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Factors Affecting the Decision-Making Process between Owner and Contractor Mining

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FACTORS AFFECTING THE DECISION-MAKING PROCESS BETWEEN OWNER AND CONTRACTOR MINING

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ABSTRACT

When making a decision between conducting owner and contractor mining, it is common for the mine owner to take into consideration a number of factors to assess the suitability of either method for any particular project. This research identifies and investigates the key factors by means of literature review and questionnaires and interviews with representatives from the resource industry across all fields - mine owners, contractors, independent consultants and Original Equipment Manufacturer (OEM)'s. The responses from 12 professionals were synthesized and compiled to form a framework that can assist both the mine owners in the decision-making process and representatives from other fields to have a better overview of a particular project in the context of owner vs. contractor mining. The key factors identified are company factors (expertise and availability of capital and personnel/workforce), geology of the deposit, geographical and political variability, availability and suitability of contractors and project's financial model and investment analysis. The research shows that there does not exist a single methodology used across the industry and that the decisions are case-specific and should consider the balance between risk, cost and benefit.

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I would like to dedicate this work to my family. Thank you for giving me freedom and encouragement to pursue my interests.

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LOM Life of Mine 16
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AISC All-in Sustaining Cost 17
AV Automated Vehicle 21
MARC Maintenance and Repair Contracts 22
OEM Original Equipment Manufacturer iv
BCM Bank Cubic Meter 24
HSSEC Health, Safety, Security, Environment and Community 25
GET Ground Engaging Tools 26
HDP Historically Disadvantaged Persons 44
BEE Black Economic Empowerment 44
CVA Customer Value Agreement 23

1 INTRODUCTION

Mining is an ancient activity dating back thousands of years when the first humans used the most primitive methods and tools to scavenge useful rocks; however, mining as we know it today did not take place until the 18-19th centuries during the industrial revolution that spurred momentous improvements in the explosives and the mining technologies. Later in 1970's the mining industry has expanded rapidly in the USA, Australia and Canada due to further changes in the mining technologies [Bo et al., 2019].

Since then mining has become a unique industry, operating within a unique environment with distinctive features. It differs from the other industries by capital intensity, uniqueness of the cost structure, long production periods, uniqueness of the deposits, having depletable assets and international competition. Although some of these features can be observed in other industries, it is the combination of all the listed factors that makes the mining industry stand out from the rest. In fact, the minerals industry is often classified as a high-risk industry, because inherent to the industry are long lead times and significant capital investments that have to be made well in advance of the returns generated by production. Furthermore, it is subject of volatile markets that result in cyclical prices and therefore cyclical returns. In addition, the projects are tied to a specific location, which means it is subject not only to the geological features of a deposit but also to the economic and political variations of the region. [Fuerstenau and Han, 2020] The contracting companies fit well into the picture because they offer solutions to some of the distinctive features of the mining industry that pose a challenge to the mine owners. Namely, the contractors can be knowledgeable about certain commodities and types of deposits and familiar with navigating through region-specific mining regulations. In addition, a contractor can offer an alternative to having a heavy capital investment at the beginning of the project as well as alleviate the risk for the mine owner.

As the industry took shape, the small individual businesses have gradually developed into large global corporations. Nowadays the mining companies can be classified into 3 categories, each with a different need in external assistance to run a mining project:

- Major mining companies generating with over 5 bn. USD market capitalization (top 50), that have the experience and capital to develop a mining project on their own;
- Intermediate companies with 500 mn. to 5 bn. USD market capitalization;
- Junior companies that rely mainly on equity financing, focus on exploration and have less than 500 mn. USD market capitalization. [Global Market Intelligence S&P, 2019; Els, 2020]

With the development of the mining industry, the demand for mining service-providers grew as well. While a large mining company has the capacity and the expertise to run a mining project relying on internal financial and physical assets, the smaller mining entities might have no choice but to outsource the mining task and focus on their core competencies such as exploration.

In the recent years contracting has become a tool and an opportunity that even the larger mining companies would consider exploiting, while focusing on management and financing or processing, which are arguably the mining companies' core competencies [Van der Lingen, 2014]. In Rupprecht's paper about owner vs. contractor mining the author stated that in South Africa in the past decade (2005-2015) there has been an increase in the mining operations that hire independent contractors to conduct mining activities. Kirk stated that between 1980-2000 there has been an increase in contracting in Australian mining operations and has the most cost-effective model in the world.

As of now, the technology in the mining industry is developing rapidly alongside those of the other industries. Furthermore, with new experiences and increased cooperation between mine owners and mining contractors the perception of the concept and the practice is gradually changing in the industry. Such development will undoubtedly have an impact on the decision-making process, which will be further discussed in this paper.

2 OBJECTIVE AND SCOPE

The following chapter introduces the objective and motivation of the research, the methods used to achieve the results and the outline of the thesis.

2.1 HYPOTHESIS

Many factors come into play in the decision-making process of whether to run an owner-mined operation or to contract. They include but are not limited to financial, political and geological variability. All factors are closely interconnected; in fact, as those factors vary, so does their relationship, in other words, they are case-specific.

A good understanding of the factors involved, standardization of terminology across the industry and comparison of perspectives of both owner miners and contract miners has the potential of giving mining companies a comprehensive guide on how to reach the final decision as well as a bench-marking opportunity.

While there is no standard decision-making procedure across the entire industry, the reasoning on the higher level might be comparable regardless of geographical location and commodity. After considering all the key factors of a mining project, it is possible to create a standardized framework to guide the decision-making process.

2.2 OBJECTIVE

The aim of this thesis is to create a framework for a tool that will assist the mining companies decide between owner mining vs. hiring a contractor to conduct the mining operations. This includes identifying and isolating the major factors that affect the decision-making process, as well as coming up with a scoring system to reflect the degree of impact of those factors on the final decision. Furthermore, the framework attempts to introduce alignment of understanding

of a project amongst the many disciplines involved in the decision-making process.

The framework can be used by the contracting companies as well as the OEM's. Knowing the basic information about the projects and going through the framework should give an indication of where the project stands in terms of the choice between owner mining and contracting.

2.3 RESEARCH QUESTIONS

The objective and the hypothesis have led to a number of research questions that form the core of this thesis.

1. What are the main factors taken into consideration in the decision-making process?
2. Are all the key factors qualifiable and quantifiable?
3. What significance and weight can be assigned to each identified key factor?
4. Is there a standard process across the industry?
5. Given the same issue, how does the perspective of the owner miners differ from that of the contract miners?
6. By means of site visits, how does the theory deviate from practice?
    - Difficulties and challenges encountered on the mine site;
    - Decision based on risks and financial analysis vs. decision made on site.

2.4 METHODOLOGY

The emphasis of the thesis lies on collection of data from the industry rather than the data available from public sources. This of course involves interaction with professionals in their field of work. In order to acquire a wide range of perspectives, both mining and contracting companies were contacted. For the same reason mentioned earlier, there was no focus on a specific geographical region or commodity. Furthermore, the data includes the inputs of independent consultants who have had experience working in both mining and contractor companies.

The mining companies were all presented with one set of relevant questions while the contracting companies with the other, all questions designed to better understand the companies' perceptions of and experience with owner vs. contractor mining.

There were also conversations held with representatives of equipment manufacturing and servicing companies. Although the professionals in this field are rarely directly involved in the decision-making process, their job roles requires a good level of understanding of various mining-related topics and they interact with both mine owners and contractors. Although the input of these professionals did not have a direct impact on the framework, the information shared was of great relevance and has put the information from other sources into perspective.

The site visits were then arranged for an opportunity to speak to people in person and to have a first-hand experience observing the dynamics between the mine owners and the contractors, as well as to cross-reference the information gathered prior to the visit.

2.5 DATA

The information and data utilized in this thesis come from the following sources:

- Literature;
- Questionnaire responses by the people from the industry;
- Phone calls and interviews with the people from the industry.

This section will discuss each category of the data listed above.

2.5.1 Literature

There is very limited amount of literature on this topic. Most of the information from the literature was pieced together from a number of papers. There are also papers focusing on a particular factor in the decision-making process, such as determining whether mining is the core competency of the mining companies or evaluation of mining contracts. There were 3 papers found that were in line with the focus of this study:

1. S.M. Rupprecht (2015): Owner versus Contract Miner – a South African Update;

2. R.S. Suglo (2009): Contract Mining versus Owner Mining – The Way Forward;
3. L.J. Kirk (2000): Owner versus Contract Mining.

All three papers discuss the merits and demerits of the two options, as well as outlining some specific examples from the mining industry. However, none of the papers have attempted to synthesize all the factors into a usable framework to assist the mine owners in the decision-making process. Thus, the gap in the research has been identified.

The initial understanding of the thesis topic relied heavily on the information acquired from these papers. They served as a good basis for identifying the key factors as well as helping with the design of the questionnaire that was sent to the companies.

2.5.2 Questionnaire Responses

The questionnaires for the mining companies and the contracting companies can be found in Appendix A. Responses were received from the following companies:

Mining companies

- Agnico Eagle: André van Wageningen (Engineering Manager, Finland);
- AngloGold Ashanti: Dan Herr (Commodity Manager – Mining Contracts);
- China Minmetals: Fei Gao (Foreign Mining Projects Department);
- Nordgold: Greg Edmonds (Group Mobile Maintenance Manager);
- Newmont Goldcorp: Jozephus Coenen (General Manager – Akyem Gold Mine).

Contracting Companies

- Thiess: Matt Petty (General Manager – Autonomy);
- Bouygues – DTP Mining: Ronan Le Roy (Mining Director) and Thierry Vaillant (Director of Material Resources);
- African Mining Services: John Kavanagh (CEO);
- VPR Mining Infrastructure: Koppoli Krupanand (Vice President - Business Development);

- Moolmans: information acquired from the site visit from Etienne Le Roux (Technical Manager), Dewald Botha (Senior Plant Manager) and Robert Nicholson (Production Manager).

Additionally, both questionnaires were filled out by an independent consultant, Marcel Damen who has had extensive experience working for both mining and contracting companies. This provided an additional data set that was used for comparative purposes.

The strength of this source is that the information comes from the experienced people who are very knowledgeable about the field. The weakness, however, lies within the questionnaire itself: the questions are all multiple choice and short answer, which is a limiting factor in regard to the volume and type of information that can be acquired, and some of the answers given, both in the multiple choice and in the short answer required further explanation.

The value of this source is that it serves as the stepping stone towards further discussions and questions. This step was crucial for extending the knowledge beyond literature and establishing the initial contact with the companies.

2.5.3 Phone Calls and Interviews

Following is the list of contacts with whom the topic was discussed and does not include the contacts with whom only the introductory call was held (no thesis topic discussion).

Calls with Questionnaire Responders

- AngloGold Ashanti: Dan Herr;
- Bouygues – DTP Mining: Ronan Le Roy and Thierry Vaillant;
- Nordgold: Greg Edmonds;
- Newmont: Jozephus Coenen;
- Thiess: Matt Petty;
- VPR Mining Infrastructure: K. Krupanand.

Other Calls

- B2Gold: Peter Montano (Project Director);
- Caterpillar: David Woodward (Product Performance Manager);
- Caterpillar: Henry Clark (Regional Security Manager);
- Caterpillar: Lilian Hu (Manager – Commercial Mining);
- Caterpillar: Lin Zhang (Industry Representative);

- Kenn Smart (Independent Consultant, TurnAround);
- SECMC: Arsalan Anwar (Mine Expansion Manager).

In-person Interviews

- Barloworld Equipment: Gerald McLoughlin (Sales Consultant);
- Marcel Damen (Independent Consultant);
- Moolmans: Arno Opperman (Senior Contract Manager);
- Moolmans: Dewald Botha (Senior Plant Manager);
- Moolmans: Etienne Le Roux (Technical Manager);
- Moolmans: Hugo Barnard (Regional Technical Analyst);
- Moolmans: Kobus Beukes (Earth-moving Plant Manager);
- Moolmans: Robert Nicholson (New Business Executive).

As seen, there is a wide range of companies and occupations amongst the contacts, which also provided a wide range of opinions. The weakness of this source is the subjectivity of opinions. While some statements were reoccurring in most of the conversations, the others differed based on the experience of the contact. This is especially the case when it comes to the perception of the relationship between mine owners and contractors.

The value of this source lies within the contacts sharing relevant experiences they have had over the years, as this is the information that cannot be acquired through the other two sources. The calls and interviews played a major role in putting the information from the other two sources into perspective.

2.5.4 Overview of Nonacademic Data Sources

The professionals listed in Section 2.5.2 and Section 2.5.3 come from different educational and professional backgrounds. Table 2.1 showcases the diversity in terms of years of experience in the mining industry, level of involvement in the context of this study, roles in the mining industry and region of coverage in the job position at the time the questionnaire responses and the interviews were taken. The table is based on the information available on 24 industry representatives whose information/data contributions have helped drive this study.

One can see that all the professionals have had extensive experience in the mining industry. Note that it is not represented in the table that all participants have held multiple and often diverse job roles within the listed number of years, implying that they have acquired

the knowledge on the owner vs. contractor mining topic from different sources throughout their career, and are therefore familiar with different perspectives. While the intention of the table is to quantitatively represent the data sources, the experience of each professional is difficult to quantify, because in the mining industry they are required to have a wide range of cross-disciplinary knowledge on various mining-related topics, and a list of all the positions held over the years does not necessarily accurately reflect this.

Involvement in the decision-making process was classified based on whether the professional is directly involved in the evaluation of the two options, creation and negotiation of the contracts, making the final decision or management of the contract. Most of the representatives are directly involved in one of the listed functions in the decision-making process. The exact role categories are then listed under the ”Roles in the Industry” section of the table.

Lastly, the classification for the region of coverage is based on the role of the representative at the time the data was collected. Although not all the listed professionals held a role with global coverage, most of them have worked in different regions throughout their career.

