



# Towards a generalizable project readiness assessment methodology for the mining industry: A literature review

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## Dates:

Received: 8 Jun. 2020

Revised: 20 Jul. 2021

Accepted: 8 Jun. 2022

Published: September 2022

## How to cite:

Mulder, H. and Bekker, M.C. 2022  
Towards a generalizable project  
readiness assessment  
methodology for the mining  
industry: A literature review.  
Journal of the Southern African  
Institute of Mining and Metallurgy,  
vol. 122, no. 9, pp. 497-504

## DOI ID:

<http://dx.doi.org/10.17159/2411-9717/1244/2022>

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## Synopsis

The principal objective of this investigation was to conduct a thorough literature review on the status of project readiness mechanisms, tools, techniques, and frameworks for mining projects. The review aimed at identifying common readiness evaluation criteria as well as potential shortcomings that prevent the establishment of a generalizable project readiness index.

The literature review included a general overview of capital project performances and the importance of project readiness assessments to improve project delivery success. The study then progressed towards literature involving mining projects and how this differs from infrastructure and industrial project assessments.

The paper concludes by summarizing the current state of mining project readiness assessments, the unique and differentiating factors to be considered, and suggests recommendations towards the development of generalizable readiness assessment criteria for mining projects.

## Keywords

Project readiness, mining projects, front-end planning, project evaluation, project assessment.

## Introduction

The quest to establish a fail-proof project readiness assessment tool, mechanism, or guideline remains elusive to the broader mining community. In recent times various industry bodies, consultants, and project owners have attempted to develop assessment tools to improve the level of readiness and certainty of project status prior to committing major capital amounts to the project (Williams and Samset, 2010, p. 40; Samanta, 2017, p. 110; Flyvbjerg, Garbuio and Lovallo, 2009, p. 173; Walker, Davis and Stevenson, 2017, p. 187). These efforts saw the establishment of various models addressing specific project types in their relevant industries (Bingham, 2010; Cho, Furman, and Gibson, 1999; Collins, 2015; Gibson and Dumont, 1996) as well as organizations developing their own in-house project assessment criteria and tools (de Wet, 2007, p. 23).

In the mining industry various companies developed and internalized project methodologies and decision systems with positive validated results. However, the problem is that no generalizable assessment criteria or index exist that provide a sufficient level of confidence on whether a capital project in the mining industry is ready to progress into implementation or not.

In order to determine what should be included in a project readiness assessment index, this paper firstly reviews the literature on readiness assessments for large capital projects. Then literature on the status of mining project assessments is reviewed. Thirdly, the unique parameters related to mining projects that could determine project readiness are listed. In conclusion further research is discussed and proposed towards the formulation of a generalizable project readiness assessment model.

## Project readiness assessments

According to Collins, Parrish, and Gibson (2015, p. 1), the front-end planning phase of a project has potentially the most significant impact on reducing risk and ensuring project success. Efforts undertaken during this phase of a project yield potentially the highest returns in ensuring success during the later stages of a project (Gibson, Kaczmarowski and Lore, 1993, p. 2). Williams and Samset (2010, p. 41) found that project success is traditionally measured by success in meeting time, cost, and quality requirements, and that projects with adequate front-end loading have an 80% success rate, as opposed to those with

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insufficient planning, which have success rates of only 20%. The quality of the front-end planning work has been shown to have a more significant impact on the success of a project than any other factor (Williams and Samset, 2010, p. 42).

Williams and Samset, (2010, p. 40) state that it is not easy to measure the level of maturity, accuracy, or completeness of a project study. Decisions regarding project approval are often based on biased, inadequate, and non-neutral analysis of the project due to political priorities, alliances, and pressure from individuals or groups of stakeholders. There is a real possibility that different parties may interpret information differently in the absence of a standard appraisal tool (Williams and Samset, 2010, p. 39).

According to de Wet (2007, p. 13), it is important for an organization to determine whether a project complies with the minimum requirements for it to be approved, prior to proceeding to the next phase. Typically, this is done *via* an audit, a health check, or a review session. The goal with review sessions is to determine if the project is indeed ready to proceed to the next phase or if additional work is required prior to proceeding, or even cancellation. The main difference between a project review and a project audit is that a project review (also called a project readiness assessment (RA)) is conducted at the end of a specific phase of a project, while a project audit can be done at any time during a project's life-cycle (Project Management Learning, 2010).

