    - **Better communication between all stakeholders**
    - **Going beyond the TSM and including the waste even after it leaves the mine**
    - **The tool needs to be short and concise or else smaller mines will not read it**
    - **The tool must show the benefits of using it such as a better image with stakeholders**

11. Markus Ekberg

Interview on May 18th, Café Esplanad, Helsinki

1. Background: Mr. Ekberg is the CEO of Endomines.
2. Sustainability of mining industry in Finland: While there seems to be a negative image of mining companies in general in Finland, Endomines is seen as a local company and all the founders are considered locals. Endomines has a good image and no issues
3. How to improve sustainability in early phases: Communication needs to be open from the beginning. Open doors communication at least once a year reduces the potential for issues and misconceptions.
4. Main issues of mining companies and how do they improve: Endomines always used to get asked if they were "making a new Talvivaara" but good communication ensures stakeholders this is not the case. Staying local, hiring local, and always working with locals improves credibility and reduces risk. Local people trust people they know and are therefore scared of foreign companies.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool is necessary but it cannot be like the 200 page EIAs that have become the norm. It must be simple and promote communication with locals in all stages.
6. What are the most essential things this tool needs to address from your perspective?
    - **Canadian TSM standard does not cover exploration phase but this is most important since it is the first impression to locals. Increase communication and gain trust early**
    - **There is not need to try and show the monetary value because companies will do that anyways but showing good reasons and reducing risk is essential**
    - **More transparency and being local as much as possible helps promote trust and reduce potential issues. Stay local in every phase**
    - **Tool must be short and concise or people will not read it**

12. Tapani Järvinen

Interview on May 21st, Café Esplanad, Helsinki

1. Background: Mr Järvinen is a board member on several mining and mining related companies including the Chairman of the Board at Talvivaara Mining Company Plc. He was a Senior Advisor at VTT and also served as CEO and President and Member of the Board of Outotec Oyj. He is also a member of the steering group on the Sustainable Action Plan for the Extractive Industry.

2. Sustainability of mining industry in Finland: The mining industry in Finland is in an interesting position because environmental issues have recently been talked about a lot. We must respond by making a culture of sustainability and go beyond what the law requires us to do.
3. How to improve sustainability in early phases: Communication and sustainability education need to be implemented in the beginning. Understanding climactic positions like how the water flows, new technologies, start-up challenges and things like that increase knowledge and help make better decisions.
4. Main issues of mining companies and how do they improve: Need to create a culture of sustainability right from the exploration phase. Communication, education, planning, and preparing for what if scenarios right at the beginning will save money and improve image
5. Tool, set of guidelines, checklist? How should it differ from others? The tool is extremely necessary and must emphasis sustainability from the first phase. The tool must have a what if section to prepare for all possible issues.
6. What are the most essential things this tool needs to address from your perspective?
    - **Create a culture of sustainability from the beginning (first phase)**
    - **You can't control the weather, but that's not an excuse. Prepare for what if scenarios to prevent risks**
    - **Increase communication from the beginning – hold monthly or ideally weekly events**
    - **Understand the weather conditions and the water balance in the area and make decisions based on that**
    - **Spend money early on so that the potential for big issues is minimal**

13. Zhen Song

Interview on May 21th, Aalto University, Espoo

1. Background: Mr Song is a PhD candidate at Aalto University where he completed his Masters Degree in using mine tailings to create asphalt roads. He is currently working an a project that would help digitalize the mining industry.
2. Sustainability of mining industry in Finland: While there were some positive parts of using tailings for asphalt, it was determined not to be economically feasible. However, the mining industry is not keeping up with other industries in terms of digitalization and creativity in problem solving and this must be addressed.
3. How to improve sustainability in early phases: Thinking outside of the box when it comes to issues like waste and asking Tekes, universities, SITRA and others to help in preliminary phases. Usually this can be done very cheaply and the results can be incredible.
4. Main issues of mining companies and how do they improve: The mining industry is very behind the times in terms of digitalization and they do everything very slowly and inefficiently. Creating good platforms that measure all aspects of the mine can help see issues early on so they can be dealt with very quickly and cheaply.

5. Tool, set of guidelines, checklist? How should it differ from others? Yes a tool would be very good and it should challenge mining companies to think outside of the box and help them not be afraid to digitalize.
6. What are the most essential things this tool needs to address from your perspective?
    - **In early phases, including experts from Tekes, VTT, SITRA, and universities can make the project much better**
    - **Having good measuring indicators in place so that issues can be spotted quickly**
    - **Promote outside of the box thinking**

14. Dr. Olli Salmi

Interview on May 21st, Open Innovation House, Espoo

1. Background: Dr Salmi is a senior research professor at VTT where he is involved in the CLEEN initiative in mining the program manager for the VTT Mineral Economy Innovation Program.
2. Sustainability of mining industry in Finland: The mining industry has a lot of potential to develop especially as we see automatic mines being considered in Sweden. Finnish mines must adapt and develop digitally as well as look towards the future to consider the "what ifs".
3. How to improve sustainability in early phases: Mining companies should look forward at what they consider to be a desired future then work backwards to determine what they need to do in the planning phases. Considering the "what ifs" by doing stress tests early on reduces the potential for disaster in the future.
4. Main issues of mining companies and how do they improve: Finnish mining companies still rely on old technology and need to use available technology to improve. More accurate measurements and data will help make better decisions from the early phase right through to closure.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool is necessary for the industry and it must challenge companies to strive for the most ideal future and then do whatever they can to get there. As automatic mines become more and more of a reality, new mining companies in Finland need to recognize this and adapt to stay competitive.
6. What are the most essential things this tool needs to address from your perspective?
    - **Futures thinking and stress tests to determine what ifs in early phases**
    - **Use VTT and others to help find useful technology that will ensure data and measurements are accurate**
    - **Make decisions based on good measurements and not educated guesses. Consider the risks in every decision and try to reduce them, not just roll the dice**

15. Maria Palin & Heikki Palin

Interview on May 22nd, Café Esplanad, Helsinki

1. Background: Maria Palin is the Communications Manager at Palin Granit Oy while Mr. Palin is the Managing Director at Palin Granit Oy. Palin Granit is one of the largest aggregate mines in Finland.
2. Sustainability of mining industry in Finland: While Talvivaara has definitely affected the perception of the industry, the aggregate industry is much smaller and usually involved in the community. Palin Oy is a fourth generation family company with good ties with the community.
3. How to improve sustainability in early phases: The key is to go beyond what the legislation demands. Making a better public water system, improving roads and things like this helps reduce issues with the community. Good dialogue is essential. Most importantly, when choosing an area, it does not make sense to locate near houses or cottages because that will scare and upset people.
4. Main issues of mining companies and how do they improve: The aggregate industry's biggest issue is dust but dust collectors inside the machines when drilling really help. Also transportation creates dust, noise, and congestion so good planning for keeping roads away from people is imperative. Noise and vibration are an issue but knowing exactly what will happen and who will feel it reduces risk and keeps a good image.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool is necessary in the aggregate industry especially for small companies that do not have a lot of resources. It must be simple and target them more than larger companies because they have environmental platforms.
6. What are the most essential things this tool needs to address from your perspective?
    - **In public meetings, no one shows up unless they are against it so having meetings that explain the work being done clearly help reduce the number of people against the project**
    - **Help the local people through better infrastructure and other things. This increases trust and reduces issues**
    - **Have dust collectors inside machines when drilling or whenever possible**
    - **Create good transportation plans and make them with the municipality**

17. Tomi Gutzen

Skype Interview on May 23rd, Helsinki to Sotkamo, Finland

1. Background: Mr. Gutzen is the consultant and risk assessment specialist with significant experience from Talvivaara Mining Co and is leader in the mining industry in terms of futures thinking and risk management.
2. Sustainability of mining industry in Finland: Before Talvivaara began, it was hailed as the saviour for the Sotkamo region because it would bring lots of jobs and infrastructure. Its image was so good that they did nothing in terms of communicating with local people or making connections. This meant that as soon as things started to go bad, their image dropped. Because Talvivaara did not make any connections, investors and partners got scared and pulled out. Mining companies win or lose in the

planning phase so making good partnerships and gaining trust early on can ensure that when times are bad, someone will always be there to help.

3. How to improve sustainability in early phases: There is a need to gain a good reputation from the very beginning to make the company more resilient. We see from Talvivaara that they had such a high reputation in the beginning that they did not try to build it up and this backfired in the time of crisis. Creating a stakeholder map and finding their values is essential.
4. Main issues of mining companies and how do they improve: Risk assessment needs to be done with the stakeholders in mind. For example, the amount of chemicals in the river, lake, etc. is normally done from a three kilometre radius around the mine. What if in the three kilometre range the river dies but no one uses it but 20 kilometres down the river it changes the colour slightly and the locals notice it? This has a huge impact on the company's image. Companies must stop making claims on the legislation and go beyond it to protect their image.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool is definitely needed and the risk assessment needs to be done based on the values of all the stakeholders. Therefore knowing how to make a stakeholder map is crucial. Furthermore, locals and Indigenous people need to be included in the preliminary phases as knowledge holders. For example, Indigenous people know exactly where fish breed and they can tell the company right away what fish are valuable to their culture and way of life.
6. What are the most essential things this tool needs to address from your perspective?
    - **The tool cannot be a plot because then if the company does not do something early on, they cannot do anything later. There must be individual points that stand alone from each other**
    - **A stakeholder map is essential in the tool and it must teach people how to make one correctly**
    - **All risk assessments should not only be based on financials but also local values because this impacts the image of the company directly. Having a good image can reduce the potential for negative press from media and ensure that environmental organizations are not trying to shut you down**
    - **Create win-win symbiotic relationships with stakeholders**
    - **Making good relationships and a positive from the very beginning is essential. Finding a local contact that is well liked in the community can help**
    - **When calculating risks, don't focus on the outcome but focus on the root problem**

18. Sari Kauppi

Interview on May 25th, SYKE headquarters, Helsinki

1. Background: Dr. Kauppi is a Researcher in the Center for Sustainable Consumption and Production (Contaminants) at the Finnish Environment Institute (SYKE) and was a part of the emergency group that made assessments of the Talvivaara gypsum pond leakage accident in 2012.

2. Sustainability of mining industry in Finland: One of the major issues mining companies face is with regards to water. Better planning and keeping different kinds of water separate can help companies improve. With what happened at Talvivaara, it is necessary for mining companies to do a good job at this because they are being watched very carefully.
3. How to improve sustainability in early phases: Measuring the water balance and how much water coming to the area before the mine is there helps make the planning process much better (water balance modeling helps to understand these). Furthermore, biodiversity must be considered as early as possible so roads/railway/electricity lines can be put in the least damaging areas to habitats. Also changes in hydrology have an impact on biodiversity.
4. Main issues of mining companies and how do they improve: One of the major issues is that mining companies are only required to do one EIA. However, during the planning phases, they do not know the exact details of their operations so what chemicals they use will change and how deep they need to go. Doing several (for example three - one before operational phase, another when mining processes have been used for a while (i.e. a year after start up) and a third after several years of operation) EIAs throughout the process can reduce risks tremendously.
5. Tool, set of guidelines, checklist? How should it differ from others? A tool is necessary that focuses on the first few phases because they are crucial. It must include the local people because they know the area the best.
6. What are the most essential things this tool needs to address from your perspective?
    - **Do several EIAs before the mine is in operation due to changing plans like different chemicals**
    - **Water issues can be significantly reduced by doing area water balance modeling and monitoring and ensuring that different kinds of water stay separate from each other to reduce contamination**
    - **Discuss with local people at the beginning and use their knowledge of the area**
    - **Consider biodiversity in every case when choosing where to locate infrastructure**

19. Sanna Hast & Anne Ollila

Interview on May 28th, Helsinki International Airport, Helsinki

1. Background: Sanna and Anne are both senior members within the Reindeer Herders Association where Ms. Ollila is the Executive Director at the and Ms. Hast is the Lead Land Use Management Advisor.
2. Sustainability of mining industry in Finland: The mining industry is growing quickly in Finland and we are seeing the effects on reindeer. After some years with operating mines in the reindeer herding area, we are now beginning to understand the impacts more concretely. For example, with regards Kevitsa mine in Sodankylä, Oraniemi reindeer herding co-operative (paliskunta), the reindeer are forced to stay more in the southern parts and further in the surrounding areas. They cannot cross through wetlands as they have before been able to according to their natural grazing migration route. The mine is blocking the route and causing disturbance. They have therefore lost

their natural migration patterns, and this is causing changes in the herding practices. Grazing is harder, there is more pressure on the remaining pastures and herders have to support the reindeer with supplementary feeding. Pastures have been lost and work expenses of the livelihood have increased. Also numbers of traffic accidents to reindeer have increased after mining operations have begun. While some mining companies have recognized these impacts, they are compensating them partially (for the loss of pastures and some increases in work expenses) but they are not willing to deal with the root causes.

3. How to improve sustainability in early phases: Special consideration must be made to reindeer migration patterns because this affects the way of life of many people too. Instead of offering solutions that do not really help, we need to prevent problems from happening in the first place.
4. Main issues of mining companies and how to improve: Mining companies must not come too close to reindeer migration areas and should take into account large buffer areas around the mines that cannot be used as pasture anymore and also that the individual reindeer do not go into the mines. Furthermore, small satellite mines are becoming an issue because they fragment the habitat and also force reindeer to be in dangerous situations. An EIA should be required for these small satellite mines as well. Uranium and thorium and other radioactive/chemically poisonous minerals must be better dealt with because they affect the reindeer and their diet and drinking water. Finally, the reindeer herders themselves have lots of knowledge and they should be included in the decision making process so that their knowledge can help make the right decisions and their voice is heard.
5. Tool, set of guidelines, checklist? How should it differ from others? Yes a tool is necessary but it must not focus on short-term solutions. It must deal with the root cause of the issue which is where the mine would be situated, where the roads go, and where the waste goes.
6. What are the most essential things this tool needs to address from your perspective?
    - **Deal with the root cause of mining impacts on reindeer – habitat loss and fragmentation of pastures and migratory routes**
    - **Include Indigenous knowledge holders in decision making process because they have the most knowledge**
    - **Uranium and thorium and other radioactive/chemically poisonous minerals affect the whole food chain and must be better disposed of/processes thorughly regulated**
    - **Satellite mines need to go through the same EIA process as large mines because they significantly affect reindeer herding**
    - **Consider migration patterns of reindeer before determining a spot for the mine**

6. ANALYSIS

This section compiles all the information from the literature reviews and the stakeholder interviews and determines the overlapping areas that have been emphasized in both forms of research. It provides a concise summary of the literature review as well as summarizes the interviews before merging the two together to create themes.

6.1 Summary of results from the literature review

The Timeline of Finnish Publications section (4.1) within the literature is quite useful to the study because it shows exactly how Finland has reacted to a growing industry. The earliest paper from 2007 on exploration (Ministry of Trade and Industry of Finland, 2007) is extremely useful because it succinctly highlights that many free applications are available to companies before they even go explore the area such as the Drill Core Register sponsored by the Geological Survey of Finland. The Mining Act (2011) is obviously quite important because compliance is necessary to ensure that there will be no issues with authorities. In 2013, the groundbreaking conference to "Make Finland a Leader in the Sustainable Extractive Industry" was the birthplace of the Finnish Network for Sustainable Mining. The Network is busy creating a tool that is based off the Canadian Towards Sustainable Mining Standard that acts as a tool to help extractive companies improve their social and environmental strategies. It is very important to understand this historical development so that all suggestions in this paper and others can reference previous studies and show how thoughts and ideologies have changed over time as climate change becomes an increasingly important topic.

The Network for Sustainable Mining is creating a tool to help industry become more sustainable and it has chosen the Canadian Towards Sustainable Mining (TSM) as its base. Therefore the TSM was analyzed and found to be very successful in many areas but fails to mention the importance of sustainability in exploration and does not demand that companies measure their waste once it leaves the mine or quarry. A new standard for aggregates was also included in the study because it is the first tool in the world to focus on the sustainability of the aggregate industry. It is more effective than the TSM because its seven principles present core requirements that the company must do in order to achieve the standard such as maintaining regular contact with Indigenous people and using their traditional knowledge of the area.

Section 4.4 of the literature review is essential because it provides leading peer-reviewed and cited literature on the sustainability issues plaguing the mining and extractive industry as a whole. The section does not focus on the historical development but rather the major issues of today. A term that is used often is "peak minerals" that means the level when the material can no longer be extracted from the ground economically because of lower quality ores or because the area is very difficult to reach. Several papers make the argument that today we cannot separate environmental and social issues from economics due to the fact that they are now large economic factors themselves. Good environmental practices such as creating community waste plans can help reduce costs by reducing transport and create a better company image that could open good economic opportunities like partners and investors (cc Mudd, 2010; Prior et al., 2012).

A study attempting to predict future trends for the Finnish metal industry notes that there is a tremendous potential for development but they warn that if companies do not pursue a high standard of environmental protection and conservation, there is a large financial risk (Tuusjarvi et al., 2014). However, Tuusjarvi et al. (2014) place the largest amount of emphasis on instituting a social license to operate in order to ensure a strong level of growth. Both Munonen (2015) and Eerola et al. (2015) agree with the other publications in this section but present a slightly more positive viewpoint that while companies are not doing enough environmentally or being transparent, they do provide valuable jobs and livelihoods to the communities. Eerola et al. (2015) propose that companies can do a lot more to improve their image by helping the community develop and being more transparent about information regarding any operational issues so that negative views caused by Talvivaara and other mining disasters are not attributed to the company near a person's community.

Due to the urgency that the papers in Section 3.4 expressed for creating social and community engagement plans and a social license to operate, the Section 3.5 of the literature analyzed whether they are truly necessary and if so, what do they entail? Owen and Kemp (2014) present a convincing literature analysis and determined that extractive companies have lost the trust of their stakeholders due to continuing problems, lack of transparency, a lack of engagement and other issues. They explain that a social license to operate is the idea that extractive companies must communicate with all affected stakeholders and work with them in order to continue their operations. If companies fail to do this, it is likely to cause significant losses to their reputation and ultimately their financial output (Owen & Kemp, 2014). Hilson and Murck (2000) present one of the most cited papers in terms of social management in the extractive industry using an extensive literature review and a comparison of two extractive companies' social engagement plans. They create a large list of recommendations such as the need to identify beforehand the potential project benefits and negative impacts to the community when a new extraction site is proposed (Hilson & Murck, 2000). The recommendations are well reasoned but they do note that smaller companies may not have the resources or skill to conduct them all.