The wide range of experience and roles of the representatives sets the basis for cross-sectional data collected in this study, providing a solid overview of the industry as well as the study-specific topics.

	Mine Owners	Contractors	Independent	Equipment Providers	Total
Years of Experience in Mining					
5-10 years	2	2			4
10-20 years	3	5		3	11
20+ years		2	2	1	5
Unknown	1	2		1	4
Level of Involvement in the Decision-Making Process					
Direct Involvement	6	7	2		15
Indirect Involvement		4			9
No involvement				5	5
Roles in the Industry					
Executive	2	4			6
Engineering/design	1				1
Maintenance/mining operations	2	7	2	1	12
Finance	1				1
Other				4	4
Region of Coverage					
Africa	3	5		1	9
Europe	1				1
Global	3	5	2	4	14

Table 2.1: Quantitative overview of the questionnaire responders and interviewees

2.6 SCOPE

The topic of the thesis covers a wide range of mining-related topics and basic background information is necessary for understanding the subject. Furthermore, the thesis includes the following topics:

- analysis of the market dynamics specific to owner vs. contractor mining through literature as well as interviews;
- analysis of the answers received from the industry, both mining and contracting companies;
- framework to aid the decision-making process.

Due to the limited amount of data available and requests to keep some of the information confidential, the scope does not cover the following:

- detailed financial analysis of the mining projects, comparing the owner mining scenario with the contractor mining scenario.

2.7 OUTLINE

The thesis consists of four sections, each having a chapter dedicated to it. The literature review was combined with the expertise of the people in the industry, as there are not many literature resources available for this topic. The Data Processing section mainly deals with the gathered data and information in an analytical manner. The Case Study is intended to reaffirm or refute some of the outcomes of the conversations held prior to the visit, and mainly to gain a different perspective and to observe the practices in action.

Literature Review and Knowledge from the Industry

- **Chapter 3:** *Common Practices in the Industry*
  Gives an overview of possible factors and considerations in the decision-making process. Part of the information is based on literature and part is gathered through conversations with the people in the industry.

Data Processing

- **Chapter 4:** *Data Processing and Classification*
  Presents the data gathered from the industry as well as the weighing and classification of the identified key factors.

Case Study

- **Chapter 5:** *Case Study: South Africa*
  Includes information about the visit and the findings and correlations made during the visit.

Synthesis

- **Chapter 6:** *Discussion, Recommendations and Conclusion*

3 COMMON PRACTICES IN THE INDUSTRY

A lot of preparatory work takes place prior to the operational stage of a mining project, such work includes exploration, pre-feasibility studies, feasibility studies and finally the execution phase. At some point in the preparation period a mining company needs to make the decision whether to undertake the mining component themselves (owner mining) or to hire a contractor to perform the task (contractor mining). The following chapter introduces the common practices in the industry as well as more in-depth examination of certain factors when it comes to the decision-making process.

3.1 OVERVIEW

Without thoroughly considering the factors it is already possible to produce a list of benefits and concerns revolving around hiring a contractor. Some of the following were outlined in Kirk's paper on contractor versus owner mining and Rupprecht's paper on the same topic focusing on South Africa.

Hiring a contractor might offer the following benefits:

- economies of scale and scope through access to capital, equipment and human resources;
- ability to benchmark their operations across a range of mines to maximize efficiencies;
- flexibility in terms of equipment and human resources;
- minimization of owner's capital exposure;
- expertise in the field of work;
- risk alleviation for owner.

On the other hand, the concerns are:

- the owner does not have direct control over the mining activities and safety;
- additional costs pertaining to the contractors' profit;

- potential increase of costs due to gaps in the contract or poor management;
- loss of intellectual property (know-how) when the contractor leaves the site;
- strenuous litigation process and delay in production in case of major conflict.

While these are sensible and important factors to consider, the following sections will dissect some of the their underlying principles.

3.2 FACTORS AFFECTING THE DECISION

The range of the factors affecting the decision is vast and can be classified in multiple ways. However, given the task at hand, it is sensible to classify them in the chronological order, starting from exploration and ending with production. As it will be shown, this classification will also tag the factors as either "natural", "human-induced" or "consequential". Regardless of the classification method, all the variables remain inter-dependent.

3.2.1 Exploration Phase

The factors falling under this category can be considered "natural", those that the mining companies do not have much control over.

Geological exploration is the process of identifying zones with geological features that are potentially economically feasible for extraction. This involves searching, sampling and analysis of the material in the area through means of geological, geophysical and geochemical methods.

Geology of the Deposit

The geology of the deposit will determine the mining method and the amount of material that has to be removed before accessing the orebody. This of course will directly affect the production schedule. Most of the mining companies would prefer to extract the most easily accessible material with the highest grade closer to the start of production in order to shorten the payback period and start making profit.

Geographical Location of the Deposit

The geographical location of the area also plays a crucial role, it entails:

- Seasonal variation in the climate that can affect the mine infrastructures as well as slope stability, tailings and water retention structures. Some extreme climate conditions might lead to forced termination or significant reduction of production.
- Region-specific laws and regulations and sociopolitical status that can affect not only how and whom the mining companies employ but also many other day-to-day aspects of the operations.
- The location of the project will determine the availability of mining equipment and services within the vicinity of the project. In terms of equipment this would mean more complex logistics involved in the process of getting the equipment on site, and in terms of mining services this would mean finding a contractor willing to travel and settle at a remote location which would in turn result in higher costs for the mining company.

3.2.2 Pre-Feasibility and Feasibility Studies Phase

Once the exploration has identified a potentially profitable ore body, a copious amount of work such as mine planning, production schedule, financial assessment, etc. in the Pre-Feasibility Study (PFS) and Feasibility Study (FS) phases is needed to ensure a smooth beginning of the construction phase and a plain sailing into the ramp-up and the production phase. The factors falling under this category can be considered "human-induced", as the mining companies have control over the decisions made during the process.

The Production Schedule

The production schedule is a complex optimization problem that requires meticulous designing with factors such as density, grade, tonnage and stripping ratio weighing in. While it is possible to produce a schedule that hinges on such requirements as maximum production or maximum profit generated per annum, what makes the task difficult is having to continuously fine-tune and adapt to the case-specific variables of a particular project. It is important to note that the schedules are not set in stone and definitive and can change throughout the feasibility stage or even during the production stage if needed. In fact, the production schedule undoubtedly takes into consideration

the commodity price, which often fluctuate throughout the project. What the production schedule will determine are:

- The Life of Mine (LOM) is the period through which the ore reserve will be extracted. While the definition itself is straightforward, the result is a product of commodity-specific and market-specific factors. Depending on the commodity and the size of the orebody, the mining company might aim to generate larger profits within a relatively short period of time or on the contrary aim to extend the life of mine to achieve long-term sustainable production and profit generation. It is also important to consider that all this tie in with the companies' capacity to mine and process the ore.
- A project might face a potential fluctuation in the mining rate in order to achieve the optimal production schedule. The creation of the production schedule starts with creation of 3D block models the units of which are then assigned specific economic values and classified as either ore or waste. The objective is to maximize the Net Present Value (NPV) of the operation while satisfying a set of physical and operational constraints [Khan and Niemann-Delius, 2014]. Depending on the geometry of the orebody, the optimal (maximum economic value) sequence might call for fluctuations in the mining rate. This is especially interesting to the mining companies as a contractor is often more flexible in terms of equipment mobility and availability than a mining company with a set mining fleet.
- A project might also face a potential transition from open-pit to underground mining method. This transition involves changes in the geotechnical, infrastructure and equipment aspects that a mining company might or might not be capable or willing to undertake themselves.

Financial Modelling

Financial modelling is the process of simulating and predicting the financial performance of a project throughout its duration, while taking into account the complexities of the real-world financial situation as well as the project-specific considerations, and it goes hand in hand with the production schedule. Similar to the production schedule, the financial models are very case-specific, and the more accurately it is able to capture the range of factors at hand, the more representative it might be of the project's financial performance. Following are the key considerations to be taken into account in the owner mining vs. contractor mining decision-making context:

- Accessibility, availability and cost of capital are very much dependent on the history and internal capabilities of the mining company. Choosing owner mining might lead to a capital-intensive start of the project, partially due to the investment in a mining fleet, while the cost of hiring a contractor can be allocated to the Operating Expenditure (OPEX) throughout the duration of the contract. Therefore, the mining companies have to consider which option is more in line with the long-term financial planning of the project.
- Although the final objective might be achieving the lowest possible All-in Sustaining Cost (AISC), the method employed for the financial analysis might vary from company to company, because not only does it reflect the factors affecting a certain project but also the risk perception and interpretation of the company undertaking that project. Furthermore, during a tendering procedure the costs listed in the offers of the contracting companies might deviate from those projected in the mining company's model due to the difference in methodology.

3.2.3 Production Phase

Under this category are the "consequential" factors that emerge as a result of the "natural" and "human-induced" factors. At this stage of the project the mining company has already made the decision between owner mining and hiring a contractor to perform the mining tasks.

Minimizing the Cost

Regardless of the choice, the mining companies' focus is on minimizing the costs. While owner mining provides more control over the operations, which in turn might mean more effective and efficient implementation of a cost-cutting strategy, it also exposes the mining company to more risk than in the scenario of hiring a contractor. On the other hand, in case of hiring a contractor, to increase efficiency at a set payment schedule is arguably the equivalent of lowering the costs. This however often calls for good relations between the mining company and the contractor, the alignment of goals of the two parties and above all diligent management by the mining company.

The Potential Switch between Owner and Contractor Mining

Another factor to consider is the potential switch between owner mining and contractor mining. A decision to make the change can happen for several reasons. For example, a project that started with a contractor mining might at one point seem more financially sound if changed to owner mining, given the mining company is confident in its expertise and has carefully assessed the risks and benefits of the transition. The switch in the other direction might happen for the same reason, or as discussed previously, as a result of an open-pit mine going underground and the mining company having to rely on a contractor to realize the plan. There is also the possibility of switching from owner mining or contractor mining to a combination of both, in most cases the contractor is responsible for overburden removal while the mine owner takes up ore mining.

3.3 KEY CONSIDERATIONS

Although, as shown above, the factors are classifiable, there is an extensive list of considerations to take into account. This section identifies a few key considerations and outlines how each one impacts the decision-making process.

3.3.1 Risk Alleviation, Reduction and Management

Starting a mining operation comes with great opportunities as well as risks. From exploration to production a mine has an impact on many businesses and people, and also faces a wide range of uncertainties, which include but are not limited to financial, sociopolitical and environmental risks. Kirk lists the following risks for the mine owners: geological modelling, grade control, mine design, geotechnical stability, environmental and community issues, overall responsibility for health and safety and the market fluctuations. He further lists the following risk areas to take into consideration in the evaluation of contractor versus owner mining:

- Equipment selection;
- Equipment performance (productivity, availability and utilisation);
- Quality control of ore mining;
- Health and safety;
- Human resources management;

- Implementation (new mine) or transition (change from one mining option to the other) risks;
- Contractual and litigation issues;
- Production or operating costs.

Given the operations in the same geographical region, how one mining company assesses and manages the risks can be very different from the ways of another. It is to some extent dependent on the internal policies of a company, but even more so on the history of the company, which entails not only the level of expertise but also the cases of failure and success.

In the context of this thesis it can be argued that regardless of the risk appetite of the company, bringing in an external party to undertake the mining operations provides an opportunity to alleviate the burden through risk-sharing. In the mining industry this is especially significant in regards to:

- **Expertise:** an experienced contractor has worked on a wide range of projects, if selected carefully, they can significantly reduce the operational risks.
- **Qualified Work Force:** with the implementations of more strict regulations on workforce in certain region, hiring a contractor can shift part of the risk away from the mine owner.
- **Economic Downturn in the Industry:** in case of extremely low commodity prices, an operation might come to a halt; having a contractor might mean a less financially painful process of "turning off the tap" for the mine owner.

It is important to remember that although outsourcing provides an opportunity to mitigate the risks, the relationship between the mine owner and the contractor is mutually-beneficial and should be viewed as cooperation rather than mere method of extrication. This will be further discussed in the following Section 3.3.2.

3.3.2 Alignment of Goals and Objectives

Alignment of goals and objectives of the mine owner and the contractor is essentially what will distinguish an unsuccessful cooperation from a successful one. This relationship starts with laying out terms and conditions not only in a form of a written contract but also verbal communication and eventually interaction on the mine site on day-to-day basis. With an increasing number of mining operations hiring contracting companies, the contracts themselves have become

more flexible in terms of conditions, incentive schemes and payment schedule [Kirk, 2000].

- This should give both parties an incentive to be more straightforward and open about their expectations, assigning responsibilities and actions in case of a deviation from the plan.
- It is in the interest of the mining company to cooperate with reputable contracting companies or those that they have done business with previously. Unfortunately, there have been instances of mining companies picking contractors based on the prices listed in the bid. While it might be tempting to select the option with the lowest cost, it is important to note that if a contracting company has listed the numbers that are significantly lower than those of its competitors it should set off an alarm bell.
- The mining companies also have to keep in mind that although the contractors are a separate entity, cooperation means shared risk and benefits. This applies not only to the production goals, but also commitment to environmental, health and safety standards. An incident happening to either party can come at a great cost for both.

3.3.3 Cyclical Nature of the Mining Industry

Another consideration worth mentioning is the cyclical nature of the mining industry. The mining industry has been experiencing commodity price cycles that have historically lasted 7-10 years. There have been many attempts to predict the future trends and line up the production volume with the commodity prices; however, there has always been a deviation, partly due to the fact that a mining project requires time to ramp up to the full production and once it starts producing it is usually in large volumes. Furthermore, it is not easy to terminate all production overnight when the demand cycle starts to take a downturn. PWC Mining explained in its 2018 annual mining report that the industry is cyclical thanks to the lag between the investment decision and new supply, and that demand tends to grow in a relatively stable fashion during the times of global economic growth; however, by contrast, the supply is added in bulk with completion of new development.