A project review is a governance tool that assists with decision-making. One of the advantages of conducting project reviews is that it helps in creating an optimal relationship between sponsors and project managers (Englund and Bucero, 2006, p. 37). The four main objectives of a project review, as mentioned by Englund and Bucero (2006, p. 38), are:

- ▶ Establishing if a project can proceed to the next phase (go / no-go decision)
- ▶ Determining if all (or enough) of the required activities were carried out during the current phase
- ▶ Establishing if the client (end-user) and project delivery organization (project manager) have agreed and signed off on the methodology and deliverables
- ▶ Identifying deviations and gaps which can be rectified during the next phase or before approval to proceed.

Some of the benefits of conducting reviews, according to Duffy and Thomas (1989, p. 102), include:

- ▶ Being proactive instead of reactive with regard to identifying potential problems
- ▶ Establishing an independent evaluation of the project team's performance
- ▶ Establishing the level to which the end-user's requirements are understood and realistic
- ▶ Ensuring that project controls (such as schedule and cost) are in place and adequate.

Some of the shortcomings of conducting a project review as noted by Conroy and Soltan (1998, p. 188) include:

- ▶ Project teams can develop the data specifically for the review, instead of as a management tool
- ▶ Because reviews are done at specific stages of a project, there may not be enough time to repair damage caused by oversights in the remaining project duration
- ▶ Project teams may not cooperate, as reviews may be viewed as 'fault-finding' rather than an assistance
- ▶ The availability of competent reviewers could hamper proper auditing.

Conducting project reviews at the end of each stage of a project's life-cycle can add value, as it enables decision-makers to make informed decisions. It can also assist the project team to identify gaps, which can be addressed during the next phase of the project. However, for project reviews to be effective, project teams must see the benefit, and the person(s) reviewing the project must be competent to do so.

### *Examples of readiness assessments*

Various industries and organizations have adopted different tools to evaluate projects before approval to proceed into detail design and implementation. Berechman and Paaswell (2005, p. 224) observed that some of these tools are aimed at determining which projects should proceed, given a capital-constrained environment, among a competing pool of projects for limited capital. These tools typically focus on attempting to decide which projects will deliver the best value for money. As such, the focus is more on portfolio management than on trying to evaluate a specific project to determine its state of readiness to proceed to implementation. Some tools are aimed at assisting a portfolio manager in evaluating a portfolio of projects which are in implementation, as well as deciding which new projects should be approved or delayed (Gifford and Wildon, 1995, p. 69).

There are tools which attempt to identify the characteristics of specific types of project (such as power plants) which correlate with schedule and cost performance using the Fischer exact test (Brookes and Locatelli, 2015, p. 59). By using this type of analysis, it is possible to identify the various factors that contribute to the failure or success of projects in a specific industry. This tool does not, however, assess the state of scope definition of a project at a specific point in time, which is the aim of this research.

The South African Mineral Reporting Codes (SAMCODES) are guidelines that set the standards for Public Reporting of mineral-related issues in South Africa (SAIMM, 2021). Currently these consist of three Codes, two Guidelines, and a National Standard. While the SAMCODES do touch on a number of the issues that should be addressed during a mining project study, these are not comprehensive as the Codes focus mainly on the reporting of Exploration Results, Mineral Reserves, Asset Valuation, and certain of the elements that should be addressed during a project study, such as environmental and social parameters. The SAMCODES do not address many of the elements that should be considered during a project study phase, such as the level of maturity of a design prior to project execution and many other critical considerations.

### *The benefits of project readiness assessments*

The purpose of a feasibility study is to demonstrate the technical and economic viability of a project to an investor (Persampieri, 2014, p. 1). Williams and Samset (2010, p. 42) found that the quality of the study and appraisal of a project, had significantly more impact on the eventual outcome, than any of the other factors considered, which included the macroeconomic environment, external factors, or government considerations.