The need to find a tool that could help extractive companies institute an effective social license to operate led to the work by Bosch and Nguyen (2012). Their work is more beneficial to extractive companies because it brings all views of stakeholders together very efficiently and creates solutions that can be unanimously agreed upon. A list of all potential stakeholders is created and they are asked to attend a workshop. At the workshop, stakeholders present their concerns and issues that are noted on a large piece of paper. The whole group works together to determine leverage points, which are specific areas that make a large sustainable difference. For example, if stakeholders are worried about increased traffic, creating a road that goes around the city can be a leverage point. A master plan is created so that all sides feel included and their voices heard. By implementing these leverage points in the master plan, the company can be assured that the stakeholders will like the plan of action because they helped make it. This increases the company's reputation and will hopefully create a great working relationship with all stakeholders. The effectiveness of the Bosch and Nguyen tool was compared to the stakeholder surveys and academic papers but neither option could help the company institute and manage the suggestions. Other options such as multi-criteria decision analysis and impact

assessments were excluded because they can help a company make internal plans but do not help with stakeholder interactions, which is the priority in building a social license to operate.

6.2 Summary of the stakeholder interviews

This section gives a brief summary of the stakeholder interviews (Section 5.1) while the subsequent Results section (Section 7) presents a detailed graph on the interviews that clearly highlights what issues are most raised by the interviewees. This analysis is incredibly important but it does not consider the weight and emphasis that the interviewees put on each issue. For example, Sanna Hast and Anne Ollila of The Reindeer Herders Association argued passionately for the need to deal with the root cause of reindeer impacts, which is habitat loss and fragmentation. They come to the same conclusion as many others in the study that exploration and choosing the right spot for the mine is important, but their emphasis and passion is incomparable. The vast majority of interviewees raised exploration as an area in need of improvement but many referenced it in terms of making a good first impression to the community.

Making a good first impression was part of a much broader theme of improving trust and communication with the community because without it, the door opens for environmental non-governmental organizations, local groups, Indigenous Peoples, and other stakeholders to critique and shed negative attention on the company. Interviewees in the industry, particularly Eeva Ruokonen who was the Director of Sustainability for Talvivaara when many of the heavily publicized issues happened, stated that opening the communication lines diffuses tension and improves trust. This, in turn, has financial benefits by removing potential risks such as poor medial exposure and a loss of investors as well as opening doors for potential partnerships and win-win opportunities with the local community and beyond. A good community engagement plan was deemed essential by several interviewees, including Pekka Suomela (Executive Director, Finnish Mining Association), who said that communication between stakeholders is crucial to success.

Maiia Uusisuo and Riikka Aaltonen, of the Ministry of Employment and the Economy, were quite convincing when they said they were members in the creation of the Sustainability Action Plan in the Finnish Extractive Industry in 2013 and felt that biodiversity protection was entirely overlooked. Several others raised this in context of the need to conduct environmental assessments regularly due to the changing ecosystem. Water and tailings were also highlighted by many as an essential area in need of improvement. Eeva Ruokonen was perhaps the most convincing once again when she explained that if the water was prevented from coming into Talvivaara in the first place by barriers, the gypsum pond leak likely would not have happened. Others approached the issue from a financial perspective stating that the better the system, the less waste and therefore lesser costs associated with mitigating risks.

While not mentioned by many people, health/safety and education was argued by Tapani Jarvinen as a way to improve the culture of sustainability within the company. Improving worker morale and providing adequate protection and equipment increase satisfaction and directly improve efficiency and output. In general, scientists such as Dr. Olli Salmi of VTT and and Dr. Mikael Rinne of Aalto University, stated that energy efficiency is a crucial issue.

Both mention that there are many new technologies that use less energy while providing more deliverables. Dr. Rinne continues to state that better analysis tools to determine the weak link in the system can save money by only needing to repair or replace one part. This leads into one last theme of systems thinking and the need to be constantly improving. Tomi Gutzen, a risk assessment specialist, illustrated this point well by stating that when calculating risks, it is important not to focus on the outcome but the root problem. Having detailed plans and ways of monitoring and constantly improving helps reduce risks and increase profits. Some others state like Mr. Gutzen that some mining companies to do not adequately plan for disasters or improve their operations whenever possible.

6.3 Combining both forms of research methods into distinct themes

1. Exploration

The literature review clearly demonstrates that no standard includes an exploration section even though the interviewees stated that it is a great time to make a good first impression and the time to begin making smart, sustainable decisions. The Ministry of Trade and Industry's paper on exploration is extremely useful in providing details about choosing the right area and what free materials are available (2007). Markus Ekberg referenced the Canadian TSM as not having an exploration section and he deemed it most important because you can make a really good first impression. This is verified in the literature review section. The suggestion of having a local contact comes directly from Nguyen and Bosch's work where they state that a local contact can help a non-native achieve trust from the community, particularly Indigenous communities, more efficiently (2012). Tomi Gutzen, a risk assessment specialist, says that having a local contact can help significantly.

The GTK points about including their free material come directly from the two GTK stakeholders and also the exploration guide for protected areas and the Sami Homeland by the Ministry of Trade and Industry (2007). The long processing times and the difficulty of the permits when trying to explore a protected are also explained in the Ministry of Tade and Industry's exploration guide (2007). It is stated that it is not recommended as well because it will have a greater impact on Finland's biodiversity (Ministry of Trade and Industry, 2007). Finally, Anne Ollila and Sanna Hast of the Reindeer Herders Association made an important point that reindeer migration issues could have been avoided if mining companies were aware of their typical routes and patterns. They state that habitat loss and fragmentation is the central cause of mining impacts on reindeer.

2. Surveying the land

Section two on surveying the land is essential because it has a direct influence on where the quarry or mine will be situated. It is largely based on the need expressed once again to improve the exploration phase to make it more sustainable (Figure 7). The Ministry of Trade and Industry's exploration guide (2007) was consulted to help create points that would find a balance between choosing a place with a good amount of minerals but also looking at the condition of bedrock, the topography, and seismic activity. Furthermore, there is a direct need from the literature to determine the amount of ore available so that it can better be determined

when extraction should be stopped for social, environmental, and economic reasons (Mudd, 2010; Prior et al., 2012).

Dr. Jussi leveinen is an experienced geologist and engineer and he makes an intuitive argument for conducting tests on bedrock, groundwater, and seismic activity to ensure that the area can withhold the stress needed for an extraction site. He explains that it could save a lot of money by conducting these tests before the mine/quarry has begun to extract minerals or metals. Tapani Jarvinen states the importance of understanding the weather in the area and using that information to find the right location for the map. Dr. Olli Salmi, Tomi Gutzen, and Dr. Mikael Rinne's suggest including futures thinking in the project and the right time to consider the future is right at the beginning. Creating risk analysis charts and using Indigenous Traditional Knowledge can help predict conditions and save a lot of money before the operation even begins.

3. Compliance with the law

In the aggregate and natural stone industry, soapstone and marble companies follow the Mining Act but granite and schist companies follow the Land Extraction Act. Pekka Jauhianen of the Finnish Natural Stone Association requested that this be explicitly stated to avoid confusion. This is why many of the interviewees in the aggregate and natural stone industry stated that the Mining Act (Ministry of Employment and the Economy, 2011) is quite confusing. Several interviewees in the mining industry, such as Eeva Ruokonen of Talvivaara, stated that some companies need several different permits for mining, environment, and chemical usage. Again this adds to the complexity of the document. Dr. Mikael Rinne expresses the need to make the mining law simpler as it is quite complicated. By drawing attention to important sections in the Mining Act, this fills that need and does not act as a hindrance to those stakeholders that believe the Mining Act is a succinct and easy to read document of law.

4. Community Engagement

The stakeholders in this research made it very clear through a unanimous call to improve community engagement for extraction companies (Figure 7). The literature is also quite definitive on this topic as well (cc: Hilson & Murck, 2000; Mudd, 2010, Owen & Kemp, 2013). Hilson and Murck present several important suggestions on how to improve a company's reputation and status by engaging with the local community and they are included as sub-points in this research too (2000). Owen and Kemp (2013) further the suggestions by Hilson and Murck by advocating for a social license to operate. They explain that extraction companies in general have lost the trust of local stakeholders and they must gain in back or risk losing valuable business and opportunities. The sustainable aggregate standard by the Cornerstone Standards Council (CSC, 2015) contains a principle that says finding benefits for the host community is essential because it helps builds trust.

In Tomi Gutzen's interview, he furthers the CSC principle when he suggests that creating win-win symbiotic relationships is possible through good community engagement. Many interviewees raise concerns that local people are most worried about traffic and dust so those

were used as examples in the sub-points. Maria and Heikki Palin talk about the importance of making good traffic plans together with the local community. Eeva Ruokonen states that opening communication lines, and creating blogs and websites diffuses tension. Finally Anne Ollila and Sanna Hast convincingly suggest that indigenous knowledge holders should be consulted for advice because they hold a substantial amount of untapped knowledge.

5. Community Engagement Plan

This principle is based almost entirely on the work by Nguyen and Bosch (2012) that was reviewed in Section 4.6 of the Literature Review. It comes in response to the tremendous need for community engagement in the extraction industry that was highlighted in the previous principle. Including a tool that has potential to help extraction companies improve their community engagement strategies as a theme is important to this research due to the pragmatic approach taken. By recognizing a trend from the literature for the need to create a social license to operate, this research compared several options and determined that the Bosch and Nguyen method would be most helpful to the Finnish extraction industry because of the short timeline and the small economic cost.

The stakeholder interviews provide intuitive input that helped isolate the Bosch and Nguyen approach. Pekka Suomela, the Executive Director of the Finnish Mining Association, highlights a need for better communication between all stakeholders and Eija Ehrukainen of INFRA agrees by suggesting that it makes everything much easier if there is a strong connection with the local community. Dr. Mikael Rinne provides an important philosophy when he says we need to use systems thinking to find the weaker areas early on in the life of the mine and improve them before they become larger issues. Finally, Tomi Gutzen talks about the risk of having a bad relationship with the community such as bad press that leads to a loss of investors. The Bosch and Nguyen tool is peer reviewed and well-cited and has a proven track record of success in more difficult areas than Finland. It can help extraction companies gain the trust of stakeholders by including them in the planning phase and quickly isolate the central issues then making a plan to remedy them.

6. Biodiversity and Conservation

Any research on sustainability must include a section that attempts to protect and conserve the natural environment. The literature review reflects this and Prior et al. (2010) clearly explains that as ores become more difficult to extract, biodiversity is more greatly damaged. Mudd (2010) continues this thought and warns that if environmental sustainability is not a priority for the extractive industry, it could destroy it. He suggests that if the natural area is not taken care of, less areas will be able to be used for extraction and can taint the product. The paper by Ayodele et al. (2012) brings attention to the usefulness of native plants in dealing with pollution naturally. The Ministry of Trade and Industry's exploration guide (2007) is also useful to help explain certain laws and protected areas that must be avoided. The TSM standard (MAC, 2015) proposes to report on the biodiversity regularly and ensure that it is not being permanently affected.

Many interviewees spoke about the need to protect biodiversity in their interviews and Figure 7 demonstrates that it is a central issue plaguing the industry. Riikka Aaltonen and Maija Uusisuo expressed a need for it because they felt it was overlooked in the Finnish Sustainability Action Plan from 2013. Dr. Sari Kauppi was very useful for this principle when she explained that mines change over time and therefore it is necessary to conduct several environmental impact assessments. The need for buffer zones around mines was presented by Riikka Aaltonen and Maija Uusisuo and Sanna Hast and Anne Ollila once again raised the importance of having throughways and overpasses to let animals migrate while they also note the importance of working with the local indigenous community to determine what areas should be protected for their intrinsic value. Eija Ehrukainen presents having dust collectors inside the ground as a useful solution to dust problems.

7. Water and Tailings/ Water and Explosives

There is a direct need in Finland to have some guidance on water issues and this is demonstrated in Section 4.1 of the Literature Review. The timeline of papers shows that water issues were not a primary concern until after the Talvivaara gypsum pond leakage in 2012. The response was that the Action Plan to Make Finland a Leader in the Sustainable Extraction Industry made its first action point the need for industry to develop water management plans (Ministry of Employment and Economy, 2013). The literature does not provide concrete solutions to water issues but stakeholders with plenty of experience were quick to give them. Eeva Ruokonen, the sustainability Director at Talvivaara, said that she wishes water barriers were placed outside all mines so the extra water could not come in. Doing this reduces contamination substantially and reduces the strain on the filtration and water systems. Dr. Jussi Leveinen's previous point about understanding the bedrock and seismic activity is again important in determining the correct location for the tailings ponds. Tapani Jarvinen is clear that humans cannot control the weather so there is a need to be prepared for the worst-case scenarios and Dr. Olli Salmi shares this view. Zhen Song, a tailings specialist at Aalto, points out that having good measuring indicators in place can help spot issues as soon as they happen so they do not grow larger. Dr. Sari Kauppi of SYKE raises an intelligent point that different types of water must be kept separate to prevent contamination. Water management plans are clearly necessary and the suggestions made in this article that are based on suggestions by leaders in the industry are essential to implement.

The Cornerstone Standards Council (2015) suggests reducing blasting as much as possible. Hem (2012) offers alternatives to blasting such as new diamond saws or chemicals that release the stones. Pekka Jauhianen states that vibrations are an issue but if they are done correctly, they can be limited. It is clear that improving technology to reduce blasting as much as possible is necessary and working with Tekes, VTT, GTK, SITRA, and universities can help substantially to determine what technology would be most effective considering the area and what type of mineral/metal is being extracted.

8. Health, Safety, and Education

The literature review section does not focus on worker health and safety but the Mining Act (2011) clearly highlights many requirements for extraction companies that pertain to these

issues. Chapers 12 and 13 focus entirely on worker health and safety and range from the necessity of an internal rescue plan in the mine or quarry to the need for all workers to be briefed about all possible threats of accidents when conducting their job. While the Mining Act is important, the stakeholders provide very interesting ideas to help improve worker health, safety, and education. Tapani Jarvinen presented an interesting idea that companies should create a culture of sustainability from the beginning. Ensuring that workers are happy and educated about sustainability will help create this culture. Furthermore, improving the lives of workers such as offering free healthcare or giving local people a job not only improves social sustainability but also makes workers more inclined to work hard. This in turn creates an economic gain. Heikki and Maria Palin of Palin Granit Oy put forward the idea that dust collectors should be placed inside the quarry because it better for the workers' health and safety. Little techniques can make a large difference and working with Tekes, VTT, GTK, SITRA, and universities can once again make a positive difference.

9. Energy and Efficiency

The new Climate Change Act (2015) is extremely important to this research because it leaves no choice for companies to have to reduce their emissions and waste in order to meet the aggressive countrywide targets. Except for the Canadian Towards Sustainable Mining standard (TSM), the literature review does not emphasize reducing energy so much as it insists on the need for better waste management. In Section 4.4 of the literature review, Prior et al. convincingly argue that better waste management systems that function within or cooperate with local strategies is essential to keep transport and other costs low (2012). They explain that technology cannot be relied upon to reduce waste because the extractive industry works with a finite resource and will therefore create waste regardless. It is essential that companies seek partners that could use their waste because these partnerships provide strong economic, social, and environmental incentives. Pekka Suomela says that is necessary to go beyond the TSM standard and take responsibility for the waste even when it has left the mine. However, the TSM standard is also a good reference for this section as it proposes ways to reduce emissions and energy consumption (MAC, 2015). Dr. Olli Salmi says that reaching out to VTT and others to find useful technology for the specific mining process can save a lot of money and hardship. The systems thinking approach that Dr. Mikael Rinne proposed of finding the areas that are working poorly and improving them would help save a lot of energy. Lastly, the Cornerstone Standards Council (2015) iterates that the importance of wind and solar energy is growing due to more efficient and cheaper technology. Extraction companies should consider these opportunities to lower energy costs and to offset carbon dioxide emissions that will need to be reduced due to the new Climate Change Act.

10. Review, Plan, Initiate, Evaluate, Repeat

The literature review does not mention systems thinking as a way forward for the extraction industry except the paper by Bosch and Nguyen (2012) makes a powerful argument that nothing is ever perfect meaning that improvements can always be made. The need to evaluate the current system, highlight issues, make a plan of action, and then initiate it is presented effectively in their paper. Some stakeholders see this systems thinking approach as a useful option. Tomi Gutzen says that when calculating risks, it is important to not focus on the

outcome but the root problem. Dr. Mikael Rinne's idea of constantly finding the weak link and improving will be very beneficial to the overall success of the mine or quarry. Dr. Olli Salmi says that making decisions based on good measurements and not educated guesses will reduce issues. The need to consider risks and attempt to reduce them is paramount to success. Looking to the future and imagining your ideal company and then working your way back on the steps you need to get there is a creative and visual way that Dr. Olli Salmi shows how futures and systems thinking can be incredibly successful.

7. RESULTS

After compiling all the information from the literature reviews and the stakeholder interviews, ten broad categories, or sustainability issues, were uncovered in the previous Analysis (Section 6). This section will highlight these ten issues and include specific sub-points that have been highlighted during interviews or within the literature review. A graphic summary of the results from the Stakeholder Interactions section (Section 5.1) is also presented.

7.1 Results from stakeholder interviews

The results of the stakeholder interviews are presented in depth in Section 5.1 where each interview has been summarized. This section will look at some of the trends in the interviews to help explain the issues that were most raised. Question 1 regarding the person's background demonstrated that there were a large range of stakeholders represented but they can be broadly put into four categories: government, industry, science and universities, and local and Indigenous Peoples. Figure 6, in Section 5, demonstrates the spectrum of people that contributed to this study and shows that industry is most represented.