- The decision of whether to go for a longer or a shorter LOM definitely depends on the geology and size of the orebody but can also be influenced by the cyclical nature of the industry. For example, given a relatively small high-grade gold deposit the mining company might decide to go for a short LOM while

the industry is at the peak of its cycle. On the other hand, if it is a large copper or iron orebody the company will likely try to extend the life of mine and aim to keep the average revenue throughout the project above the break-even point of all the cycles the LOM spans across. This factor will contribute significantly to the decision between investing in a mining fleet or hiring a contractor with available equipment.

- The cycle might also have an impact on the way the contracting companies respond to the requests to tender. At the peak of the cycle the demands for mining services certainly increases, which means the contracting companies are likely to have more mining project to select from, whereas at the trough of the cycle the contractors might be hungrier for business opportunities.

3.3.4 Technological Advancements

As mentioned previously, the technological advancements in the field have the power to shape an industry. A mine that is technologically better equipped can potentially have safer and more efficient operations. At this point the mining industry is heading steadfastly towards automation. In their 2019 industry outlook report KPMG International states that "a total of 29 percent (of the mining companies) plan to use innovation and tech transformation for growth, and 37 percent expect major disruption from these factors in next three years". Almost half of all the investment is expected to be streamed into Automated Vehicle (AV)'s and robotic process automation. Furthermore, more than 70% of the industry see the technological disruption as more of an opportunity than a threat, as it can potentially benefit the industry by 190 billion USD.

What this potentially means is that the competition between the contracting companies will not only take place on the level of efficiency and reputation but also in terms of the equipment they are able to offer their clients. It is important to note that implementation of the automated equipment might be influenced or rather disrupted by the sociopolitical state of certain regions, an example of which will be discussed in Section 5.2.3.

3.3.5 Labour Laws and Regulations

The country-specific differences extend far beyond the working culture in the region. The working environment is often dictated by the regulations a government would enforce on the mining sector. Such regulations have a great influence not only domestically - sometimes

dictating the financial performance and employment rates of a country [International Finance Corporation and World Bank, 2002] - but also on the foreign stakeholders entering the market.

Countries such as Australia, Canada and South Africa that have developed mining industries tend to have more rigorously defined industry-specific regulations. As the mining businesses keep growing in a country, the governments continuously makes adjustments to accommodate the changes [Campbell et al., 2004]. No doubt that most of the time the number of rules increases and so does the level of detail.

On one hand a more extensive set of regulations might mean more regulated area to do business in, and therefore a lower risk environment; but on the other hand it can also mean more demands by the local government and more bureaucratic procedures.

3.3.6 Partial Outsourcing

Considering all the factors mentioned above, a mining company might consider outsourcing only certain jobs. One of such functions is the maintenance of the equipment, which is crucial for a effective and safe operation for any mining project. It has been estimated that the maintenance of equipment takes up 20% to over 35% of the total mine OPEX and is increasing steadily [Springer London, 2008]. Another paper from 1998 has estimated the maintenance cost to take up 30-50% of the mine OPEX [Krellis and Singleton, 1998]. The author also explain that the increasing demands on quality and service puts pressure on delivery performance, which in turn allows less room for errors and delays, and this in turn increases focus on equipment reliability. Therefore, the mining industry maintenance is one of the key drivers for performance, as it will dictate the costs and reliability of the equipment.

If a contractor is hired to do the mining, the maintenance of the equipment is usually also taken care of by the contractor. However, if a company decides to conduct mining themselves, they have the option of getting a Maintenance and Repair Contracts (MARC) contract with the OEM of the equipment they utilize or with the dealerships.

As an example, Caterpillar dealerships provides such maintenance service. In fact, there are three main equipment servicing options:

- **Full MARC:** the Dealer performs all maintenance and repairs on a set schedule. This includes all preventative maintenance services, component removals and installs. The contract guarantees a level of equipment availability throughout the duration of the contract.

- **Customer Value Agreement (CVA):** a signed agreement to provide specific parts and services, whether related to condition monitoring and/or repair and maintenance. Unlike MARC there is no availability guarantee.
- **Parts Only Service:** the Dealer is only engaged to provide the mine owner with major components and parts. The mine owner is responsible for any required preventative maintenance services, including component removal and installation.

Similar to hiring a contractor for mining, hiring a contractor for maintenance gives an opportunity to alleviate the risks (Section 3.3.1). In case of maintenance outsourcing the major benefits are reduction of machine downtime and mitigation of qualified labour shortage.

3.4 CONTRACTING STRATEGY: MINING COMPANIES

In the decision-making process the mining companies often conduct a financial analysis in the PFS or FS stage of the project in order to compare the costs between owner mining and contractor mining. This section will present the general procedure as well as some aspects the mining companies should pay close attention to in the process.

3.4.1 Tendering Procedure

The process from the beginning of the tendering process until the deal is made between the parties can take up anywhere from two month to half a year, depending on the complications and specifications of the project.

The process begins with the mining company issuing a tendering document with the project specifications, calling for contractors to send in the estimations of costs at which they would provide their services for a particular project. There is a number of types of tenders commonly used for such purpose:

- **Open tender:** the organization seeking the service will place a notice of a contract being tendered, and it provides equal opportunity to any organization to submit a tender.
- **Pre-qualification:** the pre-qualification process might involve questionnaires and interviews, after which a short-list is created consisting of suitable service suppliers who are interested in the tender. The list of selected organizations is then invited to submit tenders.

- **Preferred contractor:** this process is the alternative of the pre-qualification process without the short-listing process; it only allows contractors to submit tenders by invitation; the pre-selected list is known by their track record to be suitable for a contract of the size, nature and complexity required.

In the industry pre-qualification is the most common method of tender, this will be discussed further in Chapter 4. It was noted during the interviews that nowadays even with an impeccable cooperation history between a mining company and a contractor, the mine owner would still go through the tendering process for comparative and incentive-giving purposes. During a phone conversation with Kenn Smart, an independent consultant specializing in mining equipment application and performance, it was mentioned that most of the time the mining companies have already had met and spoken to a number of contractors before the tender document is issued, which means the document is often targeted at certain contractors.

3.4.2 Contractor Selection and Contract Negotiation

Selecting a bid might seem to be an easy task, but it is not said that the best choice is not necessarily the one listing the lowest price per Bank Cubic Meter (BCM) or per tonne. However, a well-seasoned professional who has participated in numerous cases of tendering and contract managing might argue differently.

To begin with, a low price is not always a good indication. For example, if a mining company receives 5 bids and one of the bids lists prices that are significantly lower than the second lowest price while the deviations amongst the other 4 bids are relatively small, the mine owner should scrutinize the schedule of rates provided, ask additional questions and request supporting material from the contractor if necessary. Often a low bid is the result of a detrimental mistake made in the estimation, such as missing an important value, or impractical/unrealistic estimations of the prices. In fact, the mine owner should look into not only the calculations, but also the practicality of the estimates, namely the estimations of the number and types of the machines listed. For example, in a conventional truck and shovel operation, whether the estimations for the number and size of each type of equipment make sense in terms of cycle time and efficiency.

Cost aside, these are the areas of importance during the selection process:

- **Schedule:** quality and level of detail, how reasonable is the proposed timeline, are there evidence and visuals to support the proposal, etc.

- **Execution Plan:**
  - ***Project Management and Administrative Controls:*** organizational capability and structure, experience and management approach;
  - ***Organization and Key Personnel:*** organization charts, qualification of key personnel and subcontractors;
  - ***Engineering, Major Plant, Equipment and Fleet:*** quality and suitability of the engineering plan, details of the equipment and plant, details of the fleet;
  - ***Mining Method:*** details on grade control, blasting, stockpile handling, etc.
- **Facilities Plan:** location and layout of the facilities (storage, accommodation, offices, workshops, etc.), personnel transportation, security systems;
- **Health, Safety, Security, Environment and Community (HSSEC):**
  - ***The Plan:*** suitable and tailored to the site;
  - ***Health and Safety:*** testing and screening procedures, safety records, investigation procedures;
  - ***Security:*** employee identification, recording systems, vehicle permitting, etc.
  - ***Environment:*** all the procedures for substance management, handling and spill recovery, compliance with the project environmental management plan, reporting and recording systems;
  - ***Community:*** initiatives and contribution, management of non-local employment.
- **Material Management Plan, Logistics and Supply Chain:** shipping and tracking, customs clearance, warehousing, procurement and mobilization plan.
- **Industrial Relations Management, Subcontractors and Nationalization:** knowledge of the local labour regulations and employment laws, communication and management of the subcontractors, HR management, etc.

This list was extracted from a technical evaluation, which is used by the mining companies to evaluate the bidders, provided by Kenn Smart. In the technical evaluation that listed the points above, each one of them was assigned a different weight, the points with the most weight are Organization and Key Personnel, Engineering/Major Plants/Equipment/Fleet, Mining Method Statement and HSSEC Plan.

As it can be observed, all the points are very much in line with what a mining company needs to work out for the project regardless of whether they hire a contractor. There are also such aspects as HSSEC and nationalization that are heavily influenced by the region. This goes to show that the alignment of strategy and approach between the mine owners and the contractors and the adaptability and knowledge of the region of operation are crucial.

Another important consideration that was not mentioned in the list is ***Expertise***, which would entail the contractors' experience with the commodity, material type and volume of work undertaken previously. This is especially important, as mining projects are known to be full of surprises no matter how well-prepared one is, and this makes relevant experience especially desirable. The rest of the points would of course reveal whether a contractor is an expert, but it would take one to know one. It is therefore highly recommended to seek assistance from the experts in the field when in comes to auditing the bids.

In terms of contract negotiation, Marcel Damen, another independent consultant, has mentioned the following points to pay close attention to in a contract:

- **Rise and Fall:** during the contract term the prices for consumables, such as fuel, explosives, tyres, Ground Engaging Tools (GET) and spare parts can fluctuate, which can have a impact on the cost for the contractors, so it is important that the contractor gets compensated for increased costs via a Rise and Fall formula.
- **Variations:** normally variations only come into play when these are more than $\pm 10\%$ percent of the contract volume over the LOM, or when they necessitate a short term additional mobilisation of equipment; it is important to know how variations are being dealt with, so that the contractor can get proper compensation for additional work or types of work not agreed upon in the contract.
- **Termination:** can be for 3 main reasons - Default of Contractor, Default of Principal (mine owner) and Termination for Convenience (for the Principal); it is important to know what the obligations are for both parties under each type of termination.
  - ***Termination for Convenience:*** besides agreeing on the termination compensation, how the equipment on site is dealt with is also important, namely who has the access to the fleet after contract termination; in this case the mine owner and the contractor have different interests, the Principal might would want the equipment to stay on site, as the lead time can take up to 12 months, whereas the contractor would like to keep and mobilize the fleet to a new contract.

4 DATA PROCESSING AND CLASSIFICATION

There are as many opinions as there are people, and the mining industry is no exception. In fact, it is even more so due to the uniqueness of each project. Depending and due to all the factors listed in the previous chapter in Section 3.2, the experiences of the people working in the same field can be dramatically different.

A mining project is multidisciplinary in nature. Historically in the mineral industry there has been little exchange of information amongst different functions (in geological, mining, metallurgical, financial disciplines, etc.) during the evaluation of a new mineral venture. Such segregated approach has led to some poor investment decisions. Rarely a singe individual is knowledgeable in all the disciplines required to assess a new investment opportunity, so nowadays most of the organizations prefer to assign a multidisciplinary team to perform the task. [Fuerstenau and Han, 2020]

The purpose of this section is to survey the data collected from different disciplines, and hinging on the information from the previous chapter, analyze and synthesize it to produce a semi-quantitative framework as a guide not only for the mining companies but also the other stakeholders involved in the decision-making process.

4.1 INTERVIEWS AND QUESTIONNAIRES

4.1.1 Approach

The questionnaires (Appendix A) were created with the objective to find out whether there are standard practices in the industry when it comes to the selection process. With that in mind, here are the main points of the questionnaire design process:

- There were two versions of the questionnaire, one for the mining companies and another for the contracting companies;
- The questions were either multiple choice or short answer, both to simplify the task for the interviewee and to give a hint as to

what type of answers are asked for in case the phrasing of the questions fell short;

- The content of the questions were based on the initial understanding of the research topic and served as a good initiator for further discussions;
- The answers did not require sharing of any sensitive data (financial, strategic) in order to avoid such complications as having to sign non-disclosure agreements;
- There was not a single group of companies targeted in terms of size, location or commodity in order to receive a larger volume of responses;
- The target was to hold a call after receiving and reviewing the response for a more in-depth discussion and to clarify some answers if necessary.

4.1.2 Response Rate

There was a total of 30 companies contacted and over 40 people from those companies. There is a total of 12 responses received, 5 from the mining companies, 5 from contracting companies, and 2 filled out (1 mining company questionnaire and 1 contracting company questionnaire) by an independent consultant who has based the answers on the past experience. The list of the companies that have responded can be found in Section 2.5.3.

Although not all companies responded to questionnaire, some of the questions listed in the questionnaire were covered during the calls.

4.1.3 Questionnaires Response Summary

Table 4.1 and Table 4.2 list the questions to which 3 or more companies have given the same response. For each summary table there were 5 responses considered. The 6th response from the independent consultant was used for reference. In square brackets under the column "Most Common Answer" is the number of companies that has given that answer. If the number of same responses is lower than 5 and no alternative answers are given, it indicates that some of the companies either skipped the question or gave an unclear response. The items in each table follows the order of the questions in the questionnaires.

Mining Companies

Almost all the most common answers are identical to those of the reference response (independent contractor). The one different answer is for contract duration, the reference response is 5 years whereas 3 mining companies have listed less than 3 years. This could be due to the fact that it is in the interest of the mining companies to have a shorter contract, after which they can renegotiate the terms, change a contractor or switch to owner mining. Overall there are no responses that stood out particularly.