Muldowney (2015, p. 1) advocated educating decision-makers to understand that project approval at all costs does not translate to success, and that it is much more important to base project decisions on mature information and 'the truth'. Winch and Leiringer (2016p. 273) maintained that the ability to select the most beneficial project is foremost among the strategic capabilities that a project organization must have and that a

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proper set of assurance tools is critical to enable this. Winch and Leiringer (2016, p. 276) advocated having 'three lines of defence' to keep the project owners involved in the project, namely:

- Having effective project controls in the project team
- Internal assurance, independent of the project team
- Internal audits.

Flyvbjerg, Garbuio, and Lovallo (2009, p. 179) introduced some reasons why decision-makers could potentially make the wrong decision regarding project approval. Among these reasons, asymmetric information is mentioned as a source of 'strategic deception'. The possibility exists that parties with a vested interest in approving the project could deceive the decision-makers. The project champions could potentially do this because they have information that the decision-makers do not possess. Flyvbjerg, Garbuio, and Lovallo (2009, p. 180) also mention different risk preferences as a reason why decisions regarding project approvals could be sub-optimal. If decision-makers are perceived as risk-averse, the parties involved in the project study may be tempted to downplay or understate the risks and uncertainties in order to assure project approval. Williams and Samset (2010, p. 47) added that humans are not always rational decision-makers, but are prone to making the wrong decisions, especially if faced with incomplete information. Williams and Samset (2010) also mentioned that project sponsors often fail to consider the outcome of a project study objectively, due to them looking at the project from an 'evolutionary perspective'. If a tool is not in place to evaluate the project study outcome on a rational basis, humans are prone to succumbing to this bias.

Williams and Samset (2010, p. 37) noted three types of biases that hamper rational project decisions, and which necessitate an objective evaluation of a project study. These are:

- Technical bias (honest mistakes and inadequate forecasting techniques)
- Psychological bias (optimism bias)
- Political-economic bias (deliberately taking an over-optimistic view of the project, in order to ensure project approval).

Williams and Samset (2010, p. 39) mention that if they are not based on unbiased, adequate, and neutral analysis, project decisions may be affected by political priorities, alliances, and pressure from individuals or groups of stakeholders. It is also possible that different parties may interpret information differently, in the absence of a standard appraisal tool (Williams and Samset, 2010, p. 40).

Van Marrewijk *et al.* (2008, p. 598) held that the organizational design of a project, as well as the form of contract and execution approach, can have a significant influence on the outcome of a project, and needs to be considered when setting up the project. Landoni and Corti (2011, p. 58) compared the project cycles used by various aid agencies, such as the Australian Agency for International Development (AusAID), Canadian International Development Agency (CIDA), the European Commission (EC), the Japan International Cooperation Agency (JICA), and the United States Agency for International Development (USAID). All the agencies were found (*ibid.*, p. 59) to have some form of appraisal of the project before approval. The AusAID project cycle focuses on the detailed design which must be undertaken before approval, while the CIDA project cycle focuses on the feasibility of the project to ensure that it is viable and sustainable. The EU model considers the relevance and feasibility, as well as the

project design and financing before approval. The JICA model evaluates the participants, problems and potentials, and the project design before approval. The USAID model has separate approvals for the strategic plan (which includes the objectives and performance measure) and the activity planning (which defines the outputs and means to achieve it). Both are evaluated before approval.

### Existing project readiness assessment tools for project studies

Most mining companies use either the Independent Project Analysis (IPA) or Construction Industry Institute (CII) front-end planning models (and thus also the readiness assessment tools of these two institutions) to evaluate the readiness of a mining project to proceed to execution (Motta *et al.*, 2014, p. 402). No non-proprietary tools exist in the mining industry to evaluate scope definition before execution (Gibson and Dumont, 1996, p. 14). Bastianelli and Yeager (2012, p. 2) stated that third-party consultants have devised several methods to evaluate and assess the maturity and readiness of the front-end loading phase of a project to proceed to detail design and implementation. There are many advantages to using external facilitators during project development and evaluation. These include consultants knowing industry best practice and having project experience. Consultants are unbiased as regards internal politics and can be used for periodic follow-up assessments *via* audits and checks. The use of external consultants is especially advised when owner organizations do not have adequate internal resources. While these firms offering external project evaluation and assurance services use various methods to collect data and to interpret and evaluate the state of a project at a given time, the methodology and tools used during the assessment are not shared freely with the client, as this would impact on the consulting firm's ability to sell its services in future. The IPA does offer a range of educational programmes in the field of capital project implementation and evaluation, but clients need to hire the services of the IPA to gain access to some of their material (Motta *et al.*, 2014, p. 407). While this may assist in ensuring that industry best practices are utilized and that findings are impartial, the knowledge is not embedded within the project organization, and the knowledge regarding the tools and techniques utilized is not transferred to the end-user.