Question 5 during the interview focused on whether a tool needed to be created to help non-energy extractive companies develop more sustainably and every interviewee said that it was. However, many of the interviewees expressed a need for the tool to be short and concise and to be engaging (such as a checklist or pictures). Furthermore, some of the interviewees, namely Pekka Suomela (Director of FinnMin) noted that the Sustainable Mining Network is currently working on a tool that is based off of the Canadian Towards Sustainable Mining standard. This is also summarized in the literature review in Section 4.1. Mr. Suomela suggests that a tool will be very useful presently because it will take some time before the Sustainable Mining Network tool is ready and a short tool such as a checklist or guidebook could also work alongside whatever tool is made.

Questions 2-4 that were asked in interviews attempt to see where the stakeholder has a bias in terms of what needs to be done to make the industry more environmentally, socially, and economically sustainable. Question 6 then asks the stakeholders to state the most essential items that they think non-energy extractive companies need to do to develop in a sustainable fashion. The responses from Question 6 from each interview are highlighted in point form in Section 5.1. The combination of Questions 2, 3, 4, and 6 are represented in Figure 7 where the most repeated issues are presented. Figure 7 shows the amount of stakeholders that raised the particular issue during the interview and because the questions were not scripted, like multiple choice or true or false questions, the interviewees were able to emphasize their beliefs as to what is absolutely essential for the non-energy extractive industry. Figure 7 does not take into account that some stakeholders held extremely strong beliefs on a particular subject but this is represented previously in the Analysis Section 6. Figure 7 is useful to determine what issues are most concerning and it is very clear that community engagement strategies and exploration techniques and methods are major issues for the majority of stakeholders represented. Reducing carbon dioxide pollution and having better policies for biodiversity protection and conservation are also issues that were raised frequently. The Mining Act is the only debateable topic in the sense that some people found it to be very effective while others found it

confusing and difficult to follow or to understand the essential requirements. Finally, there is almost a unanimous agreement that the ELY centres (as explained in Section 2.5) are very effective at delivering sound scientific information to non-energy extractive companies.

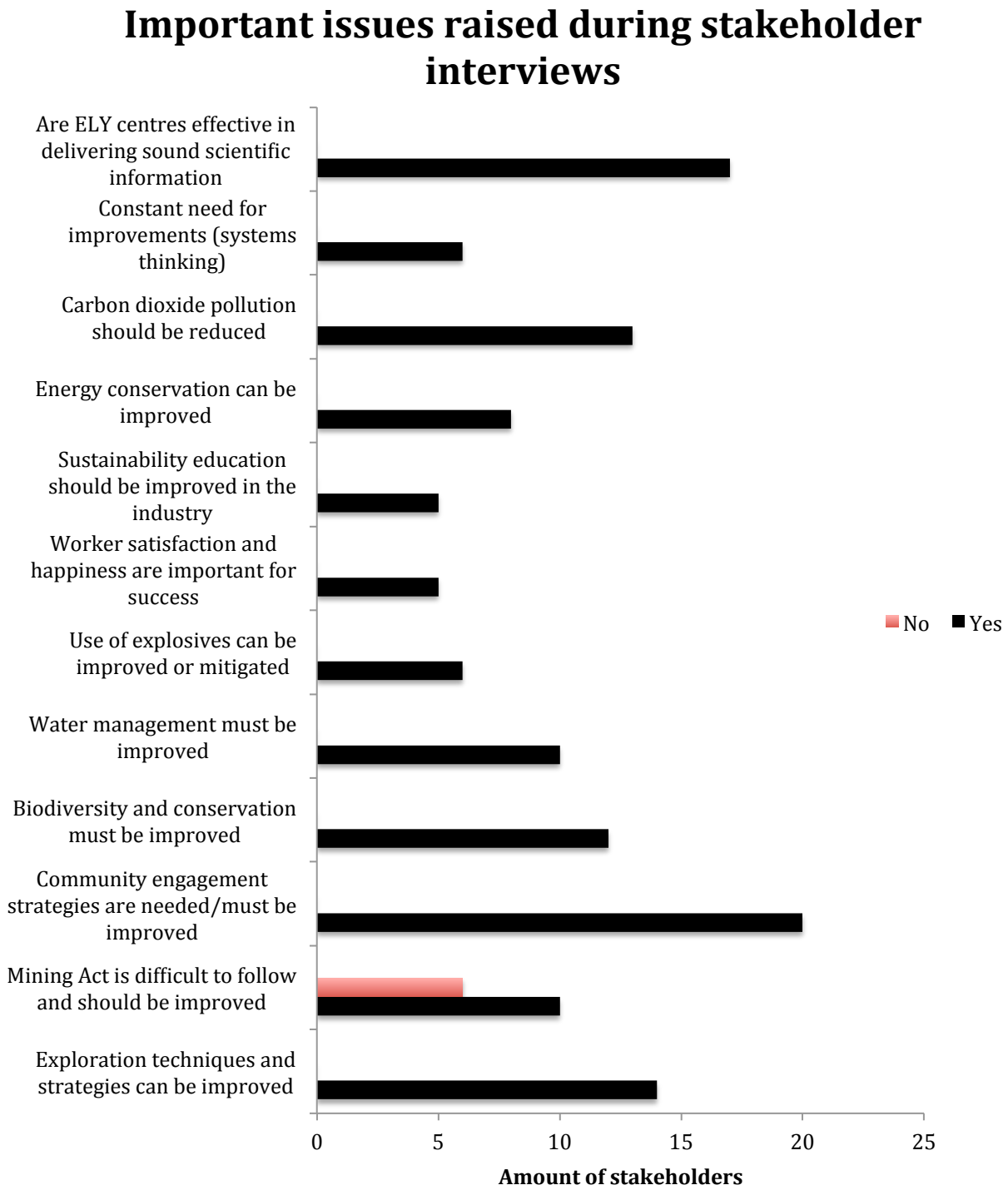

Figure 7**:** A summary of important issues raised during stakeholder interviews

7.2 The 10 themes/leverage points: A compilation of all of the research

Based on the combination of the stakeholder interviews and the literature review in the Analysis section (Section 6) 10 themes were uncovered. This section will present these themes and their subsections. These 10 themes and their subsections were peer reviewed by all of the stakeholders involved in this study. In the Methods Section 2.2 of this research, it is explained in detail how the stakeholders were given several opportunities to provide feedback and ensure that the essential themes are included.

1. Exploration

Exploration is mentioned by many of the interviewees as an area that must be improved (Figure 7). The literature review demonstrates that much can be done in the exploration phase to create better relationships with local communities, reduce the impact on biodiversity, and save money by capitalizing on free material before even going to the area. The sub-points are presented below:

- Make a local contact (a community leader, business owner, political activist, someone influential in the community). Tell them you are willing to create a beneficial partnership with them and everyone in the community. This will ensure the local contact will believe you are committed to helping the community while being environmentally sustainable.
- Conduct regional surveys without going to the site: GTK's Internet service is free and has maps showing ore-potential formations and structures, bedrock, soil, geochemical data, and regional gravity and elevation measurements. GTK also has samples at the National Drill Core Register.
- GTK can be hired as consultants during this phase and could provide valuable advice.
- SYKE has free maps of groundwater and water flows that should be reviewed.
- Choosing the right area is essential. Special guidelines for Natura 2000 sites, Wilderness Reserves, and the Reindeer Husbandry Act (that covers approximately 33% of the area of Finland) are outlined in The Mining Act (2011). Due to longer permit times, environmental impacts, and specific approval from the Government and the Sami Parliament and Skolt Council – it is highly recommended to not choose an area in these jurisdictions.
- Consult the Reindeer Herder's Association for information on the migration path of reindeer. Consider that roads and infrastructure can affect these patterns and further endanger reindeer.

2. Surveying the land

Due to the immense gap in the literature for sustainable exploration combined with a majority of stakeholders raising the need for it to be improved, exploration was broken up into two

sections. The second section focuses of how to implement sustainability when actually going to the area rather than exploring remotely and the sub-points are listed below:

- In areas with no previous exploration, new information must be collected
- Ask your local contact for advice on the area – such as how water flows, what plants grow in the summer, where the snow and ice forms, what areas have poor drainage, where the soil is weak, etc.
- If the proposed area is on Sami land, use their knowledge and understand the importance of that land to their culture. Involving local people in this phase helps them feel involved and needed, which will improve your relationship and image.
- Make notes and take photographs of all of the area, determining the position of all trees and plants, roads and water.
- Consult GTK, VTT, SITRA, universities, and other experts about the best available technology (such as till geochemical sampling with a percussion drill) for the specific material you are mining.
- With the environmental issues hampering mining companies in Finland in recent years, extensive tests to determine the best position for the mine considering the condition of the bedrock, the groundwater and hydrogeological cycle, and the seismic activity is essential to ensure the bedrock will not leak into the groundwater under any circumstance.
- Find an area that not only has abundant ore but also consider the quality of the product and the difficulty to properly take it out of the ground. Hiring an expert for this phase to ensure the data is accurate is important in this phase so that proper risk analyses can be made.
- If drilling or pilot-scale quarrying took place, consult photographs and notes to restore the area exactly how it once was.
- Create a risk analysis chart and determine if the area is economically viable taking into account the substantial costs and time needed if the area is protected by law such as the Act on Wilderness Reserves (1991).
- Keep local people informed on a monthly basis on what is being found in the exploration phase.

3. Compliance with the law

Figure 7 demonstrates that the Mining Act is the only section where there is disagreement amongst the stakeholders included in this study. Some feel that the Mining Act is confusing and others really like how it is written. Therefore it was imperative to bring out the most essential points within the act to help companies determine what exactly is required. The sub-points are presented below:

- It is essential to note that not all extraction companies are required to adhere to The Mining Act. Granite and schist companies must follow the Land Extraction Act while soapstone and marble companies for the Mining Act.
- Under Section 9 of the Mining Act (2011), an exploration permit is required in almost all circumstances. It is recommended all prospectors apply for an exploration permit

because that area is theirs to explore (typically for 3-5 years). An exploration permit is sent to Tukes and once accepted, you are required to submit an annual update on the process (Mining Act, Section 14).

- If you choose to pursue the development of an actual mine, a mining permit is required through another application to Tukes.
- In almost all cases, an environmental permit is required pursuant to the Environmental Protection Act (2000). A water permit is required as well and is usually done at the same time. These applications are submitted to AVI. An Environmental Impact Assessment must be completed pursuant to the Environmental Impact Assessment Act. The regional ELY centres will ensure that the EIA is adhered to or the permit will be removed (and the mine will be shut down until the issue is fixed). This is why it can be beneficial to conduct several EIA's throughout the lifespan of the mine.
- The local municipality will also need to be notified and typically an infrastructure permit is necessary from them according to the Land Use and Building Act. The mine must be accepted into the Local Master Plan. It is for this reason that having an influential local contact to help you from the beginning is useful.
- In cases involving the extraction of uranium or thorium, a chemical permit is required from the government. This application is also submitted to Tukes.
- In cases involving Sami Homeland or reindeer herding areas, Section 50 of the Mining Act is used and requires the company to consult the Sami people and reindeer herders and in no way damage their livelihood or culture.
- Each case is different and will likely require several more permits depending on the size of the mine and what mineral is being extracted. Be sure to read and understand the Mining Act (2011).
- The new Mining Act (2011) takes into account other key legislation applicable to mining activity such as the Environmental Protection Act (2000), the Nature Conservation Act (1996) and legislation applicable to the Sami Homeland, the Skolt area and the reindeer herding area. Reviewing and understanding them is important.

4. Community Engagement

Community engagement was the most raised issue by stakeholders in their interviews (Figure 7) while the literature also noted a growing trend that social sustainability is becoming increasingly essential for companies today due to better communications technology, the Internet, and globalization. The sub-points are presented below:

- Many of the recently published documents such as SAM, the Sustainable Action Plan, and the Mineral Strategy (see references section for full names and details) call for companies to better communicate and work with local communities. Since these will likely become the law, it is best to preemptively make a plan to execute this.
- While the Towards Sustainable Mining tool offers some suggestions, it does not go as far as the Canadian Cornerstone Standards Council tool that suggests creating benefits for host communities.
- Doing little things like improving drinking water, improving roads and infrastructure, and sponsoring local developments and community events make a large difference.

This will improve the company's image, bring in more investors, and spur positive media attention that will help increase sales and be free advertising.

- Include the community and especially Indigenous knowledge holders in every decision. This will ensure trust and reduce the risk of poor publicity. Have regular public meetings –it is a good time to explain that you are following this guidebook and are acting in good faith.
- Traffic and dust are large issues for local people – creating a good traffic plan to avoid busy areas is imperative.
- Waste stone and other material from the mine can sometimes be used by local businesses. Giving them this material saves you money and benefits them.
- Use your local contact to meet all stakeholders in the local area. Find out what is most important to them and help them in whatever way you can.
- Have good measurement indicators for waste and tailings, such as the new digital mine technology out of Sweden, and plan to make it readily available to the public.
- Include universities (and Tekes, VTT, SITRA, etc.) located close by whenever possible because they have access to new knowledge and new ideas that could save you time and money.
- Several mining and aggregate companies in Finland have noted that determining what the community needs most and spending the money to build it reduces negative stigmas attached to industry and immediately improves the company's image to local people.

5. Community Engagement Plan

Since the improvement of companies' community engagement strategies was the most important issue presented in both the literature review and stakeholder interviews, it was necessary to provide companies with a tool to help them improve. The steps are presented below:

- The Action Plan for Sustainable Extraction in Finland's 4th principle demands extraction companies to conduct active, diverse, and interactive dialogue with all stakeholder groups and the 5th principle calls for synergies to be created with local actors. The Bosch and Nguyen study (2012) is considered to be one of the most comprehensive community engagement plans available in systems thinking academic literature. It brings together all stakeholders and through an interactive workshop it identifies all of the issues and recommends a solution:

1) A stakeholder map must be created like the one on page "v" of the Introduction. Once some stakeholders have been invited, they will invite others, and so on. Remember to ask for help from your local contact to bring small business owners and others. Give all stakeholders a copy of this map.
2) You must explain your business in simple terminology in all necessary languages. Stakeholders will then write down their biggest issues.

3) As a large group, you will place the issues on the map. For instance, small business owners may worry about noise and traffic in front of their shops that will reduce the amount of customers.
4) As a large group, or breaking up into small groups, determine leverage points (areas within the system that make a big difference). For example, if many people determine traffic to be a large issue, then new roads and infrastructure would be a leverage point.
5) As you and the stakeholders work together, you will begin to see exactly what you have to do and offer to the community and what they will give you in return. For example if you create a road that avoids the city, the city may agree to take your waste and use it in local construction. These win-win situations will come up during this session and ensure trust and support from the community.
6) Create a master plan of what will be done – each stakeholder will have a role.
7) No model will ever be perfectly correct so having another meeting annually or biannually is a good idea to repeat the process and improve it.

- Consider hiring a professional to facilitate the meeting.

6. Biodiversity and Conservation

While the emphasis of the literature review may seem to be focused on the social aspect of sustainability, there are many sections that reference the integral need to protect biodiversity. Stakeholders presented extremely thoughtful techniques in their interviews that must be shared with others in order to protect the natural environment in the future. These sub-points along with the important concepts from the literature review are presented below:

- Conduct several Environmental Impact Assessments throughout the life of the mine as many things change over short periods. Doing EIAs regularly can significantly reduce the risk of leaks and environmental disasters.
- It is important to consider the larger ecosystem of the area around the proposed mine. For example, the development of a small area could shift the migration pattern of reindeer enough that they have to travel through wetlands, which causes lots of issues and could prevent them from reaching their breeding grounds.
- When roads/railways/transmission lines are necessary, having a throughway or overpasses for animals such as a bridge over a stream or large patch of land reduces road-kill, makes the roads safer, and ensures animals can migrate freely. Work with local authorities to make the best possible transit infrastructure.
- The Nature Conservation Act (2000) aims to conserve the beauty and scenic value of the environment as well as maintain natural diversity. Generally speaking, areas like shorelines and wetlands have the most biodiversity and also the most natural beauty.
- Work with local and Indigenous people, NGOs, and government to identify and protect the ecological areas that are most naturally diverse or hold intrinsic value to local people. Promise to keep these areas off limits to industrial activity and to help ensure its continued protection.
- Noise and dust are large issues. Wherever possible, have dust collectors inside the mine or quarry and avoid using explosives unless it is essential.

- Avoid disturbing areas where some species are endangered or where the site is very vulnerable to change. For example a small amount of emissions can travel within the food chain and through bio-magnification it can kill larger animals of prey.
- Some plants can be very useful to help with pollution. For example, some plants like to grow in areas with high iron. Attempt to match plants with the pollution in your mine so that the plants begin the remediation process while the mine is in operation.
- Use native plants as much as possible and create buffer zones around the mine. In reindeer areas, work with local reindeer herders to help prevent reindeer from coming into the mine. Consider that buffer zones are also important around tourist areas such as ski hills.
- Even in the early phases, continue to take photographs and note all of the flora and fauna present. This will make the remediation process much cheaper and more effective. Consult local NGOs such as FANC and universities for help determining native species or vulnerable areas. This will improve your image and ensure that NGOs will not scrutinize you in the media
- The TSM standard suggests to research on the biodiversity regularly and take measurements to ensure that it is not being permanently affected. Consider the issues mentioned in this guidebook and take regular measurements.
- A good Environmental Impact Assessment (EIA) can help reduce the risks of an environmental disaster. While many companies hire a consultancy such as Ramboll or even GTK, it is important to understand what issues are important and what actions are crucial. The Ministry of Employment and Economy's EIA guide from 2013 is a good place to begin as it is free and available online.