	Most Common Answer	**Other Answers**
Region of Operation	*Africa [4]*	*Americas, EU, Asia, Oceania*
Years of Experience	*>20 [3]*	*15-20*
Commodity	*Gold [5]*	*Silver, zinc, copper, lead, molybdenum*
Highest OPEX Contributors	*Fuel and labour [5]*	*Spare parts, explosives, consumables, equipment financing and ownership, equipment maintenance*
Equipment Depreciation Method	*Straight-line [3]*	
Owner vs. Contracting Financial Analysis	*At pre-feasibility and feasibility stage [3]*	*None*
Staff Composition	*In line with regional regulations [3]*	*Aim to be 100% local, preference to locals*
Favouring Contractors with Previous History	*Yes [4]*	*No*
Key Criteria for Contractor Selection	*Expertise, cost, commitment to HSE and sustainability [5]*	*Reputation and credibility*
Standard/Preferred Tendering Procedure	*Pre-qualification [3]*	*Open tender, preferred contractor*
Contract Duration	*<3 years [3]*	*Varies, 5 years*

Table 4.1: Mining companies' summarized responses

Contracting Companies

Similar to the mining companies' responses, the answer do not deviate from the reference response. There are, however, some answers that are not included in the summary table due to a low response rate. The last few questions in the contracting company questionnaire were designed to identify some industry trends through the expertise

of the contractors, as they are exposed to a larger number of mining operations. The only question that is listed is regarding the change in volume of work the contracting companies have received over the past 10 years. The other questions and responses:

- Are there any trends/common features in the mining companies and projects that employ mining contractors? Size of the operation, size of the company, complexity of the service, hiring a contractor for risk alleviation;
- Have the mining companies become more likely to hire mining contractors over the past 10 years? Two companies answered no change while two claimed more likely;
- Has the number of competitors changed over the past 10 years? Two companies answered that the number has remained the same but the companies have changed, two answered that there has been an increase, and one company stated decrease.

	Most Common Answer	**Other Answers**
Region of Operation	*Africa [5]*	*South America, Asia, Oceania*
Years of Experience	*>20 [4]*	*15-20*
Commodity	*Gold [3]*	*Wide range including coal, copper, diamonds, nickel, bauxite, iron ore*
Services Provided	*Complete mining process [5]*	*Maintenance, drill and blast, mine planning and engineering*
Highest OPEX Contributors	*Fuel and labour [3]*	*Equipment financing and ownership, spare parts*
Company Equipment Maintenance Strategy	*All/most maintenance conducted in-house [3]*	*Varies*
Staff Composition	*In line with regional regulations [3]*	*Aim to be 100% local, preference to locals*
Most Encountered Tendering Procedure	*Varies [3]*	*Open tender, preferred contractor*
Contract Duration	*5 years [5]*	*<3 years, 10 years*
Volume of Work over the Past 10 Years	*Increased [3]*	*Remained the same*

Table 4.2: Contracting companies' summarized responses

Mine Owners vs. Contractors Responses

Based on the responses the two sides seem to be mostly in agreement with each other. Although there was no particular focus on a region or commodity, most of the companies (both mining and contracting) are operating in Africa and working on gold projects. Both sides agree that fuel and labour costs are the highest contributors to the OPEX. They follow the same principle of hiring their personnel according to the regional regulatory demands but at the same time aim to hire a higher number of locals to have a positive impact on the local community.

The discrepancy is obvious on the contract duration, while 3 out of 5 mining companies claimed that the most common contract duration is less than 3 years, 4 out of 5 contracting companies stated 5 years. Based on the discussions outside of the questionnaire the most common duration is 5 years, but of course every project is unique. Another discrepancy not listed in the tables is penalties/rewards incentives in the contracts. While the mining companies say that in the current market it is common to have both penalties and rewards, the contractors have mixed responses, one even voiced that most of the time it is penalties only, and one needs to fight to include rewards in the contracts.

4.2 FRAMEWORK

The framework (Figure 4.2 and Figure 4.3) was developed to capture the key factors that should be considered during the decision-making process. It is not meant to serve as the ultimate tool to help the mining companies make the decision but should rather be used as a reference that captures the key elements in the decision-making process. After going through the framework, the companies can get an idea of where the project stands with respect to all the listed factors.

The framework is available both as a PDF document in which the user would have to calculate the points himself/herself and as an excel document in which the score is calculated automatically depending on the chosen answers.

4.2.1 Structure

The framework has been divided into sections I (Determining Factors) and II (Conditional Factors). The second section has also been divided into subsections – independent factors, company factor, risk

factors, contractor availability factor, geological factors and investment analysis factor. Each factor is accompanied by a number of questions, answers to which will dictate the outcome of the section or subsection. Each of the factors will also display a colour that indicates "owner mining", "contracting" or "conditional". The last one means that the conditions of the project do not favour either one owner mining or contracting.

The first section only lists three factors – company expertise, capital availability and internal availability of suitable personnel and workforce – while the second section is divided into subsections and lists the rest of the factors.

Section I: Determining Factors

The factors in the first section are critical in the sense that if the mining company does not satisfy any of the three, their only option would be to go for contracting, and moving on to the second section is no longer necessary.

As seen, in the first section none of the factors display "owner mining" in the colored boxes. The first section can be viewed as the test to see whether the mining company satisfies the conditions to further consider owner mining as an option. Only upon receiving the orange colour that indicates "conditional", should the user proceed to the following section.

All three factors in this section can be attributed to the size and history (age) of the company; however, breaking them down is necessary for the purpose of conducting a quantitative analysis and to capture as many project scenarios as possible.

Company Expertise

This factor looks into whether the mining company has had any prior experience running and managing a project, especially the mining aspect. Furthermore, it asks whether those projects took place in the same region as the location of the upcoming project and whether it was of the same commodity. The question about previous mining projects carries the most weight, while the other two would further add point to give the mining companies a pass to consider owner mining. Having conducted mining projects in the same region indicates a certain level of familiarity with the regulations and socio-political scene of that region, while mining the same commodity means familiarity with the material type, its handling as well as the market.

Although it is possible for a junior company with no prior experience to take up mining themselves, their focus is often exploration and shifting resources and time into an unfamiliar field of work leads to

higher risks. Without prior relevant experience of running a mining project and doing the earth-moving, the outcome would favour hiring of a mining contractor.

Capital Availability

The factor is accompanied by a few guiding questions (in grey italics), those that do not influence the outcome but are merely meant to refer the users to a certain direction of thinking. In general, the larger more experienced companies are able to generate cash flow from their already existing projects, while the junior companies do so by issuing new shares. It is also easier for large well-established companies to borrow money from financial institutions. However, in the end it all leads to whether the company is able to generate enough capital for the initial investment, regardless of the means. If the initial investment is lacking, the mining company has the option of hiring the contractor and making payments on regular basis as opposed to paying a lump sum for the mining equipment.

Qualified and Capable Personnel and Workforce

Similar to the capital availability factor, this one also has a couple guiding questions. Here the company should consider whether it can bring enough qualified and capable personnel and workforce into the project, from the already existing pool of employees. If not, is the company able to or willing to source the personnel locally, here it is also important to consider the mining regulations and the labour laws of the region. Essentially it sums up to whether the company is willing or able to bring in or hire the mining personnel. If this is not an option, hiring a contractor would resolve the issue.

Section II: Conditional Factors

The factors in the second section are conditional in the sense that even if the outcome in one of the subsections turns out to be either favouring contracting or owner mining, it is not the definitive choice, and the mining companies should take into consideration the outcomes of the other subsections as well.

In this section the outcomes of each factor can be coloured either green (“favouring owner”)/yellow (“depends on other factors”) or blue (“favouring contracting”).

Some of the factors were grouped to form subsections; in some cases only one factor was attributed to a subsections, whereas others have multiple.

Independent Factors

All the factors under this section are pre-coloured as yellow, which means the mining companies should refer and consider the rest of the factors. Instead of questions, each factor has an explanation as to why these factors should not be indicative of the final decision.

These factors were based on the conversations with the mining companies. It has come up that a company could favour one or the other option due to the past experience, either in regards to the previous cooperation with contracting companies or in regards to whether a mining company has always conducted owner mining or has always hired a contractor (often related to the company's internal policies). In case the mining company has had a negative experience with a particular contracting company, further cooperation is indeed unlikely, especially given the fact that success of the joint venture is heavily reliant on the dynamics between the parties. This, however, should not indicate complete elimination of the contracting option. In regard to a mining company having always conducted owner mining, while this shows that the company has extensive experience in mining, hiring a contractor whose sole focus is mining – meaning focusing on efficiency and productivity – has the potential of adding value to the mining company.

Lastly, as discussed in the Section 3.4.2, the price listed in the bid is not always indicative of a contractor's aptitude, willingness to take up the project and understanding of the project.

Company Factor

Mining companies' core competencies include but are not limited to exploration, grade control, mining, processing and management. Some larger companies might have several. There are two questions listed under this factor, to distinguish between having mining as a core competency and treating mining as a top priority, meaning not only allocating enough resources but also continuously making improvements. This distinction mainly addresses the large mining houses that might be focusing on a number of core competencies at the same time. In such a case there might be a tendency to overlook certain inefficiencies in the mining activities as long as the targets are reached.

Risk Factors

The factors listed under this category are the main identified risks that a mining company might face while starting a new mining project. To begin with, it is advised that a mining company familiarizes itself with the regional socio-political situation and the mining regulations of the region. In case the company is not familiar, there is the option of hiring a local contractor that knows how to navigate them. The second factor can be considered as a particular scenario related to the

first factor. While most of the countries where mining exists has a set of mining regulations, in some countries they are more stringent than in others. For example, the law might dictate a certain number or ratio of the local workforce hired for the project, in which case the mining company can opt for hiring a contractor to fulfill the requirement instead of going through the hiring process for each employee individually.

The last factor under the risk category covers the economic and socio-political outlook in the industry. The time period has been set to be the upcoming 5 years due to the contracts most commonly lasting for 5 years. Hiring a contractor would help the mining company alleviate those risks.

Contractor Availability Factor

This category investigates whether there are any suitable contractors available. Ideally, there would be a number of contractors for the mining companies to select from. A suitable contractor is one that has the relevant experience (operating in the same region and mining the same commodity) and that has shown interest through means of communication as well as a detailed well-thought-out bid.

Geological Factors

This category focuses mainly on the geological variations of the ore-body and the material surrounding it and whether the mining company has the capacity to tackle these variations. As discussed in Section 3.2.2, a production schedule that offers the maximum NPV can have fluctuations in the mining rate, which means a varying size of the fleet. If the company performs owner mining, it purchases its own fleet, which cannot increase and decrease in size as per demand, whereas a local contractor has the flexibility to mobilize their entire fleet to accommodate the fluctuations.

The second factor is specifically targeted at the overburden. If there is a variation in the stripping ratio, the mining company can hire a contractor to remove the overburden for the same reason as mentioned above, while the mining company itself mines the ore.

Investment Analysis Factor

The factor takes into consideration the LOM and the expected useful life cycle of the machinery. The useful life cycle of the machinery is measured in hours but can generally be considered 8-10 years. The idea is that if the LOM is expected to be significantly shorter than the machine life cycle, the mining company might want to consider hiring a contractor and utilize its fleet, as not getting the full value worth of the mining fleet can be considered a financial loss, and selling the equipment after termination of the project might not be a convenient

option. Essentially, it is the question of whether equipment investment analyses project a positive return.

4.2.2 Scoring System

The scoring system of the framework was designed to categorize the outcome of each section rather than to reflect the weight of the factors. It does, however, to a certain extent reflect the importance of certain factors.

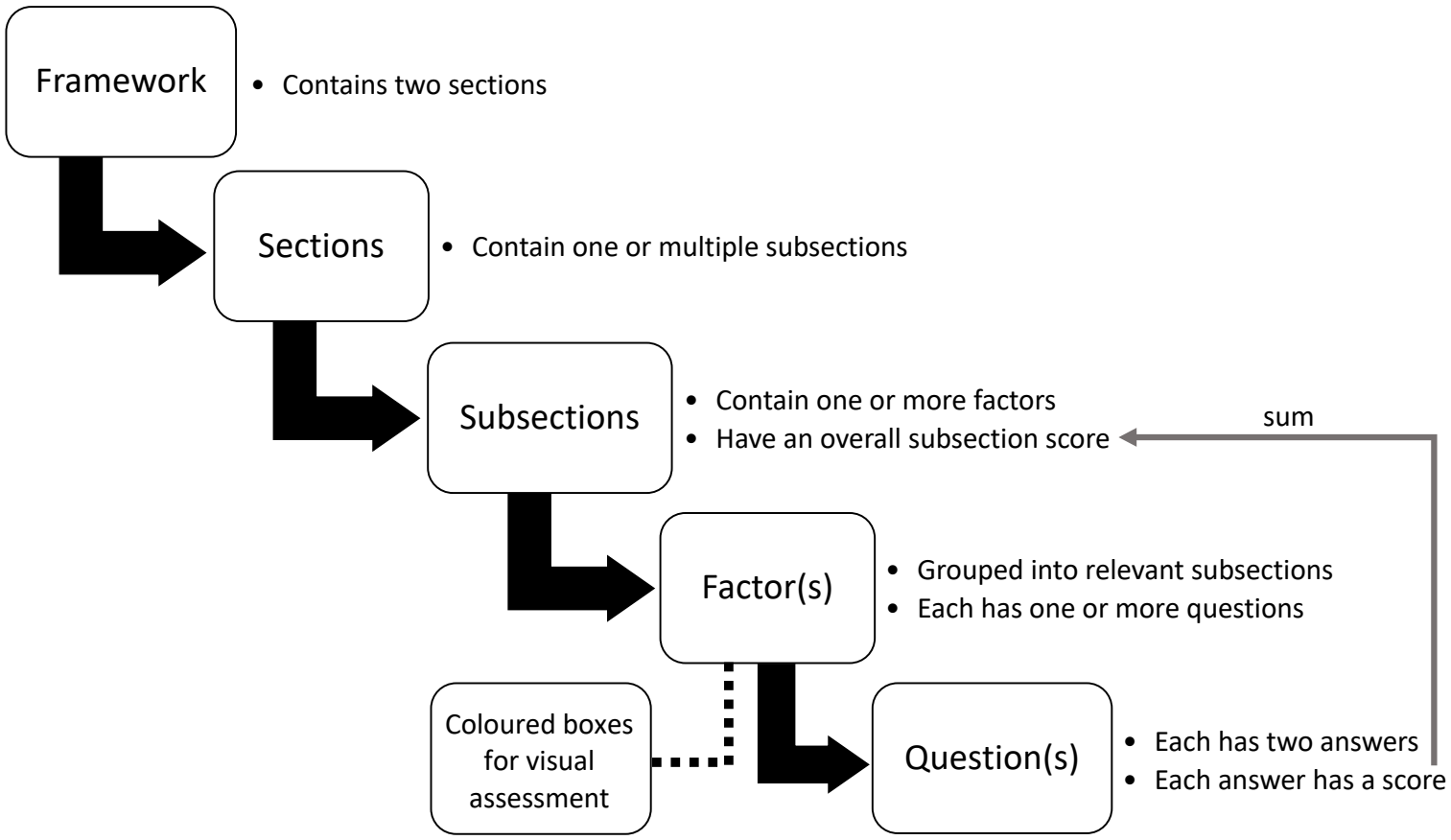

Figure 4.1: Framework structure and content diagram

As shown on Figure 4.1, each question only has two possible answers, and each answer is assigned a certain score.