The Advanced Planning Risk Analysis (APRA) tool which was developed by the Texas Department of Transport was mentioned by Bingham (2010, p. 35) as being a risk management tool that focuses on improving a project's scope clarity and comprehensiveness. It was developed specifically to be easy to use, and to measure the degree of scope development early in a project, as well as to identify potential risks. The APRA tool was developed explicitly for transport projects and as such focuses on the significant transport disciplines.

John Hackney published a Definition Rating Checklist in 1965 (Gibson and Dumont, 1996, p. 15). It attempted to quantify the degree of scope definition in industrial projects at a given stage. A revised Definition Rating Checklist was published by Hackney in 1990 to account for changes in political, economic, and engineering conditions (Gibson and Dumont, 1996, p. 16).

Gateway reviews are another type of independent peer-review that could potentially be used to evaluate a project (Kells, 2011, p. 63). Typically, these reviews are conducted at individual 'gates' or stages of a project. A checklist is used to determine if

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a pre-determined set of criteria has been achieved. Kells (2011, p. 64) noted that these are based on best practice, such as the internationally accepted Project Management Body of Knowledge (PMBOK). The outcome of such an evaluation is typically a report with findings on the various knowledge areas as defined by the PMBOK, as well as recommendations for further actions to rectify identified shortcomings. The report is accompanied by green, amber, or red 'traffic light' ratings of many areas. The shortcoming of this type of evaluations is that it is subjective and project teams cannot use it for self-assessment, as it relies on the view of the independent auditor. Most of the available tools focus more on the organizational and management issues and less on the technical issues for project evaluation (de Wet, 2007, p. 23). Table I indicates some of the current project readiness assessment tools, along with their shortcomings.

## The mining industry

The mining industry plays an essential role in the global economy. It contributes approximately 11.5% to the global GDP (Creamer, 2012, p. 3). When the mining service industry (which include construction, fuel and fertilizer production) is included, the total

contribution to the global GDP is 45% (Creamer, 2012, p. 3). The contribution of mining in low- and middle-income countries towards foreign direct investment, exports, government revenue, gross domestic product, and employment is depicted in Table II.

## Mining life cycles

A typical mine life cycle, along with the activities in each stage, is illustrated in Figure 1.

Typically, all of the activities in Figure 1, except for commercial production, form part of a mine project life cycle.

Table II

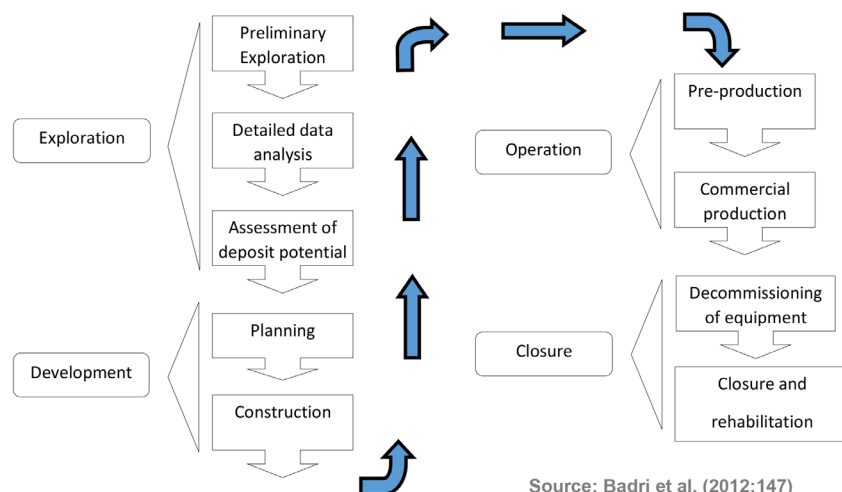
### Contribution of mining in low- to middle-income countries