7. Water and Tailings/ Water and Explosives

Water management is particularly important to the mining industry in Finland because the wastewater expelled from the mine is tightly regulated. However, since the Talvivaara gypsum pond leakage, many concerns have been raised. Stakeholders in their interviews were clearly interested in improving water management strategies but stakeholders in natural stone and aggregates were quite clear that water was not an issue and they were more interested in the improvement of the usage of explosives. Ideas and solutions to both issues are presented in the sub-points below:

- For a mine, many of the potential environmental come from wastewater or tailings leaks and overflows. Having a good water plan in place from the beginning reduces these risks.
- The plan must take into consideration that climate change is occurring and therefore it is imperative to reduce the harm caused by floods and droughts. Prepare for these situations and have a plan to reduce the risks and potential for disaster.
- Most importantly, working with Tekes, VTT, GTK, SITRA, universities and others to develop site-specific technology to cycle and reuse the water will prevent most issues from occurring. It will also tremendously reduce the amount of freshwater needed.

Spending a little more to have the most up to date technology will help reduce risk and save money over time.

- Choosing an area on a hill or with good drainage will reduce the amount of water entering the mine. Having barriers and flow paths will help ensure water from outside will not get into the mine. If extra water comes in, it can create overflows and contaminate with the tailings ponds and waste. This has happened to several mines recently in Finland but simply by putting up barriers, this has improved substantially.
- Understand the exact effect of all chemicals, heavy metal pollutants, minerals, toxins, and all substances that are being released from the mine. For example, if arsenic gets released into the river and 20 kilometres away it reaches another river where local people rely on fish, this will lead to environmental damages that may result in lawsuits, a negative effect on the company's image, and the potential loss of investors and shareholders. Just because the contaminants leave the mining area does not mean they are no longer your responsibility anymore. Under the polluter pays principle, you will be forced to pay all people affected by the contamination.
- Earlier steps suggested looking at the geological area, the water cycle, the bedrock durability, and seismic activity. These steps are crucial in determining where the tailings ponds should be located. Consider the type of bedrock, ensure there are no leaks, and make sure that the area chosen can withstand the pH level and other contaminants.
- Understand the exact effect of all heavy metal pollutants, minerals, toxins, and all substances being released from the quarry. For example, if explosives are used then iron is typically released. If it gets into the river and 20 kilometres away it reaches another river where local people rely on fish, this will lead to environmental damages that may result in lawsuits, a negative effect on the company's image, and the potential loss of investors and shareholders. Just because the contaminants leave the quarry area does not mean they are no longer your responsibility anymore. Under the polluter pays principle, you will be forced to pay all people affected by the contamination.
- Only blast when it is necessary and consider using new technology such as diamond wire saws and chemical stone cutters. If blasting, use the minimum amount of explosive material and use micro-sequential detonation or other techniques to reduce vibrations.

8. Health, Safety, and Education

There is little talk of workers and their general well-being in the literature but their importance cannot be overlooked. The Mining Act (2011) designates two large chapters on worker health and safety, which leave no choice but for industry to adapt and improve because failure to do so would be a breach of law. Several convincing arguments by stakeholders for improving worker health and safety leave no doubt that a short principle is necessary. Furthermore, a group of stakeholders state that improving sustainability education is essential in order to create a culture of sustainability so that it is not seen as a burden and rather a necessity. The sub-points are presented below:

- There are many guidebooks and protocols for health and safety in the mining industry and Chapters 12 and 13 (Sections 113-118 in particular) of the Mining Act (2011) outline the requirements. For example, there must be an internal rescue plan for the mine, there must be a person that is designated the job of mine safety, and all elements of danger and threats of accident must be stated and explained to all workers and affected parties.
- Dust collectors and containment tools inside the mine rather than outside significantly reduce health and safety issues and improve the well-being of workers and the surrounding community.
- Making sure that workers are acutely aware of all threats and have the proper training for their position is essential.
- From a social sustainability perspective, taking good care of workers through measures like making sure they and their families are well fed, well rested, and are in good health will improve the work culture. If workers are well taken care of, they will work harder and therefore create a positive working environment.
- Create a culture of sustainability. Before the mine opens, have a plan in place to support workers and their family. Educate them on the importance of sustainability. For example, creating less waste ensures less waste goes into the water that goes through nearly communities.
- Hire as many local workers as possible. Work with the community to help it grow. Workers, in turn, will work harder because they will feel a sense of community and achievement when going to work.
- Adding a games room, offering movie nights, and other little additions that could be voted on by workers helps keep everyone happy.
- Creating a work environment that is low stress where workers feel like they are making a difference will improve the quality and output of the mine. Keeping them energized and happy will reduce turnover rates and improve the overall image of the company.

9. Energy and Efficiency

The literature review does not speak of energy efficiency directly but there is a definite dialogue for increasing efficiency and reducing waste. Stakeholders do not consider energy and efficiency a primary issue but nevertheless the new Climate Change Act (2015) leaves no choice for extraction companies to reduce emissions and lower consumption and waste. Several stakeholders provide useful suggestions and they are combined with the important points from the literature review in the sub-points below:

- The Climate Change Act (2015) sets forth a greenhouse gas emissions reduction target of at least 80% by 2050 compared to 1990 levels. The extraction industry will be targeted as an area where big reductions can happen. Preparing for this now will reduce the surprise of mandatory reductions later.
- With recent tax increases for energy applied to mines and quarries, consider the benefit of using wind and solar energy in areas of the mine that are unable to be used for extraction. Electricity costs can be reduced dramatically.

- Conduct regular efficiency tests of machinery. Finding and repairing little parts that are not working at 100% can make the whole system much more efficient.
- Work with the government to make use of incentives for recycling and using green energy.
- Use VTT, Tekes, universities and others to find the right machinery for the specific project. Many new technologies are coming forward that can give you a competitive advantage and reduce energy consumption.
- Create a recycling plan with the local municipality. In some cases the waste from the mine can be useful to small businesses. Making these relationships benefits both the mine and the community.
- Conduct regular audits of utility bills. Switching to more environmentally light bulbs, more efficient heating and ventilation systems, and using solar and wind energy are an expensive initial cost but over a 5-10 year period they will save you a lot of money.

10. Review, Plan, Initiate, Evaluate, Repeat

The final principle in this research is based off the idea presented by Bosch and Nguyen (2012) in the literature review that nothing is ever perfect and improvements can always be made. A small number of stakeholders echo this sentiment and call for systems thinking in mines and quarries to analyze the specific areas that can be improved that are lowering performance. The sub points are presented below:

- This paper has a lot of suggestions and doing all of them will be difficult. You must recognize that achieving all of the suggestions may not be possible, but it is essential to strive to be better year after year.
- Consider the future in every decision and determine potential "what ifs" and try to eliminate them.
- Work backwards from what you think is an ideal mine and make short-term goals to get there.
- Make decisions based off of good measurements and always prepare for the unknown.
- It is better to be over-prepared than underprepared. Consider the worst-case scenario of being over-prepared: you will lose a bit of money. However the worst-case scenario of being underprepared is an environmental disaster, leaking, or accidents that could lead to financial liability and/or closure of the mine.
- Every year, systematically review the whole business. Engage stakeholders and local people in particular to ask how you can improve. Working closely with stakeholders and maintaining a good relationship will open up many opportunities.
- Plan to improve the weak links, make the improvements, evaluate the effectiveness, and repeat the process on a new area.

8. DISCUSSION

This section will discuss the reliability and validity of the ten themes presented in the Results section (Section 7.2) as well as the implications the themes have in the greater context of sustainability. An analysis of the study from a philosophically pragmatic perspective is also presented to determine if the research adds something to world, or in other words, makes the world better.

8.1 Implications to sustainability

This study clearly defined sustainability for the purpose of the research in the Background (Section 2.1) to be seen through a more basic philosophical lens championed by John Rawls. Rawls uses his Original Position, whereby institutions and "the basic structure of society" should do everything in their power to ensure that all decisions are made to benefit the least advantaged peoples in society (Rawls, 1999; Richardson, n.d.). In his "Just Savings Principle", Rawls theorized that the current generation owes the next generation at least the social minimum at the time. Rawls continues to say that if we continue to exploit the well-being of future generations, all we are doing is creating a larger proportion of least-advantaged groups. This creates a larger burden on society as a whole.

The ten themes, or areas of improvement, that have been uncovered in this study are described by Bosch and Nguyen in their 2012 study as leverage points (see Section 4.6 for a summary of their study). Bosch and Nguyen brought together all stakeholders in a defined area, in their case the island of Cat Ba in Vietnam, and asked everyone to write down the major issues on the island that contribute to a lower quality of life for them or future generations. Waste and contamination, unsafe drinking water, loss of identity and culture, and excessive tourism were examples of what people wrote down. Though there were some limitations (Section 3.2) such as a lack of funding and the author's inability to speak the Finnish language, this study attempted to follow a similar path by reaching out to as many stakeholders in Finland's non-energy extractive industry as possible. They were asked to express the biggest sustainability concerns within the non-energy extractive industry from their perspective. The findings, such as the need for improved community engagement plans and water plans, are important for the sustainability landscape because they present the unique perspectives of a variety of different stakeholders on what sustainability means and looks like

After each stakeholder highlighted their concerns, Bosch and Nguyen facilitated a workshop that put all of the themes together. From there, all stakeholders worked together to make linkages between the issues. Several themes emerged as leverage points, or areas that linked to many other concerns. These leverage points were agreed upon by all of the stakeholders (Bosch & Nguyen, 2012). A similar but less hands-on approach was done in this study through the Analysis (Section 6) and Results (Section 7). Though perhaps not as reliable and valid due to a less encompassing group of stakeholders, which is discussed below, this study looked for overlaps within the literature review and the stakeholder interviews. The analysis considered points of emphasis in the interviews where the stakeholders were extremely passionate. To ensure as much inclusion and validity as possible, 10 leverage points/themes were highlighted

and given to all stakeholders to review. A series of consultations (meetings, phone calls, emails, etc.) ensued until every stakeholder was satisfied with the results.

The overall implication of this study to the sustainability community as a whole is that it provides valuable insights from an esteemed group of stakeholders combined with an extensive literature review. The ten themes represent an opportunity for the Finnish non-energy extractive industry to become more aware of these themes and implement them into their operations. Because the study was inclusive by nature, it has already been placed into the hands of many decision makers, meaning that positive change could already be afoot. The subsequent section hones in on two areas that this study would declare the most crucial themes/leverage points.

8.2 Two areas of emphasis in need of immediate improvements

Section 8.1 explains that 10 themes were created after the literature review and the stakeholder interviews. While all of them are unique and powerful on their own, two themes were clearly identifiable as the most crucial leverage points. Figure 7, a graph showing the amount of interviewees that raised a certain issue, demonstrates that community engagement was unanimously brought up as an area in desperate need of improvement. The literature also highlights social sustainability and communication as crucial to the success of a company in today's day and age where media and information is at our fingertips. Strong communication can reduce many of the other themes like biodiversity protection because local people have the best knowledge of their land and can help the company avoid particularly diverse or delicate ecosystems. As explained by Eerola et al. (2015), many mining companies are aware that they provide a lot of financial benefits to the communities such as jobs and more visitors, but that does not mean that they are exempt from communicating their intents and operations. Good communication can reduce risks, create a positive social license to operate, and in some cases promote win-win and mutually beneficial opportunities.

While every interviewee did not raise exploration, the vast majority presented it as an issue that commonly gets overlooked. The literature is divided on the issue in the sense that many do not mention it but the ones that do, namely the Finnish Ministry of Trade and Industry's 2007 research on "Exploration and mining in Finland's protected areas, the Sami Homeland and the reindeer herding area", make an incredibly compelling case that it is the most essential issue of sustainability. One interviewee, Tapani Jarvinen, eloquently describes the need to create a culture of sustainability from the very beginning. By conducting an in-depth survey of the area to determine the best spot for the mine or quarry, the company can reduce many environmental and social issues from the beginning. This, in turn, reduces risks and time/money. Exploration and choosing the right area is a leverage point because it directly connects and reduces the risks some of the other themes impose. For example, it decreases the potential of water issues by avoiding aquifers and situating the mine or quarry in an area where water can easily flow into it and be contaminated. If there were to be two themes that this research would highlight for mines and quarries, it would be exploration and communication.

8.3 Reliability and validity: Discussion of results

This research draws on a sizable amount of peer-reviewed literature, where each article has been substantially cited. The articles come from recognized journals, which lends some form of reliability for the stringent protocols that they have internally for acceptance. The other publications come from recognized sources in Finland, such as federal departments like the Ministry of Employment and Economy, or the Geological Survey of Finland. Something is considered to be reliable if it produces similar results under consistent conditions; because of the quality of the literature chosen, the findings presented are quite reliable. The reliability of the interviews are a bit more difficult to determine as each person is entitled to their own opinion and they have right to freely change it. Every attempt was made to keep the interviews as reliable as possible by asking all stakeholders the same set of questions and leaving the conversation open so that interviewer biases were reduced. However, 20 interviews were conducted due to a variety of limitations (Section 3.2) and this is not an adequate sample size for the non-energy extractive industry as a whole. With this being said, the 20 interviewees were chosen for their immense knowledge in the industry and Figure 5 shows that there is a diverse set of backgrounds represented including industry, science, Indigenous Peoples, and non-governmental organizations. To name a few, the interviewees include CEOs of mining companies, the Executive Director of the Finnish Mining Association, the Chief Inspector of Mines in Finland, and the Executive Director of Finnish Reindeer Herder's Association.

While their titles and extensive experience cannot completely compensate for a sample size that is not statistically valid, the interviewees were given several opportunities to review their interviews and make changes. They also provided extensive feedback on the 10 themes through meetings, phone calls, and emails; this helps add to the validity of the results. Finally, overlapping the literature review with the interviews created the 10 themes. The fact that they were able to match and create 10 common themes in the Analysis section (Section 6), improves the validity as well. The extensiveness of the literature review and the quality of the literature used helps improve the reliability and validity of the study but the reality is that participatory research is difficult to quantify under these typical scientific measurements. Section 8.5 presents a pragmatic analysis of the study, which is arguably a better standard for which to analyze the quality and usefulness of the research. Furthermore, the 10 themes are nothing radical in terms of sustainability literature, meaning that there is no harm in seeking to improve them to make a positive difference. There most certainly needs to be more research on this topic that brings together a larger sample group; this research provides a strong foundation and roadmap for what can be done and the power that this type of research can have.

8.4 Responding to the purpose and research questions

Section 8.3 discusses the reliability and validity of the research, which helps determine its effectiveness at answering the two research questions defined in the purpose (Section 1.2). The first question asks, "What kinds of best practices or guidelines are there in the regulations and literature concerning sustainability in Finland's non-energy extractive industry?" As Section 8.3 clearly demonstrates, the literature review's depth and quality of the publications used help ensure its reliability. The literature review provides a list of publications since 2007

related to sustainability and the extractive industry. Throughout the interviews, the experts and stakeholders in the field provided other publications and these were added as well. Furthermore, since Finland is working on creating its own sustainable mining tool using Canada's Towards Sustainable Mining framework, this was also included. The literature review was improved by the addition of extensively peer-reviewed publications that look at sustainability in the extractive industry internationally. The depth of the literature review helps answer the first research question with a high degree of reliability and validity.

The second research question asks, "According to experts and stakeholders in Finland, what are the major issues and actions that need to be taken to improve the sustainability of Finland's non-energy extractive industry?" This question was answered through interviews with a wide array of experts and stakeholders. Section 8.3 clearly indicates that there is not a large enough sample size to conduct statistically valid tests, however an impressive group of stakeholders and experts were consulted. Their titles and positions leave no debate that they are incredibly knowledgeable and this helps improve the reliability of the information they gave. The fact that all interviewees, through open and unbiased conversations, answered the same questions helps answer the research question effectively. More research must be done to respond to the limitations of this study (Section 3.2), however the fact that 20 experts and stakeholders were consulted should make the reader feel satisfied that the research question was answered and that the 10 issues they helped uncover are worth improving on.

The purpose of this research was to uncover the central issues that the Finnish non-energy extractive industry must improve on to become more environmentally, socially, and economically sustainable. By combining the answers to the two research questions, this was done. Section 8.3 notes that many of the same issues were raised in the literature review and the stakeholder/expert interviews. This adds to the reliability of this research and these 10 issues are clearly areas that non-energy extraction companies should consider more thoroughly. As Section 8.3 notes, there are no repercussions to trying to improve on any of the issues highlighted in this research, which will hopefully help make this research incredibly useful and valuable to readers and decision makers.

8.5 A pragmatic analysis of the study

The pragmatist approach can be traced back to philosophers from the 20th century such as Charles Peirce and John Dewey but more recently Richard Rorty is considered as a pioneer of "new pragmatism" in the 21st century (Freeman et al., 2010). Rorty states that pragmatists will ask the practical question: "Are our ways of describing things, of relating them to other things as to make them fulfill our needs more adequately, as good as possible? Or can we do better? Can our future be made better than our present?" (Rorty, 1999: p.72). In other words, when we as academics do research, can we do it in a fashion that will make the world better? We must strive to do better and make a greater impact in order to make the world a better place.

While Rorty's work is more philosophical and speaks to the ethics of a researcher, it does not outline a path of how this can be done in practice (Freeman, 1999; Freeman et al., 2010). The

work of Michael Gonin (2007) is quite useful in this regard because it clearly emphasises eight questions that can help guide the researcher in their pragmatic research:

1. Does this work answer the question it proposes?
2. Was the question meaningful and appropriate?
3. Are there alternative modes of research that could lend insight into the question?
4. What are the direct consequences of this research?
5. If we teach this insight to managers and students, what might be the result if they act on it?
6. What is the background narrative of this research?
7. How will we begin to see ourselves and others if we act on this work?
8. How will this work shape the context in which value creation and trade takes place?

Michael Gonin states that researchers should answer the above eight questions about their research. The idea behind the questions is that if they cannot be answered, then on a pragmatic level, the research does not make society better. The questions are presented and answered below:

1. Does this work answer the question it proposes?

Yes. The purpose of the study was to uncover the central issues that are hampering the extractive industry from becoming more sustainable. This question is answered in two ways: a literature review and stakeholder interviews. The results of these two forms of research were compared and compiled in 10 themes that demonstrate where extractive companies can improve. Both the literature review and stakeholder interactions clearly demonstrate that the two most important issues in the Finnish extractive industry is that there is no thought given to sustainability in the exploration phase and that companies have lost the trust of their stakeholders and therefore community engagement strategies are essential to return this trust. This research answers the question and uses two drastically different forms of research to do so, thus improving the reliability of the study.