These scores are then summed up for the subsection total. Each of the subsections has two or three possible outcomes, each one corresponding to a different score range. It can be seen in the framework itself that in general the negative answers (”no”/ ”negative”) carry a heavier weight (higher absolute value of the assigned score) than the positive answers. The system is set up in such a way that the negative scores favour contractor mining while the positive scores favour owner mining. It is important to distinguish between the two – negative answers and negative scores – as in some instances, for example “Stringency of mining regulations” under the “Risk Factors”, the positive answer (”yes”/ ”positive”) corresponds with a negative score. The heavier weighting on the negative scores reflects the fact that the conditions required to qualify for owner mining are stricter and more demanding towards the company.

There is no final overall score of all the subsections combined, An overall score would not be able to reflective of the conditions of the project, so the sum of each subsection should be assessed individually.

For example, a situation in which the outcomes of all the subsections is favouring owner mining and only one subsection, the ”Geological Factors” favour contractor mining. To be more specific in this example the particular factor that tips the scales towards contractor mining is the fact that there is a high stripping ratio that the company does not have the personnel or equipment capacity/flexibility to accommodate (can be found under factor ”Variations in the Stripping Ratio” under ”Geological Factors”). In this instance the overall score of the Section II of the framework can be 6, which according to scoring system favours owner mining. However, looking at each subsection individually, it might become obvious that the best option for the mine owner is to conduct owner mining while hiring a contractor to remove the large amounts of overburden. In other words, the final decision will still rely on the judgement of a professional. This examples can be found in Appendix B, Figure B.1.

To further showcase that the overall score cannot be reflective of the final choice: the overall score in Section II can range from -22 to 14. Again, the negative corresponds with contractor mining while the positive corresponds to owner mining. A scenario in which the mine owner might still opt for owner mining even with a heavy overall score of -18 is shown in Appendix B, Figure B.2. From the visual colour representation it can already be seen that there is predominantly blue colour (favouring contracting), but there is one cell in green (favouring contracting). In this scenario all the factors except

for "Contractor Availability Factor" point towards contractor mining; however, unavailability of suitable contractors cannot be overlooked. As discussed in Section 3.3.2, the suitability of a contractors plays a crucial role. in this case the mine owner might consider alternatives such as further searching for contractors and allocating more capital to bring in a reputable contractor from afar.

Section I: Determining Factors

In this section are the factors that will determine whether the mining company needs to hire a contractor for the project.

Please answer the questions and sum the points in the right column, then based on the sum (positive [+] or negative [-]) circle a coloured answer in the left column, if the sum is 0 for a particular factor leave the left column untouched. The left column will serve as a visual guide to the overall conditions of the project. In *grey italics* are the guiding questions that can be considered for that particular factor.

Note: if even one factor in this section receives a negative sum, moving on to the next section would not be necessary.

contracting	
conditional	

Company expertise				subtotal
	Has the company managed a number of mining projects previously?	yes (+1)	no (-3)	
	Were they in the same region as where the new project is located?	yes (+1)	no (0)	
	Were they of the same size and same commodity?	yes (+1)	no (0)	
experienced [+]	inexperienced [-]			
Capital availability				subtotal
	Does the company generate cashflow from its own projects? *Is the company generating income from issued new shares?*			
	Does the company have high credit rating? Is debt financing an option?			
	Can the company generate enough capital for the initial investment?	yes (+1)	no (-2)	
easily accessible [+]	limited [-]			
Internal availability of qualified and capable personnel and workforce				subtotal
	Is the company able to bring in qualified personnel from abroad? *Does the company have to hire locally? (mining regulations and labour laws)*			
	Is the company able to bring in and/or hire enough qualified and capable personnel?	yes (+1)	no (-2)	
available [+]	unavailable [-]			

(-7) - 2	the company does not meet one or more criteria, contractor mining should be considered	**total**
3 - 4	the company meets all the basic criteria to conduct owner mining but might need some guidance due to the lack of relevant experience	
5	the company meets all the criteria to conduct owner mining	

Figure 4.2: Framework Section I

Section II: Conditional Factors

favouring owner
favouring contracting
depends on other factors

In this section are the factors to be considered in the decision-making process, they do not necessarily determine if a contractor is needed.

This section follows the same principles as the previous section. Please note that some of the questions are dependent on the answer of the question preceding it.

Independent Factors

Previous history with the contractors		
none	positive	negative

Regardless of whether the company has worked with contractors previously, for the future projects both owner mining and contracting should be considered. However, if the company had a negative experience with any particular contractor, a future cooperation is not likely.

Previously the mining company always did	
owner mining	contracting

Regardless of whether the company has previously always conducted owner or contractor mining, for the future projects both options should be considered, especially if the company has only considered owner mining. If managed properly, contractors have the potential to add value to a project.

Contractors bids compared to company estimations	
lower price	higher price

The price listed in the bid should not be the deciding factor. The company should look into the details of the bid, such as the numbers used for the estimations and the equipment selection.

Company Factor

Company's core competencies	
mining [+]	else [-]

What does the company focus on?	mining (+1)	not mining (-1)	subtotal
Does the company allocate enough attention and resources to the mining activities?	yes (+1)	no (-1)	

-2	the company focuses on other areas such as exploration, grade control, processing, etc., it might find benefit in outsourcing the mining	total
0	mining could be one of the core competencies in the company, but the contractors can still be considered to maximize efficiency	
2	if the company's core focus is mining with enough attention on details (e.g. efficiency, productivity) owner mining is favourable	

Risk Factors

Company's familiarity with the region of operation	
familiar [+]	unfamiliar [-]

Is the company familiar with the socio-political situation in the region?	yes (+1)	no (-2)	subtotal
Is the company familiar with the mining regulations in the region?	yes (+1)	no (-2)	

Stringency of the mining regulations	
moderate [+]	strict [-]

Are there strict mining regulations in the region? (e.g. labour and HSSEC)	yes (-2)	no (+1)	subtotal
If "no", skip. If "yes", can the company navigate them without external assistance?	yes (+1)	no (-2)	

Economic and political outlook of the industry	
positive [+]	negative [-]

How is the industry's economic outlook in the following 5 years?	positive (+1)	negative (-2)	subtotal
How is the socio-political outlook in the region in the following 5 years?	positive (+1)	negative (-2)	

(-12) - (-3)	the company is facing a number of political/economic risks and should consider contractor mining to alleviate those risks	total
(-1) - (0)	the company is facing a couple of political/economic risks and can still consider contractor mining to alleviate those risks	
1 - 5	the company is not facing many risks	

Contractor Availability Factor

Availability and interest of a suitable contractor	
not present [+]	present [-]

Is there a number of reputable contractors with relevant experience?	yes (-1)	no (+1)	subtotal
Have they shown interest or enthusiasm to undertake the task? (based on communication and the bids)	yes (-1)	no (+1)	

-2	the conditions are met for further considering contractor mining	total
0	there is a limited numbers of contractors to select from or the companies have not shown much interest, assess the situation carefully	
2	there is no reputable contractor who has shown enthusiasm in the project, owner mining should be favoured	

Geological Factors

Fluctuations in the mining rate	
no [+]	yes [-]

Does the optimal production schedule call for fluctuations in the mining rate? (in terms of max. NPV)	yes (-1)	no (+1)	subtotal
If "no", skip. If "yes", does the mining company have the personnel and equipment flexibility to accommodate the fluctuations?	yes (+2)	no (-1)	

Variations in the stripping ratio	
no [+]	yes [-]

Does the stripping ratio vary throughout the orebody?	yes (-1)	no (+1)	subtotal
Is there a high stripping ratio?	yes (-1)	no (+1)	
If "no" for both, skip. If "yes" for either question, does the company have the personnel and equipment capacity and/or flexibility to handle the waste removal?	yes (+3)	no (-1)	

(-5) - 0	the company does not have enough equipment/personnel flexibility to accommodate the geological fluctuations, contractors might help	total
2 - 4	there are no fluctuation in the mining rate and stripping ratio, or the company is able to accommodate the changes without external help	

Investment Analysis Factor

LOM and equipment lifecycle	
> equipment lifecycle [+]	< equipment lifecycle [-]

Is the company acquiring brand new equipment?			subtotal
Is the LOM longer than the expected useful lifecycle of the equipment?			
If the company purchases its own fleet, does the equipment investment analysis show positive return?	yes (+1)	no (-1)	

1	purchasing a mining fleet shows positive return, the option is feasible but should still consider if this is the optimal way to allocate capital	total
-1	purchasing a mining fleet will result in negative return, the company should consider hiring a contractor to provide the fleet	

Figure 4.3: Framework Section II

5 CASE STUDY: SOUTH AFRICA

A trip to South Africa was organized in September of 2019. At this point there was already a good grasp of the owner vs. contractor mining dynamics in the industry.

This chapter will discuss the observations made during the site visits and the outcomes of the in-person discussions that took place during the 6-day visit.

5.1 OBJECTIVE AND TIME LINE OF THE VISIT

The goal of the visit to South Africa was to get an opportunity to speak to relevant people in-person and gain further insight into the topic, gain a different perspective and relate the already acquired information to the on-site observations. The visit involved in-person conversations with both mine owners and contractors, as well as discussions with independent consultants.

5.1.1 Timeline

During the four days of visit to South Africa various meetings were organized with mining professionals from Moolmans and Barloworld Equipment, as well as site visits to the Tshipi Borwa Manganese Mine and the Sishen Iron Ore Mine. For a detailed trip itinerary refer to Appendix C.

5.1.2 Information about The Contacts

Moolmans

Aveng Group has core business activities in construction and engineering in Australia and Asia (McConnel Dowell) and also mining. Moolmans is the mining division of the company. In 2018 Moolmans' net operating earnings made up 15% of that of the entire company, and 17% in the first half of 2019. [Aveng, 2018, 2019]

Moolmans' work at the Tshipi Borwa mine started out at as a greenfield contract in 2011 where it was responsible for establishing the initial open cut. In 2016 due to the downturn in the manganese price the contract was reduced but has since recovered, the contract has been extended into 2020 and Moolmans is providing full mining service including bush clearing, top soil stripping, drilling and blasting, loading and hauling of ore and waste.

The contractor's work in the Sishen Mine started in 2006, which means they have experienced a couple full commodity cycles on the mine. The last renewal of the contract happened in 2017, and the work entails waste removal, load and haul, construction of the haul roads and undertaking of the dump rehabilitation activities. [Moolmans, 2020]

Barloworld Equipment

Barloworld Equipment is the Caterpillar dealer in Africa, the countries include Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland and Zambia. Barloworld sells a full range of Caterpillar mining equipment, it also sells certified used equipment, does equipment rental and offers such services as machine rebuild and machine maintenance. [Barloworld Equipment, 2020]

Mine Owner

The call was held with the owner of a new chrome mine. The project was past the pre-feasibility and feasibility stage and was at the time working on mine optimization. The LOM of the mine is expected to be 10 years, the mining method if open pit. The owner has also conducted a contractor vs. owner feasibility study and has in the end opted for contractor mining. The tendering process was chosen to be preferred/selected contractor (more information about this tendering process can be found in Section 3.4.1). This scenario will be discussed in more detail in Section 5.3.

Mining Professional

There was no explicit information shared about the experience of the mining professional, it is however known that the person has had extensive experience working in the mining industry in South Africa and is familiar with how both the mine owners and the contractors conduct mining activities as well as the intricacies of managing a contract.

5.2 OBSERVATIONS AND DISCUSSIONS

Many interesting stories and opinions were captured during the conversations. This section intends to summarize and highlight the key outcomes of the discussions.

5.2.1 The Mining Charter

The Mining Charter was by far the most-mentioned topic during the conversations. Very soon it became apparent that the introduction of the new Mining Charter in 2018 has greatly affected the mining industry in South Africa on all levels.