Foreign direct investment	60-90%
Exports	30-60%
Government revenue	3-25%
National income	3-10%
Employment	1-2%

Source: ICMM (2018:33)

Table I		
Various tools currently used to assess project readiness		
Generic tools		
Name	Reference	Shortcomings
Advanced Planning Risk Analysis (APRA)	Bingham, 2010, p. 47	Focuses on transport projects
Definition Rating Checklist	Gibson and Dumont, 1996, p. 29	Caters for industrial projects only
Revised Definition Rating Checklist	Gibson and Dumont, 1996, p. 29	Caters for industrial projects only
Project Health Check Model	Buttrick, 2000, p. 87	Focuses on high-level issues, not detailed enough for mining projects
Project Implementation Profile	Pinto, 1990: 175	Focuses on high-level issues, not detailed enough for mining projects
Englund and Bucero model	Englund and Bucero, 2006, p. 148	Focuses on high-level issues, not detailed enough for mining projects
Bolles model	Bolles, 2002, p. 5	Focuses on high-level issues, not detailed enough for mining projects
WS Atkins Performance Auditing Methodology	Duffy and Thomas, 1989, p. 103	Focuses on high-level issues, not detailed enough for mining projects
Stage gate process	Cooper <i>et al.</i> , 2002, p. 44	Focuses on high-level issues, not detailed enough for mining projects
Balanced scorecard methodology	Germain, 2000, p. 46	Focuses on high-level issues, not detailed enough for mining projects
Gateway reviews	Kells, 2011, p. 62	Focuses on high-level issues, not detailed enough for mining projects
(ConSERV)	Conroy and Soltan, 1998, p. 187	Time-consuming and mostly focussed on risks
Organizational-based information architecture (OBIA)	Messner and Sanvido, 2001, p. 395	Does not provide a rating score to compare projects easily
Single Period Project Selection (SPPS)	Eben-Chaime, 2000, p. 56	Needs expert inputs in order to interpret results
Fuzzy stochastic dominance model (SFD)	Wong <i>et al.</i> , 1999, p. 409	Needs expert inputs in order to interpret results
Tools used in other industries		
Name	Reference	Shortcomings
Construction Industry Institute (CII) PDRI tools	Gibson and Dumont, 1996, p. 17	Does not address all mining elements
Fischer exact test	Brookes and Locatelli, 2015, p. 58	Does not assess scope definition at a specific point in time
3rd party proprietary tools		
Name	Reference	Shortcomings
Independent Project Analysis (IPA)	Gibson and Dumont, 1996, p. 17	Not freely available
KPMG	Motta <i>et al.</i> , 2014	Not freely available
BDR	Motta <i>et al.</i> , 2014	Not freely available
PWC	Motta <i>et al.</i> , 2014	Not freely available

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Source: Badri et al. (2012:147)

Figure 1—Life cycle of a mine (Badri, Nadeau, and Gbodossou, 2012, p. 147)

During commercial production, there will be stay-in-business (SIB) projects, but these are normally smaller maintenance projects and are not considered as part of the larger project to establish and close a mining operation.

## Mining projects

Accenture (2012) noted that capital expenditure in the mining and minerals industry is predicted to reach between US\$1 trillion and US\$ 1.5 trillion in the period between 2011 and 2025. Despite the significant role that mining plays in the global economy and the large amounts of capital which are spent in the industry, the success rate of mining projects is not very good. Only 2.5% of large capital mining projects are considered as successful when evaluated on scope, schedule, cost, and business benefits (Motta *et al.*, 2014, p. 402). Between 1965 and 2014, mining project cost overruns averaged between 20% and 60% (Mining Markets Magazine, 2014). Smith *et al.*, (2007, p. 67) stated that capital investment is the life-blood of minerals companies. Because orebodies become depleted, it is necessary to continuously reinvest so that production does not decline. Since there is competition for capital, it is important to carefully evaluate each project, to ensure that only the correct projects, which will add the most benefit to the business and that have the highest likelihood of success during implementation, are approved for execution. According to Kuhn and Visser (2014, p. 106), decision-makers in mining projects are faced with a daunting task when deciding on project approval. By applying appropriate risk-management techniques (of which a generalized mining project readiness assessment tool could be one), decision-makers can potentially ask the right questions and are in a better position to get the right answers. This could enable them to make appropriate project decisions