2. Was the question meaningful and appropriate?

Yes. The question comes in direct response to the Finnish extractive industry being seen as the "villain" in the movement to mitigate climate change after incidents such as the Talvivaara Mining Co's gypsum pond leakage in 2012. The non-energy extractive industry provides metals and minerals that are essential to human life but its dirty image has affected its ability to develop in a sustainable fashion. The question helps to understand the central issues hampering the industry from becoming more sustainable so that they have the information they need to make positive change and improve their image.

3. Are there alternative modes of research that could lend insight into the question?

Yes. This question was the reason that not just one but two drastically different research approaches were taken. A literature review could not have uncovered the insights of the stakeholders during their interviews because their suggestions come from years of experience. However, the literature review was useful in showing the important papers on sustainability for the extractive industry in Finland and to present other tools that have already been created.

Other modes of research such as questionnaires and surveys could have been used but they lack the ability to determine what areas the respondent is most passionate about. The inclusive research model used by Bosch & Nguyen (2012) to bring all stakeholders together in a workshop to uncover the issues and create a plan for improvement together is a forward thinking idea that this research recommends as a next step for mine and quarry companies.

4. What are the direct consequences of this research?

10 themes were created in response to the issues uncovered in the research. They provide suggestions for a non-energy extractive industry in Finland on how to improve sustainability in a wide variety of areas. The fact that important stakeholders were included and given an important say in the research from the beginning has created an opportunity for the 10 themes to reach a large audience with a high level of credibility. It is hoped that because of this, many companies will begin to institute as many of the suggestions as possible because it will create a more environmentally, socially, and economically sustainable industry.

5. If we teach this insight to managers and students, what might be the result if they act on it?

The guidebooks were created to present convincing arguments for sustainability that decision makers cannot ignore through simple language and a visually appealing presentation. Because of the breadth of the research, if a company would be able to complete all 10 themes, they would be one of the most forward thinking and sustainable companies in Finland and throughout the world. The themes demonstrate many ways that money can be saved while making the world a better place.

6. What is the background narrative of this research?

The need for sustainability and the mitigation of climate change is one of the most important issues of our time. The science is clear that direct action must be taken to slow down global warming or we risk making irreversible damage to our planet. Every industry must improve their ways, and collaboration is imperative.

7. How will we begin to see ourselves and others if we act on this work?

Acting sustainably today will ensure that our children and grandchildren will be able to appreciate and see the natural world like we do. We will begin to see ourselves as contributors to a healthier planet and responsible citizens while making a profit and providing for our families. Decision makers can use the 10 themes to shape plans and the direction of their organization, and it will be their children and grandchildren that will stand the most to benefit.

8. How will this work shape the context in which value creation and trade takes place?

As mentioned previously, the 10 themes that are presented in easy to read guidebooks demonstrate how instituting them can save money. Furthermore, a move to a more sustainability oriented industry will improve its image and open up opportunities for more partners and investors that will increase trade and make Finland an international leader in sustainability for the non-energy extractive industry.

The questions can be answered confidently and succinctly, meaning that this paper will hopefully have a practical use and help make the Finnish non-energy extractive industry more

sustainable. This research has uncovered many important issues that are affecting the non-energy extractive industry in Finland and they are likely not what many people would have expected. Exploration and community engagement are potentially not the first things that a person would think would be the primary issues plaguing the industry but this research shows that if these are done well, everything else (like the biodiversity conservation and water management themes) becomes much easier to achieve.

9. CONCLUSIONS AND ADDITIONS TO THE SUSTAINABILITY FIELD

If you as the reader were to take away one thing from this study, it is my hope that you would read Section 8.2 on the two leverage points that are most prevalent in this study. The study was conducted in a fashion that attempted to merge scientific research with participatory, qualitative research. This was conducted by means of a thorough and extensive literature review that used extensively peer-reviewed and cited publications combined with an ambitious stakeholder interaction component through interviews and collaboration. The combination of these two approaches yielded 10 themes that were created where there was significant overlap. Of those 10 themes, two can be described as crucial leverage points because they impact all of the others. Exploration, or more specifically, choosing the right spot for extraction is crucial. By choosing the right spot with the help of local community members and knowledge holders in the area, the company can maximize profits while reducing risks. For example, water risks can be mitigated by not mining in a valley where the water can flow in and be contaminated. Communication with the stakeholders is also essential. Communication builds trust, can create win-win situations, and reduce the potential of negative media and a loss of investors. Communication can help identify important environmental and cultural areas within the community, thereby avoiding the potential of disaster.

There is an immense need for more research to be conducted so that communities, Indigenous Peoples, industry, scientists, non-governmental organizations, and others can work together to solve the sustainability problem effectively. This research has uncovered some of the major issues plaguing the non-energy extractive industry in Finland but there are certainly many more issues. Furthermore, this research highlights the issues and while it makes some suggestions, more research must be conducted in each and every situation to create a site-specific plan of action. This research can help guide the industry as a whole through the first steps of how to uncover the issues through an inclusive approach. From there, a plan can be made that benefits everyone, not just the company. A healthy and happy community provides a much better opportunity to create a profitable and socially conscious business.

9.1 Why create a guidebook?

There is an incredible amount of academic literature on climate change but there is still quite a gap in getting this information into the hands of decision makers. The most crucial and recent document is the International Panel on Climate Change (IPCC) research and it was approximately 1200 pages (IPCC, 2013). Even people that are interested and passionate about the subject would have trouble reading the research. The IPCC recognized this and made a short summary that they called a “Summary for Policy Makers” (IPCC, 2013). It is time that academia begins to publish simple and engaging literature or tools based on this literature that is given directly to decision makers so that real change can be initiated and realized.

In the context of this research, Dr. Jussi Leveinen from Aalto University stated in his interview that a guide must be created to get this information into the hands of decision makers. He said it must be short and focus on the essentials and Toni Eerola and Pekka Nurmi

from the Geological Survey of Finland echoed his sentiments. Markus Ekberg, CEO of Endomines, was very convincing when he said the guidebook must be short or no one will read it. Riikka Aaltonen and Maiia Uusisiuo, of the Ministry of Employment and the Economy, suggested a checklist or a point form document and others asked for pictures and diagrams showing why certain points were necessary. These are some samples coming from interviews with many of the most influential people in Finland's non-energy extractive industry, and most called for short, simple, and visually appealing information. Therefore, the Results Section 7.2 was transcribed into a guidebook and pictures and diagrams were added to make it visually appealing.

Interestingly, all of the stakeholders in the natural stone or aggregate extraction industry were adamant that they did not want to be grouped with mining companies because it would taint their image. Pekka Jauhiainen, the CEO of the Finnish Natural Stone Association, and Eija Ehrukainen, the Director of Sustainability at INFRA (oversight committee for aggregate committees), were extremely passionate about this. Because of the differences of the two industries, two guidebooks were created that have subtle differences.

One of the most intuitive points came from Tomi Gutzen, who is a risk assessment specialist in the extractive industry, when he said that the themes/issues must be able to stand alone as individual points. He said this because if the guidebook was in the form of a story and the company for whatever reason is unable to complete the first point, then they cannot do any of the others. Therefore the principles must be presented individually and make no reference to each other. Each issue presented in the guidebooks reflects this and can stand alone.

The guidebooks are presented in the Appendices section for the reasons expressed above. They provide a visually appealing accumulation of all of the work that was put into this study. They present the exact same information in the Results Section 7.2 but in a way that will hopefully inspire decision makers to at consider mitigating these issues. Special emphasis should be placed on the two most crucial themes, called leverage points, which are communication/engagement and exploration (more specifically choosing the site more effectively). It is hoped that the guidebooks will be distributed to as many stakeholders as possible in order to effect positive environmental, social, and economic change. All of the stakeholders involved in this research from the beginning have allowed their names to be included on the guidebooks and have offered to help distribute them to all of their contacts.

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APPENDIX 1: Sustainability in extraction: A mining guidebook

Sustainability in Mining

A guideline for implementing sustainability in the preliminary planning phases for extraction companies

2015

Introduction

Sustainability is a complex social, environmental, cultural, and economic issue. This guidebook will help you plan a mine from the very beginning phases to be sustainable in all of these categories. This should be used not only for all mines but also smaller satellite mines and aggregate or natural stone quarries. The guidebook has been created through interviews with many leaders in mining in Finland within government and non-governmental organizations, industry, science and education. They highlight the need for an easy to read document that is short (unlike long Environmental Impact Assessments that have become the norm) and brought together all of the required information in simple wording that anyone can understand. This guidebook fills that need.

This guidebook will help mining companies create a culture of sustainability starting before the exploration phase. Its 10 principles are simple to follow and will create better partnerships and increase communication with the local community, improve the company's image, lower utilities costs, and exponentially reduce the potential for risk in the future.

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Primary Author

Kieran Hooey

kieran.hoooey@aalto.fi

MSc candidate Aalto University School of Engineering

Please contact for questions, consultation and to request the full document. Facilitation and event planning services are also available

Methodology and purpose

This guidebook could not have been created without the help of these experts who contributed valuable information, offered access to their archives and gave a tremendous amount of time and resources. Thank you all for your time and support.

Riikka Aaltonen: Senior Advisor of Mineral Policy, ***TEM***
Eeva Ruokonen: Director of Sustainability, ***Talvivaara***
Tapani Järvinen: Board Member of several mines and former CEO of ***Outotec***
Sanna Hast: Land Use Management Advisor, ***Reindeer Herders Association***
Dr. Jussi Leveinen: Professor of Environmental/Geophysical Mining, ***Aalto University***
Anne Ollila: Executive Director, ***Reindeer Herders Association***
Pekka Jauhiainen: CEO, ***Finnish Natural Stone Association***
Dr. Mikael Rinne: Professor of Environmental Engineering, ***Aalto University***
Zhen Song: PhD candidate/Tailings expert, ***Aalto University***
Maria Palin: Communications Manager, ***Palin Granit Oy***

Maija Uusisuo: Development Officer, **TEM**
Dr. Sari Kauppi: PhD Researcher, ***SYKE***
Pekka Suomela: Director, ***Finnish Mining Association***
Markus Ekberg: CEO, ***Endomines***
Tomi Gutzen: Risk Assessment Specialist, ***Mining***
Dr. Olli Salmi: Lead Researcher, ***VTT***
Pekka Nurmi: Research Director, ***GTK***
Toni Eerola: Lead Researcher, ***GTK***
Eija Ehrukainen: Director of Sustainability, ***INFRA***
Heikki Palin: Managing Director, ***Palin Granit Oy***

Along with interviews with many experts in the extraction industry, an extensive literature review summarized information from environmental guidebooks, *The Mining Act (2011)* and other legislation, The Action Plan to Make Finland a Leader in Sustainable Extraction (2013), Finland's Minerals Strategy (2010) and other important references. This guidebook has taken the most essential parts from the literature and the suggestions from interviews in order to create a short guide to help extraction companies succeed from the first stage onwards. Since the interviews were open, the experts were allowed to be quite honest and tell exactly what they think industry needs from their perspective. Therefore the product is a guidebook on sustainability that has been created for the mining industry by the mining industry.

This guidebook will work alongside the tool being created by the Sustainable Mining Network that is being based on the Canadian Towards Sustainable Mining (TSM) criteria. This guidebook uses some of the TSM principles but the TSM has been critiqued in Canada and internationally so a groundbreaking community engagement tool and the first sustainability tool for aggregate extraction have been used to fill this void.

Primary References

An extensive literature review brought together all of the following essential Finnish environmental documents to make this guidebook:

2007: Ministry of Trade and Industry, Finland. "Exploration and Mining in Finland's Protected Areas, the Sami Homeland and the Reindeer Herding Area". Retrieved from https://www.tem.fi/files/18154/jul30teo_eng_20A4.pdf ***(Referred to in this guidebook as Exploration guide)***

2010: Geological Survey of Finland. Finland's Minerals Strategy. Retrieved from http://projects.gtk.fi/export/sites/projects/minerals_strategy/documents/FinlandsMineralsStrategy_2.pdf ***(Referred herein as Mineral strategy)***

2011: Ministry of Employment and the Economy, Finland. Mining Act. Issued in Helsinki June 21, 2011. Retrieved from http://www.finlex.fi/en/laki/kaannokset/2011/en20110621.pdf ***(Referred herein as Mining Act (2011))***

2013: Finnish Ministry of Employment and Economy. Making Finland a leader in the sustainable extractive industry – action plan. Retrieved from http://www.tem.fi/files/37130/TEMjul_22_2013_web_04072013.pdf ***(Referred herein as Sustainable Action plan)***

2013: Finnish Ministry of Employment and the Economy. Guide: Environmental Impact Assessment Procedure for mining projects in Finland. Retrieved from https://www.tem.fi/files/42872/New_guide_for_environmental_impact_assessment_procedure_for_mining_projects.pdf ***(Referred herein as EIA guide)***

2014: Fraboulet-Jussila, S. Finnish Network for Sustainable Mining. SITRA. https://tapahtumat.tekes.fi/uploads/37f0e529/Sylvie_Fraboulet_Jussila-6647.pdf ***(Referred herein as Network for Sustainable Mining)***

2015: VTT. SAM – Sustainable Acceptable Mining. Retrieved from http://virtual.vtt.fi/virtual/sam/english.htm ***(Referred herein as SAM)***

The Sustainable Mining Network came out of action proposals #6 and #14 of the Sustainable Action Plan to create a guidebook and a better way for stakeholders to communicate. It uses the Towards Sustainable Mining (TSM) tool from Canada as a base to help create something comparable in Finland. ***While the Sustainable Mining Network, led by Sitra and The Finnish Mining Association, work on creating a comprehensive tool, a guidebook needed to be created in the meantime. This guidebook will complement their finalized tool because it is short and gets the facts to people quickly while their tool will be more comprehensive and in-depth and will be targeted directly to the user (industry).***

This guidebook uses the TSM tool as a reference and also uses the Responsible Aggregate Standard from the Cornerstone Standards Council in Canada, which is the first sustainable aggregate standard in the world and is being hailed by environmental activists and industry alike. Finally, community engagement plans and strategies are difficult to create and understand so this guidebook relies on the work of Dr. Ockie Bosch and Nam Nguyen because they are widely known in the academic community as leaders and visionaries in systems thinking and engagement strategies.

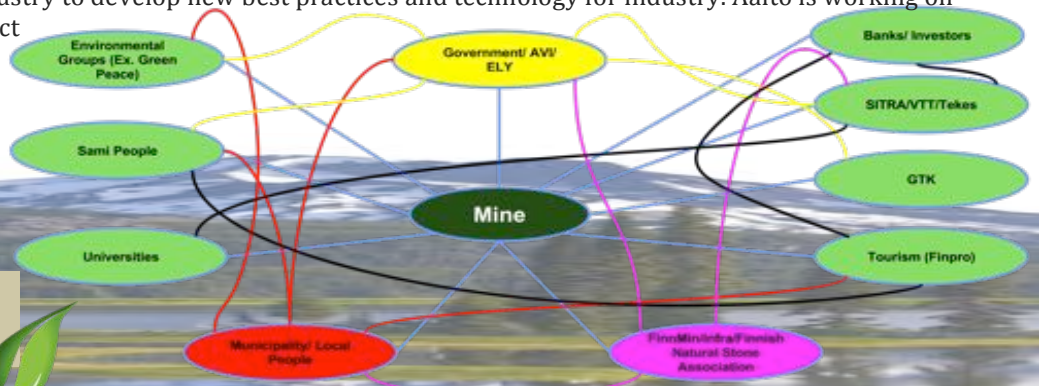
Cornerstone Standards Council. (2015). Responsible Aggregate Standard. Retrieved from http://www.cornerstonestandards.ca/wp-content/uploads/2015/03/APPROVED_Responsible-Aggregate-Standard_Version3.pdf ***(Referred herein as CSC Standard)***

Mining Association of Canada. 2015. Towards Sustainable Mining. Retrieved from http://mining.ca/towards-sustainable-mining ***(Referred herein as TSM tool)***

Nguyen, N.C. & Bosch, O.J.H. (2012). A Systems Thinking Approach to identify Leverage Points for Sustainability: A Case Study in the Cat Ba Biosphere Reserve, Vietnam. Systems Research and Behavioral Science, 30, 104–115. ***(Referred herein as Bosch & Nguyen tool)***

Primary Stakeholders

- TEM: The Ministry of Employment and Economy (TEM) is an oversight government agency that is responsible for upholding The Mining Act (2011)
- Tukes: The Finnish Safety and Chemicals Agency (Tukes) is the mining authority granting mining permits outlined in the revised Mining act (2011) including exploration/prospecting permits, mining permits (allowed to mine for a fixed period), chemical permits (when necessary like for radioactive minerals), and explosives permits.
- AVI: The State Regional Administrative Agency (AVI) makes decisions on environmental permits and licenses pursuant to the Environmental Protection Act and the Water Act.
- ELY centres: The Centres for Economic Development, Transport and the Environment (ELY centres) are responsible for the regional implementation and development tasks of the central government & ensuring the environmental permit is followed.
- SYKE: Finnish Environment Institute (SYKE) is a government research agency that assists in environmental mining issues and they have created useful environmental guidebooks and data on groundwater investigations in mining
- Municipality: Local people must be contacted by law and have the possibility to voice their complaints. The municipality is also responsible for giving construction permits.
- Sami people: The Indigenous people of Finland, represented by Sami Parliament & Skolt Council. Considered in many laws including the Mining Act.
- Reindeer Herder's Association: Tasked with directing reindeer husbandry, developing and researching reindeer herding, and handling reindeer husbandry relations with the rest of society including the mining industry
- FinnMin: The Finnish Mining Association (FinnMin) ensures national and international political interests of mines where all mines in Finland are members and pay a yearly fee.
- INFRA: Involved with infrastructure around mines and also act as the membership association for aggregate extraction companies.
- Finnish Natural Stone Association: Membership association to ensure political interests of natural stone industry. All companies pay a small yearly fee.
- GTK: The Geological Survey of Finland (GTK) is a branch of government but can also be hired as consultants for geological and environmental surveys and impact assessments.
- SITRA: Government fund that has free realm to invest and create projects. Currently responsible for creating the Sustainable Mining Network along with FinnMin.
- Tekes: Funding authority for technology. They are currently investing and funding heavily in Green Mining.
- VTT: A specialized technology firm that receives funding from industry and Tekes. Currently working on SAM that looks to improve the social responsibility of mining companies.
- FANC and environmental non-governmental organizations: Finnish Association for Nature Conservation of Finland (FANC) is the biggest environmental NGO in Finland
- Tourism: Finpro (Visit Finland) promotes tourism and helps small and medium sized Finnish enterprises grow while also promoting foreign direct investment in Finland
- Universities: UEF, Helsinki, Aalto, Tampere, etc. receive Tekes funding and work with industry to develop new best practices and technology for industry. Aalto is working on mine tailings used in asphalt while the University of Helsinki is involved in the SAM project
- Banks and Funders: Nordea and other lenders help fund mining in Finland
- YM: Finnish Ministry of Environment



Stakeholder maps are a useful way to visualize the relationships between each party and help to find which entities are most influential.