The commonly known Mining Charter also known by the name of The Broad-Based Black Socio-Economic Empowerment Charter for the South African Mining and Minerals Industry, which is more representative of the intention of its implementation. The new document was designed to redress the historical inequalities inherited by South Africa's democratic governments. The racial segregation in South Africa started in 1948, and despite the strong opposition to Apartheid, the laws remained in effect for the next 50 years. [Larson, 2019]

The Charter was first developed in 2002 and later amended in 2010. The final version released in September of 2018 was preceded by two draft charters that were transformed in accordance with the realities of the mining industry. [Deloitte, 2019]

The Charter calls for implementation of:

- Ownership;
- Mineral beneficiation;
- Inclusive procurement, supplier and enterprise development;
- Human resources development;
- Mine community development;
- Employment equity;
- Principles for housing and living conditions standard. [Department of Mineral Resouces of South Africa, 2018]

The two main areas in which the empowerment of the Historically Disadvantaged Persons (HDP) are reflected in are Ownership and Employment Equity. The new mining rights are required to have a minimum of 30% Black Economic Empowerment (BEE) shareholding. The pending applications must comply with the requirements outlined in the initial 2010 Charter, which is 26% BEE shareholding and have 5

years to increase it to 30%. In the Employment Equity section the fairness of opportunities at the workplace is promoted through diversification of employees. The targets have increased and the inclusion of black females was introduced. The compliance target has been set to 30% across all functions, including the board, executive/ senior/ junior management, employees with disabilities and employees with core and critical skills. [Deloitte, 2019]

During the discussions the topic raised a lot of controversy. While the new Charter has only been implemented for a year, the professions in the industry have already felt the effect. One of the comments was that the new regulations and raised targets have discouraged some businesses to enter the market due to the increased difficulty of starting a mining project, this in turn means less jobs for the contracting companies. Another point raised is that the Charter is ”too demanding” and ”too explicit” in contrast with the rest of the regulations in the country. Overall the impression received was that the industry professionals were skeptical about whether the new laws will do more good than harm to the industry, in the sense that whether the Charter will utilize the full potential of the country's mineral resources while introducing positive changes. However, it requires time to make such a judgement.

The laws have also affected mine owner's selection process of a suitable contractor. The Charter has made the mine owners look at more contractors and conduct stricter screening process to make sure that they will later be cooperating with a contractor that is fully compliant with the regulations.

5.2.2 Reasons to Select Contractor Mining

There were three main benefits that mine owners see in hiring a contractor:

- No fleet maintenance;
- No hiring;
- ”Momentary cancellation” (termination of the contract).

The first point ties in with the demanding mining regulations in the region. There are regular random safety inspections conducted on site. An experienced contractor would be more familiar with the regulations.

The second point is very much the result of the Charter. The contractor would be responsible for hiring all the personnel in accordance with the laws. Given the lack of highly skilled workers for certain functions, a contractor will save a lot of work for the mine owner.

The last point is related to the risk of industry downfall. The fact that the mine owner can terminate the contract at any point is seen as a major risk alleviation factor. It was noted during the discussions that the risks have been shifting more towards the contractors in the recent years.

5.2.3 Automation in the Mining Industry

As discussed in Section 3.3.4, automation in mining is now a globally trending topic. The discussion outcome skewed towards automation being difficult to implement in the South African mining environment. One of the reasons is that the companies might have promised the government to provide a certain number of jobs, whereas automation might mean a potential loss of jobs. A point was raised that perhaps introducing automation already at the start of the mining project will make it more feasible, as cutting down on staff is no longer the issue. While this is true, another concern would be lack of skilled personnel, as an automated mine might have higher technical requirements towards the employees.

5.2.4 Relationship between Mine Owners and Contractors

There were several examples of how misalignment of goals and miscommunication can lead to conflicts between the two parties. One of the examples is the mine owners demanding the contractors use OEM parts to ensure that there will be no issues during safety inspections conducted by the regulatory body. This, however, was not agreed upon while the contract was signed. While the capital cost of purchasing the original parts is higher, the quality has the potential to save cost in the long run. In the situation described purchasing OEM spare parts would not have been in alignment with the financial strategy of the contracting company. Another example of a conflict ironically arises from a long-term trusting relationship between the two parties. During the renewal of a contract the terms were not outlined in the new contract out of complacency, and when the disagreement happened between the two parties, there was no official documentation to refer to to settle the argument.

5.3 SCENARIO ANALYSIS

This section will analyze the new chrome mine described in Section 5.1.2 in the context of the framework. Certain information about

the mine is already known, but for some factors in the framework the assumptions have to be made. The framework will be filled out with the assumption that the final decision of the mine owner is unknown.

5.3.1 Framework Section I

In order to proceed to Section II of the framework, the user needs to first get a pass in Section I. For the purpose of this exercise, we will assume that the mine owner satisfies all the conditions to proceed to the following section. In other words, make the assumption that all the answers in this section have a positive score, so the answers to all the questions except for the second and third questions in factor "Company Expertise" have to be "yes".

5.3.2 Framework Section II

Figure 5.1 is the the completed second section of the framework with all the scenario assumptions that are explained below.

Company Factor

Given that in Section I all the answers were positive, it is automatically assumed that the company has had extensive experience in mining. So under the "Company Factor" it will be assumed that the company's core competency is indeed mining. It is also assumed that the company allocates enough resources and attention to the mining activities.

Risk Factors

Following the assumption of an experienced mining company, it is also assumed that it is familiar with the socio-political situation and the mining regulations of South Africa. The mining regulations in the region are strict, but the company knows how to navigate them ("Stringency of Mining Regulations"). As of March 27th 2020 Moody's Investors Rating Service has downgraded South Africa to Ba1, indicating a negative outlook, which reflects the risk that economic growth will prove even weaker and the debt burden will rise even faster and further than currently expected, weakening debt affordability and potentially, access to funding [Diron and Villa, 2020]. The socio-political outlook in the industry will likely take more than 5 years to improve.

Contractor Availability Factor

Given the company has conducted a feasibility study on owner vs. contractor mining and has opted for the latter, it is safe to assume

that there are reputable contractors in the region who have shown enthusiasm for the project.

Geological Factors

There was no information shared about the geology of the deposit. For the simplicity let's assume that there are no fluctuation in neither the mining rate nor the stripping ratio.

Investment Analysis Factor

It is known that the LOM of the mine is 10 years, this is slightly more than the average expected useful life of mining equipment (approximately 8 years). There is no way of knowing for certain whether the fleet investment analysis shows positive return, but the fact that the LOM is nearly equal the machine lifetime makes it more likely for the investment analysis to indicate positive return.

Section II: Conditional Factors

favouring owner
favouring contracting
depends on other factors

In this section are the factors to be considered in the decision-making process, they do not necessarily determine if a contractor is needed.

This section follows the same principles as the previous section. Please note that some of the questions are dependent on the answer of the question preceding it.

Independent Factors

Previous history with the contractors		
none	positive	negative

Regardless of whether the company has worked with contractors previously, for the future projects both owner mining and contracting should be considered. However, if the company had a negative experience with any particular contractor, a future cooperation is not likely.

Previously the mining company always did	
owner mining	contracting

Regardless of whether the company has previously always conducted owner or contractor mining, for the future projects both options should be considered, especially if the company has only considered owner mining. If managed properly, contractors have the potential to add value to a project.

Contractors bids compared to company estimations	
lower price	higher price

The price listed in the bid should not be the deciding factor. The company should look into the details of the bid, such as the numbers used for the estimations and the equipment selection.

Company Factor

Company's core competencies	
mining [+]	else [-]

			subtotal
What does the company focus on?	mining (+1)	not mining (-1)	
Does the company allocate enough attention and resources to the mining activities?	yes (+1)	no (-1)	2

-2	the company focuses on other areas such as exploration, grade control, processing, etc., it might find benefit in outsourcing the mining	**total**
0	mining could be one of the core competencies in the company, but the contractors can still be considered to maximize efficiency	**2**
2	if the company's core focus is mining with enough attention on details (e.g. efficiency, productivity) owner mining is favourable	

Risk Factors

Company's familiarity with the region of operation	
familiar [+]	unfamiliar [-]

			subtotal
Is the company familiar with the socio-political situation in the region?	yes (+1)	no (-2)	
Is the company familiar with the mining regulations in the region?	yes (+1)	no (-2)	2

Stringency of the mining regulations	
moderate [+]	strict [-]

			subtotal
Are there strict mining regulations in the region? (e.g. labour and HSSEC)	yes (-2)	no (+1)	
If "no", skip. If "yes", can the company navigate them without external assistance?	yes (+1)	no (-2)	-1

Economic and political outlook of the industry	
positive [+]	negative [-]

			subtotal
How is the industry's economic outlook in the following 5 years?	positive (+1)	negative (-2)	
How is the socio-political outlook in the region in the following 5 years?	positive (+1)	negative (-2)	-4

(-12) - (-3)	the company is facing a number of political/economic risks and should consider contractor mining to alleviate those risks	**total**
(-1) - (0)	the company is facing a couple of political/economic risks and can still consider contractor mining to alleviate those risks	**-3**
1 - 5	the company is not facing many risks	

Contractor Availability Factor

Availability and interest of a suitable contractor	
not present [+]	present [-]

			subtotal
Is there a number of reputable contractors with relevant experience?	yes (-1)	no (+1)	
Have they shown interest or enthusiasm to undertake the task? (based on communication and the bids)	yes (-1)	no (+1)	-2

-2	the conditions are met for further considering contractor mining	**total**
0	there is a limited numbers of contractors to select from or the companies have not shown much interest, assess the situation carefully	**-2**
2	there is no reputable contractor who has shown enthusiasm in the project, owner mining should be favoured	

Geological Factors

Fluctuations in the mining rate	
no [+]	yes [-]

			subtotal
Does the optimal production schedule call for fluctuations in the mining rate? (in terms of max. NPV)	yes (-1)	no (+1)	
If "no", skip. If "yes", does the mining company have the personnel and equipment flexibility to accommodate the fluctuations?	yes (+2)	no (-1)	1

Variations in the stripping ratio	
no [+]	yes [-]

			subtotal
Does the stripping ratio vary throughout the orebody?	yes (-1)	no (+1)	
Is there a high stripping ratio?	yes (-1)	no (+1)	
If "no" for both, skip. If "yes" for either question, does the company have the personnel and equipment capacity and/or flexibility to handle the waste removal?	yes (+3)	no (-1)	2

(-5) - 0	the company does not have enough equipment/personnel flexibility to accommodate the geological fluctuations, contractors might help	**total**
2 - 4	there are no fluctuation in the mining rate and stripping ratio, or the company is able to accommodate the changes without external help	**3**

Investment Analysis Factor

LOM and equipment lifecycle	
> equipment lifecycle [+]	< equipment lifecycle [-]

			subtotal
Is the company acquiring brand new equipment?			
Is the LOM longer than the expected useful lifecycle of the equipment?			
If the company purchases its own fleet, does the equipment investment analysis show positive return?	yes (+1)	no (-1)	1

1	purchasing a mining fleet shows positive return, the option is feasible but should still consider if this is the optimal way to allocate capital	**total**
-1	purchasing a mining fleet will result in negative return, the company should consider hiring a contractor to provide the fleet	**1**

Figure 5.1: Scenario analysis with Section II of the framework

5.4 DISCUSSION

Starting with the colour indicators, there is one cell coloured in green (favouring owner mining) under the ”Company Factors” and two cells coloured in blue (favouring contractor mining) under ”Risk Factors”.

Having mining as a core competency does not necessarily conflict with hiring a mining contractor. In a scenario where the mine owner does not allocate enough time and attention to the mining activities hiring a contractor could still bring value even if mining is the company's core competency.

The assumptions made for the risk factors were based on the current situation in South Africa. The project is facing economic and social instability in the region, along with strict mining regulations, which would categorize the project as high risk.

Taking all factors into consideration, the recommendation for this mining project would be to hire a contractor to alleviate the risks, although in all other factors the project satisfies the conditions to conduct owner mining.

The economic forecast of South Africa has changed by the end of 2019. A source from 2019 has showcased that the economic outlook of the mining industry in the following 5 years in South Africa is considered to have great growth potential [Goodman et al., 2019]. Had the outlook remained the same, the recommendation for the project would have been owner mining. This shows that the risk factors can fluctuate and have a great influence on the choice between owner and contractor mining. It is also important to note that such a change can happen at any stage of the project.

All these assumptions were based on one premise that the company is experienced, has enough capital for the initial investment and has enough qualified and capable personnel. In reality it is also possible that the company does not satisfy one out of the three requirements, which means the framework assessment would already terminate at Section I, indicating that the company should opt for hiring a contractor.

6 DISCUSSION AND CONCLUSION

6.1 DISCUSSION

The research was conducted to assess the factors involved in the decision-making process while choosing between contractor vs. owner mining. This was done by means of identifying all the factors relying on the academic sources, then selecting the key factors relying on the knowledge and expertise of the industry representatives, then finally synthesizing the findings into a framework that can be used to assess whether a company should opt for contractor or owner mining.

The framework was then populated with the information about a new chrome mine in order to test the functionality of the framework and representativeness of its outputs. While the output of the framework can only be discussed on project-specific basis, there are some aspects of the framework itself that deserve special attention. The purpose of the discussion in this section is to assess how well the framework was able to capture the complexities revolving around a mining project and what significance it will bring to the mining industry.

6.1.1 Definitive Answers

In order to extract a definite or semi-definite answer from a list of questions the answers to which are not always black and white, the framework had to rely on categorization that is based on common sense as well as simplification of certain concepts. As an example, the very first factor in Section I of the framework asks about the company expertise. While it might be straightforward for a company with 10, 20, 30 years of mining experience to answer a definite "yes", for a junior mining company with a mining team consisting of professionals who have had years of experience working in different mines with different commodities, the answer might not seem as straightforward.

In such a situation the framework would require the user to understand the purpose and the essence of the question asked, which in this particular case is whether the company has the expertise and the knowledge for the project. This is only one example of how the frame-

work might not capture all the possible scenarios that are relevant and might have an impact on the final outcome. Such categorization can be observed throughout the entire framework. While it is possible to introduce as many identifiable scenarios as possible to make the questions and the answers more explicit, this would defeat the purpose of the framework, which is to give an overview of where the project stands in regard to selecting between the two options.