## Development of mining projects

In the mining industry, the developmental stage or study of a project is often referred to as the front-end planning phase, the front-end loading phase, or the feasibility study. According to Rudenno (2012, p. 36) a well conducted front-end planning phase provides the best estimate of an uncertain future. Feasibility studies, financial analysis, and project financing, are required to bring together all the data generated during a mining project study

(Kennedy, 1990, p. 393). The front-end phase of a project was noted by Botin (2009, p. 208) as being a 'step-wise risk reduction process' where increasing amounts of money are invested in minimizing risk and financial uncertainty. In mining projects, the study phase is typically divided into several stage-gate phases, each culminating in an approval to proceed to the next phase of the study. This approach is illustrated in Figure 2.

An example of a stage-gate approach is that of the Anglo American project model, which divides the study phase into resource planning, concept, pre-feasibility, and feasibility stages (Anglo American, 2009, p. 14). As the study progresses through the various stage-gates, the level of certainty of elements regarding cost, schedule, and engineering should increase. Wittig (2013, p. 392) found that the ability to influence the value of the project is at a peak during the concept and first half of the pre-feasibility phases of a project. Figure 3 illustrates how risk is reduced as the project study progresses, while the cost of changes grows.

Specialists review the project during each phase to evaluate its readiness to proceed to the next phase (Cooper, Scott, and Kleinschmidt, 2002, p. 45). Ireland (2008, p. 41) mentioned that the stage-gate approach in mining projects gives structure to a mining project study and assists in minimizing risks. The main activities during each phase of a mining project are illustrated in Figure 4.

Differences between assumptions made during the project study and the actual performance of completed projects are often the basis for disputes in mining projects (Persampieri, 2004, p. 4). It is therefore essential that a mechanism is developed by mining houses which ensures that all the participants in a project are aware of uncertainties at the time of project approval. Implementing the wrong project can destroy value, as can executing the right project poorly.

## Mining project readiness parameters

Mining projects are synonymous with long study and implementation phases, geological unpredictability, and rapidly changing commodity prices (Kuhn and Visser, 2014, p. 106). The mining industry is becoming more capital-intensive due to high development costs and the high degree of mechanization that is required to deliver competitive products through economies of scale. Mining projects differ from other industries, in that mining involves:

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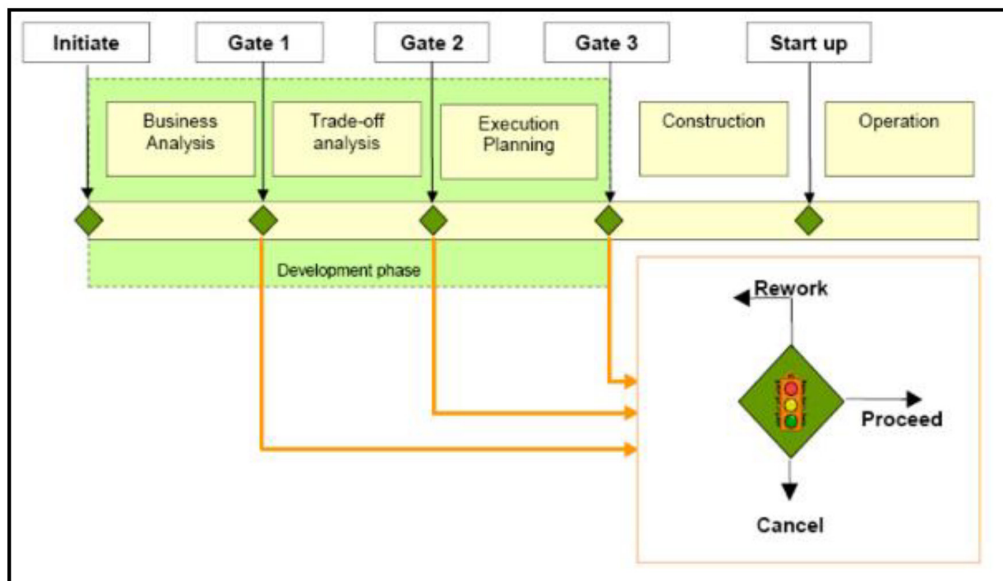