1. Exploration

Many tools including the Canadian Towards Sustainable Mining (TSM) tool fail to mention the exploration phase. Doing this phase right can create a strong image from the beginning, create a good relationship with local people, and reduce the potential for risks in the future.

Much can be done before even going to the area:

- Make a local contact (a community leader, business owner, political activist, someone influential in the community). ***Show them this document and tell them you are willing to follow these steps in the guidebook to create a beneficial partnership for them and everyone in the community. This will ensure the local contact will believe you are committed to helping the community while being environmentally sustainable.***

- Conduct regional surveys without going to the site: GTK's Internet service is free and has maps showing ore-potential formations and structures, bedrock, soil, geochemical data, and regional gravity and elevation measurements. GTK also has samples at the National Drill Core Register.

- GTK can be hired as consultants during this phase and could provide valuable advice.

- SYKE has free groundwater quality data from HERTTA and the database POVET that must be reviewed. SKYE, in partnership with the Finnish Meteorological Institute, have a Flood Centre (Tulvakeskus) that provide useful information as well.

- Choosing the right area is essential. Special guidelines for Natura 2000 sites, Wilderness Reserves, classified aquifers, and the Reindeer Husbandry Act (that covers approximately 33% of the area of Finland) are outlined in The Mining Act (2011). Due to longer permit times, environmental impacts, and specific approval from the Government and the Sami Parliament and Skolt Council – ***it is highly recommended to not choose an area in these jurisdictions***.

- Consult the Reindeer Herder's Association for information on the migration path of reindeer. Consider that roads and infrastructure can affect these patterns and further endanger reindeer.

TIP: Having a local contact will help you gain trust and respect before doing anything at all. They will be more inclined to share their knowledge of the area and the core values of the people living there. For smaller mines, this can help you save money by not hiring professionals to conduct these reviews.

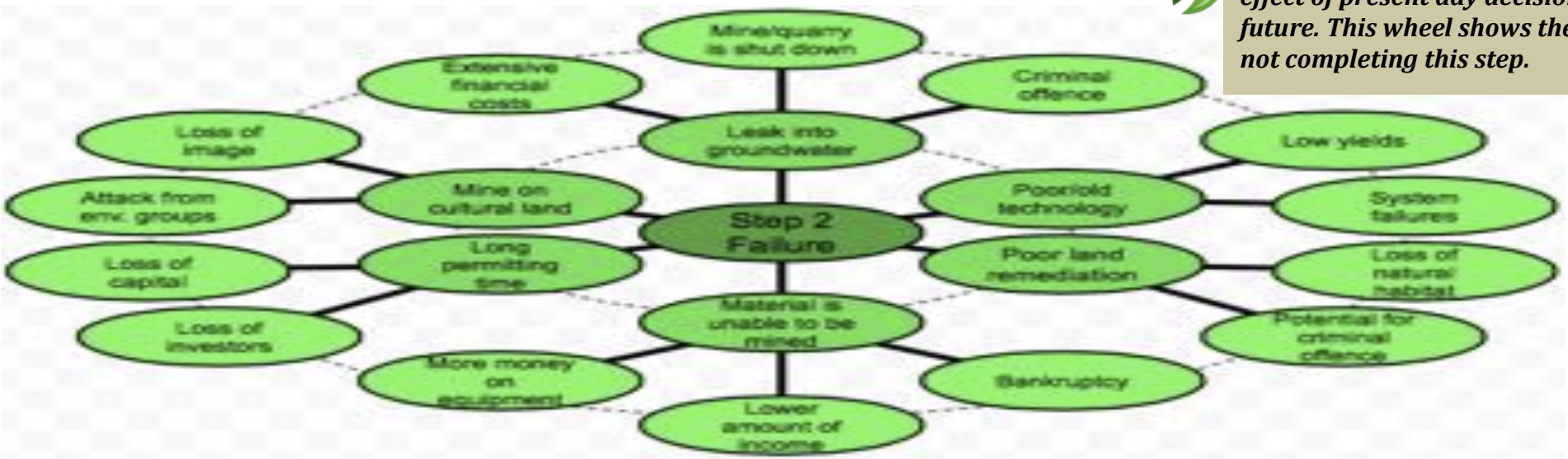
2. Siting the Area

TIP: Indigenous Traditional Knowledge and local people can help situate the mine in the spot most resilient to extreme weather conditions. Only people living in the area have seen how the land changes and adapts each and every year and can therefore predict what will happen better than experts in many cases.

In areas with no previous exploration, new information must be collected:

- Ask your local contact for advice on the area – such as how water flows, what plants grow in the summer, where the snow and ice forms, what areas have poor drainage, where the soil is weak, etc.
- If the proposed area is on Sami land, use their knowledge and understand the importance of that land to their culture. Involving local people in this phase helps them feel involved and needed, which will improve your relationship and image.
- Make notes and take photographs of all of the area, determining the position of all trees and plants, roads and water.
- Consult GTK, VTT, SITRA, universities, and other experts about the best available technology (such as till geochemical sampling with a percussion drill) for the specific material you are mining.
- With the environmental issues hampering mining companies in Finland in recent years, extensive tests to determine the best position for the mine considering the condition of the bedrock, the groundwater and hydrogeological cycle, and the seismic activity is essential to ensure the bedrock will not leak into the groundwater under any circumstance.
- Find an area that not only has abundant ore but also consider the quality of the product and the difficulty to properly take it out of the ground. Hiring an expert for this phase to ensure the data is accurate is important in this phase so that proper risk analyses can be made.
- If drilling or pilot-scale quarrying took place, consult photographs and notes to restore the area exactly how it once was.
- Create a risk analysis chart and determine if the area is economically viable taking into account the substantial costs and time needed if the area is protected by law such as the Act on Wilderness Reserves (1991).
- Keep local people informed on a monthly basis on what is being found in the exploration phase.

Futures wheels help visualize the effect of present day decisions of the future. This wheel shows the effects of not completing this step.



3. Compliance with the law

TIP: The new Mining Act (2011) takes account of other key legislation applicable to mining activity such as the Environmental Protection Act (2000), the Nature Conservation Act (1996) and legislation applicable to the Sami Homeland, the Skolt area and the reindeer herding area. While some of the effects of these acts have already been mentioned, reviewing and understanding them is important. Following the steps in this guidebook, specifically Step #6 on Biodiversity, will ensure these laws are adhered to.

- Under Section 9 of the Mining Act (2011), an exploration permit is required in almost all circumstances. It is recommended all prospectors apply for an exploration permit because that area is theirs to explore (typically for 3-5 years). An exploration permit is sent to Tukes and once accepted, you are required to submit an annual update on the process (Mining Act, Section 14).
- If you choose to pursue the development of an actual mine, a mining permit is required through another application to Tukes.

- In almost all cases, an environmental permit is required pursuant to the Environmental Protection Act (2000). A water permit is required as well and is usually done at the same time. These applications are submitted to AVI (see use of terms in the introduction). An Environmental Impact Assessment must be completed pursuant to the Environmental Impact Assessment Act. The regional ELY centres will ensure that the EIA is adhered to or the permit will be removed (and the mine will be shut down until the issue is fixed). This is why it can be beneficial to conduct several EIA's throughout the lifespan of the mine.
- The local municipality will also need to be notified and typically an infrastructure permit is necessary from them according to the Land Use and Building Act. The mine must be accepted into the Local Master Plan. It is for this reason that having an influential local contact to help you from the beginning is useful.
- In cases involving the extraction of uranium or thorium, a chemical permit is required from the government. This application is also submitted to Tukes.
- In cases involving Sami Homeland or reindeer herding areas, Section 50 of the Mining Act is used and requires the company to consult the Sami people and reindeer herders and in no way damage their livelihood or culture.
- Each case is different and will likely require several more permits depending on the size of the mine and what mineral is being extracted. Be sure to read and understand the Mining Act (2011).

4. Community Engagement

Many of the recently published documents such as SAM, the Sustainable Action Plan, and the Mineral Strategy (see references section for full names and details) call for companies to better communicate and work with local communities. Since these will likely become the law, it is best to preemptively make a plan to execute this:

- While the Towards Sustainable Mining tool offers some suggestions, it does not go as far as the Canadian Cornerstone Standards Council tool that suggests creating benefits for host communities.
- Doing little things like improving drinking water, improving roads and infrastructure, and sponsoring local developments and community events make a large difference. This will improve the company's image, bring in more investors, and spur positive media attention that will help increase sales and be free advertising.
- Include the community and especially Indigenous knowledge holders in every decision. This will ensure trust and reduce the risk of poor publicity. Have regular public meetings –it is a good time to explain that you are following this guidebook and are acting in good faith.
- Traffic and dust are large issues for local people – creating a good traffic plan to avoid busy areas is imperative.
- Waste stone and other material from the mine can sometimes be used by local businesses. Giving them this material saves you money and benefits them.
- Use your local contact to meet all stakeholders in the local area. Find out what is most important to them and help them in whatever way you can.
- Have good measurement indicators for waste and tailings, such as the new digital mine technology out of Sweden, and plan to make it readily available to the public.
- Include universities (and Tekes, VTT, SITRA, etc.) located close by whenever possible because they have access to new knowledge and new ideas that could save you time and money.

TIP: Several mining and aggregate companies in Finland have noted that determining what the community needs most and spending the money to build it reduces negative stigmas attached to industry and immediately improves the company's image to local people.

5. Community Engagement

The Action Plan for Sustainable Extraction in Finland's 4th principle demands extraction companies to conduct active, diverse, and interactive dialogue with all stakeholder groups and the 5th principle calls for synergies to be created with local actors. The Bosch and Nguyen tool (see references section) is considered to be the most comprehensive community engagement plan available in systems thinking academic literature. It brings together all stakeholders and through an interactive workshop it identifies all of the issues and recommends a solution:

1) A stakeholder map must be created like the one on page "v" of the Introduction. Once some stakeholders have been invited, they will invite others, and so on. Remember to ask for help from your local contact to bring small business owners and others. Give all stakeholders a copy of this map.
2) You must explain your business in simple terminology in all necessary languages. Stakeholders will then write down their biggest issues.
3) As a large group, you will place the issues on the map. For instance, small business owners may worry about noise and traffic in front of their shops that will reduce the amount of customers.
4) As a large group, or breaking up into small groups, determine leverage points (areas within the system that make a big difference). For example, if many people determine traffic to be a large issue, then new roads and infrastructure would be a leverage point.
5) As you and the stakeholders work together, you will begin to see exactly what you have to do and offer to the community and what they will give you in return. For example if you create a road that avoids the city, the city may agree to take your waste and use it in local construction. These win-win situations will come up during this session and ensure trust and support from the community.
6) Create a master plan of what will be done – each stakeholder will have a role.
7) No model will ever be perfectly correct so having another meeting annually or biannually is a good idea to repeat the process and improve it.

Consider hiring a professional to facilitate the meeting.

This futures wheel shows the effects of not completing Step 5. The inside circle represents short-term outcomes while the outside layer represents long-term and extreme outcomes.

6. Environment and Biodiversity

TIP: A good Environmental Impact Assessment (EIA) can help reduce the risks of an environmental disaster. While many companies hire a consultancy such as Ramboll or even GTK, it is important to understand what issues are important and what actions are crucial. The Ministry of Employment and Economy's EIA guide from 2013 is a good place to begin as it is free and available online.

- Conduct several Environmental Impact Assessments throughout the life of the mine as many things change over short periods. Doing EIAs regularly can significantly reduce the risk of leaks and environmental disasters.
- It is important to consider the larger ecosystem of the area around the proposed mine. For example, the development of a small area could shift the migration pattern of reindeer enough that they have to travel through wetlands, which causes lots of issues and could prevent them from reaching their breeding grounds.
- When roads/railways/transmission lines are necessary, having a throughway or overpasses for animals such as a bridge over a stream or large patch of land reduces road-kill, makes the roads safer, and ensures animals can migrate freely. Work with local authorities to make the best possible transit infrastructure.
- The Nature Conservation Act (2000) aims to conserve the beauty and scenic value of the environment as well as maintain natural diversity. Generally speaking, areas like shorelines and wetlands have the most biodiversity and also the most natural beauty. **Work with local and Indigenous people, NGOs, and government to identify and protect the ecological areas that are most naturally diverse or hold intrinsic value to local people. Promise to keep these areas off limits to industrial activity and to help ensure its continued protection.**
- Noise and dust are large issues. Wherever possible, have dust collectors inside the mine or quarry and avoid using explosives unless it is essential.
- Avoid disturbing areas where some species are endangered or where the site is very vulnerable to change. For example a small amount of emissions can travel within the food chain and through bio-magnification it can kill larger animals of prey.
- Some plants can be very useful to help with pollution. For example, some plants like to grow in areas with high iron. Attempt to match plants with the pollution in your mine so that the plants begin the remediation process while the mine is in operation.
- Use native plants as much as possible and create buffer zones around the mine. In reindeer areas, work with local reindeer herders to help prevent reindeer from coming into the mine. Consider that buffer zones are also important around tourist areas such as ski hills.
- Even in the early phases, continue to take photographs and note all of the flora and fauna present. This will make the remediation process much cheaper and more effective. Consult local NGOs such as FANC and universities for help determining native species or vulnerable areas. This will improve your image and ensure that NGOs will not scrutinize you in the media
- The TSM standard suggests to report on the biodiversity regularly and take measurements to ensure that it is not being permanently affected. Consider the issues mentioned in this guidebook and take regular measurements.

7. Water and Tailings

For a mine, many of the potential environmental come from wastewater or tailings leaks and overflows. Having a good water plan in place from the beginning reduces these risks:

- The plan must take into consideration that climate change is occurring and therefore it is imperative to reduce the harm caused by floods and droughts. Prepare for these situations and have a plan to reduce the risks and potential for disaster.

- Most importantly, working with Tekes, VTT, GTK, SITRA, universities and others to develop site-specific technology to cycle and reuse the water will prevent most issues from occurring. It will also tremendously reduce the amount of freshwater needed. Spending a little more to have the most up to date technology will help reduce risk and save money over time.

- Choosing an area on a hill or with good drainage will reduce the amount of water entering the mine. Having barriers and flow paths will help ensure water from outside will not get into the mine. **If extra water comes in, it can create overflows and contaminate with the tailings ponds and waste. This has happened to several mines recently in Finland but simply by putting up barriers, this has improved substantially.**

- Understand the exact effect of all chemicals, heavy metal pollutants, minerals, toxins, and all substances that are being released from the mine. For example, if arsenic gets released into the river and 20 kilometres away it reaches another river where local people rely on fish, this will lead to environmental damages that may result in lawsuits, a negative effect on the company's image, and the potential loss of investors and shareholders. Just because the contaminants leave the mining area does not mean they are no longer your responsibility anymore. Under the polluter pays principle, you will be forced to pay all people affected by the contamination.

TIP: Earlier steps suggested looking at the geological area, the water cycle, the bedrock durability, and seismic activity. These steps are crucial in determining where the tailings ponds should be located. Consider the type of bedrock, ensure there are no leaks, and make sure that the area chosen can withstand the pH level and other contaminants.

8. Health, Safety, and Education

- There are many guidebooks and protocols for health and safety in the mining industry and Chapters 12 and 13 (Sections 113-118 in particular) of the Mining Act (2011) outline the requirements. For example, there must be an internal rescue plan for the mine, there must be a person that is designated the job of mine safety, and all elements of danger and threats of accident must be stated and explained to all workers and affected parties.

- Dust collectors and containment tools inside the mine rather than outside significantly reduce health and safety issues and improve the well-being of workers and the surrounding community.

- Making sure that workers are acutely aware of all threats and have the proper training for their position is essential.

- From a social sustainability perspective, taking good care of workers through measures like making sure they and their families are well fed, well rested, and are in good health will improve the work culture. If workers are well taken care of, they will work harder and therefore create a positive working environment.

- Create a culture of sustainability. Before the mine opens, have a plan in place to support workers and their family. Educate them on the importance of sustainability. For example, creating less waste ensures less waste goes into the water that goes through nearly communities.

- Hire as many local workers as possible. Work with the community to help it grow. Workers, in turn, will work harder because they will feel a sense of community and achievement when going to work.

- Adding a games room, offering movie nights, and other little additions that could be voted on by workers helps keep everyone happy.

TIP: Creating a work environment that is low stress where workers feel like they are making a difference will improve the quality and output of the mine. Keeping them energized and happy will reduce turnover rates and improve the overall image of the company.

9. Energy and Efficiency

The Climate Change Act (2015) sets forth a greenhouse gas emissions reduction target of at least 80% by 2050 compared to 1990 levels. The extraction industry will be targeted as an area where big reductions can happen. Preparing for this now will reduce the surprise of mandatory reductions later:

- With recent tax increases for energy applied to mines and quarries, consider the benefit of using wind and solar energy in areas of the mine that are unable to be used for extraction. Electricity costs can be reduced dramatically.
- Conduct regular efficiency tests of machinery. Finding and repairing little parts that are not working at 100% can make the whole system much more efficient.
- Work with the government to make use of incentives for recycling and using green energy.
- Use VTT, Tekes, universities and others to find the right machinery for the specific project. Many new technologies are coming forward that can give you a competitive advantage and reduce energy consumption.
- Create a recycling plan with the local municipality. In some cases the waste from the mine can be useful to small businesses. Making these relationships benefits both the mine and the community.