6.1.2 Weighing Scheme

The weighing in the framework turned out to focus on the contractor vs. owner mining rather than the factors themselves. Some of the answers have "inherited" a heavier weight due to the role they play in the framework – often to outweigh the other factors so the overall score becomes more positive or more negative. As discussed in Chapter 4, this "bias" of having heavier negative or positive points in certain factors is introduced to reflect the fact that the owner/contractor mining conditions are easier/harder to satisfy for certain factors.

6.1.3 Significance for the Industry

The framework was first and foremost designed for the mining companies to assess the project in the context of owner vs. contractor mining. It can, however, also bring value to the service and equipment providers of the mining industry. This section will discuss the significance to each of the industries.

Mining Companies

The mining companies are the most "obvious" user of the framework, whether it is a large mining house such as Rio Tinto or BHP Billiton or a junior mining company focusing on exploration. The framework provides an overview of the project regardless of the stage the project is undergoing – PFS/FS, whether the mine owners already have a contractor and are considering changing to owner mining or switching a contractor or the mine needs to transition into underground operations. Of course, at different stages of the project the level of confidence of the information varies, specifically having a relatively lower level of confidence at the PFS/FS stage and higher at the other two scenarios as the mine would have already been in operation. It is expected that the framework would bring more weight at the PFS/FS stage, as it has the capacity to stir the decision one way or another before the productions start, whereas this might be more difficult when the mine has already been in operation for an extensive period of time. However, in the latter case the framework is able to provide a

structured overview and highlight the points that have not previously been considered.

Contracting Companies

A contracting company can use the framework for identifying the potential clients. Given a contracting company possesses certain information about a potential mine, it is able to assess the likelihood of the mine owner opting for contractor mining, and if the information required to fill in the framework has not been acquired, yet, the factors listed in the framework will give an indication of the type of information to look for. Furthermore, if a contractor has an opportunity to speak to a client regarding an upcoming project in which contractor mining has been identified to be the more suitable method, the contractor can utilize the framework to guide the client through the reasoning in a constructive and structured manner.

OEM

The significance of the framework for the mining OEM's is similar to that for the contracting companies – identification of potential clients. In case a mine owner decides to hire a contractor or partially outsource the mining, the OEM's target client for the mining project would be not only the mining company but also the hired contractor, as it will be making the decisions on machines purchases. To take it a step further, if the OEM is able to get early involvement in a project and consult the mining client on the decision on whether to outsource the mining part, it might have a head start in approaching the appropriate customer for future machine sales.

6.2 RECOMMENDATIONS

In the process of creating the framework the intention was to capture as many relevant factors as coherently as possible. There is, however, potential to develop and improve it further to increase the significance and the relevance of the outputs.

Firstly, through more frequent usage of the framework by different parties more factors that are considered to have the same level of significance as the ones already listed might be identified. In such situation it is important to classify the factor applying the same logic as was used to categorize the current factors, to see how the new factor fits in with the rest, whether it will have a category on its own or fall under one of the existing categories. As an example, more factors can potentially fall under the "Investment Analysis" category, especially given that there was limited financial data and limited information

relating to financial analysis methods available during the research process.

Secondly, the weighting of the factors can be fine-tuned through input of more data into and through the framework. In order to capture a wider range of information there was a large number of companies contacted, from various spheres of the mining industry. On one hand this means that the framework was able to capture and incorporate a wider range of expertise, but on the other hand this has also limited the amount of details shared by the industry due to information confidentiality. This can be overcome if a company sources such data internally to then be absorbed by the framework. As an example, an experienced mining company can look into the past projects and review how the decision of owner vs. contractor mining was made, whether most or all of them followed certain guidelines and if there is/are factor(s) that were critical to a certain project.

Lastly, the previous recommendation can be taken a step further. The spectator can try to identify if a certain factor critical to the decision had more significance at one stage of the decision than at another, and whether this is consistent through various projects. For example, if availability and interest of a suitable contractor was deemed to be of greater importance after the start of production than it was during the PFS/FS stage. It can be assumed to be the case as after the start of the production the mine owner and the contractor could face a conflict of interest significant enough for the mine owner to reconsider its future decisions. This can potentially lead to a greater weight placed on the factor to emphasize its importance for it to not be overlooked by the user.

6.3 CONCLUSION

The conclusion intends to answer and elaborate on the research questions outlined in Section 2.3.

It is assumed that the mining companies conduct a thorough investigation of all the factors involved before making the decision. While every factor plays a role and is linked to another to then cascade into the final decision, the following are the key factors identified in this research that were then reflected in the framework:

- Company factors (expertise and availability of capital and personnel/workforce);
- Geology of the deposit;
- Risks involved;

- Availability of suitable contractors;
- Project financial model and investment analysis.

All the above-listed factors, except for the geology of the deposit, are variable over time, some more than others. For example, expertise of a company is cumulative over time and is not necessarily dependent on the political and economic stability in the region, while the risk factors have a direct correlation to the stability on the region of operation. The political and economic changes in the region will in turn be reflected in the availability of the suitable contractors, capital availability and potentially personnel/workforce availability for the project, and the changes in the risk factors will inevitably be reflected in the projects' financial models as well as the investment analysis.

One of the key purposes of this research was to qualitatively and quantitatively analyze the identified factors when possible. While all of the above-listed factors are qualifiable and were classified and integrated into the framework, none was analyzed quantitatively. More explicit financial data would be required for quantitative analysis.

Another goal set in this research was to assign weighting to each factor based on their significance in the decision context. With limited amount of empirical data it is difficult to assign explicit weighting. However, inclusion of certain factors in the framework and their classification into the two sections (I and II) to an extent indicates the significance of each.

When it comes to the mining company following certain guidelines to make the decisions, it was clearly established through this research that there is no one particular method that is commonly used in the industry. Some companies have more quantitative, consistent and reason-based approaches that can be catered to each mining project, while on the other end of the spectrum a company might base it purely on its past experience (i.e. owner/contracting is how the company has done it in the past, hence we choose the same method for the next project as well).

It was also established that the mine owners and the contractors often encounter difference in opinions. Operationally, this can mean how the mining activities and equipment maintenance is conducted. The conflict of interest is often present, as it is natural for the two parties to protect their own interests, but how, if at all, the conflicts are resolved and how the parties reach consensus depends on their relationship and is always case-specific.

Through this study it was also established that the theory often deviates from practice. What is suggested in the mine plan in the FS is not always brought into reality. The mining companies often have to be dynamic and ready to make changes and adjustments as the

mining project progresses, as there are often unforeseen difficulties, such as having to cope with the mistakes made in the estimations, socio-political changes and/or conflicts with the contractors.

Overall this research has shown that the factors influencing the decision between owner and contractor mining can be and should be analyzed and classified. While it is not likely for the entire mining industry to follow the same guidelines for the decision-making process, the goal should be for all the parties involved to have a common understanding of the topic, which should in turn result in more sound decisions.

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A QUESTIONNAIRES FOR MINING AND CONTRACTING COMPANIES

Master's Thesis: Mining Company Questionnaire

Company Representative

Company Name: _____ Date: _____

Company Representative Name: _____

Company Representative Title: _____

Questions

1. In which region(s) does the company operate?
   - ☐ North America ☐ South America ☐ Central America ☐ the Caribbean
   - ☐ Eastern Europe ☐ European Union ☐ Middle East ☐ Africa
   - ☐ Asia ☐ Oceania

2. In which region(s) are most of the operations?
   - ☐ North America ☐ South America ☐ Central America ☐ the Caribbean
   - ☐ Eastern Europe ☐ European Union ☐ Middle East ☐ Africa
   - ☐ Asia ☐ Oceania

3. How many years of experience has the company had in the mining sector?
   - ☐ <5 ☐ 5-10 ☐ 10-15 ☐ 15-20 ☐ >20

4. Number of operations:

5. Commodity mined:

6. How would you describe the risk profile of the company?
   - ☐ Risk-taking ☐ Risk-averse

7. Across all projects with the same commodity, is there a common cost distribution between mining and processing? If so, what is it (ratio mining: processing)?
   - ☐ Yes, please specify ☐ No, it varies greatly from project to project

8. Which items/elements usually contribute the most to operating mining costs?
   - ☐ Labour
   - ☐ Spare parts
   - ☐ Consumables, tyres, GET
   - ☐ Fuel
   - ☐ Explosives
   - ☐ Equipment finance and ownership
   - ☐ Overheads
   - ☐ Others, please specify

9. How much contingency is applied for mining-related cost calculations at/past the execution phase?

10. In projects where the company owns the mining equipment, which depreciation method is used?

11. Is there an average expected useful life for mining machinery?
    - ☐ No, varies greatly from project to project
    - ☐ Yes, please specify (including units)

12. Is there usually a financial analysis conducted for both owner mining and contracting for comparison purposes?
    - ☐ Yes, at the pre-feasibility stage
    - ☐ Yes, at the feasibility stage
    - ☐ Yes, at the execution phase
    - ☐ No
    - ☐ Varies from project to project

13. What software does the company utilize for fleet composition and cost analysis?

14. Is there a common maintenance strategy for company-owned equipment?
    - ☐ Yes, conduct all/most maintenance work in-house
    - ☐ Yes, conduct part of the maintenance work in-house
    - ☐ Yes, assign all/most maintenance work to contractors
    - ☐ No, varies from project to project
    - ☐ Yes, other

15. Does the company have internal regulations on staff composition (e.g. number of local vs. international employees)?
    - ☐ No, only in correspondence with the country labour regulations
    - ☐ Yes, please specify

16. Does there exist a tendency to hire contractors that the company has previously cooperated with?
    ☐ Yes ☐ No

17. Please check up to 3 key criteria in selection of contracting companies:
    ☐ Reputation/credibility ☐ Expertise
    ☐ Lead time ☐ Cost
    ☐ Commitment to HSE and sustainability
    ☐ Others, please specify

18. Is there a standard/preferred tendering procedure for mining contractors that the company applies to most projects?
    ☐ Yes – open tender ☐ Yes – pre-qualification
    ☐ Yes – preferred contractor (e.g. with existing agreement in place, for other projects)
    ☐ No, varies from project to project ☐ Yes – other, please specify

19. Is there a standard payment method?
    ☐ No, varies from project to project
    ☐ Yes, please specify

20. Is it common to have penalties or rewards based on the contractor performance?
    ☐ Yes – only penalties ☐ Yes – only rewards
    ☐ Yes – penalties and rewards ☐ No, not common
    ☐ No, varies from project to project

21. What is the common mining contract duration (years)?
    ☐ ≤3 ☐ 5 ☐ 10 ☐ Other, please specify

22. Is it common to make changes in the contract (e.g. price or conditions), termination of contract or change of contractors?
    ☐ Yes – changes to the contract ☐ Yes – termination of contract
    ☐ Yes – change of contractors ☐ No – it is unusual practice, only in extreme cases

Comments

Additional comments:

Figure A.1: Questionnaire for mining companies

Master's Thesis: Contracting Company Questionnaire

Company Representative

Company Name: _____ Date: _____

Company Representative Name: _____

Company Representative Title: _____

Questions

1. In which region(s) does the company operate?
   - ☐ North America
   - ☐ South America
   - ☐ Central America
   - ☐ the Caribbean
   - ☐ Eastern Europe
   - ☐ European Union
   - ☐ Middle East
   - ☐ Africa
   - ☐ Asia
   - ☐ Oceania

2. In which region(s) are most of the operations?
   - ☐ North America
   - ☐ South America
   - ☐ Central America
   - ☐ the Caribbean
   - ☐ Eastern Europe
   - ☐ European Union
   - ☐ Middle East
   - ☐ Africa
   - ☐ Asia
   - ☐ Oceania

3. How many years of experience has the company had in the mining sector?
   - ☐ <5
   - ☐ 5-10
   - ☐ 10-15
   - ☐ 15-20
   - ☐ >20

4. Number of ongoing operations:

5. What percentage of the business is contract mining?

6. Is there a focus on a certain commodity?
   - ☐ No, there is a wide range
   - ☐ Yes, please specify

7. Which mining services do you provide?
   - ☐ Mine planning and engineering
   - ☐ Mine operations – drill and blast
   - ☐ Mine operations – complete mining process
   - ☐ Breakdown and minor repairs
   - ☐ Mine operations – loading
   - ☐ Mine operations – hauling
   - ☐ Preventative maintenance
   - ☐ Major repairs and component overhauls
   - ☐ Others, please specify

8. Is the mining equipment normally provided by the mining or the contracting company?
   - ☐ The mining company
   - ☐ The contracting company
   - ☐ Both
   - ☐ Varies from project to project

9. If the company is taking up the entire mining process, which items/elements usually contribute the most to operating mining costs?
   - ☐ Labour
   - ☐ Spare parts
   - ☐ Consumables, tyres, GET
   - ☐ Fuel
   - ☐ Explosives
   - ☐ Equipment finance and ownership
   - ☐ Overheads
   - ☐ Others, please specify

10. Is there an average expected useful life for mining machinery?
    - ☐ No, varies greatly depending on certain factors, please specify
    - ☐ Yes, please specify (including units)

11. What software does the company utilize for fleet composition and cost analysis?

12. Is there a common maintenance strategy for company-owned equipment?
    - ☐ Yes, conduct all/most maintenance work in-house
    - ☐ Yes, conduct part of the maintenance work in-house
    - ☐ Yes, assign all/most maintenance work to contractors
    - ☐ No, varies from project to project
    - ☐ Yes, other

13. Does the company have internal regulations on staff composition (e.g. number of local vs. international employees)?
    - ☐ No, only in correspondence with the country labour regulations
    - ☐ Yes, please specify

14. Is there a standard tendering procedure that applies to most projects?
    - ☐ Yes – open tender
    - ☐ Yes – pre-qualification
    - ☐ Yes – preferred contractor (e.g. with existing agreement in place, for other projects)
    - ☐ No, varies from project to project
    - ☐ Yes – other, please specify

15. Is there a standard payment method?
    - ☐ No, varies from project to project
    - ☐ Yes, please specify

16. Is it common to have penalties or rewards based on the contractor performance?
    - ☐ Yes – only penalties
    - ☐ Yes – only rewards
    - ☐ Yes – penalties and rewards
    - ☐ No, not common
    - ☐ No, varies from project to project

17. What is the common mining contract duration (years)?
    - ☐ ≤3
    - ☐ 5
    - ☐ 10
    - ☐ Other, please specify

18. Is it common to make changes in the contract (e.g. price or conditions) during the contract period, termination of contract or change of contractors?
    - ☐ Yes – changes to the contract
    - ☐ Yes – termination of contract
    - ☐ Yes – change of contractors
    - ☐ No – it is unusual practice, only in extreme cases

19. Can you identify any trends (common features) in mining companies/projects that employ mining contractors?
    - ☐ Yes – size of the operation
    - ☐ Yes – size of the company
    - ☐ Yes – complexity of the task
    - ☐ Yes – type of commodity
    - ☐ Yes – geographical region
    - ☐ No, no trends
    - ☐ Yes – others, please specify

20. Have the mining companies become more likely to hire mining contractors over the past 10 years?
    - ☐ Yes, they have
    - ☐ No, it remained the same
    - ☐ No, actually less likely
    - ☐ No observation

21. Has the volume of work changed significantly over the past 10 years?
    - ☐ Yes – increased
    - ☐ Yes – decreased
    - ☐ No, remained constant
    - ☐ No observation

22. Has the number of competitors changed over the past 10 years?
    - ☐ Yes – increased
    - ☐ Yes – decreased
    - ☐ No, remained constant
    - ☐ No observation

Comments

Additional comments:

Figure A.2: Questionnaire for contracting companies

B FRAMEWORK SCENARIO EXAMPLES

Section II: Conditional Factors

favouring owner
favouring contracting
depends on other factors

In this section are the factors to be considered in the decision-making process, they do not necessarily determine if a contractor is needed.