Figure 2—Capital project life cycle with stage gate reviews (Vasconcelos and Moraes 2010, p. 2)

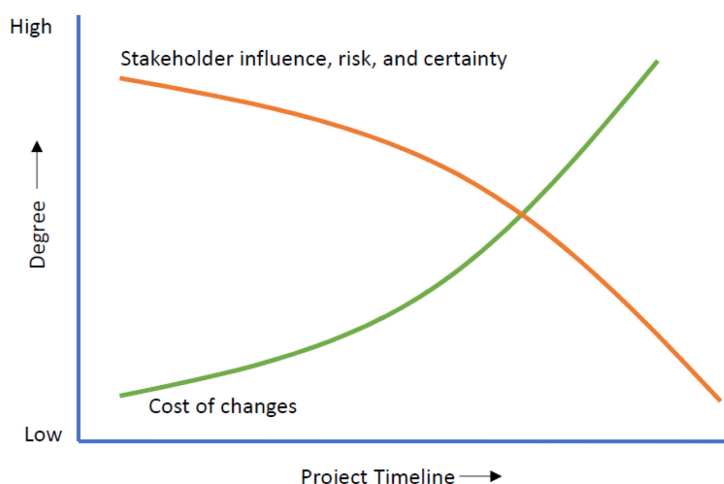


Figure 3—The cost influence curve (Schoonwinkel, Fourie, and Conradie, 2016, p. 22)

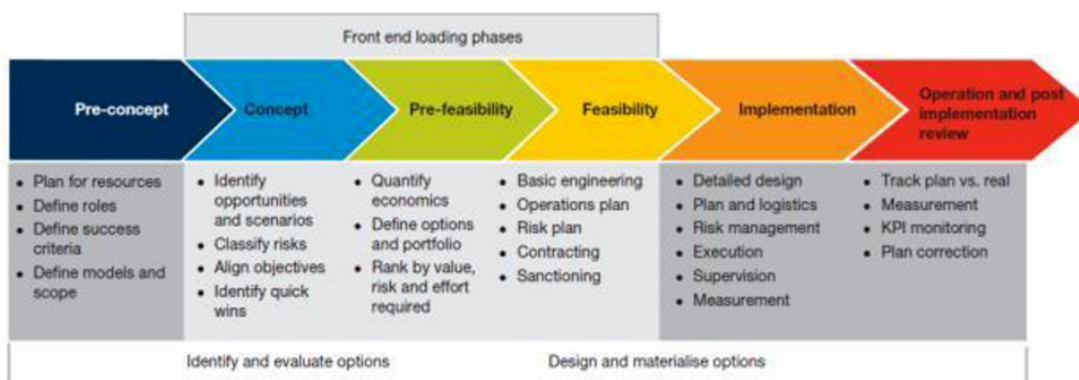


Figure 4—Mining project life cycle (Steffen, Couchman, and Gillespie, 2008, p. 6)

- Exploration - because resources need to be explored before a project can proceed, high upfront costs and risk are associated with mining projects
- Finite reserves - resources must be classified as Proven and Measured in order to determine if a project is feasible

- Commodity price volatility - because mining companies are 'price takers' and not 'price makers' and are therefore subject to the forces of supply and demand, the prices of commodities are beyond their control
- Environment - due to the need to minimize environmental

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impact and strict legislation, mining projects incur additional costs

- Land rights - the needs and expectations of indigenous people need to be considered. While industrial projects are also affected by this issue, mining projects are unique in that they must explore the area before deciding to proceed. Also, different countries have different legislation regarding land- and mineral-right ownership, which impacts on the ability to explore, develop and operate a mine.