TIP: Conduct regular audits of utility bills. Switching to more environmentally light bulbs, more efficient heating and ventilation systems, and using solar and wind energy are an expensive initial cost but over a 5-10 year period they will save you a lot of money.

10. Review, Plan, Initiate, Evaluate, Repeat

This guidebook has a lot of suggestions and doing all of them will be difficult. You must recognize that achieving all of the suggestions may not be possible, but it is essential to strive to be better year after year.

- Consider the future in every decision and determine potential "what ifs" and try to eliminate them. **Consistently create future wheels as shown on pages 2 and 5 to help do this.**
- Work backwards from what you think is an ideal mine and make short-term goals to get there.
- Make decisions based off of good measurements and always prepare for the unknown.
- It is better to be over-prepared than underprepared. Consider the worst-case scenario of being over-prepared: you will lose a bit of money. However the worst-case scenario of being underprepared is an environmental disaster, leaking, or accidents that could lead to financial liability and/or closure of the mine.
- Every year, systematically review the whole business. Engage stakeholders and local people in particular to ask how you can improve. Working closely with stakeholders and maintaining a good relationship will open up many opportunities.
- Plan to improve the weak links, make the improvements, evaluate the effectiveness, and repeat the process on a new area.

This guidebook has been created so that mines of all sizes in all different stages of their lifespan can use it. It has been created in no particular order or importance because it would be impossible to complete all of these steps. The guidebook can assist you in planning or improving your mine and is there to help you grow and become a good role model for other mines and in the community. Good luck on your journey!

If every person agreed to make a small change, the results would be astronomical. You can help be the change. Let's work - and learn - together to make the world a better place.

Kieran Hooey
Aalto University School of Engineering
MSc candidate Creative Sustainability
2015

APPENDIX 2: Sustainability in Extraction: Natural Stone and Aggregate Guidebook

Sustainability in Extraction

A guideline for implementing sustainability in the preliminary planning phases for aggregate and natural stone companies

2015

Introduction

Sustainability is a complex social, environmental, cultural, and economic issue. This guidebook will help you plan a quarry from the very beginning phases to be sustainable in all of these categories. This should be used not only for all quarries but also smaller satellite aggregate or natural stone quarries. The guidebook has been created through interviews with many leaders in mining in Finland within government and non-governmental organizations, industry, science and education. They highlight the need for an easy to read document that is short (unlike long Environmental Impact Assessments that have become the norm) and brought together all of the required information in simple wording that anyone can understand. This guidebook fills that need.

This guidebook will help mining companies create a culture of sustainability starting before the exploration phase. Its 10 principles are simple to follow and will create better partnerships and increase communication with the local community, improve the company's image, lower utilities costs, and exponentially reduce the potential for risk in the future.

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Primary Author

Kieran Hooey

kieran.hoooey@aalto.fi

MSc candidate Aalto University School of Engineering

Please contact for questions, consultation and to request the full document. Facilitation and event planning services are also available

Methodology and purpose

This guidebook could not have been created without the help of these experts who contributed valuable information, offered access to their archives and gave a tremendous amount of time and resources. Thank you all for your time and support.

Riikka Aaltonen: Senior Advisor of Mineral Policy, ***TEM***
Eeva Ruokonen: Director of Sustainability, ***Talvivaara***
Tapani Järvinen: Board Member of several mines and former CEO of ***Outotec***
Sanna Hast: Land Use Management Advisor, ***Reindeer Herders Association***
Dr. Jussi Leveinen: Professor of Environmental/Geophysical Mining, ***Aalto University***
Anne Ollila: Executive Director, ***Reindeer Herders Association***
Pekka Jauhiainen: CEO, ***Finnish Natural Stone Association***
Dr. Mikael Rinne: Professor of Environmental Engineering, ***Aalto University***
Zhen Song: PhD candidate/Tailings expert, ***Aalto University***
Maria Palin: Communications Manager, ***Palin Granit Oy***

Maija Uusisuo: Development Officer, **TEM**
Dr. Sari Kauppi: PhD Researcher, ***SYKE***
Pekka Suomela: Director, ***Finnish Mining Association***
Markus Ekberg: CEO, ***Endomines***
Tomi Gutzen: Risk Assessment Specialist, ***Mining***
Dr. Olli Salmi: Lead Researcher, ***VTT***
Pekka Nurmi: Research Director, ***GTK***
Toni Eerola: Lead Researcher, ***GTK***
Eija Ehrukainen: Director of Sustainability, ***INFRA***
Heikki Palin: Managing Director, ***Palin Granit Oy***

Along with interviews with many experts in the extraction industry, an extensive literature review summarized information from environmental guidebooks, *The Mining Act (2011)* and other legislation, The Action Plan to Make Finland a Leader in Sustainable Extraction (2013), Finland's Minerals Strategy (2010) and other important references. This guidebook has taken the most essential parts from the literature and the suggestions from interviews in order to create a short guide to help extraction companies succeed from the first stage onwards. Since the interviews were open, the experts were allowed to be quite honest and tell exactly what they think industry needs from their perspective. Therefore the product is a guidebook on sustainability that has been created for the extractive industry by the extractive industry.

This guidebook will work alongside the tool being created by the Sustainable Mining Network that is being based on the Canadian Towards Sustainable Mining (TSM) criteria. This guidebook uses some of the TSM principles but the TSM has been critiqued in Canada and internationally so a groundbreaking community engagement tool and the first sustainability tool for aggregate extraction have been used to fill this void.

Primary References

An extensive literature review brought together all of the following essential Finnish environmental documents to make this guidebook:

2007: Ministry of Trade and Industry, Finland. "Exploration and Mining in Finland's Protected Areas, the Sami Homeland and the Reindeer Herding Area". Retrieved from https://www.tem.fi/files/18154/jul30teo_eng_20A4.pdf ***(Referred to in this guidebook as Exploration guide)***

2010: Geological Survey of Finland. Finland's Minerals Strategy. Retrieved from http://projects.gtk.fi/export/sites/projects/minerals_strategy/documents/FinlandsMineralsStrategy_2.pdf ***(Referred herein as Mineral strategy)***

2011: Ministry of Employment and the Economy, Finland. Mining Act. Issued in Helsinki June 21, 2011. Retrieved from http://www.finlex.fi/en/laki/kaannokset/2011/en20110621.pdf ***(Referred herein as Mining Act (2011))***

2013: Finnish Ministry of Employment and Economy. Making Finland a leader in the sustainable extractive industry – action plan. Retrieved from http://www.tem.fi/files/37130/TEMjul_22_2013_web_04072013.pdf ***(Referred herein as Sustainable Action plan)***

2013: Finnish Ministry of Employment and the Economy. Guide: Environmental Impact Assessment Procedure for mining projects in Finland. Retrieved from https://www.tem.fi/files/42872/New_guide_for_environmental_impact_assessment_procedure_for_mining_projects.pdf ***(Referred herein as EIA guide)***

2014: Fraboulet-Jussila, S. Finnish Network for Sustainable Mining. SITRA. https://tapahtumat.tekes.fi/uploads/37f0e529/Sylvie_Fraboulet_Jussila-6647.pdf ***(Referred herein as Network for Sustainable Mining)***

2015: VTT. SAM – Sustainable Acceptable Mining. Retrieved from http://virtual.vtt.fi/virtual/sam/english.htm ***(Referred herein as SAM)***

The Sustainable Mining Network came out of action proposals #6 and #14 of the Sustainable Action Plan to create a guidebook and a better way for stakeholders to communicate. It uses the Towards Sustainable Mining (TSM) tool from Canada as a base to help create something comparable in Finland. ***While the Sustainable Mining Network, led by Sitra and The Finnish Mining Association, work on creating a comprehensive tool, a guidebook needed to be created in the meantime. This guidebook will complement their finalized tool because it is short and gets the facts to people quickly while their tool will be more comprehensive and in-depth and will be targeted directly to the user (industry).***

This guidebook uses the TSM tool as a reference and also uses the Responsible Aggregate Standard from the Cornerstone Standards Council in Canada, which is the first sustainable aggregate standard in the world and is being hailed by environmental activists and industry alike. Finally, community engagement plans and strategies are difficult to create and understand so this guidebook relies on the work of Dr. Ockie Bosch and Nam Nguyen because they are widely known in the academic community as leaders and visionaries in systems thinking and engagement strategies.

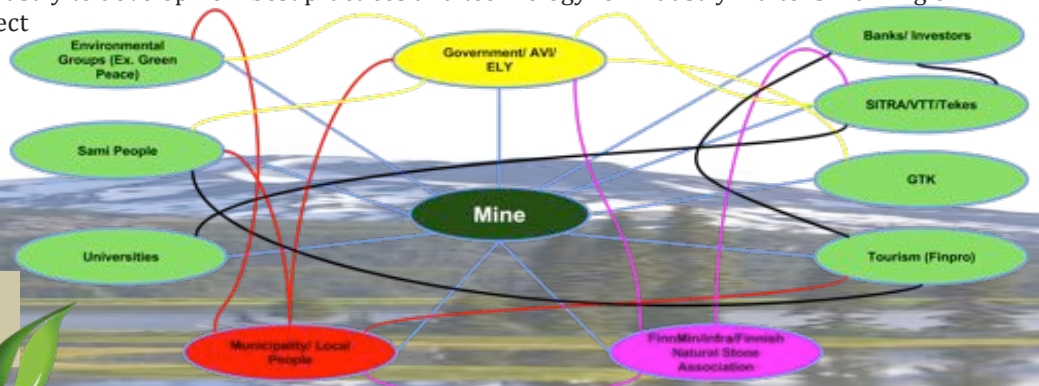
Cornerstone Standards Council. (2015). Responsible Aggregate Standard. Retrieved from http://www.cornerstonestandards.ca/wp-content/uploads/2015/03/APPROVED_Responsible-Aggregate-Standard_Version3.pdf ***(Referred herein as CSC Standard)***

Mining Association of Canada. 2015. Towards Sustainable Mining. Retrieved from http://mining.ca/towards-sustainable-mining ***(Referred herein as TSM tool)***

Nguyen, N.C. & Bosch, O.J.H. (2012). A Systems Thinking Approach to identify Leverage Points for Sustainability: A Case Study in the Cat Ba Biosphere Reserve, Vietnam. Systems Research and Behavioral Science, 30, 104–115. ***(Referred herein as Bosch & Nguyen tool)***

Primary Stakeholders

- TEM: The Ministry of Employment and Economy (TEM) is an oversight government agency that is responsible for upholding The Mining Act (2011)
- Tukes: The Finnish Safety and Chemicals Agency (Tukes) is the mining authority granting mining permits outlined in the revised Mining act (2011) including exploration/prospecting permits, mining permits (allowed to mine for a fixed period), chemical permits (when necessary like for radioactive minerals), and explosives permits.
- AVI: The State Regional Administrative Agency (AVI) makes decisions on environmental permits and licenses pursuant to the Environmental Protection Act and the Water Act.
- ELY centres: The Centres for Economic Development, Transport and the Environment (ELY centres) are responsible for the regional implementation and development tasks of the central government & ensuring the environmental permit is followed.
- SYKE: Finnish Environment Institute (SYKE) is a government research agency that assists in environmental mining issues and they have created useful environmental guidebooks and data on groundwater investigations in mining
- Municipality: Local people must be contacted by law and have the possibility to voice their complaints. The municipality is also responsible for giving construction permits.
- Sami people: The Indigenous people of Finland, represented by Sami Parliament & Skolt Council. Considered in many laws including the Mining Act.
- Reindeer Herder's Association: Tasked with directing reindeer husbandry, developing and researching reindeer herding, and handling reindeer husbandry relations with the rest of society including the mining industry
- FinnMin: The Finnish Mining Association (FinnMin) ensures national and international political interests of mines where all mines in Finland are members and pay a yearly fee.
- INFRA: Involved with infrastructure around mines and also act as the membership association for aggregate extraction companies.
- Finnish Natural Stone Association: Membership association to ensure political interests of natural stone industry. All companies pay a small yearly fee.
- GTK: The Geological Survey of Finland (GTK) is a branch of government but can also be hired as consultants for geological and environmental surveys and impact assessments.
- SITRA: Government fund that has free realm to invest and create projects. Currently responsible for creating the Sustainable Mining Network along with FinnMin.
- Tekes: Funding authority for technology. They are currently investing and funding heavily in Green Mining.
- VTT: A specialized technology firm that receives funding from industry and Tekes. Currently working on SAM that looks to improve the social responsibility of mining companies.
- FANC and environmental non-governmental organizations: Finnish Association for Nature Conservation of Finland (FANC) is the biggest environmental NGO in Finland
- Tourism: Finpro (Visit Finland) promotes tourism and helps small and medium sized Finnish enterprises grow while also promoting foreign direct investment in Finland
- Universities: UEF, Helsinki, Aalto, Tampere, etc. receive Tekes funding and work with industry to develop new best practices and technology for industry. Aalto is working on mine tailings used in asphalt while the University of Helsinki is involved in the SAM project
- Banks and Funders: Nordea and other lenders help fund mining in Finland
- YM: Finnish Ministry of Environment



Stakeholder maps are a useful way to visualize the relationships between each party and help to find which entities are most influential.

1. Exploration

Many tools including the Canadian Towards Sustainable Mining (TSM) tool fail to mention the exploration phase. Doing this phase right can create a strong image from the beginning, create a good relationship with local people, and reduce the potential for risks in the future.

Much can be done before even going to the area:

- Make a local contact (a community leader, business owner, political activist, someone influential in the community). ***Show them this document and tell them you are willing to follow these steps in the guidebook to create a beneficial partnership for them and everyone in the community. This will ensure the local contact will believe you are committed to helping the community while being environmentally sustainable.***

- Conduct regional surveys without going to the site: GTK's Internet service is free and has maps showing ore-potential formations and structures, bedrock, soil, geochemical data, and regional gravity and elevation measurements. GTK also has samples at the National Drill Core Register.

- GTK can be hired as consultants during this phase and could provide valuable advice.

- SYKE has free groundwater quality data from HERTTA and the database POVET that must be reviewed. SKYE, in partnership with the Finnish Meteorological Institute, have a Flood Centre (Tulvakeskus) that provide useful information as well.

- Choosing the right area is essential. Special guidelines for Natura 2000 sites, Wilderness Reserves, classified aquifers, and the Reindeer Husbandry Act (that covers approximately 33% of the area of Finland) are outlined in The Mining Act (2011). Due to longer permit times, environmental impacts, and specific approval from the Government and the Sami Parliament and Skolt Council – ***it is highly recommended to not choose an area in these jurisdictions***.

- Consult the Reindeer Herder's Association for information on the migration path of reindeer. Consider that roads and infrastructure can affect these patterns and further endanger reindeer.

TIP: Having a local contact will help you gain trust and respect before doing anything at all. They will be more inclined to share their knowledge of the area and the core values of the people living there. For smaller quarries, this can help you save money by not hiring professionals to conduct these reviews.

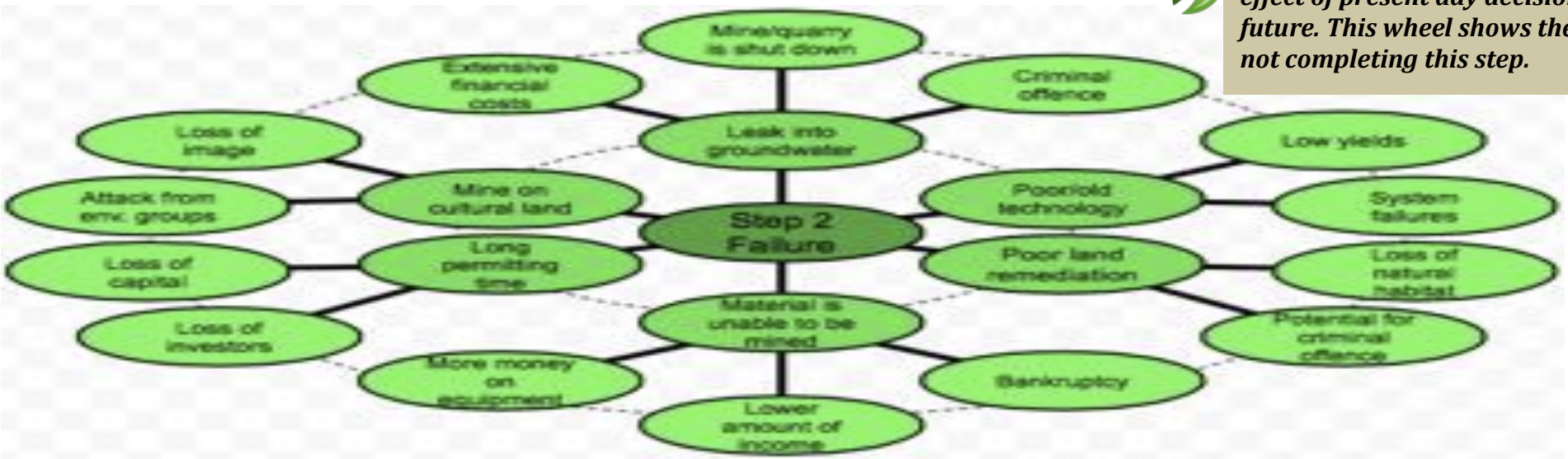
2. Siting the Area

TIP: Indigenous Traditional Knowledge and local people can help situate the quarry in the spot most resilient to extreme weather conditions. Only people living in the area have seen how the land changes and adapts each and every year and can therefore predict what will happen better than experts in many cases.