This section follows the same principles as the previous section. Please note that some of the questions are dependent on the answer of the question preceding it.

Independent Factors

Previous history with the contractors		
none	positive	negative

Regardless of whether the company has worked with contractors previously, for the future projects both owner mining and contracting should be considered. However, if the company had a negative experience with any particular contractor, a future cooperation is not likely.

Previously the mining company always did	
owner mining	contracting

Regardless of whether the company has previously always conducted owner or contractor mining, for the future projects both options should be considered, especially if the company has only considered owner mining. If managed properly, contractors have the potential to add value to a project.

Contractors bids compared to company estimations	
lower price	higher price

The price listed in the bid should not be the deciding factor. The company should look into the details of the bid, such as the numbers used for the estimations and the equipment selection.

Company Factor

Company's core competencies	
mining [+]	else [-]

				subtotal
What does the company focus on?	mining (+1)	not mining (-1)		
Does the company allocate enough attention and resources to the mining activities?	yes (+1)	no (-1)		2

		total
-2	the company focuses on other areas such as exploration, grade control, processing, etc., it might find benefit in outsourcing the mining	
0	mining could be one of the core competencies in the company, but the contractors can still be considered to maximize efficiency	**2**
2	if the company's core focus is mining with enough attention on details (e.g. efficiency, productivity) owner mining is favourable	

Risk Factors

Company's familiarity with the region of operation	
familiar [+]	unfamiliar [-]

				subtotal
Is the company familiar with the socio-political situation in the region?	yes (+1)	no (-2)		
Is the company familiar with the mining regulations in the region?	yes (+1)	no (-2)		2

Stringency of the mining regulations	
moderate [+]	strict [-]

				subtotal
Are there strict mining regulations in the region? (e.g. labour and HSSEC)	yes (-2)	no (+1)		
If "no", skip. If "yes", can the company navigate them without external assistance?	yes (+1)	no (-2)		1

Economic and political outlook of the industry	
positive [+]	negative [-]

				subtotal
How is the industry's economic outlook in the following 5 years?	positive (+1)	negative (-2)		
How is the socio-political outlook in the region in the following 5 years?	positive (+1)	negative (-2)		2

		total
(-12) - (-3)	the company is facing a number of political/economic risks and should consider contractor mining to alleviate those risks	
(-1) - (0)	the company is facing a couple of political/economic risks and can still consider contractor mining to alleviate those risks	**5**
1 - 5	the company is not facing many risks	

Contractor Availability Factor

Availability and interest of a suitable contractor	
not present [+]	present [-]

				subtotal
Is there a number of reputable contractors with relevant experience?	yes (-1)	no (+1)		
Have they shown interest or enthusiasm to undertake the task? (based on communication and the bids)	yes (-1)	no (+1)		-2

		total
-2	the conditions are met for further considering contractor mining	
0	there is a limited numbers of contractors to select from or the companies have not shown much interest, assess the situation carefully	**-2**
2	there is no reputable contractor who has shown enthusiasm in the project, owner mining should be favoured	

Geological Factors

Fluctuations in the mining rate	
no [+]	yes [-]

				subtotal
Does the optimal production schedule call for fluctuations in the mining rate? (in terms of max. NPV)	yes (-1)	no (+1)		
If "no", skip. If "yes", does the mining company have the personnel and equipment flexibility to accommodate the fluctuations?	yes (+2)	no (-1)		1

Variations in the stripping ratio	
no [+]	yes [-]

				subtotal
Does the stripping ratio vary throughout the orebody?	yes (-1)	no (+1)		
Is there a high stripping ratio?	yes (-1)	no (+1)		
If "no" for both, skip. If "yes" for either question, does the company have the personnel and equipment capacity and/or flexibility to handle the waste removal?	yes (+3)	no (-1)		-1

		total
(-5) - 0	the company does not have enough equipment/personnel flexibility to accommodate the geological fluctuations, contractors might help	
2 - 4	there are no fluctuation in the mining rate and stripping ratio, or the company is able to accommodate the changes without external help	**0**

Investment Analysis Factor

LOM and equipment lifecycle	
> equipment lifecycle [+]	< equipment lifecycle [-]

				subtotal
Is the company acquiring brand new equipment?				
Is the LOM longer than the expected useful lifecycle of the equipment?				
If the company purchases its own fleet, does the equipment investment analysis show positive return?	yes (+1)	no (-1)		

		total
1	purchasing a mining fleet shows positive return, the option is feasible but should still consider if this is the optimal way to allocate capital	
-1	purchasing a mining fleet will result in negative return, the company should consider hiring a contractor to provide the fleet	**1**

Figure B.1: Framework scenario example 1 (description in Section 4.2.2)

Section II: Conditional Factors

favouring owner
favouring contracting
depends on other factors

In this section are the factors to be considered in the decision-making process, they do not necessarily determine if a contractor is needed.

This section follows the same principles as the previous section. Please note that some of the questions are dependent on the answer of the question preceding it.

Independent Factors

Previous history with the contractors		
none	positive	negative

Regardless of whether the company has worked with contractors previously, for the future projects both owner mining and contracting should be considered. However, if the company had a negative experience with any particular contractor, a future cooperation is not likely.

Previously the mining company always did	
owner mining	contracting

Regardless of whether the company has previously always conducted owner or contractor mining, for the future projects both options should be considered, especially if the company has only considered owner mining. If managed properly, contractors have the potential to add value to a project.

Contractors bids compared to company estimations	
lower price	higher price

The price listed in the bid should not be the deciding factor. The company should look into the details of the bid, such as the numbers used for the estimations and the equipment selection.

Company Factor

Company's core competencies	
mining [+]	else [-]

			subtotal
What does the company focus on?	mining (+1)	not mining (-1)	
Does the company allocate enough attention and resources to the mining activities?	yes (+1)	no (-1)	-2

-2	the company focuses on other areas such as exploration, grade control, processing, etc., it might find benefit in outsourcing the mining	**total**
0	mining could be one of the core competencies in the company, but the contractors can still be considered to maximize efficiency	**-2**
2	if the company's core focus is mining with enough attention on details (e.g. efficiency, productivity) owner mining is favourable	

Risk Factors

Company's familiarity with the region of operation	
familiar [+]	unfamiliar [-]

			subtotal
Is the company familiar with the socio-political situation in the region?	yes (+1)	no (-2)	
Is the company familiar with the mining regulations in the region?	yes (+1)	no (-2)	-4

Stringency of the mining regulations	
moderate [+]	strict [-]

			subtotal
Are there strict mining regulations in the region? (e.g. labour and HSSEC)	yes (-2)	no (+1)	
If "no", skip. If "yes", can the company navigate them without external assistance?	yes (+1)	no (-2)	-4

Economic and political outlook of the industry	
positive [+]	negative [-]

			subtotal
How is the industry's economic outlook in the following 5 years?	positive (+1)	negative (-2)	
How is the socio-political outlook in the region in the following 5 years?	positive (+1)	negative (-2)	-4

(-12) - (-3)	the company is facing a number of political/economic risks and should consider contractor mining to alleviate those risks	**total**
(-1) - (0)	the company is facing a couple of political/economic risks and can still consider contractor mining to alleviate those risks	**-12**
1 - 5	the company is not facing many risks	

Contractor Availability Factor

Availability and interest of a suitable contractor	
not present [+]	present [-]

			subtotal
Is there a number of reputable contractors with relevant experience?	yes (-1)	no (+1)	
Have they shown interest or enthusiasm to undertake the task? (based on communication and the bids)	yes (-1)	no (+1)	2

-2	the conditions are met for further considering contractor mining	**total**
0	there is a limited numbers of contractors to select from or the companies have not shown much interest, assess the situation carefully	**2**
2	there is no reputable contractor who has shown enthusiasm in the project, owner mining should be favoured	

Geological Factors

Fluctuations in the mining rate	
no [+]	yes [-]

			subtotal
Does the optimal production schedule call for fluctuations in the mining rate? (in terms of max. NPV)	yes (-1)	no (+1)	
If "no", skip. If "yes", does the mining company have the personnel and equipment flexibility to accommodate the fluctuations?	yes (+2)	no (-1)	-2

Variations in the stripping ratio	
no [+]	yes [-]

			subtotal
Does the stripping ratio vary throughout the orebody?	yes (-1)	no (+1)	
Is there a high stripping ratio?	yes (-1)	no (+1)	
If "no" for both, skip. If "yes" for either question, does the company have the personnel and equipment capacity and/or flexibility to handle the waste removal?	yes (+3)	no (-1)	-3

(-5) - 0	the company does not have enough equipment/personnel flexibility to accommodate the geological fluctuations, contractors might help	**total**
2 - 4	there are no fluctuation in the mining rate and stripping ratio, or the company is able to accommodate the changes without external help	**-5**

Investment Analysis Factor

LOM and equipment lifecycle	
> equipment lifecycle [+]	< equipment lifecycle [-]

			subtotal
Is the company acquiring brand new equipment?			
Is the LOM longer than the expected useful lifecycle of the equipment?			
If the company purchases its own fleet, does the equipment investment analysis show positive return?	yes (+1)	no (-1)	-1

1	purchasing a mining fleet shows positive return, the option is feasible but should still consider if this is the optimal way to allocate capital	**total**
-1	purchasing a mining fleet will result in negative return, the company should consider hiring a contractor to provide the fleet	**-1**

Figure B.2: Framework scenario example 2 (description in Section 4.2.2)

C | SOUTH AFRICA VISIT ITINERARY

Day 1: Moolmans Headquarters in Johannesburg

- Discussion with Moolmans New Business Executive;
- Discussion with Moolmans Senior Contract Manager.

Day 2: Barloworld Equipment Office in Johannesburg

- Discussion with Barloworld Sales Consultant;
- Brief discussion with Barloworld Key Account Manager.

Day 3: Meetings and Discussions with Mining Professionals

- Discussion with Moolmans Technical Manager - New Business Development;
- Discussion with Moolmans Earth-Moving Plant Manager;
- Phone discussion with a mine owner of a new mine;
- Discussion with an independent mining professional.

Day 4: Site Visits in Sishen

- Discussion with Moolmans Regional Technical Analyst;
- Discussion with Moolmans Senior Plant Manager;
- Tour of the Tshipi Borwa Mine;
- Tour of the Sishen Mine;
- Discussion with the Moolmans Contract Manager of the Sishen Mine.

D | LIST OF CONTACTS

There was a total of 50 people contacted, 45 of whom with a request to fill out the questionnaires and potentially hold phone discussions, and 5 for in person interviews. Out of the 45 people 11 have agreed to fill out the questionnaires and/or hold a phone call or an interview. The following is the list of contacts who have responded positively to the request.

Name	Company	Function	Contact Information
André van Wageningen	Agnico Eagle	Engineering Manager	
Daniel Herr	AngloGold Ashanti	Commodity Specialist	dherr@AngloGoldAshanti.com
Gao Fei	China Minmetals Non-Ferrous Metals Co.	Overseas Mining General Manager	fgao@minmetals.com
Greg Edmonds	Nordgold	Mobile Maintenance Director	greg.edmonds@nordgold.com
John Kavanagh	African Mining Services	CEO Africa	jkavanagh@amsgh.com
Jozephus Coenen	Newmont	Mine Manager	jozephus.coenen@Newmont.com
Kenn Smart	Independent Consultant, TurnAround		smart.turnaround@gmail.com
Koppoli Krupanand	VPR Mining Infrastructure	Vice President	krupanand@vprmininginfra.com
Marcel Damen	Independent Consultant		miningdamen@hotmail.com
Matt Petty	Thiess	Autonomous Services General Manager	mpetty@thiess.com.au
Ronan Le Roy	DTP Mining	Director	ro.leroy@bouygues-construction.com
Thierry Vaillant	DTP Mining	Material Director	t.vaillant@bouygues-construction.com

Table D.1: List of contacts who have responded positively to the request to assist with the research

COLOPHON

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