According to Botin (2009, p. 210), a mining project must take into account health, safety, and social risks. Risks such as dust, noise, impact on water and land resources, immigration due to the project and operations, resettlement of communities, and risks to artisanal miners also need to be addressed (Botin, 2009, p. 210). These factors, along with numerous others that must be considered during a mining project study, contribute to the long study timelines, and need for RAs before proceeding to the next phase of a mining project

## Conceptual mining project readiness index

An initial list of elements that should be considered during a mining project study, was compiled using a literature review and by evaluating the existing PDRIs. Apart from providing a list of elements applicable to mining project studies, the list also divides the elements into categories and sections. This initial division was based on the previous PDRIs. Together, the sections, categories and elements equate to a draft readiness assessment tool (RAT) for mining projects. The conceptual model for this study is thus a graphical depiction of the way the sections and categories result in the draft unweighted RAT. The model is depicted in Figure 5.

The draft RAT for mining projects consists of three sections, namely Basis of decision, Basis of design, and Execution approach. The Basis of decision section consists of eight categories, the Basis of design section consists of three categories, and the Execution approach section four categories.

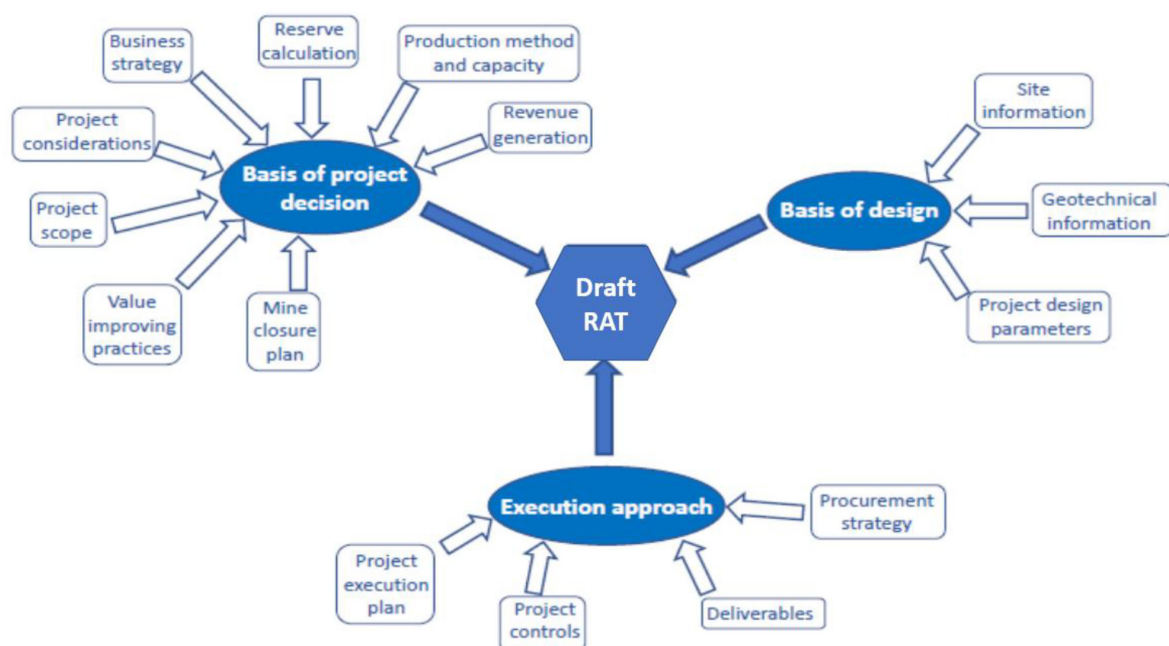


Figure 5—Conceptual mining project readiness index

## Conclusions

The mining industry is an important contributor to global GDP and spends large amounts of capital in order to study and execute mining projects. Despite the significant investment in projects, the track record of mining projects is not very good. Only 2.5% of large mining projects are considered as successful. The front-end loading phases of a project can significantly improve the likelihood of overall project success, if performed well. In order to determine the quality of front-end loading, a generally accepted readiness assessment tool for mining projects is required. Such a tool will enable decision-makers to determine if adequate levels of maturity have been reached in a mining project study before it is allowed to proceed to the next phase.

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