In areas with no previous exploration, new information must be collected:

- Ask your local contact for advice on the area – such as how water flows, what plants grow in the summer, where the snow and ice forms, what areas have poor drainage, where the soil is weak, etc.
- If the proposed area is on Sami land, use their knowledge and understand the importance of that land to their culture. Involving local people in this phase helps them feel involved and needed, which will improve your relationship and image.
- Make notes and take photographs of all of the area, determining the position of all trees and plants, roads and water.
- Consult GTK, VTT, SITRA, universities, and other experts about the best available technology (such as till geochemical sampling with a percussion drill) for the specific material you are mining.
- With the environmental issues hampering mining companies in Finland in recent years, extensive tests to determine the best position for the quarry considering the condition of the bedrock, the groundwater and hydrogeological cycle, and the seismic activity is essential to ensure the bedrock will not leak into the groundwater under any circumstance.
- Find an area that not only has abundant ore but also consider the quality of the product and the difficulty to properly take it out of the ground. Hiring an expert for this phase to ensure the data is accurate is important in this phase so that proper risk analyses can be made.
- If drilling or pilot-scale quarrying took place, consult photographs and notes to restore the area exactly how it once was.
- Create a risk analysis chart and determine if the area is economically viable taking into account the substantial costs and time needed if the area is protected by law such as the Act on Wilderness Reserves (1991).
- Keep local people informed on a monthly basis on what is being found in the exploration phase.

Futures wheels help visualize the effect of present day decisions of the future. This wheel shows the effects of not completing this step.



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TIP: The new Mining Act (2011) takes account of other key legislation applicable to extraction activity such as the Environmental Protection Act (2000), the Nature Conservation Act (1996) and legislation applicable to the Sami Homeland, the Skolt area and the reindeer herding area. While some of the effects of these acts have already been mentioned, reviewing and understanding them is important. Following the steps in this guidebook, specifically Step #6 on Biodiversity, will ensure these laws are adhered to.

- **It is essential to note that not all extraction companies are required to adhere to The Mining Act. Granite and schist companies must follow the Land Extraction Act while soapstone and marble companies for the Mining Act.**

- Under Section 9 of the Mining Act (2011), an exploration permit is required in almost all circumstances. It is recommended all prospectors apply for an exploration permit because that area is theirs to explore (typically for 3-5 years). An exploration permit is sent to Tukes and once accepted, you are required to submit an annual update on the process (Mining Act, Section 14).
- If you choose to pursue the development of an actual quarry, a mining permit is required through another application to Tukes.
- In almost all cases, an environmental permit is required pursuant to the Environmental Protection Act (2000). A water permit is required as well and is usually done at the same time. These applications are submitted to AVI (see use of terms in the introduction). An Environmental Impact Assessment must be completed pursuant to the Environmental Impact Assessment Act. **The regional ELY centres will ensure that the EIA is adhered to or the permit will be removed (and the quarry will be shut down until the issue is fixed). This is why it can be beneficial to conduct several EIA's throughout the lifespan of the mine.**
- The local municipality will also need to be notified and typically an infrastructure permit is necessary from them according to the Land Use and Building Act. The quarry must be accepted into the Local Master Plan. It is for this reason that having an influential local contact to help you from the beginning is useful.
- In cases involving the extraction of uranium or thorium, a chemical permit is required from the government. This application is also submitted to Tukes.
- In cases involving Sami Homeland or reindeer herding areas, Section 50 of the Mining Act is used and requires the company to consult the Sami people and reindeer herders and in no way damage their livelihood or culture.
- Each case is different and will likely require more permits depending on the size of the quarry and what mineral is being extracted. Be sure to read and understand the Mining Act or Land Extraction Act.

4. Community Engagement

Many of the recently published documents such as SAM, the Sustainable Action Plan, and the Mineral Strategy (see references section for full names and details) call for companies to better communicate and work with local communities. Since these will likely become the law, it is best to preemptively make a plan to execute this:

- While the Towards Sustainable Mining standard offers some suggestions, it does not go as far as the Canadian Cornerstone Standards Council tool that suggests creating benefits for host communities.
- Doing little things like improving drinking water, improving roads and infrastructure, and sponsoring local developments and community events make a large difference. This will improve the company's image, bring in more investors, and spur positive media attention that will help increase sales and be free advertising.
- Include the community and especially Indigenous knowledge holders in every decision. This will ensure trust and reduce the risk of poor publicity. Have regular public meetings – **it is a good time to explain that you are following this guidebook and are acting in good faith.**
- Especially in quarries, traffic and dust are large issues for local people – creating a good traffic plan to avoid busy areas is imperative.
- Waste stone and other material from the mine can sometimes be used by local businesses. Giving them this material saves you money and benefits them.
- Use your local contact to meet all stakeholders in the local area. Find out what is most important to them and help them in whatever way you can.
- Have good measurement indicators for waste, such as the new digital mine technology out of Sweden, and plan to make it readily available to the public.
- Include universities (and Tekes, VTT, SITRA, etc.) located close by whenever possible because they have access to new knowledge and new ideas that could save you time and money.

TIP: Several mining and aggregate companies in Finland have noted that determining what the community needs most and spending the money to build it reduces negative stigmas attached to industry and immediately improves the company's image to local people.

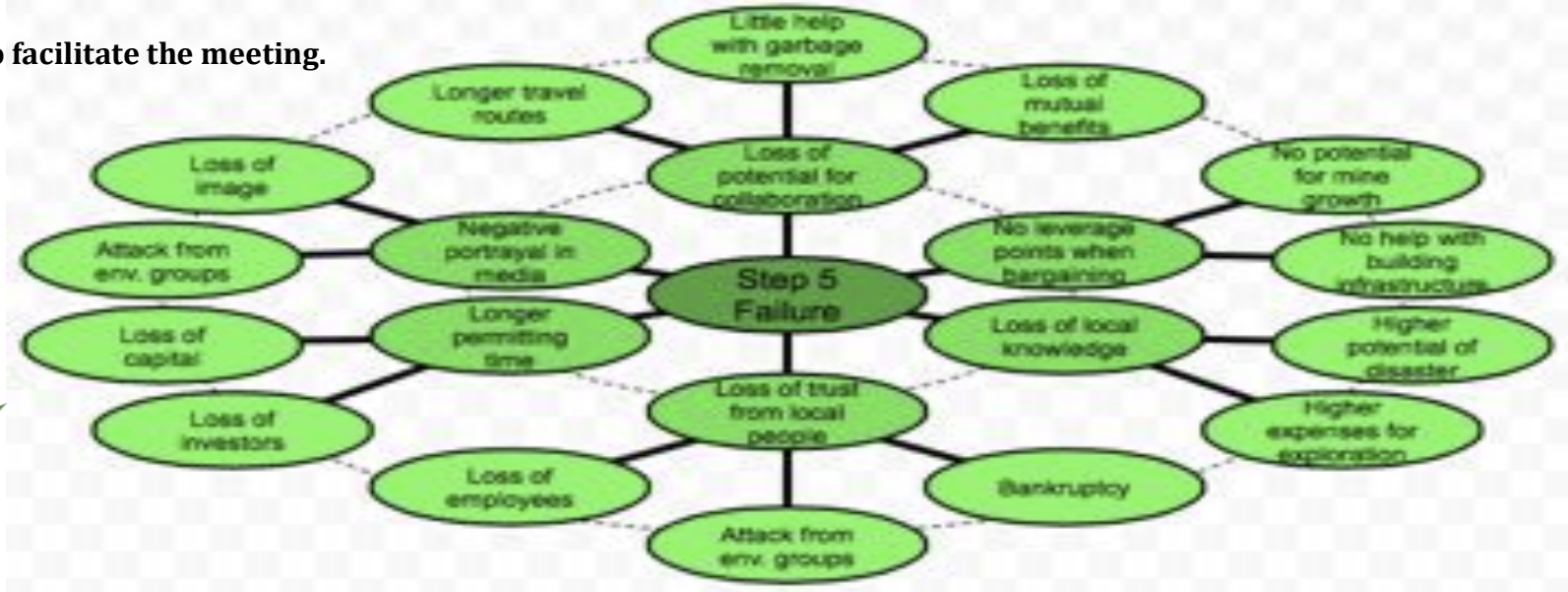
5. Community Engagement

The Action Plan for Sustainable Extraction in Finland's 4th principle demands extraction companies to conduct active, diverse, and interactive dialogue with all stakeholder groups and the 5th principle calls for synergies to be created with local actors. The Bosch and Nguyen tool (see references section) is considered to be the most comprehensive community engagement plan available in systems thinking academic literature. It brings together all stakeholders and through an interactive workshop it identifies all of the issues and recommends a solution:

1) A stakeholder map must be created like the one on page "v" of the Introduction. Once some stakeholders have been invited, they will invite others, and so on. Remember to ask for help from your local contact to bring small business owners and others. Give all stakeholders a copy of this map.
2) You must explain your business in simple terminology in all necessary languages. Stakeholders will then write down their biggest issues.
3) As a large group, you will place the issues on the map. For instance, small business owners may worry about noise and traffic in front of their shops that will reduce the amount of customers.
4) As a large group, or breaking up into small groups, determine leverage points (areas within the system that make a big difference). For example, if many people determine traffic to be a large issue, then new roads and infrastructure would be a leverage point.
5) As you and the stakeholders work together, you will begin to see exactly what you have to do and offer to the community and what they will give you in return. For example if you create a road that avoids the city, the city may agree to take your waste and use it in local construction. These win-win situations will come up during this session and ensure trust and support from the community.
6) Create a master plan of what will be done – each stakeholder will have a role.
7) No model will ever be perfectly correct so having a meeting annually or biannually is a good idea to repeat the process and improve it.

Consider hiring a professional to facilitate the meeting.

This futures wheel shows the effects of not completing Step 5. The inside circle represents short-term outcomes while the outside layer represents long-term and extreme outcomes.



6. Environment and Biodiversity

TIP: A good Environmental Impact Assessment (EIA) can help reduce the risks of an environmental disaster. While many companies hire a consultancy such as Ramboll or even GTK, it is important to understand what issues are important and what actions are crucial. The Ministry of Employment and Economy's EIA guide from 2013 is a good place to begin as it is free and available online.

- Conduct several Environmental Impact Assessments throughout the life of the quarry as many things change over short periods. Doing EIAs regularly can significantly reduce the risk of leaks and environmental disasters.
- It is important to consider the larger ecosystem of the area around the proposed quarry. For example, the development of a small area could shift the migration pattern of reindeer enough that they have to travel through wetlands, which causes lots of issues and could prevent them from reaching their breeding grounds.
- When roads/railways/transmission lines are necessary, having a throughway or overpasses for animals such as a bridge over a stream or large patch of land reduces road-kill, makes the roads safer, and ensures animals can migrate freely. Work with local authorities to make the best possible transit infrastructure.
- The Nature Conservation Act (2000) aims to conserve the beauty and scenic value of the environment as well as maintain natural diversity. Generally speaking, areas like shorelines and wetlands have the most biodiversity and also the most natural beauty. **Work with local and Indigenous people, NGOs, and government to identify and protect the ecological areas that are most naturally diverse or hold intrinsic value to local people. Promise to keep these areas off limits to industrial activity and to help ensure its continued protection.**
- Noise and dust are large issues. Wherever possible, have dust collectors inside the mine or quarry and avoid using explosives unless it is essential.
- Avoid disturbing areas where some species are endangered or where the site is very vulnerable to change. For example a small amount of emissions can travel within the food chain and through bio-magnification it can kill larger animals of prey.
- Some plants can be very useful to help with pollution. For example, some plants like to grow in areas with high iron. Attempt to match plants with the pollution in your mine so that the plants begin the remediation process while the mine is in operation.
- Use native plants as much as possible and create buffer zones around the quarry. In reindeer areas, work with local reindeer herders to help prevent reindeer from coming into the quarry. Consider that buffer zones are also important around tourist areas such as ski hills.
- Even in the early phases, continue to take photographs and note all of the flora and fauna present. This will make the remediation process much cheaper and more effective. Consult local NGOs such as FANC and universities for help determining native species or vulnerable areas. This will improve your image and ensure that NGOs will not scrutinize you in the media
- The TSM standard suggests to report on the biodiversity regularly and take measurements to ensure that it is not being permanently affected. Consider the issues mentioned in this guidebook and take regular measurements.

7. Water and Explosive

For a mine, many of the potential environmental come from wastewater or tailings leaks and overflows. However, aggregate and natural stone companies do not have many water-related issues. However, protecting natural streams, being aware of a changing climate, and being resilient to extreme weather events is essential.

- The plan must take into consideration that climate change is occurring and therefore it is imperative to reduce the harm caused by floods and droughts. Prepare for these situations and have a plan to reduce the risks and potential for disaster.
- Working with Tekes, VTT, GTK, SITRA, universities and others to develop site-specific technology to cycle and reuse the water that is necessary will prevent most issues from occurring. It will also tremendously reduce the amount of freshwater needed. Spending a little more to have the most up to date technology will help reduce risk and save money over time, even if only a little water is needed.
- Choosing an area on a hill or with good drainage will reduce the amount of water entering the quarry. Having barriers and flow paths will help ensure water from outside will not get into the mine. **If extra water comes in, it can create overflows and contaminate the product or machinery. This has happened to several mines recently in Finland but simply by putting up barriers, this has improved substantially. Aggregate and natural stone quarries should consider using barriers as well.**
- Understand the exact effect of all heavy metal pollutants, minerals, toxins, and all substances being released from the quarry. For example, if explosives are used then iron is typically released. If it gets into the river and 20 kilometres away it reaches another river where local people rely on fish, this will lead to environmental damages that may result in lawsuits, a negative effect on the company's image, and the potential loss of investors and shareholders. Just because the contaminants leave the quarry area does not mean they are no longer your responsibility anymore. Under the polluter pays principle, you will be forced to pay all people affected by the contamination.
- Only blast when it is necessary and consider using new technology such as diamond wire saws and chemical stone cutters. If blasting, use the minimum amount of explosive material and use micro-sequential detonation or other techniques to reduce vibrations.

TIP: Earlier steps suggested looking at the geological area, the water cycle, the bedrock durability, and seismic activity. These steps are crucial in determining where explosives should be used to maximize effectiveness. Consider the type of bedrock, ensure there are no leaks, and make sure that the area chosen can withstand the explosion level and drilling.

8. Health, Safety, and Education

- There are many guidebooks and protocols for health and safety in the extractive industry and Chapters 12 and 13 (Sections 113-118 in particular) of the Mining Act (2011) outline the requirements. For example, there must be an internal rescue plan for the mine/quarry, there must be a person that is designated the job of quarry safety, and all elements of danger and threats of accident must be stated and explained to all workers and affected parties.

- Dust collectors and containment tools inside the quarry rather than outside significantly reduce health and safety issues and improve the well-being of workers and the surrounding community.

- Making sure that workers are acutely aware of all threats and have the proper training for their position is essential. Especially when using explosives, ensure that the highest level of safety and precautions are followed.

- From a social sustainability perspective, taking good care of workers through measures like making sure they and their families are well fed, well rested, and are in good health will improve the work culture. If workers are well taken care of, they will work harder and therefore create a positive working environment.

- Create a culture of sustainability. Before the quarry opens, have a plan in place to support workers and their family. Educate them on the importance of sustainability. For example, creating less waste ensures less waste goes into the water that goes through nearly communities.

- Hire as many local workers as possible. Work with the community to help it grow. Workers, in turn, will work harder because they will feel a sense of community and achievement when going to work.

- Adding a games room, offering movie nights, and other little additions that could be voted on by workers helps keep everyone happy.

TIP: Creating a work environment that is low stress where workers feel like they are making a difference will improve the quality and output of the mine. Keeping them energized and happy will reduce turnover rates and improve the overall image of the company.

9. Energy and Efficiency

The Climate Change Act (2015) sets forth a greenhouse gas emissions reduction target of at least 80% by 2050 compared to 1990 levels. The extractive industry will be targeted as an area where big reductions can happen. Preparing for this now will reduce the surprise of mandatory reductions later:

- With recent tax increases for energy applied to mines and quarries, consider the benefit of using wind and solar energy in areas of the quarry that are unable to be used for extraction. Electricity costs can be reduced dramatically.
- Conduct regular efficiency tests of machinery. Finding and repairing little parts that are not working at 100% can make the whole system much more efficient.
- Work with the government to make use of incentives for recycling and using green energy.
- Use VTT, Tekes, universities and others to find the right machinery for the specific project. Many new technologies are coming forward that can give you a competitive advantage and reduce energy consumption.
- Create a recycling plan with the local municipality. In some cases the waste from the quarry can be useful to small businesses. Making these relationships benefits both the mine and the community.

TIP: Conduct regular audits of utility bills. Switching to more environmentally light bulbs, more efficient heating and ventilation systems, and using solar and wind energy are an expensive initial cost but over a 5-10 year period they will save you a lot of money.

10. Review, Plan, Initiate, Evaluate, Repeat

This guidebook has a lot of suggestions and doing all of them will be difficult. You must recognize that achieving all of the suggestions may not be possible, but it is essential to strive to be better year after year.

- Consider the future in every decision and determine potential "what ifs" and try to eliminate them. **Consistently create future wheels as shown on pages 2 and 5 to help do this.**
- Work backwards from what you think is an ideal mine and make short-term goals to get there.
- Make decisions based off of good measurements and always prepare for the unknown.
- **It is better to be over-prepared than underprepared. Consider the worst-case scenario of being over-prepared: you will lose a bit of money. However the worst-case scenario of being underprepared is an environmental disaster, leaking, or accidents that could lead to financial liability and/or closure of the quarry.**
- Every year, systematically review the whole business. Engage stakeholders and local people in particular to ask how you can improve. Working closely with stakeholders and maintaining a good relationship will open up many opportunities.
- Plan to improve the weak links, make the improvements, evaluate the effectiveness, and repeat the process on a new weak link!

This guidebook has been created so that quarries of all sizes in all different stages of their lifespan can use it. It has been created in no particular order or importance because it would be impossible to complete all of these steps. The guidebook can assist you in planning or improving your quarry and is there to help you grow and become a good role model for other mines and in the community. Good luck on your journey!

If every person agreed to make a small change, the results would be astronomical. You can help be the change. Let's work - and learn - together to make the world a better place.

Kieran Hooey
Aalto University School of Engineering
MSc candidate Creative Sustainability
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